Investigating younger pupils' beliefs in Cyprus on the value of classroom talk for their mathematical learning related to the use of the Interactive Whiteboard: understanding dialogic teaching

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INVESTIGATING YOUNGER PUPILS' BELIEFS IN CYPRUS ON THE VALUE OF CLASSROOM TALK FOR THEIR MATHEMATICAL LEARNING RELATED TO THE USE OF THE INTERACTIVE WHITEBOARD: UNDERSTANDING DIALOGIC TEACHING

by

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ABSTRACT

Improving the quality of classroom talk has been set as a target globally during the last four decades, considered as an indicator of improved teaching and learning; yet research globally indicates that this target *still* remains unresolved. The broad installation of Interactive Whiteboards (IWBs) in the UK was envisaged to support more interactive teaching and raise attainment. However, the initial waves of enthusiasm are now replaced by the realisation that synchronizing technological features to pedagogically informed methods which open up space for dialogic interactions is yet to be confirmed. This study investigates the impact of IWBs on standardised forms of assessment, on the quality of interactions during lessons and get an insight into pupils' views of their own learning during IWB lessons. A mixed method methodology was applied, which employed a systematic review and a pupils' questionnaire using targeted groups. Results of the systematic review indicate that there is no evidence indicating that the use of IWBs influence interaction and outcomes consistently and higher levels of interactivity are related to factors other than the installation of IWBs. Pupils' responses from the questionnaire reinforce these results while, rather surprisingly, show that pupils consider techniques that are mainly attached to typical methods of teaching as learning 'strengtheners'. This might be due to their experiences and expectations being narrowed in such teaching structures. All in all, investigating more rigorously the relation between the type of teaching and content of summative assessment might explain the durability of traditional teaching patterns.

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List of Abbreviations

BECTA: British Educational Communications and Technology Agency (agency of DfE)

CEM: Centre for Evaluation and Monitoring (at Durham University)

DfE: Department for Education

ELL(s): English Language Learner(s)

EPPI Centre: Evidence for Policy and Practice Information and Coordinating Centre

ESRC: Economic and Social Research Council

ICT: Information and Communication Technologies

IDZ: Intermental Development Zone

IWB(s): Interactive Whiteboard(s)

KS1: Key Stage 1

KS2: Key Stage 2

MS: Mean Score

PIPS: Performance Indicators in Primary Schools

PISA: Programme for the International Student Assessment

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

TIMSS: Trends in International Mathematics and Science Study

US: United States

ZPD: Zone of Proximal Development

Declaration

I have read and understood the University Regulations on cheating and plagiarism and state that, the work covered by this declaration is my own, does not contain any unacknowledged work from other sources, and has not been submitted by the author in any university.

Statement of Copyright

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Dedication

To my mother, for supporting all of my dreams no matter what.

1. INTRODUCTION

During my Masters in England, I was fascinated by the use and introduction of the IWBs in primary education. This led me in conducting a small scale study for my dissertation to investigate the level of use and interaction during IWB lessons in some primary classrooms. After graduation I have been working as a primary school teacher in my home country (Cyprus). My teaching experience boosted my interest to investigate more rigorously the use of IWB in terms of enhancing interaction during lessons.

Besides, pupils will eventually enter a globalized society of professionalism where developing skills such as collaboration and critical thinking becomes a necessity that needs not overcome but thrive. Teachers are at the core of this process since educational policies and curriculums are delivered at a classroom level. At the same time this becomes even more complex since teaching needs to be synchronized to the constant technological expansion of our era. Six years ago, at the beginning of my PhD, IWBs had a strong merit in the educational research field whereas today personal tablets and multi-touch computer tables have been integrated into the scheme.

In light of these, this thesis aimed at investigating the use of IWB in terms of classroom interaction and standardised testing, as well as pupils' beliefs about the value of the IWB technology on their own learning.

2. LITERATURE REVIEW

This chapter constitutes the basis upon this study was developed and is divided into four sections. In the first section, the reader is provided with an extensive analysis of the adopted theoretical stance. The second section begins by presenting a general view on effective teaching in terms of the teacher’s role. An interpretation of quality instruction is presented, throughout the third section, from a process-product perspective. In the last section, a literature review on IWBs is extensively presented.

In the first section, the reader is provided with an extensive analysis of the adopted theoretical stance. Since the study was related to mathematics, an interpretation of mathematical understanding is presented at the beginning. Then, the adopted view on learning is more generally explained. The author’s stance is further elaborated by comparing Piaget’s and Vygotsky’s views on learning. Afterwards, the link between talking and thinking is presented through the use of a metaphor. Interpretations of metacognition and self-regulation are presented right after, since they are embedded in talking and thinking processes. At the end, it is claimed that dialogic teaching is aligned to the theoretical perspective of the author.

The second section begins by presenting a general view on effective teaching in terms of the teacher’s role. Having outlined the scope of the term, teaching effectiveness is then analysed in more detail, through an expertise model by focusing on teacher’s decisions across three mutually interacting levels: curriculum, organisational and instructional. The main focus is on instructional strategy which is the one that has the potential to vary the most from teacher to teacher. Finally, the relationship between formative and summative assessment to the instructional strategy is also outlined.

An interpretation of quality instruction is presented, throughout the third section, from a process-product perspective. Dialogic teaching mirrors the notion of quality instruction and is adopted as the most applicable teaching method. The principles of dialogic teaching, as well as connections to the theoretical basis of the study are discussed. Dialogical schemes, discussion and dialogue, are pivotal to the process of dialogic teaching and are interpreted in greater depth right after. Towards that end, the interpretations given by other authors for the terms discussion and dialogues are compared to the interpretations adopted by the author, as presented in the first chapter. This process offers the reader a clearer view on the adopted notion of discussion and dialogue. Yet, observing dialogical schemes within classrooms remains an everlasting target of education, argument extensively presented afterwards. The chapter ends with an extensive focus on quality instruction from a process perspective, though this constitutes a difficult task. Many suggestions are presented by grouping evidence and arguments from existing literature.

Finally, a literature review on IWBs is extensively presented in the fourth section. A brief history on the IWB installation in UK is provided to the reader at the beginning. IWB's interactivity is then explored at technological and pedagogical levels. An analysis of technological features of the technology is then presented, followed by a section citing studies that investigate the impact of IWB on *actual* interactivity within classroom. In a brief section afterwards, some arguments are made to stress the importance of pedagogically oriented interactivity of the IWB. At the end, there are some suggestions from existing literature suggested to enhance IWB's *actual* interactivity.

2.1 THEORETICAL SYNOPSIS

Mathematical Understanding

In order to teach you have to decide in advance what kind of learning you want to produce. Consequently, clarifying understanding constitutes another crucial parameter of learning. In this study, Pirie and Schwarzenberger's view (1988) is adopted who consider understanding to "encompass the comprehension of concepts, the relationships between these concepts and ordinary language or physical objects" (p.461). Especially in mathematics (maths hereafter), relations between concepts constitute the corner stone of mathematical understanding. Even from the very early stages of education, pupils' understanding begins by capturing the relation between numbers when putting them in order and by realising the relation between addition and subtraction. Mathematical understanding should therefore be mainly relational understanding (Skemp, 1976).

In parallel, understanding the relations between mathematical concepts is about relating the meaning of each concept. The meaning of a concept might arise by understanding the relation of that concept in regard with another concept or might arise only by focusing on the very same concept, relating instances of the concept to each other. Whatsoever, understanding the relation between them constitutes mathematical understanding. For example, it is fundamental during early schooling to realise the connection of addition and subtraction, as well as multiplication and division.

Moreover, interactions within a classroom should aim at reaching common understanding and offering chances of grasping meanings. "Mathematical meanings are only taken as shared when they are produced through negotiation" (Voigt, 1995, p.172). Pupils should not reach a level of understanding in a form of "copy" and "paste" from one another.

By reaching a common understanding, it is not implied that all pupils have the same subjective knowledge; participants' subjective background understandings are not identical with those of other participants (ibid). Pupils construct slightly different versions of the meanings that arise during the interchanges shared by the whole class and the teacher (Barnes, 2008), based on their subjective experiences and their background knowledge. For example, a teacher poses the following question/ mathematical problem: "How many pens that cost £3 can you buy with £27?". Pupils, one way or the other, reach and understand "why" the answer is "9". For one, the answer lies in the equation "3 X 9 = 27", for another is related to the equation "24÷3=8", while some others might calculate "3, 6, 9, 12… 27". "Together the participants contribute to a single over-all definition of the situation which involves…a real agreement as to whose claims concerning what issues will be temporarily honored" (Goffman, 1959, p.9f). One characteristic of mathematics is that people collaborate effectively although they actually ascribe different meanings to the objects (Voigt, 1995). It is argued that common understanding is a state where all pupils reach a higher level of their own understanding, pioneered through the discourse that takes place; the crucial role of discourse becomes evident in the remaining part of this chapter. Literally, they understand an exercise but their argumentation towards the solution might have many different nuances.

In line with this, Smith (2010) suggests that mathematical understanding is actually the process of the abstraction of mathematical ideas, which mirrors our proposed notion of common understanding above.

> Even in their earliest encounters with numbers…children are reasoning with abstract ideas. The number five may be attached to many concrete examples – the number of brothers that Sally has, the number of DVDs beneath the television. However, the idea that all of these sets are connected by the number five…is an abstract idea and it is unsurprising that most children need many varied experiences to connect their concrete and abstract understandings. (p. 96)

He also suggests that the abstract nature of mathematics should galvanize increasing opportunities for pupils to talk about their understandings.

Indeed, Carpenter et al. (2003) concluded that pupils who explain their own mathematical ideas after applying their own as well as others' reasoning develop their own mathematical understanding. Also, when children verbalise their mathematical thinking give teacher the chance to assess their level of understanding (Vacc, 1994; Bils and Grey, 2001). "The importance of language…is that it makes knowledge and thought processes readily available to introspection and revision" (Barnes, 1976, p.19). These arguments underline the importance of talk during mathematics. The ability to talk purposefully about mathematics is not synonymous with mathematical understanding however, it is an important prima facie evidence (Pirie and Schwarzenberger, 1988).

This argument is embedded in the theoretical stance of the author and is extensively presented hereafter by analysing *how* pupils learn.

Constructivism as an Approach to Learning

Educational theories offer teachers and administrators opportunities to improve educational outcomes by interpreting how pupils learn. In other words, an educational theory constitutes a magnifying glass, which offers a view and interpretation of learning. Different positions and angles result in looking at the same thing in diverse ways thus one need to be cautious when deciding about which position to hold. Based on the theory of learning one adopts, he or she then can make judgments about the effectiveness of teaching methods and techniques. Educators should have in mind what kind of learning they want to produce in order to decide what kind of teaching might produce such learning (Lampert, 1988).

Thus, is crucial for each study related to teaching, to present a strong theoretical basis that underpins the study. This is especially the case for a study dealing with aspects of effectiveness within classrooms, like the one presented here.

In this study, the theoretical basis of the writer could be characterised as *Constructivism through a Vygotskian perspective.* Constructivism is a psychological theory of learning which describes knowledge and how one "comes to know", literally how people learn (Fosnot, 2005; Lambert et al., 1995). Fosnot makes it clear that, constructivism does not provide descriptions of teaching but through a constructivist approach to teaching one can think about and form his or her educational practices. Constructivism constitutes the magnifying glass for this study through which learning is interpreted as follows.

> Individuals bring past experiences and beliefs, as well as their cultural histories and world views, into the process of learning; all of these influence how we interact with and interpret our encounters with new ideas and events. As our personal perspectives are mediated with the world, we construct and attribute meaning to these encounters, building new knowledge in the process. This constructive, interpretative work is facilitated and deepened when it is undertaken with others and with reflection
>
> (Lambert et al., 1995, p. xi-xii)

The above interpretation captures and presents in few lines the general notion of constructivism. It stresses the importance of cultural and social life because of its power and potential to generate experiences and beliefs based on a person's past experiences. Individuals, based on their own beliefs, interact with others by sharing perspectives; a procedure through which knowledge is constructed. More importantly, construction of knowledge is "facilitated and deepened when it is undertaken with others and with reflection". A crucial line for educators and teachers since it could represent educational environment within a classroom; *others* being students and teacher while *reflection* being the interactivity of the classroom.

Knowledge should be constructed within a class by interacting with *others,* an argument which underpins the basis of the theoretical stance adopted and analysed in more depth hereafter. Yet, is the quality of the interactivity that will reinforce the social construction of knowledge.

Social interactions within a classroom have the potential to improve understanding. Indeed, Rogoff and Gardner (1984, in Bliss et al., 1996) argue that social interaction is a crucial “cultural amplifier” to improve children’s cognitive processes with the teacher serving the role of expert in introducing children to society’s conceptual tools. A cross-cultural study by Rojas – Drummond and Mercer (2003), is aligned and stresses that argument. Their study indicates that, “by the use of certain kinds of interactional strategies, teachers can enable children to become more able in managing individual and joint reasoning and learning activities in the classroom” (ibid, p.99).

Language is the center of all these interactions during lessons (Joshua, 2008). Alexander (2004) argues that through language, especially spoken, teachers teach and children learn; language is teacher’s main pedagogic tool (Mercer and Littleton, 2007). Indeed, Swain (1997) stresses that language is both the mode by which teachers and pupils interact as well as the goal of learning activity; the character of classroom talk impacts on learning in important ways (Nystrand et al.2003). Classroom talk is crucial to the way in which pupils build their understanding (Zuengler & Cole, 2005). Thus, ‘an analysis of the process of the teaching, of constructing knowledge, must be an analysis of language in use’ (Mercer, 1995, p.6). Apparently interactions within a classroom have the power to support and shape learning while classroom talk has the power to shape the type of the interaction. Put in brief, classroom talk has a crucial role in the development of learning.

In this we adopt Halliday’ s (1993) argumentation:

> When children learn language, they are not simply engaging in one type of learning among many; rather, they are learning the foundations of learning

> itself…the ontogenesis of language is at the same time the ontogenesis of learning. (p.93)

In line with this, Mortimer and Scott (2003) stress that talk is central to the meaning making process and thus, central to learning. Such argumentation can be found extensively in literature, and Alexander's (2008) words are chosen to sum up, by grasping the essential meaning of talk in a curriculum oriented manner. "Reading, writing and number may be the acknowledged curriculum 'basics', but talk is arguably the true foundation of learning' (p.9).

Cognitive processes leading to improved learning will be distilled in the following section by emphasizing on Vygotsky's view on the connections between language, social interaction and learning, while raising some contrasting points by Piaget.

Constructivism through a Vygotskian cognitive perspective: comparisons with Piaget's view

Researchers, educators, curriculum developers and school administrators might share totally different views about learning; a fact that should not surprise the reader. As Phillips (2000) supports, opinions are situated within a line where at the one end constructivism is seen as a dangerous modern theory and at the other as a fruitful example guiding educational research. However, even within constructivism spectrum opinions are contradictory; they look through the same magnifier standing in different angles. Also, as stated by the title of Phillips' book "Constructivism in Education: Opinions and Second Opinions on Controversial Issues …", he argues that the term *constructivism* leads to at least two quite different things.

According to the constructivist stance adopted, one might support either an *individual-centered learning* view or a *collaborative learning* one (Luppicini, 2000). Others refer to these two categories as *psychological constructivism* and *social-constructivism/ constructionism* respectively (Phillips, 2000). Innumerable articles have been published supporting views regarding this tension, but it is not our aim to analyse in depth this debate. However, we will refer to the cognitive theories of Piaget and Vygotsky as being among the most important constructivist theorists, whose work fits and seems to have shaped the two categories mentioned above; bearing in mind Piaget is often seen as the key idea creator of constructivism according to Ernst von Glasersfeld (2005). Besides, any investigation addressing language and its relation to thought would be inadequate, if it failed to take into account the learning theories of Piaget and Vygotsky (Smith, 2010).

Viewing again Lambert et al.'s (1995) argument, that construction of knowledge is "facilitated and deepened when it is undertaken with others and with reflection", opinions will be presented both for and against this viewpoint. An argument that constitutes a magnifier for both Piaget and Vygotsky, but when describing in depth how meanings are constructed, their different angle of looking through the magnifier becomes apparent.

Ernst von Glaserfield (2005) believes that, in Piaget's view what we see, hear and feel is the result of our specific ways of perceiving and conceiving; thus concepts are developed intrinsically and individually. According to Piaget (1926) interactions between children holding different views on intellectual or moral issues can lead to cognitive conflicts. Students will learn from one another because 'cognitive conflicts will arise, inadequate reasoning will be exposed and higher quality understanding will emerge' (Slavin, 1990, p.63 in McConnell, 1994). In simple words, Piaget supports that when a child argues or disagrees with another child they are improving their mental capacity solely through intramental processes. Piaget views development from an individualistic perspective and emphasises individual action and development rather than the interactions which surround the individual (Mercer et al., 1999; Slavin, 1990 in McConnell, 1994).

On the other hand, Vygotsky (1978) advocates that pupils' development functions in two levels, the intermental (between pupils) and the intramental (inside the pupil). The former is a precondition to move on to the later.

> Every function in the child's cultural development appears twice: first, on the social level, and later on the individual level; first between people (interpsychological), and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formulation of concepts. All the higher functions originate as actual relations between human individuals. (p.57)

The language that forms the social interaction at the intermental level proposed by Vygotsky forms as a dichotomy between the two theorists. Piaget argues that, pupils' egocentricity makes it impossible for them to decenter from their own point of view thus, true social interaction is impossible (Smith, 2010). Contrastingly, Vygotsky considers the use of language as externalised thought acting both at the social (intermental) and self-directing (intramental) level which eventually remains within the mind as inner speech (ibid).

More precisely, Vygotsky (1978) viewed development from a social perspective and proposed that higher mental functions are developed through interactions either with adults or more capable peers.

> Learning awakens variety of developmental processes that are able to operate only when the child is interacting with the people in his environment and in cooperation with his peers. Once these processes are internalized they become part of the child's developmental achievement… (p.37)

Another difference between the internal (intramental) processes suggested by both, Vygotsky and Piaget, is the pre-existing cognitive levels of those participating in any interaction. Vygotsky underlines the importance of the cognitive superiority that should characterise one of the participants (Mercer and Littleton, 2007). Indeed, Bliss et al. (1996) stresses that according to Vygotsky the adult's role in the process of learning is crucial. Adults or more capable peers are assumed to be at a higher-level of cognitive and mental capability in relation to a child. The interaction between them will facilitate and support the later to construct meanings, a fact which ideally and slowly will lead the child towards a higher or more complex cognitive level. Contrastingly, Piaget argues that inadequate reasoning is the essential necessity which leads to improved understanding through intramental processes (as mentioned in the previous page).

Based on Vygotsky's theory, this construction takes place within the Zone of Proximal Development (ZPD hereafter) which presents child's potential for development as following:

> […] the distance between the actual development as determined by independent problem solving and level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.
>
> (Vygotsky, 1978, p.86)

Kozulin (1986) gives an interpretation of the ZPD - using Vygotsky's writings - as the place where child's "spontaneous concepts meet the systematicity and logic of adult reasoning" (p.xxxv). Similarly, analysis of Newman et al.'s study (1989) indicates that when children enter the ZPD, or *Construction Zone*, cognition is modified through interactions dominated by adults' system of understanding. In Bickmore-Brand and Gawned (1993) words "the most effective learning occurs when the adult draws the child out to the jointly constructed 'potential' level of performance" (p.49). Sharing the same view, Wood et al. (1976) proposed the notion of "scaffolding" to refer to the construction process leading to improved understanding. They argue that problem solving "involves a kind of 'scaffolding' process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (p.90).

Interestingly, Mercer and Littleton (2007), while clearly building upon Vygotsky' s work, stress that the concept of ZPD is problematic in terms of assessing a person's mental state. ZPD is a rather static concept since it assesses a person's capabilities at a specific point in time while the process of dialogue, inhibited in it, empowers dynamic development. Thus, they introduce the concept of Intermental Development Zone (IDZ hereafter) in order to grasp more accurately "how a teacher and a learner stay attuned to each other's changing states of knowledge" (p.21); this is a key concept adopted for this study

By supporting constructivism through a Vygotskian perspective it should be made clear that, the role of individual and self-centered learning is not diminished. However, in order to develop individual *and* collaborative learning, attempts should aim at *both* learner and learning environment (Luppicini, 2000). The debate between those who emphasise individual cognitive structuring and those who stress the social and cultural effects of learning, underestimates the potential of a synthesis generated by both views. Indeed, Ernst von Glasersfeld (2005) argues that the question is not whether the individual's cognition or the social-cultural context should be given priority while analysing learning, instead; focus should be on the felicitous question "What is the interplay between them?" (p. 28). Adopting a Vygotskian glance at learning, a teacher can facilitate individual learning by focusing on the type of interactions developed within the IDZ of each learner.

Overall, general principles of constructivism as presented by Ernst von Glasersfeld (2005) are:

- "Learning is not the result of development; learning *is* development" (p.33).
- Mistakes need to be perceived as a result of learners' conceptions and contradictions should be illuminated, explored and discussed.
- "Reflective abstraction is the driving force of learning" (p. 34).
- Dialogue within community lives within further thinking.

Looking at the second principle is obvious that, once more, both Piaget's and Vygotsky's views are embedded in it. While the importance of contradictions is illuminated by Piaget, application of a Vygotskian perspective does not devalue this contradiction but might use it as the base to construct new scaffolds through discussion inspired by more capable participants.

To sum up, social constructivists interpret learning in terms of the dialogic production of "constructions" (Moseley et al., 2005), and for the author of this study it takes place in the Vygotsky-influenced IDZ. The nature of talk under which "constructions" are developed, as well as thinking processes embedded in it are presented in the following section.

A Framework for thinking - and talking

Learning procedures as interpreted so far sustain the function, and ideally development, of thinking processes. The centrality of language, especially spoken, has already been stressed. Vygotsky's adopted view on language as externalised thought, underlines the link between thinking and talking. Having said this, talking and thinking are mutually acting upon learning and it is the combination which orchestrates learning. Indeed, Smith (2010) suggests that it is more useful to consider them – talking and thinking - together as being inextricably linked. Thus, the emphasis is put on their mutual importance and interdependence, aiming at improving understanding through managing classroom talk, and consequently thinking in the classroom. Before elaborating on *how* talk generates higher-order thinking, in the following section, an interpretation of "higher-order thinking" needs to be presented.

To begin, it is difficult to understand how people think "since we can only try to understand these things by using the very processes that we do not fully understand" (Moseley et al., 2005, p. 10). Borrowing Smith's (2010) metaphor of driving, as one that mirrors thinking skills in a comprehensive and easy-to-grasp manner, makes it easier to grasp the process of higher-order thinking.

> To identify the skills of driving we might begin with the set of physical actions required, such as steering, accelerating, braking and gear changing….any one of these…reveals a complex web of skills, awareness and understanding involved in its execution. Steering, for example, requires the physical ability to hold the car on a straight or curved path. Almost beyond our awareness, though, this action in practice also depends upon a feedback loop involving our response to what we see, hear and feel as each sense… It is the ability to effectively use this

> large range of skills over a sustained period of time which allows us to claim…that a person is a good driver but…these skills include what we might call 'dispositions' (for example, alertness, careful judgement, care for others) as well as the…physical skills… (p.71-72)

This metaphor can be translated, by considering the physical actions as the cognitive actions incorporated during thinking, and "dispositions" as the distinct thinking skills which empower the cognitive actions. Such skills include, reflective thinking, creative thinking and critical thinking, selected because they embrace a broad merit of literature focusing on thinking skills (see table below).

Table 1: Thinking Skills

Thinking Skills	Interpretation	Described by
Reflective thinking	A sequence of thought leading, through enquiry, to a conclusion.	Dewey, 1933 [in Moseley et al. 2005]
Creative thinking	"Creative thinking is exemplified by the thinking that goes into the making of art, by the idiosyncratic encoding through which each work withholds itself from us. It is the discrimination of or the fabrication of relationships, patterns and orders producing in us the shock of unfamiliarity." p. 248	Lipman, 2003
Critical thinking	Reflective thinking which is focused on taking decisions about what to believe or do.	Ennis, 1985 [in Moseley et al. 2005]

It is suggested that these processes act mutually and simultaneously upon each other. However, Dewey's notion of reflective thinking, as presented in his book "How we Think?", considers that this type of thinking is the driving force of the whole procedure, embedded in the view of learning presented already. Literally, in order to reach any conclusion, common understanding (as explained in the first section 'Mathematical Understanding'), one should interact verbally to shape enquiries, while scaffolds or support would be generated within the IDZ and so as to improve one's own level of learning. This relates to the inextricable link between talking and thinking already mentioned. Also, Ennis' (1985, cited in Moseley et al., 2005) interpretation employs reflective thinking, which in turn demands - at least according to the view underpinning this study - socially constructed talk. This argumentation might as well be expressed in the following figure.

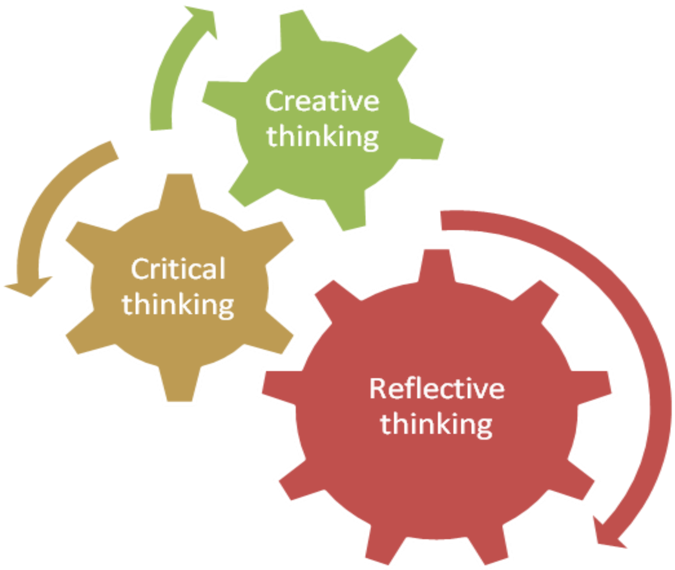

Figure 1: A representation of the interconnection of thinking skills

Moving on, the cognitive actions incorporated in thinking are clearly articulated by Anderson and Krathwohl (2001) while improving and building upon Bloom's taxonomy (1956, cited in Anderson and Krathwohl, 2001). These thinking actions can fit into six cognitive processes, presented below, whereas the learner can as well move to a higher level without mastering all those below it, in contrast to Bloom's original and more hierarchical taxonomy (Moseley et al. 2005).

- Create: *generating, planning, producing.*
- Evaluate: *checking, critiquing;*
- Analyse: *differentiating, organizing, attributing;*

- Apply: *executing, implementing;*
- Understand: *interpreting, exemplifying, classifying, summarizing, inferring, comparing, explaining;*
- Remember: *recognizing, recalling;*

Summing up, it makes it easier to reach higher cognitive levels by mastering reflective thinking, creative thinking and critical thinking; the 'dispositions' of the suggested driving metaphor. Reaching higher levels of cognitive actions through this complex and interconnected procedure, constitutes the interpretation of higher-order thinking used for this study. Not in terms of looking at it in terms of duration at a higher-level of thinking, but rather the ability to reach higher-order thinking at certain points, in the same way a good driver might prove his or her abilities by an instance of reacting correctly to a specific driving challenge in the road.

Metacognition and Self-regulation

The process of considering your own thinking processes is called meta-cognition. The term was initially introduced by Flavell (1976, p 232) to refer to "one's knowledge concerning one's own cognitive processes or anything related to them". Put in brief, it is one's realisation of what is more helpful to support his or her own learning. This is evident for example, "if I notice I am having more trouble learning A than B…if I sense that I had better make a note of D because I may forget it" (ibid).

It is suggested that there are two dimensions within metacognition (Boekaerts and Simons, 1993; Hacker, 1998). On the one hand, the realisation of one's cognitive functioning or metacognitive knowledge, and on the other hand, the application of such functioning or metacognitive skills. For example, when realising that to solve a mathematical problem it is helpful to draw a map or a diagram is the first dimension – metacognitive knowledge, while when one actually draws a diagram when he or she faces a mathematical problem is the second dimension of metacognitive skills. At this point a question can be raised: Which one is the most difficult to reach? It is argued that the answer is the former the knowledge and awareness, while the development of skills constitutes a prerequisite. Indeed, Alexander et al. (2004) support the idea that children might develop strategies to solve a problem through creative thinking, but without being able to give an account of the process. This can be translated as not being actually able to describe the cognitive actions they employ or are unaware of them and employ them unconsciously. For example, one might sketch a diagram to solve a problem without knowing or being able to explain in details the reasons for doing so.

Following this line of argument, Demetriou' s (2000) interpretation of self-regulation is also important because it incorporates both dimensions of metacognition in a conscious manner, while also involving conscious control of motivational, emotional and behavioural processes. Accepting this interpretation, metacognition constitutes a dimension of self-regulation with the last being hierarchically above the former. Even though there is some confusion between the two terms (Moseley et al. 2005) they are adopted as such in this study so that metacognition has a cognitive dimension, whereas self regulation encompasses all aspects of self regulation, the cognitive, affective and conative (motivational).

Not surprisingly, empirical evidence indicates that thinking skills, particularly at the level of metacognition and self-regulation have important effects on pupils' attainment. Hattie (2008) conducted a meta-analysis involving about 50,000 studies and concluded that teaching methods which encouraged metacognition were found to be particularly effective. Other meta-analyses have also reached the same conclusions, e.g. Hattie et al. (1996), Marzano (1998), Higgins et al. (2005). The importance of metacognition and self-regulation is also embedded in the metaphor presented in the previous section. "Any one of these (translated here as cognitive skills)…reveals a complex web of skills, awareness and understanding involved in its execution." (Smith, 2010, p.71-2).

This said, even though children might not be able to give a complete account of the cognitive processes they employ, it is reasonable that they should be taught towards that end. We might not know precisely how to support children to develop metacognition but practicing their cognitive skills and articulating awareness of these skills seems to lead to their development (Smith, 2010).

Overall, by developing awareness of thinking processes and their associated cognitive actions teachers raise the potential of their pupils to reach higher-order thinking. Towards that end, thinking needs to be strategic and reflective (Moseley et al.2005).

Adopting the Terms Discussion and Dialogue as Dialogical Schemes

It has already been stressed that the social construction of learning is pioneered through talk. Dialogue is the nature of talk which can be synchronized with the adopted view of learning in terms of improving learning outcomes, this can be translated into developing more complex or higher-order thinking. A conceptualisation for dialogue is presented in this section taking into consideration the Vygotskian perspective on learning outlined above. Dialogue as a process is further analysed in a following chapter (p.59). The term might be used for written language too but this study is focussed on oral exchanges.

To begin, the dynamics of classroom interaction constitute the main difference between Piaget's and Vygotsky's thinking (as argued previously; p.26-28). Indeed, von Glasersfeld (2005) suggests that while Piaget sought to study and elucidate the role of contradiction, Vygotsky sought to study dialogue. Dialogue is embedded in the social perspective of Vygotsky rather than the more individually-centered Piagetian view.

Wegerif (2008) argues that Vygotsky does not employ an explicit focus on dialogue in his writings, a view also adopted by Howe and Abedin (2013). He argues that Vygotsky's concept of effective talk is *dialectic* while Bakhtin's, though influenced by Vygotsky, is *dialogic*. Through extensive argumentation, Wegerif concludes that the two concepts are superficially used interchangeably even though they do not actually correspond. He stresses that:

> […] dialogic presupposes that meaning arises only in the context of difference, whereas dialectic presupposes that differences are contradictions leading to a movement of overcoming. (p. 359)

But since mathematical understanding is actually the process of the abstraction of mathematical ideas through common understanding (p.21-23) the Vygotskian notion of *dialectic* is the one that fits into our concept of learning. Put in brief, "overcoming" different ideas and views is when a child conceives abstract mathematical meanings.

This is not said to dismiss in any case Bakhtin's *dialogic* view on effective talking. Besides, as being genuinely influenced by Vygotsky (Howe and Abedin, 2013) he clearly underlines the importance of constructing meaning socially through talking while judging the use of monologue; a procedure he names "pedagogical dialogue".

> In an environment of . . . monologism, the genuine interaction of consciousness is impossible, and thus genuine dialogue is impossible as well. In essence, idealism knows only a single mode of cognitive interaction among consciousness: someone who knows and possesses the truth instructs someone who is ignorant of it and in error; that is, it is the interaction of a teacher and a pupil, which, it follows, can only be a pedagogical dialogue, (p. 81) … Monologism, at its extreme…denies the existence outside itself of another consciousness with equal rights and responsibilities…Monologue is finalized and deaf to the other's response, does not expect it and does not acknowledge in it any *decisive* force. . . .Monologue pretends to be the *ultimate* word" (pp. 292-293; emphasis in original) (Bakhtin, 1984, cited in Nystrand et al. 2001)

Thus, the *dialectic* concept by Vygotsky is the one adopted as representing the concept of talk that underpins the theoretical basis of this study. However, the term "dialogue" will be employed to refer to this concept as being the one which is broadly used to address effective classroom discourse (e.g. Alexander 2008). Alternatively, the use of the term "dialectical method" seems to co-ordinate Wegerif's (2008) point of view, as well as the argumentation on the desirable type of talk presented in this chapter. Yet, it would perhaps be awkward and confusing for the reader, since these distinctions are rarely observed in the literature.

Either way, the most important point is to offer a substantial and clear interpretation of the chosen terminology. Towards that end, it should be clear that Bakhtin's notion of *dialogic,* even though it does not precisely coincide with the interpretation of the cognate word "dialogue" used in this study, it is still considered as a dialogical scheme. This scheme fits into interpretation of "discussion" used in the study while being at a cognitively lower level compared with "dialogue". Even though sharing information through "discussion" might lead, for example, to problem solving however, it may be deficient in terms of reaching abstract mathematical meanings. From this perspective, "discussion" and "dialogue" are both seen as dialogical schemes and reflect Alexander's (2008) interpretation. Extensive interpretation of the two terms is presented in the third chapter 'Quality Instruction through Dialogic Teaching' (p.57), focusing also on characteristics of the process rather than solely on their outcomes.

Dialogic Teaching

This section is perhaps succinctly encapsulated in one of Smith's (2010) key points in his chapter of theorising about talk.

> Thinking is a social activity as well as a private activity. If you learn to structure classroom talk well and give children opportunities to demonstrate higher-order thinking then you will help them to develop this social construction of knowledge and understanding. 'Dialogic teaching' is the name which is often given to this kind of teaching which is based around dialogue between teachers and pupils rather than teacher monologues. (p. 31)

As such, dialogic teaching as developed by Alexander (2008) constitutes the corner stone of this study as the one which develops meaningful learning; a phrase used also by Ausubel (1968, cited in Moseley et al., 2005). The concept of dialogic teaching has shaped the methodological structure of this study and it is presented later as an aspect of instructional design in the third chapter of the thesis, 'Quality Instruction through Dialogic Teaching'. The quality of instruction is key to support dialogic teaching. Literally, any teaching instruction de facto produces some interactions. Yet, the quality of the interactions is the ultimate characteristic of dialogic teaching.

2.2 EFFECTIVE TEACHING

The Baseline of 'Effective' Teaching

Much of the research literature in education which relates to teaching makes claims about what makes it effective or how to improve it. Research about curriculum, educational policies and instruction aim to improve the way teachers teach and the way that students learn. Influences on the quality of education are mediated by who the teacher is and what the teacher does (Clark, 1995). However, it is impossible to give a single, precise definition of an effective teacher (Good and Brophy, 1997). Thus, existing literature offers a vast array of information which stresses the key characteristics of good teaching which are either directly or indirectly related to teachers' methods of teaching. In that, it should be clarified that if effective teaching was a resolved and agreed issue, there would not be a need for studies as the one presented. This justifies the use of quotation marks in the subtitle above. Literally, a broad view on teacher's role towards effective teaching is therefore presented next.

Alexander (2010, pp. 281-282) states that good teaching:

- is well-organised and planned
- is reflective
- is based on sound subject knowledge
- depends on effective classroom management
- requires an understanding of children's developmental needs
- uses exciting and varied approaches
- inspires
- encourages children to become autonomous learners
- facilitates children's learning
- stimulates children creativity and imagination

Borich (2007) introduces five *key behaviours* essential for effective teaching and five *helping behaviours* that can be used to implement the previous ones. The *key behaviours* are: Lesson clarity, Instructional variety, Teacher task orientation, Engagement in the learning process, Student success rate. The *helping behaviours* are: Using student ideas and contributions, Structuring, Questioning, Probing, Teacher affect.

Clark (1995) suggests that the teacher has three roles that influence the quality of education: teacher as a person; teacher as a curriculum planner; and teacher as instructor. Looking at Borich's ten behaviours above is not difficult to relate them to the respective role/ roles as presented by Clark. For example, teacher task orientation relates to how a teacher acts as a curriculum planner, teacher affect to teacher as a person, lesson clarity to teacher as a curriculum planner and as instructor.

Teacher as a person certainly constitutes a significant parameter in being a good teacher. Stronge et al. (2004) state that, the most effective teachers are those who are passionate about their chosen profession. "The personality and values of the teacher are clearly reflected in how a life in a classroom is lived out" (Clark, 1995, p.4). The affective side of teaching – categorised above among the *helping behaviours* for effective teaching – is also related to a teacher's character. Students are good perceivers of emotions and intentions inherent in teacher's actions (Borich, 2007), and realise if teacher enjoys lessons and cares for them. For example, enthusiasm is displayed through vocal inflection, gesture, eye contact and animation while the coordination of those signs signals to students the teacher's respect regarding their experiences and understandings (ibid). Teacher's personality constitute a relatively stable effect on the quality of education and cannot be easily altered or changed through seminars or training; though some might argue that it can be influenced by personal life experiences.

Contrastingly, the other two roles, those of curriculum planner and instructor, can be modified throughout a teacher's career through experience and continuous education such as through training, seminars and the development of skills and knowledge. Not surprisingly, teaching experience is considered to be among the essential elements of effective teaching (Stronge et al., 2004). While this study is primarily focused on teacher's role as instructor, a general notion of effective teaching is provided before analysing further the parameters of effective teaching and instruction.

Effectiveness through Specific Features of *Teaching Strategies*

There are many terms used to refer to a teacher's actions during classes such as teaching method, teaching style, teaching strategy, teaching tactics, and the like. The interpretation of all these terms might be different for each study, however the terms *teaching method* and *teaching strategy* will be adopted in this research as interpreted by Taba and Elzey (1964). They argue that, a strategy consists of teacher's efforts to translate his or her intentions into practice. Similarly Alexander (2000) argues that, nowadays researchers avoid the term "teaching style" because it implies that is the overall style which produces gains in pupils' learning. Instead, he supports that effective teaching and learning is more likely to stem from particular attributes and strategies that might relate to several different 'styles'.

According to Taba and Elzey (1964), teacher's actions are connected with three types of strategy: the organisational, the curriculum and the instructional. The organisational strategy relates to decisions made in order to divide teaching time into the different activities and finding the balance in between individual, class and group teaching. The curriculum strategy refers to the content and the balance of the curriculum. The instructional strategy corresponds to the term *teaching method* and refers to class discussion, lecturing, the use of work sheets, demonstrating collaborative group work and so on.

However, *teaching method* is certainly influenced by decisions within organisational and curriculum strategy. McLeod et al. (2003) support the idea that classroom organisation and management set the stage for instruction. Thus, the term could be assumed to be synonymous with *teaching strategy* since teacher's methods are directly related to the curriculum and the organisation of the lesson. Contrastingly, organisational and curriculum strategies are often made or influenced by others than the teacher such as government, head master/ mistress and policy makers. However, they might inhibit decisions by the individual teacher as well. Having this in mind, Taba and Elzey's correlation of *teaching method* only with instructional strategy becomes reasonable. Decisions made regarding precisely how to teach a specific lesson to a specific class are made by the individual teacher and may vary across a number of teachers even if organisational and curriculum decisions are the same for all of them. Sometimes teachers might have the freedom to make their own decisions in the those two strategies of curriculum and organisation as well.

It is crucial to view teaching as decision making (Good and Brophy, 1997) since above all it demands from teachers the exercise of judgment in deciding how to act (Pollard and Tann, 1993). Teaching is seen as a process through which the capacity to make judgments can be developed and maintained and as such is often characterised as reflective teaching (ibid). After all, effective teaching is all about decisions that are reflected in teacher's actions. In the remaining part of this section, I present arguments from literature about what might influence a teacher's decisions according the three distinct but mutually interacting strategies. As such, this constitutes an expertise model.

Curriculum strategy

Alexander (2000), through his comparative cross-cultural study, concluded that differences in teaching methods can represent contrasting conceptions of curriculum. As stated in the first chapter, a teacher consciously or unconsciously has in mind how children learn, a fact that orientates his or her teaching. For example, the writer holds a social constructivist view through Vygotskian perspective and this perspective implies applying the curriculum by constructing meanings socially within the classroom through whole-class interaction and talk. Thus, a robust curriculum design should include theories that underpin its purposes with a clear connection to the teaching procedures and activities. Even when the teacher is not responsible for designing curriculum, the quality of education is affected by his or her interpretation of it (Clark, 1995).

Alexander (2008) stresses that classroom talk in general has been one of the essential tools of teaching and arguably the foundation of learning. However, he says that the acknowledged curriculum basics have been reading, writing and number. This fact underestimates the power of oral language in the learning process and might mislead teachers to focus on written language. Indeed, teachers "tend to be less reflective about what is said in….classrooms than about what is written" (Alexander, 2008, p.9).

Having this in mind teachers should make use of the curriculum in order to design their lessons. However, "it may seem obvious that curriculum planning should be goals-driven and should feature alignment among its elements, but this ideal model is not often implemented in classrooms" (Good and Brophy, 1997, p.359). Decisions regarding the design of each lesson should be goals driven and a goals-driven design should be aligned with each of the curriculum's components: content, organization, activities, and methods (ibid). Indeed, Borich (2007) presents "Teacher task orientation" among the five key characteristics of effective teaching. Literally, teachers should have a clear idea of lesson's goals in order to prepare a good task or series of activities so that these activities target the specific lesson goals.

However, even if it has been the tradition that teacher (and increasingly the school and the government) has the power to set the goals and make the decisions, research indicates that whenever students share that power with the teacher it has a positive effect in their own learning (Wells and Ball, 2008). "A curriculum made only of teachers' intentions would be an insubstantial thing from which nobody would learn much" (Barnes, 1976, p.14). To become purposeful a curriculum has to be enacted by pupils as well as by teachers (ibid).

Also, curriculum pacing should move pupils through the curriculum quickly but in small steps that minimise frustration (Good and Brophy, 1997) which is directly related to the time dedicated for each activity or goal and reasonably connected to the organisational aspects of the lesson.

Organisational strategy

A large number of studies of classroom teaching have focused on identifying how a teacher should divide his or her teaching time between class instruction, group work and individual work but with contrasting results (e.g. Duncan and Biddle, 1974). Over the last couple of decades, a number studies have converged towards the same path pointing at the value of interactive whole-class teaching (e.g. Muijs and Reynolds, 1999, 2001). This study focuses solely on whole-class teaching without though implying that other classroom organisations are less important.

In 1967 Plowden Committee undoubtedly influenced the educational system in the UK (Galton et. al, 1980) and included a warning against an excess of whole-class teaching, though it was stressed that it might be desirable at some instances. According this Report, which seems to be aligned with the Piagetian perspective, individualisation is the basic parameter leading to effective learning and, so, to effective teaching (ibid). In order to succeed that, teachers should dedicate most of their time in group work and individual guidance.

The practical difficulty of this task is recognised by the Committee which stated that the demands on teachers appear “frighteningly high” (p.875). Even if we accept this view and assume that all teaching were on one-to-one basis, only some seven to eight minutes would be available for each pupil (Galton et al., 1980). In reality, teachers have to manage 20, 30 or more children, a fact that forces most teachers to rely on whole-class teaching strategies (Alexander, 2000; Good and Brophy, 1997).

Even holding a Piagetian stance on learning, it is practically impossible to dedicate each pupil individually the amount of time he or she needs to reach a certain level of understanding in every day lessons. But even without this difficulty, it would not be reasonable to support such a teaching method exclusively, since learning is socially constructed which becomes possible through participating in an interactive whole.

Indeed, Galton et al.'s (1980) process-product study, ORACLE, which took three-years and, concluded that "interaction with a specific cognitive content is maximised in the whole class situation" (p.93). Interactions which belong cognitively at a higher level are most likely to occur when the teacher is interacting with the class as a whole, and least likely to occur during individual, one-to-one, interactions.

Reynolds and Farrell's (1996) international comparative research has indicated that countries with higher scores in international studies, dedicate substantially more time in whole-class interactive teaching; the term 'interactive' is related to the way a teacher instructs and will be analysed in the next section, 'Instructional strategy' in p.49. They indicated that students in countries such as Singapore did much better in international studies of maths and science than UK, and one of the main factors that is claimed to distinguish these more successful countries is a more widespread use of whole-class teaching.

Muijs and Reynolds (1999) after a classroom observation study which included at least 100 maths teachers in UK indicated that teachers, who spend more time teaching the whole class as opposed to teaching individuals students, were those whose students scored much higher in maths attainment. The same researchers (2001) in their book published a year after the study argue that, policies have now shifted from "child-centered" strategies where pupils spent most of time working on their own, to whole-class teaching. They argue that research in USA also shows that more effective teachers tend to actively teach the whole class considerably more time than less effective teachers.

More importantly, in order to raise standards of literacy and numeracy in English primary schools the UK government launched strategies whose emphasis was on "interactive whole class teaching"; the National Literacy Strategy was launched in 1998 (DfEE, 1998) and the National Numeracy Strategy in 1999 (DfEE, 1999). In both initiatives interactive whole class teaching was seen as a model promoting high quality dialogue and pupils' contribution (Smith et al., 2005). Once more, it is obvious that whole-class instruction is seen as the best scenario to promote effective teaching.

Brown et al. (1998) stress that there is also evidence that whole class teaching can be related to poor results and the quality of the interaction is much more important than the overall class organisation. The importance of interaction will be presented below but since a significant number of studies points towards whole class teaching, a quality interaction within a whole class organisation is the focus for this study.

In conclusion, by suggesting that the majority of teaching time should be dedicated to instruct the whole-class does not minimise the importance of group and individual work. Referring to "the majority of teaching time" indicates that other organisational strategies are also part of the teaching procedure. Individual or group practice also constitute essential parts of the lesson if student learning is to be maximised (Muijs and Reynolds, 2001), since learning is reinforced by applying different methods according lesson's goals and students' interests. But latest studies clearly point towards the direction of whole-class teaching as the daily basic teaching strategy.

Also, I would suggest that a sub-category of *organisational strategy* could be *management strategy*. As stated earlier, *organisational strategy* relates to decisions made in order to divide teaching time into the different activities and finding the balance in between individual, class and group teaching (Taba and Elzey, 1964). In order to maintain to initial planning of time teacher should also solve any problems that arise during lesson and this is a daily pragmatic scenario in schools. Using Doyle et al.'s (1986) explanation of classroom management, *management strategy* is considered as "the actions and strategies teachers use to solve the problem of order in classrooms" (p.397). Using rules, procedures and routines has been an effective technique to ensure pupils' active participation in lesson (Marzano et al., 2003).

<u>Instructional strategy</u>

Interactions between students and teacher are a crucial factor in successful teaching and learning (Muijs and Reynolds, 2001) and as already pointed out in the theoretical stance of study. Indeed, Pollard and Tann (1993) argue that "there is a constructive relationship between the *state* of classroom competence and the *processes* of reflection through which competence is developed and maintained" (p.4). In other words, the type of interaction directs the development of competence in the classroom. The instructional strategy, or teaching method, applied by the teacher shapes the interaction within a class and is directly related to the specific actions of each teacher individually.

Instruction is related to "how teachers speak and act in the presence of students with the intention of changing what they know, understand and can do" (Clark, 1995, p.5). Besides, it has already been extensively argued above in the 'Theoretical Synopsis' chapter that classroom talk, if developed effectively, leads to meaningful learning since it is inextricably linked to developing thinking processes. Thus, not surprisingly Stronge et al. (2004) stress that verbal ability is among the qualities of effective teachers. Indeed, Darling-Hammond (2001) supports that it constitutes an indicator of teacher effectiveness because it relates to how well a teacher conveys concepts and skills to students. As Nystrand et al. (1997) stress, "what counts is *the extent to which instruction requires students to think, not just report someone else's thinking*…"(p.72, italics in the original). The critical issue is to explain how to instruct in order to shape effective interactions, a topic analysed in the section 'Focusing on Quality Instruction from a Process Perspective' of the following chapter. Teaching is reflected in teacher's own words shaping the way a teacher instructs while the importance of teacher's talk is embedded in the theoretical stance of the author.

The importance of teacher's talk is also evident when looking in dictionaries for the meaning of "instruction". Though it generally has the meaning of giving details on how something should be done, it is also interpreted as "the profession of a teacher" (www.thefreedictionary.com) while elsewhere it is considered as a synonym to "teaching" (www.oxforddictionaries.com). We should also make it clear that teacher's instruction is important not in terms of its magnitude but of its dynamic to shape the discourse that develops and thus the interactivity during lessons.

Moreover, classroom talk is hugely shaped by the questions posed by the teacher. The quality of talk orchestrated by the teacher is primarily related to questioning techniques (Weigand and Cunningham, 1977) embedded in his or her verbal fluency. Questioning can be used to check pupils' understanding, to scaffold their learning, to help them clarify and verbalise their thinking and to help them construct a sense of mastery (Muijs and Reynolds, 2001). A question is defined as any utterance which seeks an answer (Galton et al., 1980) while Kerry (1982) supports that teachers ask about one thousand questions a week. Looking at Borich' s (2007) ten key behaviours of effective teaching as presented earlier, questioning is listed as one of them. However, it is also embedded in all of the other key behaviours since teacher's talk constitutes an indicator of all of them and it is certainly shaped by the number and type of questions. The acknowledgement that questioning constitutes a vital skill for effective teaching (Kerry, 1982) is the reason for being among the most widely studied elements in teaching research (Muijs and Reynolds, 2001).

More precisely, Rojas-Drummond and Mercer (2003) state that teacher's questions can:

a) encourage children to make explicit their thoughts, reasons and knowledge and share them with the class;

b) “model” useful ways of using language that children can appropriate themselves[…];
c) Provide opportunities for children to make longer contributions in which they express their current state of understanding, or to articulate difficulties. (p.101).

Thus, through effective questioning teacher can generate quality thinking as evident in the potential of the questions above; quality instruction through effective questioning is further analysed in the following chapter (see below p.70).

Another critical issue is that decisions within the instructional strategy shape the type of the provided assessment. However, it is not implied that instruction is solely an assessment procedure or vice versa. Assessment is interpreted as those activities or actions taken by both teacher and pupils, to provide information that can alter teaching and learning towards pupils’ needs (Black and Wiliam, 1998). The term evaluation is also found extensively in literature reflecting the very same concept. Assessment can be distinguished between formative and summative, where formative assessment is directly related to the process of instructional strategy. Summative assessment refers to measurements of learning outcomes, often through testing or formalised procedures.

Adopting Clark’s (2012) argument the relationship between instruction and formative assessment becomes apparent.

> Formative assessment is a potentially powerful instructional process because the practice of sharing assessment information that supports learning is embedded into the instructional process by design. (ibid, p. 24)

In line with this Stronge et al. (2004) stress that assessment should be clearly linked to instruction. More precisely, formative assessment is related to quality judgements of pupils’ achievement and progress during classes, identifying pupils’ strengths and weaknesses while providing feedback to both pupils and teacher to guide learning and teaching strategies on a day-to-day basis (Callingham, 2008; Peterson and Siadat, 2009; Tveit, 2014). An activity where a pupil is solving a problem on the board, pupils' comments during discussions, teacher observations of work in progress, homework evaluated or discussed in class and written activities in progress are some examples of the formative assessment process. With the importance of talking already being emphasised, it is not a surprise that provoking pupils to externalise their thinking as part of the learning process constitutes a valuable mechanism to assess their learning. The effectiveness of this lies in the teacher's ability recognise what the pupil's actions mean and to alter his or her instruction accordingly taking into account this on-going assessment process. Indeed, Clarke et al. (1990) state that classroom talk is a crucial part of teachers' continuous assessment and influences teachers' decisions on how to adapt their instruction.

Not surprisingly, for constructivists, this kind of assessment constitutes a crucial part of constructing knowledge which is based on the process, rather than the outcome, of the procedure (Semerci, 2001 cited in Sahin, 2010). According to Peterson and Siadat (2009), the notion of formative assessment is embedded in the Vygotskian perspective of learning which forms part of the rationale for this study. It reflects the concept of scaffolding where learning is supported through activities led by an instructor more competent that the learner. Thus, any instructional strategy should ideally be seen as a continuous process of formative assessment, developed to scaffold pupils' understanding through decisions and actions which alternate throughout the provided instruction. The teacher has the control of this process through constantly deciding, provoking and handling pupils' reactions during interactions. This argumentation diminishes criticisms over "teacher directed" instruction while stresses the importance of feedback during lessons; an issue further presented in the next chapter in p.81.

Moreover, the importance of summative assessment should not be diminished since there is an inextricable, though not always explicit, link to formative assessment. Summative assessment is related to "factual knowledge and the final (learning) outcomes only" while "formative assessment should, in theory, prepare students to excel on summative tests" (Peterson and Siadat, 2009 p.93). Literally, it is any type of testing or assessment taking place at the *end* of an instructional period (Bloom et al., 1971). Callingham (2008) says that it measures the "size" of learning outcomes (quotation marks in the original). Indeed, accountability is embedded in this form of assessment (Tveit, 2014). Many terms are used to refer to measurements of summative assessment through standardised forms of testing, such as scoring, attainment and achievement whereas according to the interpretations above formative assessment influences directly or indirectly achievement on summative testing.

The importance of scoring well on standardised achievement tests is clearly explicit in summative assessment, and may perhaps undermine the vital process of formative assessment, as well as effective connections between formative and summative assessment. Indeed, Dixon and Williams (2001) concluded that, while teachers realised the importance of formative assessment and its connection to instruction, they were unable to describe how they used the assessment information to enhance pupils' learning. Perhaps this is due to the direct impact of summative forms of testing on significant decisions and implications, for both pupils and schools.

Summative assessment aims to inform pupils and their parents as well as school leaders, curriculum developers and national authorities about pupils' skills and to monitor the quality of education system (Tveit, 2014). This process aims to indicate weaknesses and strengths of the diverse educational programmes and monitor changes over time (Callingham, 2012). Also, McFarlane et al. (2011) claim that achievement became more important in today's society than acquiring skills because of the economical crisis; schools receive financial rewards related to high test-scores which once may devalue some of the wider outcomes from education such as collaboration and team working skills often demanded by employers (Collet et al., 2014; Kordik, 2015).

However, achievement in summative tests is the key tool for teachers to help their pupils' learning progress and gain a picture of what has been learned (Harlen, 2007). Overall the key aim in education improving learning which is often measured by tests of attainment while also expanding more complex thinking skills (Klopfer et al., 2009). But improvement and effective learning should be reflected in the improvement of scores, and not solely in high scoring. Raising each pupil's own level of skills and knowledge is the ultimate characteristic of effective learning and this should be related to the progress pupil makes, not just their level of attainment; designing assessment tools to achieve this also constitutes a major factor towards that end but this does not fall into the scope of this study.

This said, testing does not constitute the only strategy for a teacher in deciding upon improvement in pupils' learning, since it has already been stressed that synchronizing instruction to pupils' needs through formative assessment is essential. Summative testing is only a single snapshot of data and should be used in conjunction with other relevant information to evaluate overall progress (Campbell, 2010). For example, the ability of pupils to participate orally is considered to be crucial, yet not usually measured through testing or formal assessments. However, as pupils move through schooling, standardised forms of testing hold the key to their subsequent learning opportunities and their potential success. At the end of school life comparisons at national level are based on testing of one kind or another so as long as this is the reality of any educational system, the importance of scoring well on assessments remains crucial.

Moving on, thinking all the above arguments it is not a surprise that, the terminology of addressing effective teaching is related to actions taken by the teacher as an instructor, in other words the selected teaching method; as mentioned previously instructional strategy is considered synonymous to teaching method (p.43). Many concepts have been developed to address ideal teaching methods, such as "inquiry learning" (Good and Brophy, 1997), "discovery learning" (Plowden, 1967), "active teaching", "reflective teaching" (Pollard and Tann, 1993), "direct teaching", "thoughtful teaching" (Clark, 1995), "dialogic teaching" (Alexander, 2004), etc. Barnes (2008) argues that abstractions such as "active learning" probably leave many teachers asking themselves how these ideas can be enacted in lessons. However, most of the terms found in literature leave untouched the issue of applying the suggested methods while focusing on explaining ideal outcomes.

As already presented in the theoretical basis of this study, dialogic teaching is the key instructional strategy (or teaching method) of this study, but bearing in mind that it certainly impacts on and shapes the other strategies as well. Analysis of a process-product dialogic teaching approach is presented in the following chapter, where the alignment to the theoretical approach of the study is made more explicit.

2.3 QUALITY INSTRUCTION THROUGH DIALOGIC TEACHING

Dialogic Teaching

Dialogic teaching develops higher-order thinking skills since it is profoundly being developed when it empowers such skills thus, it is considered as the most effective teaching method, or instructional strategy as mentioned in p.42. This is evident in the characteristics of such teaching as presented by Alexander (2008) who generated the term in use. Also, even though dialogic teaching is a form of interactive teaching, interactive teaching itself cannot be considered as dialogic. The quality of interactions is the characteristic that transform interactive teaching to dialogic, as explained right after.

The essential components of the dialogic classroom can be summarised in five principles, so it can be said that dialoging teaching is:

- *collective*: teachers and children address learning tasks together, whether as a group or as a class, rather than in isolation;
- *reciprocal*: teachers and children listen to each other, share ideas and consider alternative viewpoints;
- *supportive*: children articulate their ideas freely, without fear of embarrassment over "wrong" answers; and they help each other to reach common understandings;
- *cumulative*: teachers and children build on their own and each other's ideas and chain them into coherent lines of thinking and enquiry;
- *purposeful*: teachers plan and facilitate dialogic teaching with particular educational goals in view.

(p. 28, italics in the original)

Regarding the type of talk that supports a dialogic learning environment Alexander argues that there are two types of teaching talk that seem to meet that target; in terms of what has been observed in classrooms in his comparative research in five countries. These are:

> - *discussion* (teacher-class, teacher-group or pupil-pupil): the exchange of ideas with a view to sharing information and solving problems;
> - *dialogue* (teacher-class, teacher-group, teacher-individual, or pupil-pupil): achieving common understanding through structured, cumulative questioning and discussion which guide and prompt, reduce choices, minimize risk and error, and expedite 'handover' of concepts and principles."
>
> (p.30, italics in the original)

Evidently, his interpretation and categories mirror the suggested dialogical schemes which provoke higher-order thinking, in line with those adopted by the author presented in p.36. Indeed he states that, "discussion and scaffolded dialogue have by far the more cognitive potential" (p.31). A view which itself justifies the appropriateness of dialogic teaching as the most desirable selected instructional method. Besides, Alexander's own perspective can be aligned to the theoretical basis of this study; a Vygotskian stance towards learning where the value of talk is considered as pivotal.

Further analysis of the meaning attributed to discussion and dialogue is presented in the next section of this chapter, as being the most effective discourse genres, but also complex and ambiguous in terms of interpreting them. Alexander also identifies three more types of teaching talk, which are presented as well in the following section; rote, recitation, instruction/ exposition. He also stresses that, classroom talk should be characterised by an oral and organisational repertoire where each genre has its merit. Yet, some argue that research has not yet indicated the effectiveness of each genre or correlations to particular types of tasks or classroom organizations; issues discussed in other sections of this chapter.

Whatsoever, Alexander (2008) stresses that dialogic teaching is indicated by many characteristics evident in the talk developed during lessons, as presented below. Even though he refers to the importance of applying diverse classroom organisations, it should be reminded that this study is focused solely on whole-class teaching; as explained in the second chapter, under the title “Organisational strategy” (p.46). He suggests that dialogic teaching is evident by:

> *Teacher-pupil interaction* ... in which:
> - questions are structured so as to provoke thoughtful answers…
> - answers provoke further questions and are seen as the building blogs of dialogue rather than its terminal point;
> - individual teacher-pupils and pupil-pupil exchanges are chained into coherent lines of enquiry…;
>
>   […]
> - pupils – not just the teachers – ask questions…;
>
>   […]
> - children have the confidence to make mistakes… (Alexander, 2008, p.42)

Moreover, dialogic teaching is mirrored in questioning which builds on existing knowledge, elicits pupils’ understanding, includes a repertoire of question types where leading question are infrequently used, gives pupils time to think, etc. Equally important is that, responses to questioning do not recall information but provoke extended answers in a “thinking aloud” manner. Feedback to such responses is informative, praises responses discriminatingly and reformulates responses to avoid ambiguity.

These characteristics of dialogic talk are also cited throughout the last section of this chapter, where quality instruction within dialogic teaching is presented from a process perspective. Having in mind that this is a difficult task, dialogic talk as a process is presented spherically rather than comprehensively. Also, the notion of scaffolding and building understanding in a shared community where talk is considered as pivotal, is obviously embedded in the above indicators of dialogic teaching mirroring the theoretical approach of this study.

Interpreting *Discussion* and *Dialogue*

The adopted interpretations for *dialogue* and *discussion* (in italics for this chapter), are those of Alexander (2008). Comparisons with other categorisations related to classroom talk are made, to present how Alexander's terms are interpreted and conceptually adopted in this study; see also the table at the end of this section. Certainly this is not done in an exhaustive manner of counter-comparison of all classroom talk typologies, this is done in an indicative way.

The terms *discussion* and *dialogue* refer to an exchange of ideas and opinions in a form of conversation between two or more participants. Dialogue often refers to interchange of ideas between one source and another (Mercer and Littleton, 2007; Howe and Abedin, 2013) while discussion is met in literature based on the very same concept as well (Vacc, 1994; Pirie and Schwarzenberger, 1988). Sometimes the two terms when met in literature refer to the same scheme of talk as being synonymous. For example, Mercer and Littleton (2007), while referring to classroom talk they quote:

> The dialogues we will consider include teacher-student exchanges and discussions amongst students. Both those types of dialogue have potential value for learning and development, but we will show that each has special functions. (p.2)

By saying "Both those types of dialogue…" is assumed that dialogue and discussion are both a form of dialogue. It seems that a more general meaning is given to the term *dialogue* since discussion is a type of *it*, and not vice versa. Even though they argue that, "each has special functions", this mirrors differentiation according the participators in the talk; teacher – pupil or pupil- pupil. Thus, according to Mercer and Littleton *dialogue* refers to a broader scheme of talk exchange which has more or less positive impact on learning outcomes.

Using Alexander's interpretation (2004), there is difference between the two terms, at least in a classroom context. Through *dialogue* pupils reach common understanding while during *discussion* pupils and teacher share information. It seems a rather simplistic argument but inhibits significant and specific differences that clearly distinguish the two types of talk.

Alexander's view of *dialogue* echoes Barnes and Todd's (1977) interpretation of "collaborative dialogue".

> […] the group members ascribe meaningfulness to one another's attempts to make sense of the world. This helps them to continue…to shape their own understanding by talking, and contrasts sharply with any schooling which reduces the learner to a receiver of authoritative knowledge. (p.36)

According to this view, talking to each other, while trying to understand one another's thoughts, shapes and support understanding. In other words, reach common understanding through *dialogue* as Alexander phrase it.

On the other hand, Voigt (1995) uses the terms "discussion pattern" and "elicitation pattern" to describe patterns of talking during maths. "Discussion pattern" is the exchange of ideas and explanations, whereas the starting point of the discussion is a solution. When this pattern is reconstructed, the argumentation profits from pupils' contributions and pupils learn how to argue mathematically. "Elicitation pattern" is observed when pupils follow teacher's way of solving step by step with main target to reach a solution at the end. Pupils participate successfully in the last pattern, by learning how to solve problems as expected by the teacher.

"Discussion pattern" can refer to both *discussion* and *dialogue*. *Discussion* is the exchange of ideas in order to solve problems, "discussion pattern" suits perfectly Alexander's explanation. However, the very same pattern could upgrade talk into a higher cognitive level, if teacher structures and guides the discussion by reducing choices aiming common understanding. In this situation, *dialogue* would suit the pattern. *Discussion* could also fit into "elicitation pattern", which does not suit to *dialogue*. According to this pattern, pupils discuss with explanation being already decided and the design of discussion's constructions is limited into thoughts and ideas that are coincided with teacher's thinking. *Dialogue* is about expressing different opinions and ideas, whereas pupils might argue whose thinking makes more sense, think of different ways to reach a solution, or disagree with suggested explanations.

Pirie and Schwarzenberger (1988) have distinguished pupils' talk during mathematical discussions into two categories of statements: "reflective statements" and "operational statements". "Reflective statements" describe concepts and the relationship between them, thus are linked to relational understanding. It has already been argued in the first chapter, that mathematical understanding is linked to relational understanding. "Reflective statements", could be observed through a construction of *dialogue.* "Operational statements", describe actions regarding instrumental understanding, which might be observed in both, *discussion* or *dialogue*. The coexistence of quality "reflective statements" with "operational statements" does not erase the possibility of *discussion* to become a *dialogue.* It is not about the quantity of talk, but about its quality even at some instances during lesson.

Brown (1982), also distinguishes pupils' talk into "message-oriented" and "listener-oriented". "Message-oriented" talk is goal directed that expresses certain message aiming at changing listener's state of knowledge. In order to change listener's state of knowledge, listener should be active by listening and comparing arguments with his own views and knowledge. A discussion of higher mental functions should be developed, in other words *dialogue*, while pupils participate successfully by listening and contributing to the argumentations. "Listener-oriented" talk aims at establishing and maintaining good social relations with the listener, which can be observed while exchanging ideas within a *discussion*. It might seems that everyone pays attention but in this situation pupils are mainly passive listeners, by accepting others opinions but without relating them with their own.

Mercer (1995), identifies three types of pupils' talk in the Spoken Language and New Technology (SLANT) project supports that pupils' talk can be divided into three categories; disputational talk, cumulative talk and exploratory talk. Cumulative and exploratory talk seem to suit into the *discussion* and *dialogue* scheme respectively. Cumulative talk is when speakers "build positively but uncritically on what the other has said...construct 'common knowledge' by accumulation" (p.37). Mercer's reference to 'common knowledge' is not synonymous to Alexander's notion of common understanding, since the last inhibits critical construction of understanding by considering others' points of view. Besides, Mercer uses quotation marks when he refers to 'common knowledge' since through cumulative talk, knowledge is only seemingly common. From that perspective, cumulative talk might be observed within a *discussion* by sharing ideas cumulatively without developing views on each other's idea. Exploratory talk is when pupils "engage critically but constructively with *each* other's ideas" (p.37). It is when pupils use justified statements to challenge and counter-challenge each other which it certainly fits into the *dialogue* scheme.

Borich (2007), refers to "teacher-mediated dialogue" and gives to the term the same meaning Alexander offers for the term *dialogue.* It helps learners reconstruct what is being learned using their own ideas and thought patterns. "Teacher-mediated dialogue", is not about the correct answer but asks the learner to internalise the meanings by elaborating, extending, and commenting on it using the learner's own technique thoughts.

Burbules (1983), uses the term dialogue to refer to all classroom talk generally while among the four two hierarchical categories presented in his study, one is coincided with *discussion* while two fit Alexander's schema of *dialogue.* "Dialogue as a conversation" inhibits sharing of information in order to build a community of shared knowledge thus, it fits the *discussion* pattern of Alexander. "Dialogue as inquiry" and "dialogue as debate", could be both translated into *dialogue* since the concept of consensus. In other words, common understanding, is embedded in both of them, while "dialogue as a debate" suits much better since it underlines that participants are characterised by critical and combative stance.

Scott et al. (2006), categorise interaction during science classes into four distinct types. Among them, "dialogic interaction" can be aligned to both *discussion* and *dialogue*. They define it as a situation where teacher and pupils consider a range of ideas, pose genuine questions and explore different points of view. However "if the level of interanimation is low, the different ideas are simply made available" (ibid, p.611). Thus, at a low interanimation level the ideas are only shared and not critically developed through talking. This mirrors the concept of *discussion*, whereas at higher interanimation level it becomes a *dialogue* since different points of views are taken in mind by the participants through cumulative questioning.

Lastly, “contextual privileging format” and “pastiche format”, suggested by Renshaw and Brown (2007), seem to be coincided with *discussion* and *dialogue* respectively. “Contextual privileging format” requires teacher to support pupils in judging the importance of an idea which is coincided with *discussion's* interpretation of sharing knowledge and solving problems. However, Renshaw and Brown clearly indicate the significance of pupils adopting a certain way of speaking and acting. A notion which remains untouched in Alexander’s dialogic teaching, probably because of its asynchronous connection to the notion of dialogic teaching. *Dialogue* enables “handover” of concepts in line with “pastiche format”, which offers multiple representations of the very same concepts in order to be considered by all the participants.

Considering Wegerif’s (2008) argumentation, *discussion* and *dialogue* are translated according to Bakhtin’s and Vygotsky’s writings to dialogic and dialectic, respectively. This is extensively presented in the section “Adopting the Terms Discussion and Dialogue as Dialogical Schemes”, in the first chapter.

Concluding, *discussion* and *dialogue* should characterise the daily lessons even at some instances during classes. A simple exchange of opinions is transformed into *dialogue* when the context of the lesson is designed to enable quality contributions by the pupils. Contributions that could not be made by anyone alone, rather than the pupils built their thinking according the contributions of the classmates; this is how quality is addressed to the contribution. As Alexander (2004) stresses, “the dynamics of talk matter no less than its content, while social and cognitive purposes go hand in hand”. *Discussion* has its own importance since it is only a “step” away from *dialogue*. If teacher appropriates the context and teaching methods is easy to make that step forward. The question is *how* a teacher can reach that level in order to become more effective, an issue developed in the following sections.

Table 2: Typologies aligned to Alexander's *discussion* and *dialogue*

Author	*Discussion*	*Dialogue*
[Bakhtin, see p.36-37]	Dialogic	
[Vygotsky, see p.36-37]		Dialectic
Barnes and Todd, 1977		Collaborative dialogue
Voigt, 1995	Discussion pattern/Elicitation pattern	Discussion pattern
Pirie and Schwarzenberger 1988 (pupils' talk)	Operational statements	Operational statements/ Reflective statements
Brown, 1982 (pupils' talk)	Listener-oriented	Message-oriented
Mercer, 1995 (pupils' talk)	Cumulative talk	Exploratory talk
Borich, 2007		Teacher-mediated dialogue
Burbules, 1983	Dialogue as a conversation	Dialogue as inquiry/ Dialogue as a debate
Scott et al., 2006	Dialogic interaction	Dialogic interaction
Renshaw and Brown, 2007	Contextual privileging format	Pastiche format

Dialogical Schemes: an everlasting target of education

Raising quality classroom talk, has been a target of education internationally for many decades. Edwards and Westgate (1994) argue that, important studies on classroom dialogue can be found from 1970s. English et al. (2002) indicate that, the need for interactive teaching has risen in USA in late 1920s with a research emphasis on pupils' freedom of speech after concerns about the rise of fascism in Europe. In UK government introduced the National Literacy and Numeracy Strategies in 1998, stressing the importance of "interactive whole-class teaching" where pupils should involve and contribute to high quality discussions (DfEE, 1998, 1999). More recently, England's primary national curriculum in 2009 underlined, among others, the importance of acquiring the key skills of communication and working with others, as well as thinking skills of reasoning, enquiry and creative thinking (Alexander et al., 2010). However, it is quite ironical that while research and educational policies have been stressing the importance of quality interactivity, through inspired and creative classroom talk, there is no consistent evidence indicating that teaching instruction follows such scheme; on the contrary.

Alexander (2008) through his cross-cultural study found that dialogical schemes though the most cognitively valued types of classroom talk are those met rarely in classrooms. However, he found that classroom talk mainly consisted from a basic repertoire of three types of teaching talks, other than dialogical schemes:

- *rote* (teacher-class): the drilling of facts, ideas and routines through constant repetition;
- *recitation* (teacher-class or teacher-group): the accumulation of knowledge…through questions…to…stimulate recall…or to cue pupils work out the answer from clues provided in the question
- *instruction/ exposition* (teacher-class, teacher-group or teacher-individual): telling the pupil what to do, and/or imparting information, and/or explaining facts, principles or procedures.

(p.87)

Apart from Alexander's study, extensive literature points to the pervasiveness of similar patterns of talk within classroom in terms of being poor in cognitive demand by the pupils. Some of the most broadly known are the three moves IRF/IRE structure, recitation script, triadic dialogue and the two-thirds rule; IRF structure is further discussed for its cognitive value in the following section 'The importance of feedback', in p.81.

The IRF structure was first indicated by Sinclair and Coulthard (1975) as a teacher-led talk consisting of three moves observed dominantly in all classrooms. Those are initiation (I), usually in the form of teacher question, a response (R), in which a student attempts to answer the question, and Follow-up move -also found as Feedback (F), where teacher provides some form of feedback to pupils' answer. The IRF structure consists of closed questions, brief pupils' answers, recalling of information and is prevalent in directive forms of teaching (Smith et al.2006). Mehan (1979) named the third move evaluation (E) thus some refer also to the IRE structure. Lemke (1990) gave the name "triadic dialogue" to refer to the three moves of such structures. Tharp and Gallimore (1988), refer to the "recitation script" to describe the situation within classrooms. It consists mainly of teachers asking questions, in hope of eliciting certain predictable and 'correct' answers from their students. As they point out, in such circumstances interactions restrict largely to rote learning and reciting facts. Flanders' (1960) "two-third rule", stresses the results of his study which indicated that two-thirds time of classroom time is dedicated to talking. About two-thirds of that talking teacher is the person who talks while two-thirds of teacher's talk is devoted in directing pupils.

Typologies and characterisations of talking patterns can be found extensively in literature. Besides, Howe and Abedin (2013) stress that characterisation of talking patterns can be found extensively in literature and should not be considered of high priority for future research. Thus, since the interpretation of the essential dialogical schemes has been made clear, any type of classroom talk which refrains from such scheme will be simply named traditional or stereotypical type of talk, because they have become a “tradition” within classrooms. A fact evident in many more studies beyond those already mentioned.

Three decades ago, Galton et al. (1980) have concluded that only few questions made by the teacher enabled imagination and reasoning in primary school classroom, while teacher’s talk was related to routine and management issues as well as monitoring and checking pupils’ work. This constitutes the first large scale study on teacher-pupil interaction in primary education in UK (Hargreaves et al., 2003). In Australian setting, it has been concluded that questions were related to content-knowledge and recall of facts while only few encouraged higher order thinking in maths (Daines, 1986, cited in Way, 2008; Sullivan and Clarke; 1990).

Nowadays, the scene still remains the same while the need for skillful thinkers has become more urgent, in a universally set arena of professionalism. In US, studies indicate that classroom talk is one-dimensional with the teacher mainly orchestrating monologic discourses to provide factual information and rarely to boost dialogical forms of talk (Nystrand et al., 2003; Piccolo et al., 2008; Bennett, 2010). In Germany (Cutrim Schmid, 2010), in an ethnographic study the teacher participating in the project after seeing the video-recorded lessons, pointed out - to herself - that there was too much teacher talk which followed the IRF structure and lessons were teacher-centered. Studies in Singapore, also conclude that teaching is characterised by transmission of content knowledge, while teacher’s talk dominates the discourse (McInerney and Liem, 2007, cited in Teo 2003). Even though some teachers might attempt to develop quality pupils’ talk, by no means it can be quoted as spells of dialogic teaching (Teo, 2013, p. 98).

In UK, the National Literacy and Numeracy Strategies introduced in 1998 pointed towards dialogic forms of teaching to reform traditional approaches characterised by lecturing and drilling of facts (Smith et al. 2006). But this was adopted along with the need to keep a well paced lesson with a sense of urgency where teachers should remain intact to the initial objectives, thus control pupils’ contributions (English et al. 2002). Indeed, Hargreaves et al.

(2003) reveal that, teachers increased interactivity by increasing the number of questions, but they still spent most of their time to give information and tell to pupils what to do. Also, investigating the introduction of the new curriculum in England Galton et al. (1999) found that, teachers spent more time providing information than asking questions while interaction had worsened in quality compare to their previous study in 1970s. A cross-cultural study by Alexander (2000) in five countries indicated that, classroom interaction in England is characterised by what it could be called the traditional IRF structure, in line to Mroz et al.' s (2000) conclusions.

Certainly, comparative educational analysis among countries does not fall into the scope of this thesis. However, it becomes evident across the references above that, while many countries recognise the importance of quality talk it is not mirrored in their educational practice. Indeed Alexander (2008), in his intercultural comparative study of primary education in England, France, India, Russia and the US concluded that, "discussion and dialogue are the rarest yet also the most cognitively potent elements in the basic repertoire of classroom talk" (p.31). Hence, it seems that recitation, constitutes the default mode of British pedagogy (ibid). In line, a systematic review on classroom dialogue by Howe and Abedin (2013), targeting studies since 1972, indicate that the situation remains static for over 40 years. Literally, classroom talk still follows the traditional IRF structure. Evidently, as stated in the beginning, while patterns of teaching synchronized to dialogic teaching have been set as a target, it has not yet been fulfilled.

Consequently, the importance is now drawn on the quality of the oral exchanges rather than their observed frequency during lessons. A fact mirrored across literature where studies stress the importance of developing quality talk through dialogical schemes by presenting their cognitive potential. However, this is not coupled with an explicit focus on *how* a teacher can develop them whereas it might be the reason of the pervasiveness of the observed stereotypical talk across classrooms.

Indeed, Howe and Abedin (2013, p.326) pose the question "…how a classroom dialogue is organised, and are some modes of organization more beneficial than others?". Their comprehensive systematic review did not answer that question but lead in suggesting ways to resolve it. They suggested that initially a strong model of classroom dialogue need to be decided followed by studies examining diverse factors that influence the application of the model. Howe and Abedin (2013), also stress the importance of designing quantitative research in this field while the majority of the studies so far has been purely qualitative. In line, Alexander (2008) articulates many dilemmas related to classroom organisation. For example, "Should the teacher …be seated on a chair above the children?", "What are the best conditions for whole-class dialogue?" (p.48). Moreover, there is no evidence to indicate the relationship between the diverse discourse genres and particular types of tasks or activities (Wells 1999).

Evidently, the interplay between instructional and organisational strategies to support dialogic teaching is yet unresolved. Under such circumstances, it is a priori a difficult task to argue about process-related features of dialogic teaching approaches. As such in the following section a spherical view on quality instruction towards dialogic teaching is developed as encapsulated by existing literature focusing particularly on issues regarding procedures of questioning.

Focusing on Quality Instruction from a Process Perspective

<u>Quality questioning across subjects</u>

In order to create discursive classroom approaches teachers should be trained in relation to how successful teachers pose questions (Piccole et al., 2008). Besides, as already pointed out while presenting the crucial role of the teacher as an instructor (p.49-55), teacher's questions constitutes the skeleton of any discourse. Consequently, posing and handling questions shapes the discourse of a lesson. Besides, Alexander (2008) stresses that dialogic teaching can be indicated through the questioning procedure within the context of the lesson. Thus, one needs to do this properly in order to develop dialogical schemes. In other words, quality questioning is assumed as empowering dialogic teaching and provokes higher-order thinking.

Even though the focus of this study is on maths, developing questioning techniques can be applied across all subjects. Teachers participating in Knuck' s (2010) study mentioned that, the same ideas of talk and questioning apply and should be integrated in all subject areas. Indeed, Falle (2004) state that, techniques related to the teaching of the language may be adapted to teach maths. Also, Smith (2005) indicates that talk and thinking are related to all areas of pupils' learning. Literally, as long as subjects are taught through language, techniques for quality questioning can be universally applied. Thus, the following issues can be related to many subjects across the curriculum, beyond maths.

Looking at discourse as a whole

Brown and Elizabeth (2007) drawing on Bakhtin, contend that classroom talk encompasses both "what" is being said, the "way" in which it is spoken and the positioning of participants according the framework established within each classroom. Thus judgments about the type of talk that focus solely on each question-and-answer exchange during lessons are too simplistic (Mercer and Littleton, 2007). Each and every question serves a specific role based on what was previously said or done during lesson influenced by the context of it. Indeed, Cobb and Bauersfeld (1995) argue that, activities and children's responses in maths are constituted according to the social event rather than the social setting. "It is the context rather than the setting that distinguishes qualitative differences in students' explanations", (ibid, p. 28). Thus, analysis of talk should take place in the context of the discourse as a whole. Many studies aim in analysing talk that takes place during lessons either from teacher's (Smith et al. 2006), or pupil's perspective (Brown, 1982; Pirie and Schwarzenberger, 1988; Mercer, 1995). Yet, teacher's and pupils' talk should be reciprocally interpreted and investigated; communicating individuals cannot be easily separated.

The importance of looking at classroom discourse as a whole taking place in a context, is stressed by others as well. Burbules (1993), as well as Renshaw and Brown (2007), classified classroom talk in four overarching categories embedding the importance of context. For example, Renshaw and Brown identify four formats of classroom talk; replacement, interweaving, contextual privileging and pastiche. According the last discourse typology, looking at the designation and interpretation of its last two categories it is apparent that improvements in the quality of talk are related in appropriate context allocations. More precisely, in contextual privileging format "certain ways of speaking and thinking are chosen over other possibilities on the grounds of appropriateness to the particular setting with its specific set of ground rules for participation" (p.537). If at the same time pupils elicit and communicate different ways of thinking about concepts through teacher's support then talk is characterised by the most effective format, the pastiche.

Similarly, the adopted categorisation by Alexander (2008) regards *teaching talk* and constitutes another argument, in favor of his conceptualisation of dialogic teaching. His categorisation suits a context-related analysis engaging both teacher and pupils, while grasping the essence of quality teaching avoiding flamboyant and highfalutin terminology. The five categories of teaching talk introduced by Alexander have already been presented at the beginning of the chapter; rote, recitation, instruction or exposition, discussion and dialogue (p.57 and 66).

Overall, classroom talk should be seen as a whole within the context that takes place. The most ideal organisational setting for each case within the context of the talk constitutes a matter which needs to be further investigated as already mentioned previously in this chapter, in p.70.

The importance of ground rules for talking

The appropriateness of a context for every new interaction between speakers and listeners is shaped through a set of ground rules applied to establish the type of talk within that context (Mercer, 2000). Ground rules for talking, have been related and found to be effective for peer group discussions (e.g. Mercer et al. 1999; Mercer and Sam, 2006). Renshaw and Brown (2007) argue that, quality classroom talk goes hand in hand with its specific set of ground rules for participation, as mentioned in the previous page.

Frequently, ground rules remain implicit for teachers and students since they are rarely explicitly negotiated in classrooms (Staarman, 2009). Mercer and Dawes (2008) argue that an implicit ground rule, among many others, is that teacher is the only one who can evaluate pupils' comments. This contradicts the notion of dialogic teaching, since it is related to authoritative and traditional teaching undermining the importance of pupil-pupil interaction. Indeed, Smith (2005) states that changing such patterns is considered as crucial for advocates of dialogic teaching.

From a different perspective, Lambirth (2009) supports that the application of ground rules for talking introduce a "principled" way of talking, controlling the language in use in schools, resulting in reproducing the traditional social class authority in education. Adopting a similar view in a broader perspective, Black (2004) suggests that, the introduced focus on teacher-pupil talk may more beneficial for pupils of higher ability. But, the notion of dialogic teaching is profoundly developed upon egalitarianism, evident in the characteristics of dialogic teaching at beginning of this chapter. For example, teacher and pupils address learning tasks together, teacher as well as pupils might pose questions during lessons, pupil-pupil interaction is empowered, etc.

Teo (2013) supports that, establishing an egalitarian relationship between teacher and students constitutes the basis of dialogic teaching. Towards that end, he suggests that ground rules for talking must change so that teacher is not the only one who evaluates responses or decides who gets to speak. Only by establishing ground rules in that manner there is space for true solidarity and equity to emerge (ibid).

The necessity of oral repertoire

Even though the most desirable type of talk is dialogue it is utopian to argue that classroom discourse should or could be characterised solely by this type of talk. Indeed, Alexander (2008) stresses that dialogue has its merit within a larger oral repertoire. On the one hand, discussion and dialogue are not mutually exclusive and on the other hand, "we are not arguing that rote, recitation and exposition should be abandoned" (ibid, p.39). Indeed, in practice the boundaries among different types of talk in such categorisations is permeable and might constitute a synthesis of one or more categories hence the context of the talk needs to be taken into consideration (Teo, 2013).

Alexander (2008) stresses that, dialogic teaching is facilitated when teachers are prepared to meet the needs of different types of talk according the learning tasks. In line, Wells (1999) explains that discourse throughout a lesson cannot be characterised by a single type of talk since discourse genres are selected according the goal of each task within activities. He argues that discourse genres should be chosen based on the tasks involved rather than the activities. Thus, homogeneity of discourse does not exist in multi-task activities (ibid). More importantly, Wells (1999) stresses that there is no evident, so far, to suggest which discourse genres are best suited to different types of tasks.

Consequently, this should be aligned to a question repertoire as well since questioning constitutes the skeleton of any discourse, as already argued in the "Instructional strategy" sub-section p.49. Questioning has been a widely studied field thus one can find an extensive number of question categorisations. One perspective is that, the different types of questions depend on their cognitive demand, mirrored in the content and length in answering them. However, research findings on questions' classification have been uninformative as to when and why different questions should be used and point out that that all types of questions have their merit in learning (Good and Brophy, 1997).

It is possible for closed forms of questioning to support a more genuine rather than a rehearsed response while open questions might elicit only the 'right answers' from pupils (Burns and Myhill, 2004; Skidmore et al., 2003; Teo, 2013;). This should not diminish though the importance of open questions which has been found to have great effect in developing dialogic discourse (Nystrand et al.2003). Similarly, Askew and William (1995) state that, lower-level questions test recall and higher-level questions pupils' understanding while both have their importance. Galton et al. (1999) suggest that, a solution to this problem of diverse question types and their functionality could be solved by defining questions according teachers' reactions to pupils' responses.

Indeed, Smith and Higgins (2006) suggest that, emphasis should be more on the manner teachers react to pupils' responses rather than the questions posed; the importance of feedback is discussed at the end of this section. Thus, when a dialogue arises it certainly includes many types of questions while the critical issue is to reach cognitively demanding questions. Blending higher and lower level questions, is better than using the same type of questions (Askew and William, 1995). Thus, questioning is seen as a procedure taking place in a context, rather than constituted by the type of each question (Boyd and Markarian, 2001; Teo, 2013); arguments which reinforce and stress the importance of the context in shaping discourse. Literally, questioning techniques should point towards a quality questioning context, rather than quality questions per se. In the remaining sub-sections, questioning-related issues are developed in more detail.

Structuring and distributing questions

Among others, structuring the lesson effectively relates to the way questions are posed during a lesson. The critical issue is the sequence and meaningfulness of the information being exchanged and not the cognitive level of each question (Good and Brophy, 1997). Effective questioning tends to run in sequences, which build up from lower order questions to higher order, making progressive demands on pupils' thinking (Kerry, 1982). Good and Brophy (2007) suggest that, the previous sequence is appropriate for calling students' attention to the lesson and then stimulating them to integrate facts and draw a conclusion. They also argue that, sequences could begin with a higher-level question, and then move on to several lower level questions in cases that teacher wants to examine possible applications of an idea by the students and then probing for details of how these applications might work.

Planning the lesson in advance should lead the teacher to decide an appropriate structure of questioning, but only few teachers take the time to plan specific questioning techniques on a regular basis (Reinhart 2010). As Groisser (1964) explains, advance planning helps teacher to raise previously designed and targeted questions. He also explains that planning should not be firmly prepared, since teacher might have the chance to build up the lesson from a student's question or comment. However, improvising most of the questions might lead teacher to ask irrelevant and confusing questions (Good and Brophy, 2007).

Also Kerry (1982) argues that, "good question technique includes the ability to distribute questions around the class" (p.8). Students learn more when they are involved in discussions and teacher might succeed that, by distributing questions widely instead of allowing few students to answer most of them (Bell, 1993, cited in Falle, 2004; Good and Brophy, 1997). Besides, the notion of egalitarianism is embedded in dialogic teaching, as already mentioned previously in this chapter within the sub-section 'The importance of ground rules for talking', p.73) .

Using a statement as a basis to develop dialogical schemes

Interestingly, some argue that sometimes teacher could pose a statement to stimulate and structure a discussion (Askew and William, 1995; Naylor and Keogh, 2000). In maths for example, teacher might say "A child in another class said you couldn't have two rectangles that had the same perimeter but different areas…" (Askew and Williams, 1995). Such statements could be posed using puppets or cartoons since it increases pupils' interest to participate in the discussion (Askew and William, 1995; Naylor and Keogh, 2000; Keogh and Naylor, 2009).

Using process questions

It is critical to direct pupils to the procedure of solving a problem rather than simply phrasing the correct answer, since only through this path teacher can find out how pupils think (Falle, 2004). Mercer (1995) argues that asking pupils why they had gone through an activity in the way they did, is useful to externalise their perspective and stimulate their own reasoning.

An excellent example of process versus product question is one given by Duffin (1986). While asking a pupil to match pieces of paper cut out from cylinders, to the respective cylinders a teacher might pose two questions: "1) Which piece of paper will wrap round each of these cylinders? 2) How could you match these pieces of paper to these cylinders? " (p.12). Obviously, the second one while focusing on developing pupils' thinking at the same time sets the scene for diverse responses. Under such circumstances teacher creates a risk-free environment which is crucial in raising quality talk (Bell, 1993 cited in Falle, 2004; Alexander, 2008; Knuck, 2010).

Waiting time

For each question phrased by the teacher there is another important question to be borne in mind: How long should teacher wait in order to get an answer? Waiting time depends on the type of the question. Closed, lower level factual questions require short period of waiting time which is around 3 seconds (Muijs and Reynolds, 2001). Higher-level questions which demand thoughtful answers should be given more waiting thinking time, up to 15 seconds (Kerry, 1982; Muijs and Reynolds, 2001). Rowe (1974) concluded that, after training teachers extended their wait times to three to five seconds, there was a decrease in failures to respond, an increase in student-initiated questions, an increase in students' responses, greater variety of contributions by students, etc. "If I always call on one of the first students who volunteers, I am cheating those who need more time to think about, and process a response to, my question." (Reinhart, 2000, p.480). Indeed, Cohrssen et al. (2014) conclude that incorporation of pauses raise the quality of talk, while pauses are not necessarily silent; teacher might as well interact with another child in between. Interestingly Chapin et al. (2009), suggest the use of two wait times, one after the question and one after a pupil has answered it. In line Mercer et al. (2004) stress that, dialogic silence or long pause might improve problem-solving.

Also, in an egalitarian concept of dialogic teaching teachers might also need thinking time to answer to pupils without feeling obliged to offer a response right away. As Alexander explains,

> It would be refreshing to hear them say that "I need to think about that answer" rather than that they should feel obliged always to pounce on a pupil's contribution with an instant evaluation or follow-up question. (p.51)

Overall, waiting time has its merit for both pupils and teachers in shaping quality instruction.

<u>Handling prompting</u>

Even given the appropriate waiting time, getting partially correctly answer or getting no answer at all is another issue teacher has to deal with. When this happens, teacher calls someone else to respond, rephrase the question or give clues. However, teacher should first try to help the student who first answered the question partially to find the right answer (Muijs and Reynolds, 2001). Kerry (1982) indicates that teacher should prompt by going back some steps and making simpler questions and gives the following example to explain it:

> Teacher: What are the arguments in favour of euthanasia, John?
> John: (no response – shrugs)
> Teacher: Do you remember what euthanasia is? I broke it up into parts to explain it: "EU" meaning "well" or "easy" and "THAN". What did "THAN" mean?
> John: Death.
> Teacher: Good. So what did the whole word mean?
> John: Making death easy, like when you're old and very sick.
> Teacher: Yes, good. Well, some people believe the end should be made easy, then. Why do they believe that? (…)
>
> (p.58)

Apart from verbal prompts, teacher can also use gestural and physical prompts (Muijs and Reynolds, 2001), but is recommended to start by using verbal prompts which are the least intrusive (Cooper et al., 1987). Teachers should make explicit which part of the answer is correct or incorrect and also to acknowledge excellent responses (Good and Brophy, 1997). As Alexander (2004) mentions feedback should be honest whereas in UK (and America) it is common "for a child's contribution to be praised regardless of its appropriateness or quality, so as not to discourage the child" (p.20).

Repeating pupils' exact own words though is not considered as prompting, yet it could be argued that in some instances using the appropriate manner repeating pupils' words could serve as prompting. Putting a different emphasis or using an interrogative tone pupils might be encouraged for further comments. However, it is argued that teacher should avoid repeating one's own questions and pupils' answers, answering one's own question and questioning for chorus answering (Turney, 1975). "Never say anything a kid can say" is the title of Reinhart's (2000) publication emphasizing to the positive effect of avoiding the temptation to repeat or rephrase a pupils' response. He mentions that, "if students realise that I will repeat or clarify what another student says, they no longer have reason to listen" (p.481). In line Hennessy (2011) argues that, avoidance of repeating pupils' contributions constitutes a dialogic teaching amplifier by developing pupils' confidence and skills to express their own ideas. Interestingly, Smith and Higgins (2006) suggest that, teacher's comments where they paraphrase pupils' ideas ratify their importance and can facilitate share understanding. Repeating and paraphrasing pupils' contributions certainly refer to distinct and potentially co-existing actions, that could be taken by the teacher. Thus, previous views might be in line if they accept Smith and Higgins' argument. Perhaps, teacher should decide when it is necessary to clarify pupils' responses in case of misunderstandings so that others could follow-up in the discourse. Whatsoever, this issue is further resolved in the last sub-section of this chapter, 'The importance of feedback', where the process of providing feedback is further analysed.

Pupils get chances to pose questions

In a dialogic classroom environment pupils and not just teachers ask questions while pupils listen and build on each other's contributions (Alexander, 2008). Pupils should get chances to question their peers and ask for further clarifications in case of misunderstandings. Indeed, Groisser (1964) notes that, in order to raise and maintain discussions, is also helpful to allow students to respond to one another. Wright and Nuthall (1970) concluded that, this last technique applied in science lessons was followed by increment in achievement. In line, Reinhart (2000) suggests that, allowing pupils to listen to each other is a far more effective way to deal with misunderstandings than announcing to the class that an answer is incorrect.

This seems to contradict Good and Brophy's (1997) previously mentioned argument that, teachers should make explicit which part of the answer is correct or incorrect. However, a teacher might correct some pupils only in some instances during peer discussions, which points towards two already posed arguments. On the hand, it is important to focus on the context rather than analysing discourse moves in isolation, as argued at the beginning of this section. On the other hand, during lessons classroom talk might take many forms and this is considered to be not only realistic but desirable too, oral repertoire is a realistic target of dialogic teaching (refer to 'The necessity of oral repertoire', p. 74).

The importance of feedback

Dialogue aims to develop quality thinking thus, instead of focusing on the duration of an answer we should consider what happens to each answer that makes it worth uttering (Alexander, 2008). Providing feedback in the right manner constitutes a crucial characteristic of developing dialogic talk and quality thinking.

Many suggest that when handling children's contributions is better to answer in a personalised manner instead of an institutionalised one (Mercer, 2000; Smith and Higgins, 2006). Using Smith and Higgins' (2006) transcript of a classroom talk instance, this argument will become more explicit. Pupils had to write a radio advert for their new imaginary toy and teacher asked them to describe it to the class:

> Pupil: Ehm, it's a guitar with, ehm, laser strings but the strings aren't exactly laser so they don't chop your fingers off [general laughter]. It's, it's for teenagers that actually knowhow to play the guitar and its main features are laser strings so they can't snap. Ehm, it's the mainframe of it is black with planes on it.
> Teacher: Ah, now I have to say I think that's going to appeal to people who play guitar. I know my sister plays the guitar, drives her mad every time the strings break, so if she heard, if she was driving to work and heard an advert for that on the radio, I can guarantee she'd go out and buy one!
>
> (p.498)

By answering using his/her personal experiences, instead of just saying "that toy is good because…", teacher defines the talk as reciprocal (Smith and Higgins, 2006) while pupil recognises that his/her contributions are indeed important; an emotional bond is also inherent in such type of talk exchanges.

Moving on, in a previous section of this chapter (p.67) IRF structure was cited as a type of talk which is found to be prominent in classrooms pointing towards traditional talk where the importance of feedback is diminished. Howe and Abedin (2013), represent this giving an example of the three moves such as, I: "When was the Battle of Hastings?" R: "1066", F: "Very good". Similarly, Smith (2005) represents it as, I: "What is the capital of France?" R: "Paris" F:

"Good girl". Obviously, this mirrors a closed type of teachers' questions searching for an already known single answer as evident in teacher's third move-feedback (Rojas-Drummond and Mercer, 2003; Smith et al., 2006).

Many argue that, using this typology to assess teachers' questions diminishes the multilevel nature of talk and is based on a poor understanding of talk (Mercer, 1995; Wells, 1999; Rojas-Drummond, 2000; Alexander, 2001). This mirrors previous argumentation about the importance of looking to the discourse as a whole, instead of looking at each question and answer in isolation. Indeed, Wells (1999) argue that as long as the third move (feedback) of the IRF structure forms the next cycle of the teaching-and-learning spiral in the co-construction of meaning, it has a point of departure. It can be said that, this mirrors Alexander's (2008) argument that the three moves should be progressively developed into a coherent and expanding chain of enquiry. Evidently, emphasis should be more on the manner teachers provide feedback rather than the questions (Smith and Higgins, 2006), since feedback constitutes the critical move to chain questions into a coherent spiral of discourse.

The importance of this issue is apparent in the perceived value of scaffolding, presented in the theoretical perspective of the author. At the same time, the manner a teacher provides feedback shapes the scaffolding procedure along with the questions posed; feedback could be posed through another question as well. Thus, it becomes apparent that teacher has a control over this procedure indicating that, criticisms over "direct instruction" are rather exaggerated since teacher should guide and direct scaffolding (Ausubel, 1968; Hattie, 2002; Moseley et al. 2005). Besides, this is evident even by the term "instructional strategy", extensively analysed in the previous chapter (p.49), since teacher is the person who instructs and shapes the discourse, while handling the formative assessment process embedded in his or her instruction. Also, Hawthorne (1987) stresses the importance of feedback by arguing that formative assessment aims to improve learning outcomes through structured feedback.

Moreover, Smith (2005) stresses that scaffolding – and thus feedback- should be provided "for as long as it is required but should be gently removed thereafter", in a manner that teachers do not create "a culture of dependency…by providing more scaffolding than is needed…" (p. 22). Scaffolding more or longer than necessary is perhaps the reason of criticisms against "direct instruction" but this should not diminish the importance of teacher-led discourse.

Overall, a teacher-directed discourse does not imply teacher's prominence, neither should be connected to stereotypical patterns of discourse. On the contrary, by handling pupils' responses and providing feedback which progressively scaffolds pupils' thinking can serve as an amplifier to dialogical schemes.

Concluding, classroom talk has long been shown to impact effectively on pupils' learning in maths (Bennett, 2010); argument broadly and well established (Cobb et al. 1991; Gose, 2009; Lampert, 1990; Pugalee,2001; Way,2008). Nowadays, considering as a de facto the crucial role of talk during maths, research focus in investigating ways to develop effective and dialogic discourse patterns (Black, 2004; Bennett, 2010; Brown and Elizabeth,2007; Cohrssen et al. 2014; Knuck, 2010;)

Overall, questioning has a direct impact upon the talk that takes place during lessons while teacher impacts on the development of discourse by his or her decisions and actions. Teacher should aim at activating pupils thinking and motivate them to verbalise their thoughts. "Questions are rarely ends themselves but rather a means of engaging students in the learning process by getting them to act on, work through, or think about the material presented" (Borich, 2007, p.22). The target is not to increase the amount of talk, but to raise the quality talk (Chapin et al., 2009).

2.4 INTERACTIVE WHITEBOARD TECHNOLOGY: THE TRANSFORMATION OF EDUCATIONAL CONTEXTS IN OUR ERA

Brief history of the introduction of IWBs in UK's educational system

Enormous amount of money, in forms of funding and grants, have been placed into UK schools so that IWBs could be installed (Glover et al., 2005; Higgins et al. 2007; Lee, 2010) aiming to support more interactive teaching delivery (Smith et al. 2005) and raise of attainment in core subjects (Beauchamp, 2004); with a range of arguments about the potential benefits evident in numerous Becta and Ofsted reports. More precisely, around 2002 schools which pioneered in technological equipment started placing IWBs (Lee, 2010) while until 2010 they were found in 70 per cent of UK classrooms (Futuresource Consulting 2010, cited in Hennessy, 2011). Five years on probably that percentage has become even greater with UK holding worldwide the highest proportion of IWB classroom installations; at least until 2010 (Futuresource Consulting 2010, cited in Hennessy, 2011).

Obviously, enhancing interactivity is envisaged to be the most desirable outcome of this technology in terms of leading to attainment gains. It is critical though to refer to IWB's potential to enhance interactivity across two distinct levels: technologically oriented and pedagogically oriented change. As Dawes (2001, in Mercer et al. 2010) stresses, in UK initiatives have been "technology led" rather than "educationally led". Similarly Smith et al. (2005) conclude that it would be interesting to investigate the intersection between technical and pedagogic interactivity from a realistic perspective. Synchronizing technological features to pedagogically informed methods which open up space for dialogic interactions, is yet to be clearly confirmed.

Technologically interpreted interactivity of the IWB

To begin, a description of the IWB technology is given by Mercer et al. (2010, p.196) as embracing succinctly the term "IWB", even though an interpretation of what is an IWB probably has become redundant.

> Interactive whiteboard systems comprise a computer linked to a data projector and a large touch-sensitive electronic board displaying the projected image; they allow direct input via finger or stylus so that objects can be easily moved around the board or transformed by teacher or students. 'Flipchart' software provided with the board or obtained separately provides a variety of functions, including those which replicate non-digital technologies such as flipcharts, dry-wipe boards, overhead projectors, slide projectors, and video-players, and others which have not previously been possible on a large, vertical display.
>
> (p.196)

Obviously, there has never been one single device in a classroom before resulting in such a range of digital tools converging (Kent, 2006), characterised by such multimodal interaction (Hennessy, 2011) using a range of multimedia resources (Kennewell and Beauchamp, 2003) through display technology. Numerous characteristics and functions of IWB can be found extensively and repeatedly in literature. These include facilities to save and re-use material, to drag and drop, to present in sharp colours, movement and animation, to get immediate feedback, to manipulate and annotate images, amongst others (Glover and Miller, 2001, 2002; Higgins et al.2007; Smith et al. 2005, 2006).

All these functions seem promising in terms of supporting various approaches to learning (Ball, 2003; Bryant and Hunton, 2000), increasing pace, participation and motivation mirrored in holding more strongly pupils' attention (Smith et al. 2005) while expanding positively teachers' and pupils' perception of the technology (Hall & Higgins, 2005; John, 2005; Loveless, 2003; Slay et al., 2008; Tanner and Jones, 2007b; Wall et al., 2005).

However, quality interactivity is not imposed or intrinsically enhanced when such claims are made. Towards that end, Higgins et al. 2007 suggest that IWBs could be called more accurately electronic or digital whiteboards. The actual impact of IWBs is decided by investigating teaching procedures and outcomes, by targeting dialogically enriched classroom environments. There is evidence to suggest that quality interactivity has not been yet - systematically at least –evident within IWB lessons, as presented right after.

IWB's *actual* impact on interactivity: Scanning literature

Few teachers employ technological tools –hardware and software - in ways which improve teaching and learning while teaching processes mirror patterns of previously applied teaching methods (Cuban, 2001). It seems that this is the case for the IWB technology as well. Smith et al. (2006) found no differences in teaching and learning practices when compared IWB and non-IWB lessons.

The target of moving away from the traditional teacher-centered lecture type lesson seems to remain untouched. Instead, IWB use without the right guidance, reinforce a teacher-centered lesson enhancing a passive than active role for learners (Knight et al. 2004). Moss et al. (2007) argue that the pressure to "get through" curriculum content in IWB lessons result in decreasing pupils' thinking time while teacher becomes the one and only operator. Under the same scope, the main findings of my Master thesis in 2007 (Appendix 7) suggest that, the IWB is used rather often during the lessons but mainly as a presentation tool for the teacher. Pupils might work on the board but they are not engaged interactively with the activities. They mainly go briefly to the board to indicate or write an answer.

There is a general agreement in literature that teachers consider IWBs as valuable in gaining and maintaining the attention of pupils (Beauchamp et al. 2010). The fact that IWB holds pupils' attention probably boosts the pace of moving through the curriculum using the presentational function of it while having the control at the touch of the screen speeds up the procedure. In parallel, it is argued that pupils enjoy more lessons where teachers make least use of the interactive potential of the IWB and most use of its facility to present multimedia resources (Beeland, 2002). Unfortunately, this happens at the expense of pupils' quality in responding, which consequently limits chances for reflection and development of quality talks (Higgins et al. 2005; Kennewell, 2007; Kennewell and Beauchamp, 2007). As elaborated in a section of the previous chapter (p.70), pupils' responses, as well as pauses, shape the context of the talk while constitute a corner stone in developing quality interactivity.

Interestingly and more recently, Mama and Hennessy (2010) contend that, the highest integration level of technology was met in contexts – at least one case - without an IWB. In this context a particular teacher's practice was translated as "constantly monitoring…progress, encouraging…reticent students while occasionally assembled them around a computer…discussing the different levels of the program" (p. 271). Contrastingly, other teachers were found to use the IWB in a less thought-provoking manner such as drill and practice.

Such evidence is in line with Goodison's (2003) suggestion that, the technological medium dictates the design of the lesson at the expense of a clear pedagogical principle. A view adopted and broadly found in literature nowadays stressing the need for interpreting interactivity from a pedagogical perspective and not only technological. The issue of IWB's *actual* impact on interactivity is further investigated in depth through a systematic review (p.104), which forms as a part of the methodology of this study (p.102).

Pedagogically oriented interactivity of the IWB

The introduction of the IWBs into classroom contexts involves much more than the physical installation of the board and the software (Armstrong et al. 2005; Moss et al. 2007). There is a need to shift the focus from presenting affordances of the technology to consider developing the applied pedagogy (Higgins et al., 2007). Even though IWB might encourage pupils' verbal and physical participation the *quality* of such participation is not addressed nor implied as being enhanced (Smith et al. 2005), whereas such broad participation is considered as surface, non-effective, feature of interactive teaching (Essarte-Sarries and Paterson, 2003). Even functions considered to be more effective are not necessarily applied to support dialogic teaching and might as well contribute to traditional patterns of teaching; effective application it is not inherent in the technology (Mercer et al. 2010). This is predetermined by teacher's skill and professionalism (Wood and Ashfield, 2007), evident in his/her practical understanding of how to engage and help pupils learn (Mercer et al. 2010). Overall, "the main emphasis needs to rest with the appropriateness of the pedagogy, not the use of the technology per se" (Moss et al. 2007, p. 6).

Investigating IWB's potential in terms of enhancing *actual* interactivity through supporting dialogue schemes

Revising our theoretical stance, it is crucial to mention that "dialogue is itself the primary thinking skill from which all others are derived" (Wegerif, 2006, p.143). The level to which technologies can facilitate dialogue is the level to which they succeed as educational tools (Johnson, 2011, in Hennessy, 2011). The target of IWB's interaction, should be in drawing learners into forms of productive dialogue between different views (Hennessy, 2011). As a teacher mentions in Mercer et al.'s study (2010, p. 201), regarding the use of the IWB to orchestrate dialogues ,"… in order to move forward, I need to look now at … using questioning more effectively to enable cumulative talk to take place more regularly". In parallel, it is suggested that the multimodal nature of the IWB contributes in developing dialogic teaching (Wegerif, 2007) and has the power to stimulate whole-class dialogues more easily than other technologies do (Mercer et al. 2010).

In exploiting ICT potential, there is a general notion found extensively across literature pointing towards orchestrating resources and the use of the digital to support improvisation. The IWB is certainly set hierarchically high in the list of ICT classroom resources, as shaping one of the more important developments in the history of schooling (Lee, 2010); also mentioned at the first section of the chapter. Thus, references in literature in terms of ICT enhancing *actual* interactivity, can and should be directly related to the use of IWB as well. In other words, this entails practices to use the IWB to enhance pedagogical interactivity by developing dialogic teaching schemes.

As such, many have argued that pupils should get more involved with the ICT resources and a greater role in orchestrating resources, by being the primary actors (Beauchamp and Kennewell, 2010; Beauchamp et al., 2010; Olive, 2000). Shifting the focus from extensive argumentation in favor of IWB's technological features to the crucial issue of offering pupils the power to use them perhaps, is a step towards interweaving technological and pedagogical interactivity. Nevertheless, Hall and Higgins (2005) concluded in their study that pupils might be enthusiastic about IWBs' features but they reported as a negative aspect the lack of access to the technology.

Moreover, as Beauchamp et al. (2010, p.143) argue, while expanding the parallelism of "orchestration" by comparing teacher's role to that of a musician, "a classical view of orchestration would fail to recognise the extent to which effective teaching and learning make use of serendipity and improvisation – characteristics more often associated with jazz" (p.143). In line with this Gillen et al. (2007), argue that effective use of IWB is balanced between structured well-resources lesson and being able for spontaneous adaptation as the lesson proceeds. Beauchamp (2004) identifies the levels of transition from novice to expert in the use of IWB. He refers to the fifth and most desirable level in the hierarchy as the "synergistic user" whose "intuitive interaction with technology…facilitates a fluid lesson structure" (p. 343). Indeed, it is argued that teachers who were developing a dialogic teaching environment in some cases changed the course of a lesson (Smith and Higgins, 2006). Yet, Higgins et al. (2005) concluded from observational study that, spontaneous contribution by pupils in IWB lessons is limited.

Revising interpretations of effective teaching in the relative chapter (p.41-42), improvisation seems to exist only inherently in some of the key characteristics such as using student ideas and contributions (Borich, 2007) or stimulating children's creativity and imagination (Alexander, 2010). Nevertheless, Kennewell et al. (2009, cited in Beauchamp et al.2010) found that most effective teachers offer learners considerable chances to influence the course of the lesson while applying Alexander's (2004) approach, namely dialogic teaching. Perhaps this constitutes an intersection between revising existing pedagogy and new technologies to expand IWB's potential. Overall, Beauchamp et al. (2010) stress the need to establish conditions for more "jazz-like" – spontaneous - performances when using ICT whereas they (ICT) have the power to demonstrate thinking processes and not just the final product.

Specific conditions and realistic practices for IWB lessons which raise chances for developing dialogic teaching are hardly found across literature. At the moment this thesis was written four studies were found as such, however no systematic search was conducted towards that end thus they cannot be considered as the only ones. These are Hennessy (2011), Jewitt (2009, cited in Hennessy, 2011), Littleton et al. (2010, cited in Hennessy, 2011) and Mercer et al. (2010). They all point towards methods which develop dialogues by shifting the lesson beyond of what is being viewed on the screen. Five examples found in the aforementioned studies are briefly explained, while reader can refer to the original studies for an extensive analysis.

1) ***Subject: "What can poetry tell us about Western Front?"***

   The teacher showed photographs, used the "cover and reveal" function to highlight the first two lines of a poem. Teacher asked pupils to work in pairs and ask each other why they think is interesting and why while he/she interacted with some pairs (Mercer et al. 2010)

2) ***Subject: "Is it possible for us to imagine the experience of trench warfare?"***

   The teacher played a recording of the sound of trench warfare and a silent film. A discussion followed whereas outcomes were written on the IWB. (ibid)

3) ***Subject: "Personal safety"***

   The teacher played a recording of herself reading a personal safety scenario which was also previewed at the IWB's screen. A pupil was asked to go on the board to take suggestions from the class and highlight on the text of what they thought it was important. Then same pupils annotated around the text other pupils' understandings of the characters' feelings. (Hennessy, 2011)

4) ***Subject: " Interpreting a character's feelings"***

   Pupils annotated frozen frames of a DVD extract played on the IWB (Littleton et al., 2010, cited in Hennessy, 2011) .

5) ***Subject: "Interpreting character's feelings in a poem"***

> The original poetry became visual and fragmented, using evocative image to represent poem's persona supporting and brainstorming the messages of the poem on the IWB. (Jewitt, 2009, cited in Hennessy, 2011).

Obviously the multimodality of the IWB is evident in such types of use, however it can only be characterised as effective if the context appropriates discussions and dialogues, whose importance has been repeatedly stressed.

Teacher's comments, questions and responses are decisive in appropriating the content towards that end, as evident in the examples above. This was evident in teacher's non-evaluative and commenting role allowing pupils to work on the IWB to annotate texts, which in turn has the power to stimulate quality talk (Mercer et al. 2010). Thus, if teacher appropriates the discourse that takes place, "visualising or modeling a problem…; explicating ideas and arguments; constructing or deconstructing texts…to create new, richer ones" develop and reformulate common understanding (Hennessy, 2011, p.470). Literally, constructing and deconstructing texts might create new richer ones however, they might mirror teacher's beliefs or predefined texts found in teacher's notes when planning the course of the lesson. In turn, this underlines the importance of improvisation as mentioned previously. Overall, the potential of the IWB lies in synchronizing dialogic interaction with physical interaction with the board (Smith et al., 2005).

3. METHODOLOGY

The remaining part of this thesis is dedicated in analysing whether and in which ways the use of the IWB has changed traditional patterns of teaching, since it was envisaged to boost quality interactivity. Towards that end, a research was designed in a manner explicit throughout this chapter of the thesis. It consists three distinct parts; 3.1, 3.2, and 3.3.

In the first part, “Methodological Design”(3.1), an overview of the applied mixed methods methodology is elaborated. It is developed within a two-stage research plan, including a systematic review – first stage - and a pupils’ questionnaire survey – second stage. The systematic review (3.2) and the survey (3.3) are presented in the second and third part of this chapter, respectively.

3.1 METHODOLOGICAL DESIGN

Mixed Method Methodology

Overview

As extensively presented in the third chapter (pp.66-70), developing dialogical patterns of talk at a classroom level has become an unresolved target of education, perhaps at a global level. Broad installation of IWBs in UK school classrooms seemed promising in reaching that target, even without having any rigorous data indicating *if* and *how* this target was met (pp.87-88). Thus, this study had initially focused in finding and presenting practical techniques to support an IWB dialogic teaching environment. But as presented earlier in the previous part, piloting particular methodologies indicated that observing effective use of the IWB during lessons was at a risk level while the traditional pattern of teacher talk seemed quite persistent; even if teachers were targeted to raise the chances to observe quality classroom talk.

Recognising the possibility that this could be a result of weaknesses in the applied methodological designs, there was also a possibility that this could be the case even if any other design would have been applied. Consequently, concerns were raised about the implications of IWBs on pupils' learning thus, looking systematically across literature for such evidence would have been crucial as this issue had never been studied before; at least while this study was conducted. Under these beliefs two research questions were addressed:

1) What does research on IWBs tell us about its actual impact on teaching and learning, in terms of supporting more dialogic teaching practices?
2) What do pupils think about the value of dialogic teaching practices for their learning, with and without an IWB?

In light of these questions two research methods were applied:

- Systematic review
- Pupils' questionnaire survey using targeted groups.

The systematic review's results indicated that, the questionnaire piloted for another methodology (Appendix 1), suited the aim to get an insight on pupils' own views on their learning, as well as triangulate results.

Rationale

A mixed method approach was adopted which means that both qualitative and quantitative data were collected and analysed (Creswell, 2003). This method is also referred to as integrating, synthesis, qualitative and quantitative methods, multimethod and multimethodology (Tashakkori and Teddlie, 2003). This method was employed because getting both quantitative and qualitative data weakens the disadvantages of each type over the other, enables their benefits and enhances reliability and validity through triangulating results (Hesse-Biber, 2010). Also, it is argued that the strong side of quantitative approach is set at the production and generalisation of decontextualised knowledge but at the same time education policy and practice are highly contextualised processes (Baucal, 2014). This indicates the importance of a balanced methodology as "the quantitative approach needs to be combined in different ways with the qualitative approach...to bring back contextual aspects of...decontextualised knowledge" (ibid, p.28).

In the light of these beliefs, a mixed method methodology was applied combining qualitative and quantitative methods. Besides, deployment of qualitative methods does not rule out the use of quantitative methods (Hesse-Biber, 2010).

3.2 SYSTEMATIC REVIEW

Aim

The target of the systematic review was set in finding studies to examine the impact of IWB on pupils' learning which has never been studied before systematically. As already presented, learning is mirrored in summative and formative assessment (pp.49-55). Assessment is measured through numerical scoring and in-class quality measures during teaching instruction; summative and formative assessment, respectively. As such the following questions were addressed.

Research Questions for Systematic Review

- Does the IWB technology have an effect on students' achievement in terms of standardised assessment of students aged 5 to 16?
- Does the IWB technology have an effect on students' achievement in terms of in-classroom quality measures of students aged 5 to 16?

Why a Systematic Review?

Systematic reviews are "the underappreciated workhorses of academic publication" (Hallinger, 2013, p.127). Yet good systematic reviews play a crucial role for evidence-based decision making by policymakers thus bridging the gap between research and practice (Gera, 2012; Murphy et al., 2007). More importantly, as a result of the expansion of digitally saved material, access to a massive amount of data is now a-click-away via the innumerable databases at a global level. A fact which enables researchers to compare and target systematically studies in an international set scene.

Even though systematic research synthesis is a method established mainly in the area of health, recently it has expanded across the social sciences (Penn and Lloyd, 2006). Indeed, stressing the need to review evidence-based research in social sciences an international network has been developed, Campbell Collaboration. At the same time, EPPI-centre was established towards that end at the Institute of Education (University of London), primarily funded by the DfE.

Under this scope a systematic review was conducted to locate, evaluate and synthesise the best available evidence related to the above research questions, in order to offer informative and evidence-based answers (Boland et al. 2014). The transparency regarding the selection and reviewing of studies distinguishes a systematic review from other types of reviews (Hall, 2002) while enhancing its quality (Penn and Lloyd, 2006). Put in brief, "a systematic review is a review of research literature using systematic and explicit, accountable methods" in a range from quantitative to qualitative research (Gough et al., 2012, p.5).

It is important to distinguish a systematic review from a meta-analysis. Many times the terms are used interchangeably but meta-analysis refers to the quantitative analysis of the results of multiple studies in a statistical manner, even though most of the times it is based on a systematic review (Valentine et al. 2010).

Conducting a Quality Systematic Review

The key features of a systematic review as presented by EPPI centre (2012, cited in Hallinger) are:

- Explicit and transparent methods are used
- It is a piece of research following a standard set of stages
- It is accountable, replicable and updateable
- There is a requirement of user involvement to ensure reports are relevant and useful.

The transparency of the systematic review in this study becomes evident by the ability of the reader to conduct the same review once again since each stage of the procedure is explicitly presented.

More precisely, as suggested by Fink (2005) seven steps were followed:

1. Finding research questions (p.104)
2. Selecting the sources from which the sample will derive (p.106)
3. Choosing search terms (p.106)
4. Applying practical screening criteria (p.106)
5. Applying methodological screening criteria (p.106)
6. Conducting the review (fulfillment of all the above steps)
7. Synthesising the review. (p.107-131)

All stages are thoroughly presented as indicated by the pages in the brackets.

Gathering Data through Online Resources

A specific set of words was selected as the one having the most effective searching results through FirstSearch and Proquest; (interactive whiteboard OR electronic *board OR digital *board) AND (assessment OR scores OR attainment OR evaluation OR test*) AND (primary OR elementary). All searches were made on the 29th of July in 2013 resulting in 14735 studies which were limited to 553 after scanning through the titles; practical screening criteria. After a lot of readings and applying the exclusion criteria, a final set of 16 papers was included in the review for analysis (Appendices 5, 6 and 7); methodological criteria. One study could not be retrieved online but this was solved by contacting directly with the authors. The term "study" reflects diverse types of cases included in the review such as journal publications, conference papers, PhD and EdD theses, all presented in Appendix 6.

Initially the aim was to identify studies included in academic journals related to the use of IWB in primary school and its impact on pupils' maths achievement. However, at the moment of this systematic review, limited data could be retrieved under the above scheme. The final search was made by having nursery up to elementary school pupils as the targeted population, without any limitation according to the teaching subject and type of publication: PhD or EdD thesis, dissertation,

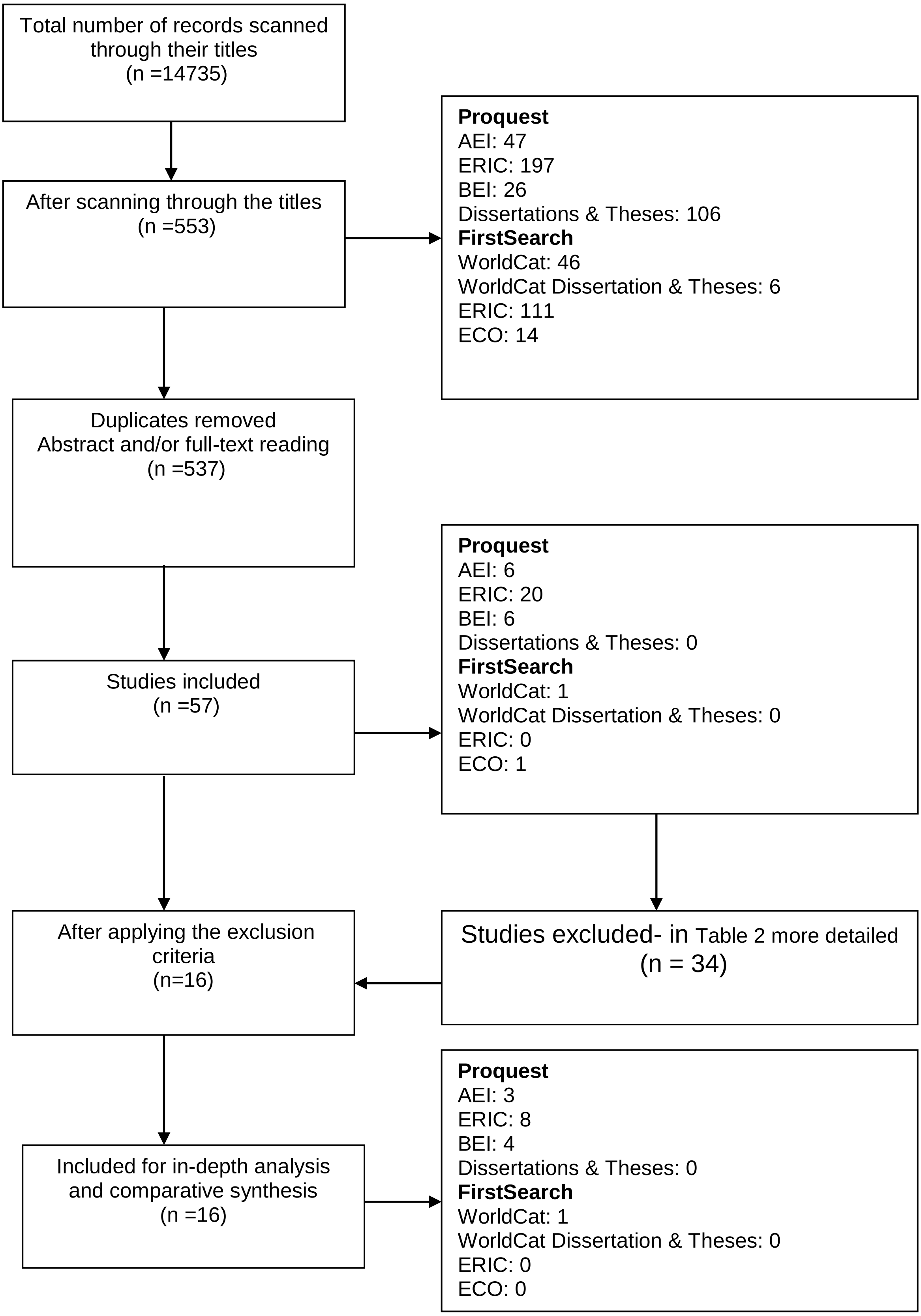

Figure 2: Numerical representation of the selection procedure

book chapter, conference paper, research report were considered legitimate for inclusion. Exclusive criteria are clearly listed in Appendix 7 while only the study of Lopez (2010) might be confusing since it seems to fit in the excluded category, “Targeted population not applicable (minority pupils, difficult to teach, ELLs, etc.)”. However, English language learners (ELLs hereafter) of the specific study were taught in regular classes with native speakers, and data were gathered through the regular final exams thus it was included. Also, one study was found twice in a form of report (Somekh et al. 2007) and as a journal publication (Lewin et al. 2008). The report was the one added into the analysis because of its more complete description and presentation of data.

Synthesising the review

Conducting a systematic review without employing statistical analysis is often criticised based on the assumption that the results arise from the unique “cognitive algebra” of the reviewers (Valentine et al 2010). In other words, the procedure of vote counting which “has properties that seriously limit its validity as an inferential technique” (ibid, p.240). Indeed, Hedges and Olkin (1985, cited in Valentine et al., 2010) argue that, vote counting has less statistical power, the more low-to-moderate statistical power studies are included in the procedure. However, even for studies characterised by high-statistical significance, an extensive analysis of the applied methodology might indicate a validity or reliability flaw. This was the case for the study of Somekh et al. in this review, presented in p.113-115. At the same time, such criticisms inhibit an underestimation of qualitative studies which are the fundamental part of the discussions of educational research (MacClure, 2005).

Whatsoever, the systematic review of this study included both type of data as a result of the research questions, while wherever possible effect sizes or statistical significance analyses were taken in mind to compare studies.

More importantly, the methodology of each study was investigated in an explicit manner to take account potential bias (Penn and Lloyd, 2006) while targeting strengths and weaknesses of each methodological design (Hallinger, 2013). A process which ultimately ensures that review's conclusions will be informed only from sound research studies (Hall, 2002). Using Miles and Huberman's (1994) terminology, a vertical analysis preceded the horizontal analysis, meaning that the unit of analysis was a single study each time.

Besides, evaluating the quality of each study was a necessity since "peer-reviewed" was not selected as a choice during search. Peer-review search suggest that a study has passed a minimum level of professional examination (Cooper et al., 2009). If "peer-reviewed" criterion was applied only five studies would have been gathered. Instead, it was preferable to gather more studies and evaluate their methodologies. Remarkably, among the five peer-reviewed studies (Appendix 6: studies 1,6,8,9 and 14) only two were considered as having strong methodological body (studies 1 and 6).

The horizontal analysis that followed, in other words cross-case analysis, resulted in shaping six categories. The diversity of the methodologies in the final set of studies made the comparison amongst *all* of them impossible. In line, Hall (2002) argues that diverse research methods found across a systematic review explicate the reviewing process itself. As such, content analysis was employed to bring the similar data together under certain themes (Ciltas et al. 2012). Categories derived from the data and were not predetermined, procedure which Hsieh and Shannon (2005) name conventional content analysis.Six categories were shaped based on each study's focus (see table below) so that comparisons could be made; a paper could fit in more than one category. A table was generated for each category to present overall strengths, weaknesses and conclusions of each study, serving as an amplifier to the descriptive analysis.

3.3 PUPILS' QUESTIONNAIRE USING TARGETED GROUPS

Aim

Interestingly, results of the systematic review indicate that refocusing the methodological scheme was the right choice - at least in the context of this thesis. Through the systematic review it became clear that the use of IWB cannot be simplistically related to the term "effective teaching". On the one hand it seems that there is no consistent evidence indicating that IWB impacts on learning in terms of classroom interaction and attainment while on the other hand, such results raise issues about understanding of pupils' learning, bearing in mind the vast amount invested on IWB aiming at raising attainment yet failing to do so.

In order to understand such results while gaining an insight into pupils' learning and the connection with the use of IWB it is crucial to investigate pupils' own views. In light of these the following research question was addressed:

- What do pupils in Cyprus think about the value of dialogic teaching practices for their mathematical learning, with and without an IWB?

Towards that end a questionnaire was designed and handed out in public primary schools in Cyprus, the home country of the researcher.

Selection of the Method

A survey was considered to be the most appropriate type for gathering additional data having in mind the preliminary character of the aforementioned target; a general picture and not detailed information was the aim. As such, a small scale survey was selected since no generalisations will be attempted.

As Cohen et al. (2000, p.169) describe, among others ‘surveys gather data at a particular point in time with the intention of describing the nature of existing conditions’ and they vary in their level of complexity. The conditions under investigation were the results of the systematic review (pp.127-129). Using the IWB does not seem to enhance the quality of classroom talk directly. Thus, it was envisaged to triangulate and compare these findings by investigating pupils’ own views through a questionnaire.

It was important to investigate this from pupils’ perspective since teachers’ responses might perhaps introduce a level of bias when asked for example, whether they offer chances to their pupils to ask questions, to explain their thinking to the class, and the like. Though it would be interesting to compare each classroom’s teacher and pupils responses this falls out of the scope of this study.

Questionnaire as a Tool

Questionnaires provide good descriptive information (Munn and Drever, 1990) and “collect data on phenomena not easily observed, such as...self-concepts” (Selinger and Shohamy, 1989, p.172). Describing pupils’ perceptions on their own learning and its connection to the use of IWB constituted the base to design the tool employed.

The practicality and advantages of employing a questionnaire are broadly recognised and are related mainly to securing anonymity, fast and easy administration, good response rates and standardised questions, if added, making it easier to analyse and compare findings (Munn and Drever, 1990; Rani, 2008). This is mirrored also in Baki et al.’s (2011) study where results were questionnaires, along with achievement tests, were found to be the most preferable instruments to collect data in maths education in Turkey. It seems that this is not the case only in maths education research. Rani (2008) argues that questionnaires are more selected than any other tool in the area of Teaching English as a Second or Foreign Language.

Investigating pupils' views, using a questionnaire in this case, has been broadly accepted as important. In Smith's words (2010, p. 11), "the growing importance of children's own views...should be borne in mind..." while this is addressed as "pupil voice". Besides many studies have been designed towards that end (e.g. Fisher and Larkin, 2008; Patt, 2006)

Questionnaire Design

The design of the questionnaire is important since it can empower – or not- the advantages of the tool. Decisions about the type and phrasing of the questions, each question's and questionnaire's length were matched to the targeted age group and the aim of the study.

Having in mind that respondents were 8-12 years old, rating scale questions were considered as the best choice. Besides, it is a very attractive and broadly used type of question since it combines flexibility in responses and the ability to conduct quantitative analysis (Cohen et al., 2000). In total 19 items were added in the questionnaire while almost all them were rating scale questions; see Appendix 2 and the table below. The dichotomous gender question was not added in the numerical order of the questions which correspond to 10 questions or 18 items; explained further in the 'Data Analysis' in pp. 142-144. It should be stressed that, each item is hereafter cited as a question, question1 (q1) to question18(q18).

Table 3: Type of Questionnaire's Items

Type of question	Number of Questions	Ranking/Choices
Rating scale	16	Strongly disagree/Disagree/Agree/Strongly Disagree (12) Never/Rarely/Quite often/A lot of times (4)
Dichotomous	2	Yes/No (1) Boy/Girl (1)
Open-ended	1	-

In order to make the questionnaire more applicable and acceptable to pupils, smiley faces represented the scale for the 12 same rating scale questions. Under the same scope the open-ended question was added at the end of the questionnaire in a form of drawing activity. This type of questions often leads to low response rate (Selinger and Shohamy, 1989) because they demand “quite a bit of writing” (Dornyei, 2003, p.48, in Rani, 2008). Thus, drawing was considered an alternative choice ideal for younger respondents.

Having in mind the aim of the survey, questions were shaped to form as indicators across four categories as presented in the table that follows. Considering the systematic review’ s results it was crucial to investigate pupils’ views on their own learning regarding factors that were not only related to the use of the IWB. At the same time, an insight into each classroom’s situation in terms of *what is going on* during lessons with or without the IWB was the target of some other questions. The target was to be able to describe and develop potential explanations by comparing questions across the categories. The last open-ended question (q18) did not fall into that scope since it was related solely to the fun side of IWB as a possibility to provide information that has not previously arisen or seen elsewhere.

Table 4: Targets of the Questionnaire

Target of the question	Questions aligned to that target
Classroom situation	q1, q2, q3.
Classroom situation while using the IWB	q4, q11, q12, q14.
Pupils’ views on their learning	q5, q6, q7, q8, q9.
Pupils’ views on their learning and its connection to the IWB	q10, q13, q15, q16, q17.
Pupils expressing enjoyable feature(s) of the IWB	q18

Finally, a two page questionnaire was designed including 19 questions, 18 questions plus the gender question, taking about 15 minutes to be completed by the pupils as indicated through piloting (further information in the 'Validity and Reliability Concerns' section, p.137).

The Educational System in Cyprus at a Glance

The tool was distributed in public primary schools in Cyprus, the home country of the researcher. Therefore, it is crucial to provide the reader with a general picture of the educational context where the survey was conducted, before presenting in more details the process of questionnaire distribution and analysis,.

Education in Cyprus is led by a national centralized authority, namely the Ministry of Education and Culture. Curriculum, material, books and personnel are strictly formed and distributed by the ministry.

The vast majority of the pupils enroll in public primary and secondary schools which are free and divided into four sections in the following order: pre-primary education – one year, primary education – six years, lower secondary education – three years and, upper secondary education – three years. Pre-primary education begins approximately at the age of five and students graduate from secondary education around the age of 18. Pre-primary, primary and lower secondary education are all compulsory while pupils enroll in the school nearest to their home, thus there is no option to select a school of your choice. Notably, there are some private schools but there are expensive and attract a relatively low number of pupils.

It is worth mentioning that Association of Parents of each school is a well established and in many cases powerful body of guiding decisions and sponsoring for resources at a school level. As such, in many cases the installation of IWB in schools is a result of a sponsorship by the

Association of Parents. More details on the introduction of IWBs in Cyprus are provided in a following section, 'Sampling' (p.138) .

Teachers are employed by the ministry – thus it is a governmental post – through a rather dated system. As soon as one graduates as a teacher, he or she can enter a numerical catalogue where each participant is hierarchically placed in the catalogue according his or her scoring. Scoring is calculated based on the date of birth, the year of graduation, the overall degree score, the teaching experience and, any post-graduate education; the catalogue is revised once a year.

Ethical Considerations

The survey was conducted according the ethics procedures of Durham University. At the same time this was aligned with the procedures imposed by the Ministry of Education and Culture in Cyprus to get access to schools. The researcher needed to have an approval of the research plan from the ministry to conduct schools. Towards that, an on-line application was filled through the Cyprus Pedagogical Institute (www.pi.ac.cy) in the beginning of the school year 2013-2014. This was then forwarded to the ministry. In October I got the approval in a letter posted to me directly from the ministry.

At this point the researcher contacted some teachers (explained in p.111). Those interested to participate handed the letter of approval to the Head of the school along with an information sheet about the study. Once the Head was informed and agreed teachers handed out informed consent to each pupil. This was a single piece of paper informing parents about the study, ensuring the anonymity of their children and asking for their consent by signing and returning it to school. Children were also asked if they agreed to participate even if their parents agreed towards that.

Anonymity was secured by the design of the survey since questionnaire is a tool that either way it can easily be completed anonymously. Teachers who distributed the questionnaire grouped the questionnaire by class indicating only the age group of each class. School was also indicated using numbers 1 to 4 throughout the data collection and analysis. Same age group classes were coded alphabetically, for example Y3a, Y3b, Y3c, etc.

Securing the anonymity of both schools and pupils perhaps speeded up the application for approval to carry out the study as well as the high rate of consent by parents and pupils. Also, the researcher contacted teachers at the beginning of the year rather than towards the end, as opposed to the first methodological design (Appendix 1).

Validity and Reliability Concerns

Piloting the questionnaire, internal validity, triangulation of data and the process of distribution and filling of them formed as validity and reliability amplifiers.

Small-scale piloting is essential as it enables researcher to find out how long does it takes to be filled and discovers ambiguities in question phrasing (Munn and Drever, 1990). Towards that end, piloting was conducted as part of the first methodological design (explained in p.95) in two Year 5 classrooms; 29 pupils in total. The researcher was present while pupils were filling the questionnaires thus it was easy to discuss and realise with pupils ambiguities within the tool in use. This resulted in changing the initial design of the questionnaire (Appendix 1) by rephrasing only q9, as presented in the final form of the questionnaire (Appendix 2).

Moreover, in order to illustrate the level of internal validity two set of questions will be related; q4 and q14 (pp.202-206), q13 and q 17 (pp.216-220). Internal validity seeks to demonstrate that the explanation of a set of data which a piece of research provides can actually be sustained by the data (Cohen et al. 2000).

Findings from the questionnaires were compared with the review conclusions, since this is a mixed-method approach; as already outlined in pp. 102-103.

Lastly, it was not possible to be present when questionnaire were completed by the pupils since I was also working as a teacher; in any case the researcher is not usually present in this procedure (Munn and Drever, 1990). However, the distribution and responsibility of filling the questionnaires were in the hands of a teacher who was familiar with the pupils but was not their own teacher. On the one hand, this minimised potential bias of the teacher on pupils' responses either by "leading" them to some answers or by putting pressure on them to "hurry-up". On the other hand, pupils participated in the procedure with a familiar person who taught them a subject other than language and maths; time constraints to go through the curriculum are not so tight for these teachers.

Sampling

Purposive and opportunity sampling was the method employed to target groups on the basis of their typicality; also mentioned in the first methodological design in p. 97. In this case, typicality was Y3 to Y6 classes in Cyprus which had already installed an IWB. Personal relations were also used as a sample was found through my personal contacts and created an opportunity sample. This is unlikely to have introduced a bias in terms of the findings as the selected teachers varied in terms of their experience and interest in technology use, however overall it increased the likelihood of take up and completion of the questionnaire. The age of pupils was chosen from their ability to fill in a questionnaire of this kind in the time the schools were prepared to allocate; about 15 minutes.

The IWB technology is certainly at an introductory level in the schools of Cyprus but the schools included in the sample had installed IWBs at least three years earlier at the moment of the questionnaires' distribution which took place in 2013-2014. Besides, the initial hypothesis that innovative use of IWB would have been met in UK having in mind that technology was well established had been diminished by the application of the first design, the systematic review's results as well as the review of literature of this study.

As such nine teachers from different primary schools in Cyprus were contacted through telephone calls. Four of them agreed to help with the distribution of questionnaires forming as the 'ambassadors' of the researcher. The 'ambassadors' informed and invited other teachers in their school to participate in the research, on the basis of the typicality as explained above. Heads in all of the schools were also informed by the 'ambassador' and had to provide permission to the teachers to participate in the study. Approval by the Cyprus Pedagogical Institute to conduct the study made the procedure easier, a process explained previously in p. 137. Fortunately, Heads and teachers in all of these schools agreed on the procedure, three schools were in urban areas and one in rural area.

Finally, the 'ambassador' teachers distributed the questionnaires accordingly. In total 301 questionnaires were filled from pupils aged 6 to 12 coming from 16 classes (Y3-Y6) in four different schools; 136 boys and 165 girls (see Tables 6-9 below).

For Cyprus this is a reasonable sample bearing in mind that pupils in public primary schools in 2013-2014, were in total 48,645 (Cyprus Ministry of Education and Culture, 2015). In that case, according to Krejcie and Morgan (1970, cited in Cohen et al.2000) 381 respondents would have been a representative sample, but only had they been selected randomly. The selection of schools may have therefore introduced some bias into the findings, but it was more important to achieve a high rate of return.

The following (four) tables include more detailed information about the type and size of the sample.

Table 5: Sample Overall

School Classes			Frequency	Percent	Valid Percent	Cumulative Percent
1	Valid	Y4a	18	17.0	17.0	17.0
		Y4b	16	15.1	15.1	32.1
		Y5a	17	16.0	16.0	48.1
		Y5b	14	13.2	13.2	61.3
		Y6a	20	18.9	18.9	80.2
		Y6b	21	19.8	19.8	100.0
		Total	106	100.0	100.0	
2	Valid	Y3a	20	23.8	23.8	23.8
		Y3b	19	22.6	22.6	46.4
		Y4c	25	29.8	29.8	76.2
		Y4d	20	23.8	23.8	100.0
		Total	84	100.0	100.0	
3	Valid	Y4e	24	29.6	29.6	29.6
		Y6c	23	28.4	28.4	58.0
		Y6d	17	21.0	21.0	79.0
		Y6e	17	21.0	21.0	100.0
		Total	81	100.0	100.0	
4	Valid	Y5c	14	46.7	46.7	46.7
		Y5d	16	53.3	53.3	100.0
		Total	30	100.0	100.0	

Table 6: Schools

1= School 1, 2= School 2, 3= School 3, 4= School 4

School		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	106	35.2	35.2	35.2
	2	84	27.9	27.9	63.1
	3	81	26.9	26.9	90.0
	4	30	10.0	10.0	100.0
	Total	301	100.0	100.0	

Table 7: Age groups

Y3 = Year 3, Y4 = Year 4, Y5 = Year 5, Y6 = Year 6

Year		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Y3	39	13.0	13.0	13.0
	Y4	103	34.2	34.2	47.2
	Y5	61	20.3	20.3	67.4
	Y6	98	32.6	32.6	100.0
	Total	301	100.0	100.0	

Table 8: Gender

B=Boy G=Girl

Gender		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	B	136	45.2	45.2	45.2
	G	165	54.8	54.8	100.0
	Total	301	100.0	100.0	

Data Analysis

The questionnaire included 18 items numbered as 10 questions. The separate items of the fifth and sixth question are presented as distinct questions resulting in 18 questions/items overall (Appendix 2), which will be referred to in order. An additional question referred to participant's gender, aiming to investigate gender differences as well. Data analysis that follows consists of two sections, in the first section each of the 18 questions is presented and analysed descriptively while in the second one inferential statistics are used to check for any variations based on gender, school and age.

First Section: Analysis of Questionnaire Using Descriptive Statistics

Each question was analysed quantitatively by comparisons made at two levels, micro- and macro-level, using descriptive statistics through SPSS. At the micro-level, comparisons aimed at investigating whether overall results of each question were aligned to those at a class level, in order to examine their consistency across the sample and thus their overall importance. At the macro-level, comparisons between questions draw some further conclusions while considering results at the micro-level; significant questions had more impact in the overall conclusions. Micro- and macro-level analyses for each question are interdependent and interweaved, therefore they are not presented separately but discussed together wherever applicable.

An overall level of analysis could be undertaken by simply looking at the Standard Deviation (*SD*) value of each question; a question having low *SD* is considered as having more consistent responses. However, *SD* is calculated based on the Mean Score (*MS*) of each question thus in case of outliers there are concerns about the credibility of both measures. Indeed, Leys et al. (2013, p.764) stress that *SD* and *MS* "are particularly sensitive to outliers" and indicate their concerns on existing methods of *SD* estimation while suggesting another model to deal with this problem. Analysis at the micro-level validates such concerns since ordering questions according their consistency, based on the micro-level analysis, is not necessarily the same as those produced by using the *SD* values. Therefore, even though *SDs* and *MSs* are presented at the beginning of the first section, further variation is explored based on comparisons made at the micro-level. Thus, for each question a table of frequencies and a graph represent the overall results, followed by a table of frequencies of responses at a class level; generated in SPSS after splitting file by class.

The last open-ended question (q18) is not included in either micro- or macro-level of analysis, because of the variation in responses due to its nature. It is presented by the end of the first section, 'Analysis of Questionnaires Using Descriptive Statistics'.

During the analysis, percentages were grouped into bands. More precisely, 70 per cent and above was considered as *the vast majority* whereas 50-70 per cent as *the majority*. Also, in the tables of each question "no answer" was indicated by "0".

Lastly, it is important to clarify that the above analysis offers a *description* of pupils' views on their learning and the use of IWB, however potential *explanations* for pupils' responses are also provided.

Second Section: Analysis of Questionnaire Using Inferential Statistics

Inferential statistics were employed in order to check for statistically significant differences across the sample based on gender, age and school of the participants. Therefore, each question was tested for the following hypotheses:

1) *There is no difference between boys and girls in terms of their responses.*
2) *There is no difference between year groups in terms of their responses.*
3) *There is no difference amongst schools, in terms of pupils' responses.*

In order to test the above hypotheses, cross-tabulations, chi-square tests and p-values were conducted in SPSS, for each question separately. The level of significance was set at 0.05 (p= 0.05) for all statistical analyses.

Findings of the inferential analysis are presented in three sub-sections, one for each hypothesis. In each sub-section a table presents chi-square and p-value measures for all of the questions, followed by cross-tabulation tables and graphs only for significant questions; null hypothesis was rejected. In other words, more details are provided for questions that were considered as having significant differences in terms of the variable under investigation; gender, age, or school. At the end of each sub-section follows a discussion referring to overall results for each hypothesis.

4. RESULTS AND DISCUSSION

The chapter is separated into two parts, one for each of the employed research methods. As such, in the first part (4.1) the results of the systematic review are presented followed by a discussion. Afterwards, this is done in the same manner for the questionnaire survey (4.2.). Moreover, the questionnaire analysis is done in two sections as explained in pp.115-117. The first section refers to the descriptive analysis results and the second one to the inferential analysis results.

4.1 SYSTEMATIC REVIEW

Results of the Analysis of the Studies Included in the Review

As already presented in the previous chapter (pp.102-103), in order to synthesize and analyse the studies included in the review six categories were shaped. The following table represents the categorization while analysis and results for each category are presented right after.

Table 9: Categorisation of the studies included in the systematic review

CATEGORIES	STUDIES INCLUDED
Pupils' Scoring	Diaz 2012; Kennewell et al.2007; Lopez 2010; Martin 2007; Masera 2010; Bahadur and Oogarah 2013; Thompson and Flecknoe 2003; Swan et al.2010; Winkler 2011 (9 studies)
Length of time of IWB experience	Campbell 2010; Higgins et al. 2005; Somekh et al. 2007; Rains 2011. (4 studies)
Gender	Campbell 2010; Diaz 2012; Higgins et al. 2005; Hwang et al. 2006; Martin 2007. (5 studies)
Pupils' abilities in terms of scoring	Hwang et al. 2006; Martin 2007; Masera 2010; Higgins et al. 2005; Somekh et al.2007; Swan et al. 2010 Thompson and Flecknoe 2003. (7 studies)
Comparing IWB with other sources and techniques	Huang et al. 2009; Masera 2010; Watt 2009. (3 studies)
Classroom Interaction	Hwang et al. 2006; Winkler 2011; Kennewell et al. 2007. Swan et al. 2010; Higgins et al. 2005. (5 studies)

Pupils' Scoring

Overall looking at the majority of the papers in the category – 5 out of 9 - there were no significant gains in numerical scores related to the use of IWB (Appendix 8). However, it is crucial to investigate in more detail the methodology of each paper before reaching to conclusions. Only studies with strong methodological designs should be taken into consideration before finalising the results of each category; as pointed out in the previous page.

More specifically the importance of having a control group *and* pre-post testing is a crucial validity amplifier, at least in this case. Cheung and Slavin (2013) state that, "lacking a control group, of course, a pre-post design attributes any growth in achievement to the program, rather than to normal, expected gain" (p.92). Similarly, lacking pre-testing cannot provide valid data of a program's effectiveness since –as stated previously – improvement in scores is an indicator of effectiveness and not just high scores in a final test. Only through comparing scores before and after any program's sessions one can take decisions about its effectiveness.

Thus, papers of Martin (2007) and Swan et al. (2010) are considered of low validity in the respective field. Swan et al. (2010) while including around 3000 pupils in their study (1686 control group and 1466 experimental group) the absence of pre-testing weakens its methodology since comparisons were based on a test given only once at the end of the year. Martin (2007) studied the effect of Big Books via the IWB on scores through a random sample of 10 pupils in her classroom without comparing it to a control group. Martin concluded that there was no significant effect on scores related to the IWB while Swan et al. argue that there is a small achievement increase in the IWB group statistically significant only in maths.

Thompson and Flecknoe (2003) studied how IWB impacts pupils' scores in a low advantage school concluding with overwhelming results in favor of IWB. But the absence of a control group in parallel with additional strategies applied in the specific school to boost performance - because of schools' high poverty and disadvantage area – might overestimate the effectiveness of IWB and thus cannot be considered as valuable for consideration in our review. However, the importance and potential of the strategies applied through the IWB in the specific school are certainly not erased but should be studied more explicitly.

Similar results were drawn by Lopez (2010) but paradoxically related only to ELL. By having control and experimental group, pre- and post- testing he concluded that the use of IWBs foster performance parity and close the achievement gap between ELL and regular students. This argument rises questions on the one hand, about the achievement of regular students since, in order to close the achievement gap regular students should at least remain at the same levels of achievement and consequently IWBs do not impact on their achievement. On the other hand, if there are gains for both ELL and regular students related to the use of IWB and at the same time achievement gap is closing up it means that ELL are gaining much more from the use of IWB than regular students. Apparently, the two studies mentioned above are in favor of IWB's use however there are some validity concerns related to the methodology.

Diaz (2012) and Bahadur and Oogarah (2013) in their case studies applied similar methods in well-organised scheme by "experimenting" with certain aspects of the IWB using pre- and post-testing and a group of 40 pupils divided into two groups – experimental and control . Through the experimental group Diaz applied a voting system for multiple questioning in English lesson and Bahadur and Oogarah an educational resource designed using XERTE while teaching solar system. Both studies concluded that there was no difference in scores with or without the IWB ($p<0.119$ and *T-value* is greater than *T-calculated* values respectively).

Masera (2010) divided 45 nursery pupils and 42 pupils in Year 1 into three subgroups and taught them 45 sight words using three different methods; traditional, tactual/kinesthetic/, IWB. He concluded that the IWB group scored lower than the other groups ($p<0.001$ for short term word recall, $p<0.01$ for long term word recall). The study is presented more descriptively in a following section.

Kennewell et al. (2007) in a greater scale study included 21 teachers from 41 schools and investigated whether the use of ICT generally impacts on attainment by comparing pupils' scores in ICT and non-ICT classes through pre- and post-testing. IWB is clearly connected to the group using ICT resources since in the report (p.16) they mention that teachers using ICT all had IWB. However, there is no clear explanation of specific use of other resources in parallel with the IWB such as personal laptop, desktop, tablet, etc. Thus, probably the study is particularly addressing the use of the IWB under the acronym ICT. The specific report did not offer more details in terms of sampling and statistical presentation of scoring however the fact that it was funded by ESRC certainly constitutes a factor enhancing its methodological strength. Once more the conclusion was that IWB did not have any impact on pupils' scores.

Finally, Winkler (2011) using a total sample of 18 teachers and 311 students investigated whether specially designed training related to effective use of IWB (experimental group) would impact on maths scoring in relation to non-featured training teachers (control group), by comparing improvement from pre- to post-tests. Students represented nursery school, first, fourth and fifth grade. The training programme lasted 5 weeks with weekly sessions, in-class mentoring and many more while non-featured trained teachers did receive the usual method of training and support. Improvement in scoring in the trained teachers group was found to be significant only in nursery school (p=0.001) and 5th grade (p<0.0005). Notably pupils of non-trained teachers in 5th grade did not improve their scoring in maths but instead they did worse in post-testing. A fact which enhanced the importance of the positive results for featured trained teachers in the specific age group. Thus, it cannot be assumed that there is a clear advantage in maths scoring via the use of IWB related to the specific training.

Notably, the above mentioned six studies considered as having a stronger methodological body are in consistent and support the idea that there is no gain in scoring related in any way to the use of the IWB. The last study by Winkler raises far more questions since even training teachers to use the IWB did not prove that IWB impacts positively on pupils' scoring. An optimistic view would certainly argue that the use of IWB itself has a positive effect in scoring which was not further enhanced through training teachers. However, so far there are no indications in favor of that argument having in mind the other studies in this category.

Length of time

In total there were found 4 studies which investigated whether the duration of IWB use in months or years impacts on pupils' scores; Appendix 8. However, Rains' study (2011) is excluded from the comparison since the three groups of pupils who participated in the study according the years of IWB use (3 years, 2 years and1 year) were numerically unequal (99,87 and 14 pupils respectively). Campbell (2010) compared maths scores for two subsequent years of 356 Year 4 pupils in four schools, two had IWBs (215 pupils) and two did not (141 pupils). National testing at the end of each year -2007 and 2008- was taken into account when comparing attainment among the two groups. Some additional tests throughout the year were also taken into account. The comparisons were made based on gender, ethnicity and income but from the tables provided one could easily conclude that there is no difference when comparing the improvement in scores among the two groups. Mean scoring was about 300 points the first year and 400 points the second year. The IWB group had an improvement of 104 points in mean scoring during the second year while the non-IWB group 102.5. Thus, a rather negligible difference was observed among the two groups the specific years.

Interestingly, the two remaining studies are the greater studies amongst all in terms of duration, number of pupils engaged and level of analysis. Notably, both applied methods assessing the improvement of scores for each pupil. They investigated the impact of the duration of IWB use in English, maths and science and were both conducted in UK; Higgins et al. (2007) and Somekh et al. (2007). However, there are some differences when it comes to the results and methodological strength of them.

Higgins et al. (2005) applied a well designed method to compare national test scores between IWB and non-IWB group across a 3-year period involving about 5000 pupils in Year 6. In order to compare the two groups, scores in 2002 were used to assess progress in 2003 and 2004 forming as a pre-testing. This kind of method is in line with our view on attainment as presented in the introduction since improvement in scores can form as an indicator of effective learning and not high-scoring itself. Additionally, the two groups (IWB and non-IWB) were well matched in terms of national test performance in 2001, mean number of pupils on roll in 2002, etc. In the 3-year long study they concluded that improvement in scores is only related to the 2nd year of IWB use (2003) with a slightly more progress of IWB schools in relation to the non-IWB schools with a small effect size though (0.09). But when comparing 3rd year's results (2004) to the baseline scoring in 2002, IWB schools made less progress than in non-IWB (effect size -0.10). Also, there is some evidence that IWB improves the performance of low-achievers in English particularly in writing.

Contrastingly, Somekh et al. (2007) report that the use of IWB is related to gains in scores directly related to the time taught with an IWB. The report is a large-scale mixed method approach study involving 7000 pupils in KS1-Year 2 and KS2 – Year 6. However it raises many questions about its methodological design. Progress of each pupil was measured only once, for Year 6 by comparing KS2 and KS1 national test scores and for Year 2 by comparing FSP summaries (Foundation Stage Profile) and KS1 test scores. Progress of pupils was then compared to each pupil's length of IWB use at classroom level counted in months. But the gap of 2 to 4 years between the two measures without a sustained exposure to IWB by all pupils cannot attribute progress to the use of it; the mean number of time exposed to IWB was 16.2 months for KS2 and 13.4 for KS1. More importantly, the absence of a control group is a parameter which weakens the results of the study. Progress cannot be simply attributed to the initiative without comparing it with progress in schools not included in the project. This kind of studies tends to overestimate the impact of the project and do not offer a realistic view of the initiative and thus raise validity concerns. Indeed, Somekh et al. conclude that the length of time students have been taught with an IWB is a major factor which leads to attainment gains

Overall, Higgins et al. study has a stronger methodological body related to Somekh et al. while Campbell's results are in line with Higgins et al.'s thus their results have a clear advantage. In other words it seems that the length of IWB use has no impact on pupils' attainment at least during the period of the particular studies (2002-2006).

Gender

In this category there are five studies which investigated the behavior of boys and girls during classroom and could be divided into two groups; Appendix 10. On the one hand Diaz (2012), Campbell (2010) and Higgins et al. (2005) compared scoring among boys and girls in IWB and non-IWB group. On the other hand Martin (2007) and Hwang et al. (2006) observed pupils' behaviour in terms of participation and comments while using the IWB and made comparisons based on gender.

Diaz (2012) in his well designed case-study concluded that there is no gender bias in experimental and control group in terms of scoring (p=0.197 at 0.05 level of significance). Results came from comparisons among small-groups of pupils: 9 male using the IWB compared to 11 male not using the IWB, 9 female using the IWB compared to 11 female not using the IWB. Campbell (2010) using a sample of 356 Year 4 pupils concluded that, girls seem to do better in non-IWB while boys seem to do better in IWB classes. But these differences were not significant at the 0.001 level of significance since p-value was calculated 0.48 for the variable gender, resulting in accepting the null hypothesis (no significant difference among pupils using IWB and not using IWB regarding gender). These results are strengthened by a larger-scale and excellently done study by

Higgins et al. (2005) who concluded that the use of IWBs appears to have a broadly similar impact on both boys and girls (presented previously in p.113). The importance of small-scale studies is certainly not erased. Instead, even if larger-scale studies have a bigger merit in the conclusions, it is the compilation of data which strengthens the overall outcome as long as it comes from independently well-designed studies.

Martin (2007) by filling observational schedules for 17 pupils (5 high achieving girls and 2 low, 5 high achieving boys and 5 low) concluded that higher achieving girls participated most "frequently in 'positive' observable behaviours such as putting hands up or being invited to comment" (p.31). Looking at the results the participation of higher achieving girls is certainly impressing. During a 20 minute writing discussion each higher achieving girl corresponded to a mean of 15 answers while all the others to a mean of 4 answers. However, as clearly stated elsewhere is what is being said the crucial factor of classroom discourse and not the quantity or duration of each utterance. Thus, it would be even more interesting to assess the type of the discourse, as investigated by the following authors.

Hwang et al. 2006 applied a design built on the same theoretical basis of this thesis assuming that one understands a mathematical problem when he/ she can orally explain it. A multi-media IWB system was developed enabling students to use a voice recording tool to explain their thinking while solving mathematical problems of fraction division. Subjects were 36 6th grade pupils whose oral explanations were quantity and quality analysed using the voice recorded feature of the applied programme which records the whole content of the lesson including teachers' comments. Pupils' comments were aptly categorised based on their quality. They were categorised into "calculation", "critique" (comments on others solutions), "refutation" (replies to "critiques"), "judgement" (answering correct) and "explanation" (answering correctly and explaining why the specific method was chosen). They concluded that female pupils perform better in observable positive behaviours such as "explanations" than male pupils (p=0.016 while p<0.05).

Concluding, it seems that the use of IWB does not seem to impact differently on pupils' scoring according their gender. However, in the second group/pair of studies there is an indication that girls participate and comment much more compared to boys during IWB lessons. But the important question is whether girls either way participate more, with or without the IWB, which would have been answered if a control group was added to the methodological design. This would be crucial since, it is broadly document in literature that, on average boys have a greater merit in playing focal roles than girls (Duffy et al. 2001; Jule, 2002; Howe and Abedin, 2013; Howe, 1997). In turn this raises a concern whether contrasting results, in the previously mentioned study, were extracted due to the use of IWB. Participation can take many forms and it should be observed more descriptively in terms of its content and connection to the learning procedure. As clearly stated in the beginning of this thesis quality participation through arguments and justification constitutes an indicator of improved learning.

Pupils' abilities in terms of scoring

Another interesting field of exploring IWB effects on pupils' scoring is scoring itself. Literally, to investigate whether there are any differences in attainment among low and high scoring pupils, related to the use of IWB; Appendix 11. My search resulted in seven studies which among others, made comparisons based on pupils' abilities based on their scoring. However, for reasons mentioned above three of them will be excluded; Somekh et al.(2007), Swan et al. (2010) and Thompson and Flecknoe (2003). Remaining four studies are presented below.

Martin (2007) and Hwang (2006) through qualitative designs measured pupils' participation as presented in the previous category. Interestingly both concluded that high achievers participated more in discussions during IWB classes. But such results cannot be related to the use of IWB since both studies did not have a control group. However, the fact that high achievers participate much more during lessons reinforces the theoretical stance hold by the writer. Literally, when you understand what is being said you are able to explain it orally and you are more confident to participate in discussions. Similarly, when teachers empower pupils to shape quality discussions and dialogues they reach a higher level of understanding compared their prior knowledge.

Higgins et al. (2005) and Masera (2010) measured scoring using pre- and post-testing. Higgins et al. investigated whether the proportion of low attaining pupils would be decreased after a full year of IWB use comparing scoring in 2003 and 2004, for both IWB and control group. Results indicate that there is a 16 per cent decrease in lower-achieving pupils in English in the IWB group and 11 per cent decrease in the control group ($p< 0.01$). However, in science the proportion of low-achievers was increased by 24 per cent in the IWB group while in the control group was increased only by 2 per cent ($p< 0.05$).

Masera investigated and compared the use of IWB, projector and traditional method to teach vocabulary in younger pupils; presented more descriptively in the following section. Regarding the use of IWB, post-testing on long term recall indicate that lower-achieving pupils did significantly worse when using the IWB while higher-achieving pupils had the same scores across all methods.

Such contrasting results, stress once more the need for more longitudinal research in the field while emphasizing the complexity of studying a technological resource such as the IWB. Even within Higgins et al. study there are different outcomes of IWB's use according the subject taught, while Masera' s results for English contradict Higgins et al.'s in the same subject. Higgins et al. concluded that the use of IWB has a positive effect in English for low-achievers as opposed to Masera who indicated that low-achievers did significantly worst while using the IWB. Certainly the different age of pupils in the specific studies might constitute a parameter justifying some differences in the overall outcome. But this should be further analysed through more rigorous and longitudinal research designs.

Overall, none of the above studies indicates a positive effect towards a certain group of pupils clearly related to the use of IWB. Having this said, as presented in previous sections, effective teaching is mirrored into raising each pupil's level of understanding. As long as a teacher's reality is mainly related to whole-class teaching in a mixed ability class, positive impact of IWB should be interpreted as having an effect on both low and high achievers. But, even if a positive impact was indicated towards only a certain group of pupils according their abilities, specific features and activities could be exploited at some instances in favor of either low or high achievers. Unfortunately, this issue still remains a hypothesis.

Comparing IWB with other sources and techniques

Interestingly some studies investigated the impact on learning attainment by comparing pupils' scoring across different teaching methods and instruments while IWB was among one of them; Appendix 12.

To begin, Masera (2010) using a sample of 87 children in nursery and Year 1, compared the effects of traditional, tactual/kinesthetic and IWB instruction while teaching a specific set of 45 sight words. Children, while divided in groups were taught 15 words at a time so that all children received all the types of instruction and were taught all of the words. Post-testing was conducted twice to check short-term and long-term recall of the taught words. Comparisons were made after subtracting the pre-test scores from short and long term post-tests. Overall, data indicated significantly highest short and long-term word recall when students were taught via tactual/kinesthetic method compared to traditional ($p<0.01$short-term, $p<0.5$ long-term) or compared to IWB ($p<0.001$ for both short and long-term recall). The IWB seemed to be the less effective instructional method.

However, quite surprisingly when making the same comparisons by grouping pupils in high and low achieving groups, Masera concluded that there was no significant difference for high-achieving pupils in favor of any of the instructional methods. High-achieving pupils were in total 33 while low-achieving were 54. Since pupils in the low-achieving group constitute more than half of the total sample (62 per cent) it could be argued that it caused an effect in the overall conclusion towards the positive effect of tactual/ kinesthetic instruction, since it mirrors the results in the low-achievers group. But, as long this ratio can be, and it probably is, the reality for many more schools rather than the one participating in the study the general conclusions are considered reliable. Overall, instruction via the IWB was not proven to be effective for either group of pupils.

Huang et al. (2004) compared pre and post-testing scores on statistics and pie-charts, among 60 participants in Year 6. Comparisons were made between an IWB classroom (experimental group) and a classroom owning overhead projector (control group) after one month of teaching statistics in each group. There was a significant positive difference in experimental group post-testing which increased its overall scoring 10 points, while control group increased its overall scoring only 2 points (p=0.003). Also, comparing pre-testing scores between the two groups resulted in no significant difference (p= 0.752) and the high statistical relationship between pre- and post-testing (p=0.708) strengthens the positive results in favor of the IWB.

Third and final study of the category, Watt (2009) compared the effects of Programmed Learning Sequenced (PLS) and IWB instructional methods on the maths achievement. Sample included 72 Year 8 students of a middle school, divided into two groups. Each group was taught with both methods. PLS is an instructional resource that programs content according each pupil's learning style (visual, tactual, in small steps, etc.) without direct teacher instruction. A statistical significant pre-post test effect was found across both methods (p<0.001) while there was no significant effect related to either method (p=0.053), indicating that both methods were equally effective in raising scores. Watt assumes that PLS is proven to be an effective instruction to raise achievement (presented extensively in his thesis) and consequently since IWB has the same effect it also constitutes an instructional tool which impacts positively on pupils' scoring. However, it would be more interesting to add a third variable/instruction which has been clearly connected and compared to the use of IWB, the projector.

As being the most difficult category in extracting conclusions because of the diversity of the methodologies but also the conclusions of each study separately, it becomes apparent that research can, should and has to be diverse in studying about the IWB. While it seems that younger pupils are best taught vocabulary kinesthetically rather than using the IWB, it (IWB) seems to have a positive effect on Year 6 and 8 (high-school) pupils' mathematical scoring. Such results in favor of IWB can be taken in mind if one accepts that the instructional method compared to IWB - the projector and PLS – is prima facie considered to have a positive effect in leaning. In any case, it would be more enlightening to add traditional instruction in any comparison.

Classroom Interaction

As being the corner stone of this thesis that quality interactions reflect and are reflected in effective teaching, this category is the most important and interesting category along with the first one presented here; *Pupils' scoring*. A positive effect in either category would be a clear indication that IWB has at least the potential to impact positively on learning. While in the first category results did not lead at all towards that direction in this category data are interestingly different and diverse. Studies in this category are presented as follows and are five in total; Appendix 13.

Higgins et al. (2005) investigated the type of discourse in IWB and non-IWB literacy and numeracy lessons in Year 5 and 6. They observed 114 lessons in 2003, 60 with an IWB and 54 without, in a total population of 30 teachers. The key detail which enhances the validity and reliability strength of this part in this study is that most teachers were observed four times: once using IWB during maths, once without it; once using the IWB during literacy, once without. Observing same teachers with and without the IWB enables researchers to draw conclusions on the actual impact of the technology; like having at the same time control and experimental group by the same participants. In 2004, further 70 IWB lessons were observed while 15 of the teachers were among those who participated in the observations in 2003 as well. Apart from the fact that observing same teachers many times reinforces the strength of an observational research, the total of 184 observations of this study is a very large number in the field. Researchers used a handheld computerised device where the type of discourse, both for teacher and pupils, was instantly inserted enabling a real-time quick coding during the observations.

Eighteen discourse moves where coded as to how many times a discourse type was observed per hour in IWB and non-IWB lessons. During the IWB lessons there were significantly more open questions, repeat questions, probes, evaluation, answers from pupils and general talk. Fewer pauses and uptake questions were also observed in the IWB classes. A faster pace in IWB lessons, especially the second year of use, consisted of 96 more discourse moves per hour. However, the content and duration of a discourse will add value to the intervention. Initially it seems that answers lasted longer during IWB lessons compared to non-IWB lessons ($p<0.001$) and pauses were briefer ($p<0.001$). Teachers' explanations and uptake questions lasted longer in non-IWB lessons ($p<0.05$ and $p<0.001$ respectively). But when analysing the data by year, there was an increment of answers in IWB lessons only in 2003 which settled back down in 2004. Similarly the decrease of pauses and teacher explanation in IWB lessons was temporal. Higgins et al. conclude that actually only three discourse moves were found to be significantly different among the two groups. In the IWB classes evaluation was twice the amount of evaluation in the other classes ($p<0.001$) while uptake questions and presentations from pupils were lower ($p<0.001$ and $p<0.05$ respectively). So while IWB group seems to gain a benefit in respective to the other group, at the same time loses some others. Such results indicate that IWB has the potential to change a lesson's structure and enhance classroom's discourse having in mind first year's observational results. But without sustainability the potential is minimised, while evolution in pedagogy constitutes the key to secure it.

Kennewell et al. (2007) also gathered data in two phases similar to Higgins et al. (2005); in Phase I data came from both IWB and non-IWB classes while in Phase II only from IWB. Qualitative data concerning classroom interactivity was collected from classroom observation; each observation was recorded by two cameras, one focused on the front of classroom and one capturing pupil activity. During Phase I there were two different groups of teachers during, opposed to Higgins et al.'s where same teachers were observed using IWB and not using IWB. Overall, in Phase I "no significant difference" was found between IWB and non-IWB lessons, but there was a trend across the non-IWB using teachers to demonstrate greater proportion of dialogic teaching. But same teachers appeared to be less effective in Phase II. Kennewell et al.(2007) argue that this could be a short-term dip in effectiveness whilst gaining expertise in using new technology. Contrastingly, Higgins et al.'s study indicate that through the first year of IWB use there was an effective interactivity boost which almost vanished the second year. Of course, comparison between the two studies can be taken in mind only if the two phases of gathering data are similar in terms of duration and date of each phase; Kennewell et al.(2007) do not provide reader with such data in his particular publication.

More importantly, while as previously mentioned there was no significant difference in attainment between pupils using IWB and not using IWB, differences in attainment across whole sample were found to be related to the level of interactivity in teaching. Supporting Alexander's (2004) dialogic teaching, Kennewell et al.(2007) explain that improved learning and attainment was associated with more dialogic interactivity. Irrespective from the use of IWB, dialogic teaching is the key to enhance learning outcomes, with no indications that teachers use the IWB towards that direction.

Swan et al. (2010) while in the first category was excluded because of methodological concerns as presented earlier, in order to investigate qualitatively the use of IWB a different method was applied but still raises many questions regarding its validity and reliability. Only the

IWB (experimental) group was targeted for qualitative analysis. Through SAT at the end of the study they targeted teachers based on their students' scoring; below-low average and high-achieving teachers. Then they compared teachers' own reports through an on-line self report system where each teacher commented on the IWB use and reported the frequency of IWB on a weekly basis. Certainly the reliability of such data can be questioned since teachers might not be precise or exaggerate on the frequency of IWB use for the sake of the study. Such possibilities cannot be eliminated though such data gathering systems. Also, as stressed throughout this thesis it is not about how many times a teacher turns the IWB on, instead it is how to use it in order to motivate pupils' to externalise their thinking. Results indicated that teachers of high-achieving students were using the IWB more often than the others.

However, looking at the comments of higher-scoring group of teachers it is apparent that they address features of IWB which were mentioned in a previous chapter as the effective characteristics of IWB while teachers of lower-achievers refer to the less effective side of IWB. More precisely, higher-scoring group of teachers focus on visualisation of concepts by having their students working on the IWB (ex. building fractions, completing graphs and tables, designing PowerPoint presentations) while they were using it also for brainstorming and interactive editing while none mentioned the use of IWB for motivation. The other group of teachers referred to activities that could be related to the use of projector such as PowerPoint presentations, timer function, pupils correcting sentences, etc. There is a clear match between the ideal use of IWB and teachers of higher-scoring students which erases up to a point our validity concerns about the online data system if we accept the following hypothesis. Teachers who are able to explain and refer to IWB's effective features and use are more likely to use it more often. However, as explained previously no connection can be made between IWB and high-scoring because scores were measured only once so it cannot be assumed that the intervention resulted in scoring higher.

Winkler (2011) conducted observations during IWB lessons with featured-trained and non-featured trained teachers. During observations two forms of data were gathered, observation rubrics and observation checklists. Each teacher was observed twice at 5^{th} and 8^{th} week of the nine week duration of this study. Through rubric scale each teacher could gather 4 to 20 points; a more interactive lesson resulted in higher scoring. Featured-trained teachers had higher mean scores (N=11, M=12.18) in relation to the other teachers (N=7, M=6.14) and this difference was statistically significant (p=0.027). Observations checklists represented teachers' schematic, inventive and constructive skills in a form of scoring. Similarly with rubrics' results, featured-trained teachers had a higher mean oppose to the non-trained teachers (12.86 versus 4.21) which was statistically significant (p<0.0005). The difference in the lesson quality and effectiveness among the trained teachers it is quite impressive. However, the two groups of teachers should also be observed before the intervention since it is a possibility that this difference might existed either way thus it cannot be assumed that training leaded to such differences. Whatsoever, the observed quality lessons of featured trained teachers it is not reflected in pupils' scoring, as explained in the relative previous section of the review. Surely, the fact that quality and more interactive lessons were observed via the use of IWB constitutes the crucial fact of this study and addresses IWB's potential, but still without a clear effect in scoring.

Hwang et al. (2006) applied a voice recording system through the IWB to teach fraction division problems which enabled pupils to record their own oral explanations about the solutions, comment on others' solutions or reply to others' arguments. The innovation of such initiatives is the cornerstone of the IWB technology. Not surprisingly, comparisons made between pupils' achievement and performance in oral explanations indicated that higher achievers performed better in commenting during lessons. Such results reinforce writer's argument; the more you understand the better you explain it. Additionally, after using this system in lessons pupils filled questionnaires and presented their agreement in a number of statements. It is remarkable that pupils strongly agreed on the following statements:

> "I can grasp various math solution methods through studying others' solving processes in the …whiteboard system"
> "It is helpful to math problem solving using voice playback to listen others' oral explanation about their solving methods." (p.115)

Once more such results are in line with the adopted theoretical view. Literally, pupils' learning is enhanced when they get chances to exchange orally their opinions and understanding on a specific mathematical problem while IWB enables them to do it by applying such voice recording systems. Of course this is not to say that mathematical problem solving becomes easy through such technological innovations. Indeed, Hwang et al. state that it is hard for most pupils to truly understand and explain the difficult mathematical problems and even if they solve it arithmetically it does not mean they understand it. Thus, it is even more necessary to apply such systems and enable pupils to improve their understanding of difficult subjects such as the fractional division.

Overall, anyone would agree that, this kind of IWB applications offer teachers a view on pupils' level of skills and understanding which cannot be seen in any other way, at least not in such rhythm and so instantaneously.

Discussion

Discussion will be drawn by answering the research questions of this review.

- Does the IWB technology have any effect on students' achievement in terms of standardised assessment of students aged 5 to 16 years old?
- Does the IWB technology have any effect on classroom's discourse in whole-class teaching of students aged 5-16 years old?

Regarding the first research question, there is a general consensus across the studies of this review, that IWBs have not raised pupils' achievement levels, at least as measured by tests of attainment. Similar results across a diversity of studies, perhaps indicates the need for more longitudinal studies. Most studies do not take into account the novelty of the IWB's *application,* and longer-term studies should explore the development of specific features of the technology and of any further potential. It is crucial for future research on pupils' attainment to adopt designs where claims can be made based on progress or additional improvement made by learners, e.g. Higgins et al. (2005).

Thinking about the second question, it does not seem like the IWB necessarily impacts on the lesson's quality as there were no consistent effects across the studies, particularly when related to a control group. There appears to be considerable variation in the ways in which IWBs were used, with some studies indicating benefits in relation to lesson quality, and others not. This is partly related to the training and support provided to teachers. However, the potential of the IWB can be understood through studies similar to Hwang et al.' s (2006), who designed a web-based multimedia system, which enabled voice recording through the use of the IWB. Such results are mirrored in the development of a project at the University of Cambridge to train teachers to impact on the quality of classroom talk using the IWB, funded by the ESRC (Hennessy et al. 2014).

The most interesting result which supports approaches based on dialogic teaching is identified by Kennewell et al. (2007). He concludes that differences in attainment were found to be related to the level of interactivity in teaching while improved learning and attainment was associated with more dialogic interactivity, either with or without an IWB. This argument is mirrored also in Higgins et al.'s (2007, p.217) conclusions that:

> Good teaching remains good teaching with or without the technology; the technology might enhance the pedagogy only if the teachers and pupils engaged with it and understood its potential in such a way that the technology is not seen as an end in itself but as another pedagogical means to achieve teaching and learning goals.

In the light of the above conclusion it is not a surprise that Mama and Hennessy (2010) conclude that, the most high integration level of technology was met in contexts without an IWB. More precisely, an example of such context was characterised by a teacher "constantly monitoring…progress, encouraging…reticent students while occasionally assembled them (pupils) around a computer…discussing the different levels of the program" (p. 271). Contrastingly, other teachers were found to use the IWB in a less thought provoking manner such as drill and practice.

It becomes clear that the diversity of the use of the IWB lies across three major categories: 1) the subject taught, 2) ages of pupils, and 3) particular type(s) of use. Thus, while a particular *application* of the IWB can be effective (e.g. Huang et al. 2004) another might not impact positively on pupils' learning (e.g. Masera, 2010). This reflects the IWB's complex potential and how a single technological device can be exploited in such diverse ways. Thus it is not merely about the technology and its uses but about aligning its use with more effective and more dialogic approaches to teaching. Indeed, Hennessy (2011) underpins the "added value" of the IWB compared to a computer or a data projector alone; as analysed in detail in the section 'Investigating IWB's potential…', pp. 89-93.

Dialogic teaching, of course, does not require technology. Indeed, while Beauchamp and Kennewell (2010) argue that the wider literature supports the move towards more dialogic teaching, they stress that there is greater potential in ICT to support dialogic teaching than witnessed presently, underpinning the need to shift towards a more active role for learners in orchestrating resources to support their own learning.

Summing up, assuming that IWB was an expensive car the teacher would be the driver. Having said this, the following metaphor grasps in a humorous way the current situation of IWB use. A good-driver can drive safely and enjoy the ride with any type of car. But even a Ferrari can still be crashed by a novice, a bad driver or an enthusiastic speed-driver.

All in all, conclusions of this review may not constitute a fault line in the field of research on the IWB, but they are exceptional because they were generated by looking systematically at an international group of studies. However, it is strongly argued here that further inquiry driven by the conclusions of this review could determine such potential.

Further discussion

Interestingly, the results of the two research questions are in line. The impact of the IWB on classroom talk and summative assessment is consistent, thus it can be suggested that it enhances the theoretical framework adopted. Offering opportunities to pupils to elaborate and discuss, enhances their learning, and this learning will be mirrored in the improvement in scoring; as a result, no improvement in the quality of classroom talk leads to no increment in scoring. Having said this, it is also implied that summative assessment offers substantial insight to students' learning. This issue, however, is very complex and needs to be addressed elsewhere since it had arisen after thinking about the results mentioned previously. More precisely, it has evolved around the concern that, perhaps, the pervasiveness of a traditional type of classroom talk is strongly related - and limited to - a reproduction of knowledge and processes that aim at succeeding in standardised forms of testing.

The content of summative assessment is the crucial factor in what kind of learning it addresses. Its importance has already been outlined (pp.52-54). For example, in maths, problem solving in unfamiliar contexts is an increasing demand from employers and universities but this factor is “neglected in most examinations of mathematics and, consequentially, in classroom teaching” (Jones et al., 2015, p.151). Jones et al. argue that teaching on problem solving is shaped by, and for, the examination. Indeed, Greatorex and Malacova (2006) found that any coursework or examination is closely related to the teaching strategies. This said, research on interactive teaching practices and summative assessment should be synchronized in a realistic perspective to impact positively on educational systems.

Moreover, it seems that within the existing patterns of testing and examinations in secondary education, it is rather challenging to assess skills, such as, abstract thinking and reasoning. For example, the maths General Certificate of Secondary Education (GCSE) taken at the age of 16 mostly consists of short items testing memorisation and duplication of routine procedures (Noyes et al., 2011 in Jones et. al., 2015). Similarly, PISA is delivered as a multiple-choice test of short answers (Murphy, 2010). In other words, the education system demands from students the ability to respond effectively to prescribed types of testing since this formula will most probably secure them a qualification and employment or place in a university. Educators practically prepare students for such types of testing from early schooling to high-school, and consequently their teaching is shaped by, and for, them. In addition, the importance of developing and sustaining competence in maths education from early years is broadly recognised (Dorman et al., 2003; Gifford, 2003).

Similar concerns are also evident by the addition of a new domain in the latest PISA, in 2015 (OECD, 2013), called “Collaborative Problem Solving” interpreted as:

> Collaborative problem solving competency is the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution. (p. 6)

At the same time there has been a considerable amount of research in England aiming at finding how to develop dialogic teaching practices; such the one presented. The importance of this issue has been outlined throughout this study and its importance is also highlighted by the fact that many bodies have funded projects towards that end such as the Education and Social Research Council (ESRC), Nesta, the Education Endowment Foundation (EEF) amongst others.. Without changes in the existing summative forms of testing what would be the outcome of applying such practices? Thus, in order to truly transform an educational system, changes in both teaching and testing should be reciprocal. Consequently, it is crucial to investigate the interplay between interactive teaching and different patterns of summative assessment, including the existing ones.

3.3 PUPILS' QUESTIONNAIRE USING TARGETED GROUPS

Results of the Questionnaire Analysis Using Descriptive Statistics

<u>Standard Deviation (*SD*) and Mean Score (*MS*) Values</u>

Table 10: *SD* and *MS* for each question. Minimum and Maximum indicate the scale of the options for each question.

Question (q)	*N*	Minimum	Maximum	*MS*	*SD*
q1:In my classroom we share rules about classroom talk	301	1	2	1.90	.304
q2:During Mathematics I participate in classroom discussions	301	1	4	3.29	.726
q3:I interrupt to make a question when I don't understand something	301	1	4	2.07	.792
q4:When I give an answer it is tested on the IW in front of the class	301	1	4	2.56	1.068
q5:It is helpful to understand a difficult exercise when I ask the teacher by raising my hand	300	1	4	3.00	.920
q6:It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation	300	1	4	2.04	.897
q7:It is helpful to understand a difficult exercise when I pay attention to the lesson	299	1	4	3.52	.672
q8:It is helpful to understand a difficult exercise when I explain my own thinking to the class	299	1	4	2.84	1.031
q9:It is helpful to understand a difficult exercise when I participate in the discussion during lesson	299	1	4	3.21	.894
q10:It is helpful to understand a difficult exercise when teacher explains it while using the IW	300	1	4	3.19	.930
q11:When teacher uses the IWB he/she raises a lot of questions	299	1	4	2.54	.883
q12:When teacher uses the IWB we begin discussion	299	1	4	2.75	.989
q13:When teacher uses the IWB I	300	1	4	3.35	.780

understand the lesson easier					
q14:When teacher uses the IWB my explanation is tested on the IWB in front of the class	299	1	4	2.99	1.052
q15:It's easier to understand something when I look or manipulate a shape on the IWB	300	1	4	3.21	.813
q16:It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB	300	1	4	2.84	.974
q17:I understand Mathematics better when teacher uses the IW	300	1	4	3.24	.748
Valid N (listwise)	298				

Even though *SD* and *MS* are presented in the above table, and cited during the descriptive analysis, they did not form the main component of the analysis, as argued in the 'Data Analysis' section (pp.115-117). This was mainly due to the fact that, micro-analysis drew attention to some questions which may have missed scrutiny, if *SD* was the only measure taken in mind to address each question's consistency and importance.

More precisely, the descriptive analysis indicated that the most important questions were q1, q2, q3, q6 and q7; presented as follows. However, looking at the *SD* measures in the Table 11 (next page), only some of them are amongst the most consistent ones (q1, q2, and q7), while for others the SD indicates a greater range of responses (q3, q6).

The descriptive analysis is therefore driven by quantitative comparisons from the micro-level analysis rather than by the range in *SD* values; further discussed in the 'Data Analysis' section previously in pp.115- 116. Literally, each question is analysed independently and comparisons with other questions are made wherever possible.

Table 11: Ordering questions according to *SD.* Minimum and Maximum indicate the scale of the options for each question.

Ordering questions	*N*	Minimum	Maximum	*MS*	*SD*
1:q1	301	1	2	1.90	.304
2:q7	299	1	4	3.52	.672
3:q2	301	1	4	3.29	.726
4:q17	300	1	4	3.24	.748
5:q13	300	1	4	3.35	.780
6:q3	301	1	4	2.07	.792
7:q15	300	1	4	3.21	.813
8:q11	299	1	4	2.54	.883
9:q9	299	1	4	3.21	.894
10:q6	300	1	4	2.04	.897
11:q5	300	1	4	3.00	.920
12:q10	300	1	4	3.19	.930
13:q16	300	1	4	2.84	.974
14:q12	299	1	4	2.75	.989
15:q14	299	1	4	2.99	1.052
16:q8	299	1	4	2.84	1.031
17:q4	301	1	4	2.56	1.068

Overall Frequencies for Each Question

Tables 12 to 14 below, provide an overview of the results as an introductory stage for the reader before the detailed analysis that follows. Similar questions in terms of the type of multiple choices they included are grouped into the same table.

Table 12: Overall results for q1

Question	**No**	**Yes**
[q1] In my classroom we share rules about classroom talk	31 10.3%	270 89.7%

Table 13: Overall results for q2, q3, q4 and, q17

Question	**Never**	**Rarely**	**Quite often**	**A lot of times**
[q2] During mathematics I participate in classroom discussions	3 1.0%	39 13.0%	126 41.9%	133 44.2%
[q3] I interrupt to make a question when I don’t understand something	69 22.9%	156 51.8%	61 20.3%	15 5.0%
[q4] When I give an answer it is tested on the IWB in front of the class	61 20.3%	83 27.6%	84 27.9%	73 24.3%
[q17] I understand mathematics better when teacher uses the IWB	6 2.0%	38 12.7%	133 44.3%	123 41.0%

Table 14: Overall results for q5 to q16

Question	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
[q5] It is helpful to understand a difficult exercise when I ask the teacher by raising my hand	19 6.3%	70 23.3%	104 34.7%	107 35.7%
[q6] It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation	91 30.3%	128 42.7%	58 19.3%	23 7.7%
[q7] It is helpful to understand a difficult exercise when I pay attention to the lesson	3 1.0%	21 7.0%	92 30.8%	183 61.2%
[q8] It is helpful to understand a difficult exercise when I explain my own thinking to the class	42 14.0%	61 20.4%	100 33.4%	96 32.1%
[q9] It is helpful to understand a difficult exercise when I participate in the discussion during lesson	18 6.0%	40 13.4%	101 33.8%	140 46.8%
[q10] It is helpful to understand a difficult exercise when teacher explains it while using the IW	19 6.3%	49 16.3%	87 29.0%	145 48.3%
[q11] When teacher uses the IWB he/she raises a lot of questions	38 12.7%	103 34.4%	117 39.1%	41 13.7%
[q12] When teacher uses the IWB we begin discussion	38 12.7%	78 26.1%	103 34.4%	80 26.8%
[q13] When teacher uses the IWB I understand the lesson easier	8 2.7%	33 11.0%	106 35.3%	153 51.0%
[q14] When teacher uses the IWB my explanation is tested on the IWB in front of the class	37 12.4%	56 18.7%	80 26.8%	126 42.1%
[q15] It's easier to understand something when I look or manipulate a shape on the IWB	11 3.7%	41 13.7%	122 40.7%	126 42.0%
[q16] It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB	35 11.7%	64 21.3%	114 38.0%	87 29.0%

Question 1: "In my classroom we share rules about classroom talk"

Table 15: Question 1. Overall frequencies and percentages of responses. Y=Yes N=No

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
No	31	10.3	10.3	10.3
Yes	270	89.7	89.7	100.0
Total	301	100.0	100.0	

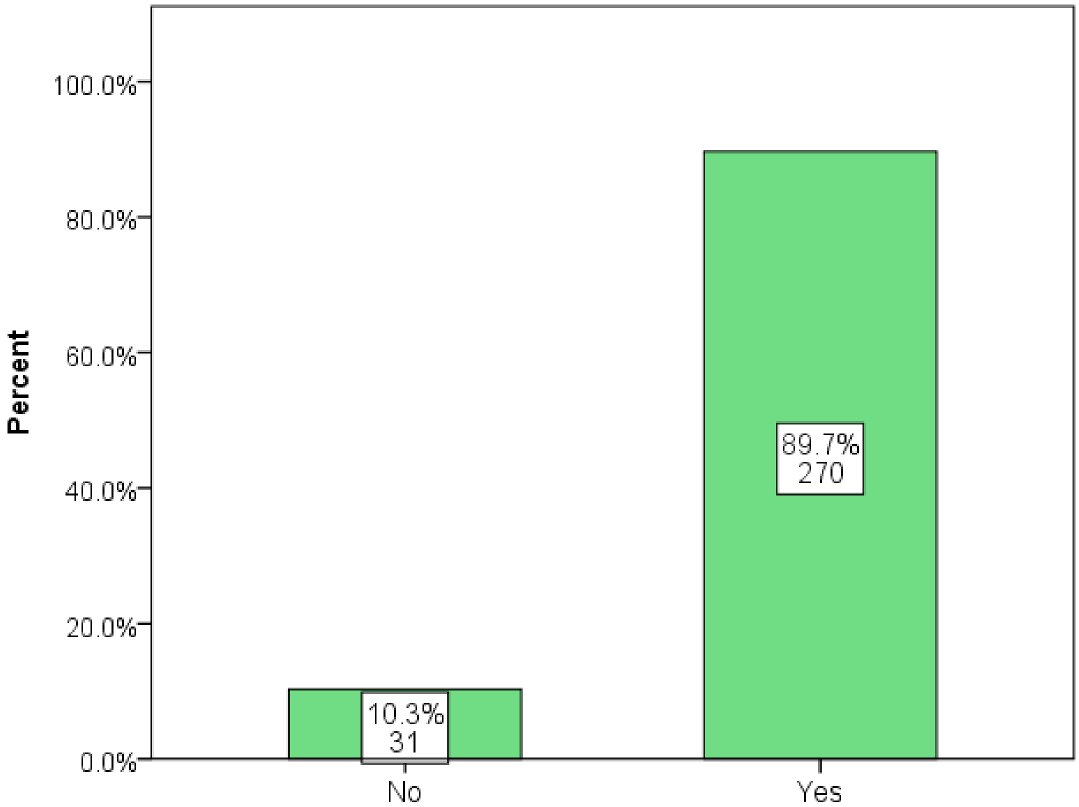

Figure 3: Question 1. In my classroom we share rules about classroom talk

Beginning with the simplest question, the vast majority of the classrooms set rules on classroom talk. The small amount of pupils who answered "no" reasonably indicates that, either in some classes of the sample they did not share such rules or some pupils had a blurred understanding of this question or/and its answer. The following table resolves this issue.

Table 16: Question 1. Frequencies and percentages by class

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Yes	20	100.0	100.0	100.0
Y3b	No	1	5.3	5.3	5.3
	Yes	18	94.7	94.7	100.0
	Total	19	100.0	100.0	
Y4a	No	3	16.7	16.7	16.7
	Yes	15	83.3	83.3	100.0
	Total	18	100.0	100.0	
Y4b	Yes	16	100.0	100.0	100.0
Y4c	No	1	4.0	4.0	4.0
	Yes	24	96.0	96.0	100.0
	Total	25	100.0	100.0	
Y4d	No	11	55.0	55.0	55.0
	Yes	9	45.0	45.0	100.0
	Total	20	100.0	100.0	
Y4e	No	8	33.3	33.3	33.3
	Yes	16	66.7	66.7	100.0
	Total	24	100.0	100.0	
Y5a	Yes	17	100.0	100.0	100.0
Y5b	No	2	14.3	14.3	14.3
	Yes	12	85.7	85.7	100.0
	Total	14	100.0	100.0	
Y5c	Yes	14	100.0	100.0	100.0
Y5d	No	1	6.3	6.3	6.3
	Yes	15	93.8	93.8	100.0
	Total	16	100.0	100.0	
Y6a	No	1	5.0	5.0	5.0
	Yes	19	95.0	95.0	100.0
	Total	20	100.0	100.0	
Y6b	No	3	14.3	14.3	14.3
	Yes	18	85.7	85.7	100.0
	Total	21	100.0	100.0	
Y6c	Yes	23	100.0	100.0	100.0
Y6d	Yes	17	100.0	100.0	100.0
Y6e	Yes	17	100.0	100.0	100.0

By looking at the above table it seems that while in some classes pupils answered “no”, responses seem to be an exception in each case; in other words, the vast majority in their class chose “yes”. Thus, a negative answer only by 1-3 pupils in some of the classes indicates that most probably in those classes they shared rules for classroom talk but some pupils might misunderstood or had a blurred meaning of this question or/and its answer.

However, this pattern does not fit into classes Y4d and Y4e where is not clear whether they shared or not classroom rules. More than half of the pupils in Y4d and nearly half of the pupils in Y4e gave a negative answer. The fact that some pupils answered ‘yes’ could probably indicate that in their class teacher raised an issue of classroom talk rules but this was not made in a systematic way, in contrast to the other classes. Systematic way refers to a sustain application and reference of clearly set classroom rules. Overall, the vast majority of the classes, 14 out of 16 classes, share rules for classroom talk.

Question 2: “During Mathematics I participate in classroom discussions”

Table 17: Question 2. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Never	3	1.0	1.0	1.0
Rarely	39	13.0	13.0	14.0
Quite often	126	41.9	41.9	55.8
A lot of times	133	44.2	44.2	100.0
Total	301	100.0	100.0	

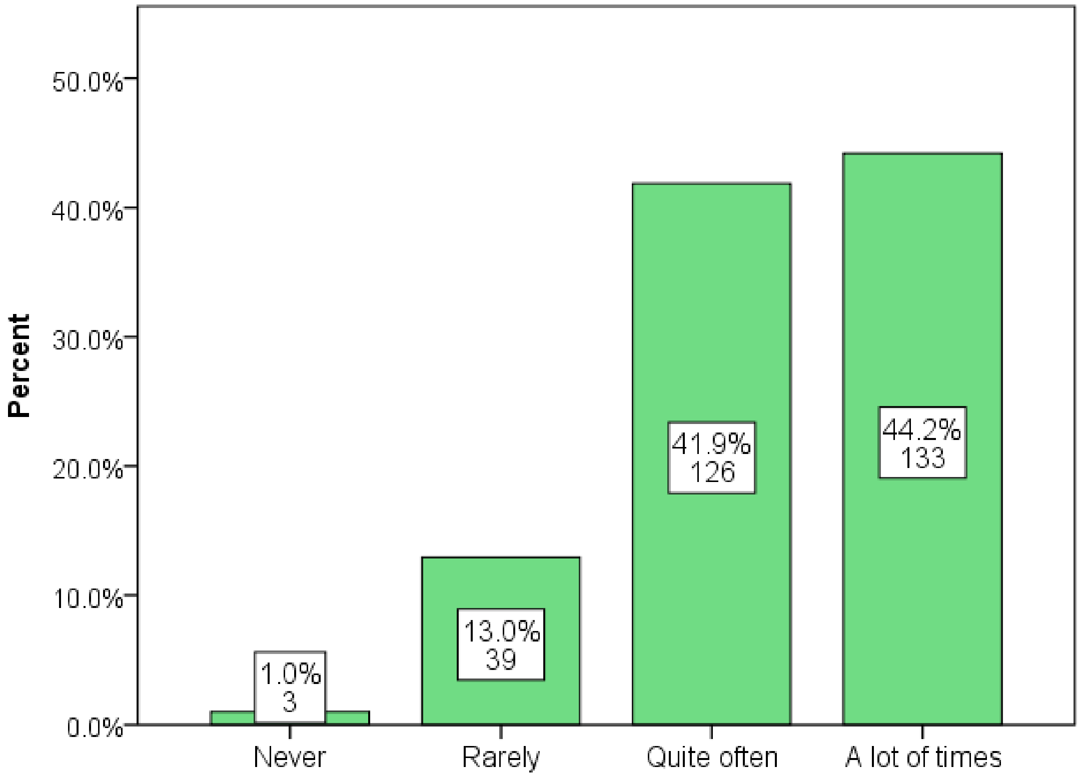

Figure 4: Question 2. During Mathematics I participate in classroom discussions.

Obviously, the vast majority of pupils reported that they were participating in discussions during maths, since 86,1 per cent of the sample noted that they were participating “quite often” or “a lot of times”. At first glance that could be interpreted into effective teaching in the particular classes having in mind the theoretical perspective of the writer. However, this question could be quite tricky in analysing it.

It is a possibility that teaching practices were in favour of dialogic teaching since during maths pupils participated in *discussions*, as interpreted in pp.36-38 and pp. 57-65. But as clearly and repeatedly argued throughout this thesis, oral exchanges within a class should not be translated into a *discussion*. Literally, what meaning do pupils give to the term *discussion* while answering positively to this question?

It could be a scenario that Cyprus has a good educational system where teachers develop practices in a context that enables the development of discussions or by a matter of luck the majority of teachers whose pupils participated in the survey, open up dialogic space during interactions. However, this is a quite extraordinary (and optimistic) scenario since this is rarely found even in England which seems to have a better educational system from Cyprus. According to PISA 2012 results, England had higher mean scores in maths and problem solving than Cyprus. Also, TIMMS 2007 results indicate that England had significant higher mean score achievement on maths than Cyprus (Mullis et al., 2008). Moreover, IWBs were introduced in Cyprus around 2008 while in England much earlier, around 2003 (East Sussex County Council, 2004). Yet, evidence suggest that the introduction of this technology in England did not impact on classroom interaction and scoring. An argument broadly presented in this thesis, in the literature review on IWBs (pp. 84-93), the first methodological plan (pp. 95-101), the systematic review (pp.104-131),and the MA thesis of the author (Appendix 17).

In light of these, if pupils participated orally to offer answers, brief or more detailed, to a teacher's single question they most likely translated this exchange into *discussion*, perhaps because they were not familiar with any other way of classroom talk. Looking at the results of other questions (ex. 3, 6, 8, 9) as well as the conclusion after inter-correlating all the questions, this scenario seems to suit better into the scheme.

Table 18: Question 2. Frequencies and percentages by class

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Quite often	9	45.0	45.0	45.0
	A lot of times	11	55.0	55.0	100.0
	Total	20	100.0	100.0	
Y3b	Rarely	2	10.5	10.5	10.5
	Quite often	11	57.9	57.9	68.4
	A lot of times	6	31.6	31.6	100.0
	Total	19	100.0	100.0	
Y4a	Rarely	7	38.9	38.9	38.9
	Quite often	2	11.1	11.1	50.0
	A lot of times	9	50.0	50.0	100.0
	Total	18	100.0	100.0	
Y4b	Rarely	3	18.8	18.8	18.8
	Quite often	6	37.5	37.5	56.3
	A lot of times	7	43.8	43.8	100.0
	Total	16	100.0	100.0	
Y4c	Rarely	8	32.0	32.0	32.0
	Quite often	12	48.0	48.0	80.0
	A lot of times	5	20.0	20.0	100.0
	Total	25	100.0	100.0	
Y4d	Never	1	5.0	5.0	5.0
	Quite often	10	50.0	50.0	55.0
	A lot of times	9	45.0	45.0	100.0
	Total	20	100.0	100.0	
Y4e	Rarely	1	4.2	4.2	4.2
	Quite often	13	54.2	54.2	58.3
	A lot of times	10	41.7	41.7	100.0
	Total	24	100.0	100.0	
Y5a	Rarely	3	17.6	17.6	17.6
	Quite often	6	35.3	35.3	52.9
	A lot of times	8	47.1	47.1	100.0
	Total	17	100.0	100.0	
Y5b	Quite often	10	71.4	71.4	71.4
	A lot of times	4	28.6	28.6	100.0
	Total	14	100.0	100.0	
Y5c	Rarely	2	14.3	14.3	14.3
	Quite often	6	42.9	42.9	57.1
	A lot of times	6	42.9	42.9	100.0
	Total	14	100.0	100.0	
Y5d	Quite often	8	50.0	50.0	50.0
	A lot of times	8	50.0	50.0	100.0
	Total	16	100.0	100.0	

Y6a	Rarely	3	15.0	15.0	15.0
	Quite often	4	20.0	20.0	35.0
	A lot of times	13	65.0	65.0	100.0
	Total	20	100.0	100.0	
Y6b	Rarely	4	19.0	19.0	19.0
	Quite often	7	33.3	33.3	52.4
	A lot of times	10	47.6	47.6	100.0
	Total	21	100.0	100.0	
Y6c	Never	1	4.3	4.3	4.3
	Rarely	2	8.7	8.7	13.0
	Quite often	10	43.5	43.5	56.5
	A lot of times	10	43.5	43.5	100.0
	Total	23	100.0	100.0	
Y6d	Rarely	2	11.8	11.8	11.8
	Quite often	5	29.4	29.4	41.2
	A lot of times	10	58.8	58.8	100.0
	Total	17	100.0	100.0	
Y6e	Never	1	5.9	5.9	5.9
	Rarely	2	11.8	11.8	17.6
	Quite often	7	41.2	41.2	58.8
	A lot of times	7	41.2	41.2	100.0
	Total	17	100.0	100.0	

In each class, except Y4a and Y4c, the vast majority of pupils reported that they participated in classroom discussion “quite often” or “a lot of times”. In Y4a and Y4c most of the pupils agreed to this question but not in their vast majority. In most of the remaining classes “quite often” was the most popular answer (Y3b,Y4b,Y4d,Y4e,Y5b). In five other classes most of the pupils reported that they participate in discussions a lot of times (Y3a, Y5a, Y6a,Y6b,Y6d) while in four others most responses were divided among “quite often” and “a lot of times” (Y5c,Y5d,Y6c,Y6e). It is also important to mention that in three classes all pupils - with no exception - reported that they participated either quite often or a lot of times in discussions (Y3a,Y5b,Y5d). This question is among the questions with the most consistent results at a class level; the others are q1, q3, q6 and q7.

Clearly, pupils do get chances to participate in classroom talk however it is questionable whether pupils' interpretation of the term *discussion* is aligned to the one given by the author, as indicated by results in forthcoming questions, q3 and q6.

Question 3: "I interrupt to make a question when I do not understand something"

Table 19: Question 3. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Never	69	22.9	22.9	22.9
Rarely	156	51.8	51.8	74.8
Quite often	61	20.3	20.3	95.0
A lot of times	15	5.0	5.0	100.0
Total	301	100.0	100.0	

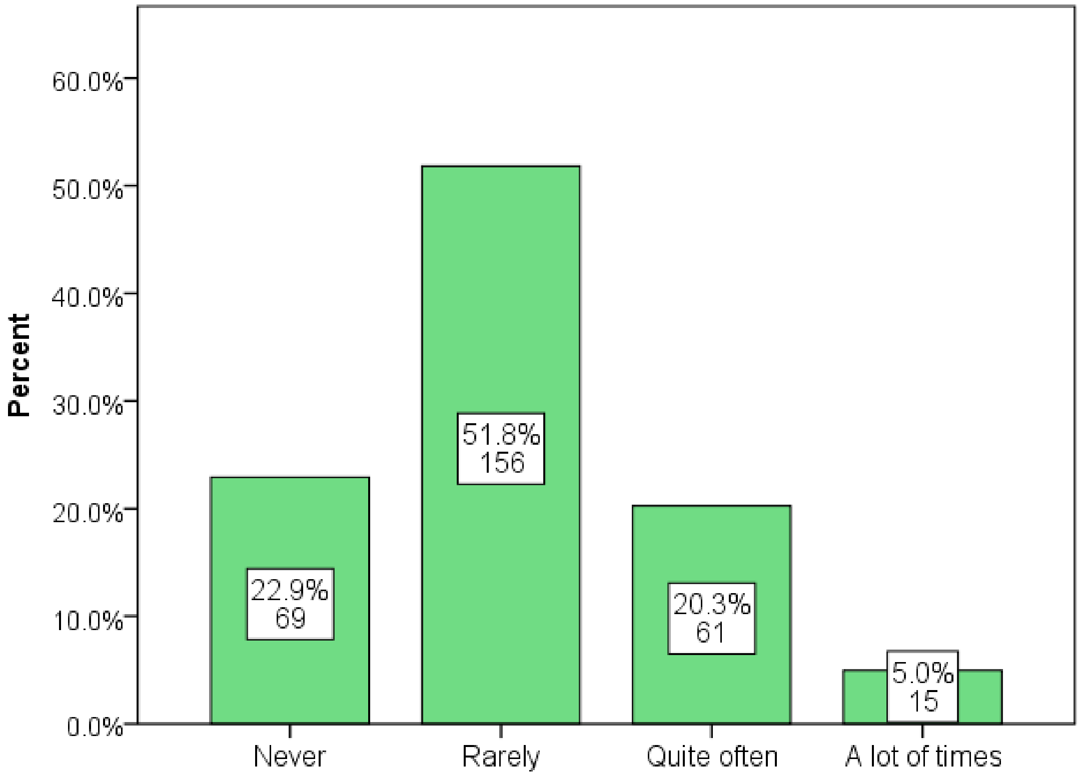

Figure 5: Question 3. I interrupt to make a question when I do not understand something

The majority of pupils (51,8 per cent) indicated that they rarely interrupted to make a question when they did not understand something, while 74,7 per cent of the pupils answered rather negatively to the above question by choosing either "never" or "rarely". Overall results, quite surprisingly, are coincided with each class results, as indicated in the next table. This question is among the five questions with the most consistence results; along with questions 1, 2, 6 and 7.

This fact reinforces the scenario mentioned in the previous question (q2). If *discussion* was a characteristic of the lesson then pupils would be motivated to interrupt in order to raise issues and make questions (e.g. refer to 'Pupils get chances to pose questions' in p.80) especially when they did not understand something. Thus, the more the negative answers given to this question, the more the possibilities for a lecture style teaching.

Table 20: Question 3. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Never	4	20.0	20.0	20.0
	Rarely	12	60.0	60.0	80.0
	Quite often	2	10.0	10.0	90.0
	A lot of times	2	10.0	10.0	100.0
	Total	20	100.0	100.0	
Y3b	Never	8	42.1	42.1	42.1
	Rarely	6	31.6	31.6	73.7
	Quite often	4	21.1	21.1	94.7
	A lot of times	1	5.3	5.3	100.0
	Total	19	100.0	100.0	
Y4a	Never	7	38.9	38.9	38.9
	Rarely	8	44.4	44.4	83.3
	Quite often	3	16.7	16.7	100.0
	Total	18	100.0	100.0	
Y4b	Never	5	31.3	31.3	31.3
	Rarely	8	50.0	50.0	81.3
	Quite often	3	18.8	18.8	100.0
	Total	16	100.0	100.0	
Y4c	Never	4	16.0	16.0	16.0
	Rarely	12	48.0	48.0	64.0
	Quite often	6	24.0	24.0	88.0
	A lot of times	3	12.0	12.0	100.0
	Total	25	100.0	100.0	
Y4d	Never	7	35.0	35.0	35.0
	Rarely	12	60.0	60.0	95.0
	Quite often	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Y4e	Never	6	25.0	25.0	25.0
	Rarely	14	58.3	58.3	83.3
	Quite often	4	16.7	16.7	100.0
	Total	24	100.0	100.0	
Y5a	Never	2	11.8	11.8	11.8
	Rarely	5	29.4	29.4	41.2
	Quite often	9	52.9	52.9	94.1
	A lot of times	1	5.9	5.9	100.0
	Total	17	100.0	100.0	
Y5b	Never	3	21.4	21.4	21.4
	Rarely	5	35.7	35.7	57.1
	Quite often	4	28.6	28.6	85.7
	A lot of times	2	14.3	14.3	100.0
	Total	14	100.0	100.0	
Y5c	Never	2	14.3	14.3	14.3
	Rarely	8	57.1	57.1	71.4
	Quite often	3	21.4	21.4	92.9
	A lot of times	1	7.1	7.1	100.0
	Total	14	100.0	100.0	
Y5d	Rarely	7	43.8	43.8	43.8
	Quite often	7	43.8	43.8	87.5
	A lot of times	2	12.5	12.5	100.0
	Total	16	100.0	100.0	
Y6a	Never	8	40.0	40.0	40.0
	Rarely	9	45.0	45.0	85.0
	Quite often	3	15.0	15.0	100.0
	Total	20	100.0	100.0	
Y6b	Never	2	9.5	9.5	9.5
	Rarely	14	66.7	66.7	76.2
	Quite often	4	19.0	19.0	95.2
	A lot of times	1	4.8	4.8	100.0
	Total	21	100.0	100.0	
Y6c	Never	3	13.0	13.0	13.0
	Rarely	14	60.9	60.9	73.9
	Quite often	6	26.1	26.1	100.0
	Total	23	100.0	100.0	
Y6d	Never	3	17.6	17.6	17.6
	Rarely	12	70.6	70.6	88.2
	Quite often	1	5.9	5.9	94.1
	A lot of times	1	5.9	5.9	100.0
	Total	17	100.0	100.0	
Y6e	Never	5	29.4	29.4	29.4
	Rarely	10	58.8	58.8	88.2
	Quite often	1	5.9	5.9	94.1
	A lot of times	1	5.9	5.9	100.0
	Total	17	100.0	100.0	

Question 4: "When I give an answer it is tested on the IWB in front of the class"

Table 21: Question 4. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Never	61	20.3	20.3	20.3
Rarely	83	27.6	27.6	47.8
Quite often	84	27.9	27.9	75.7
A lot of times	73	24.3	24.3	100.0
Total	301	100.0	100.0	

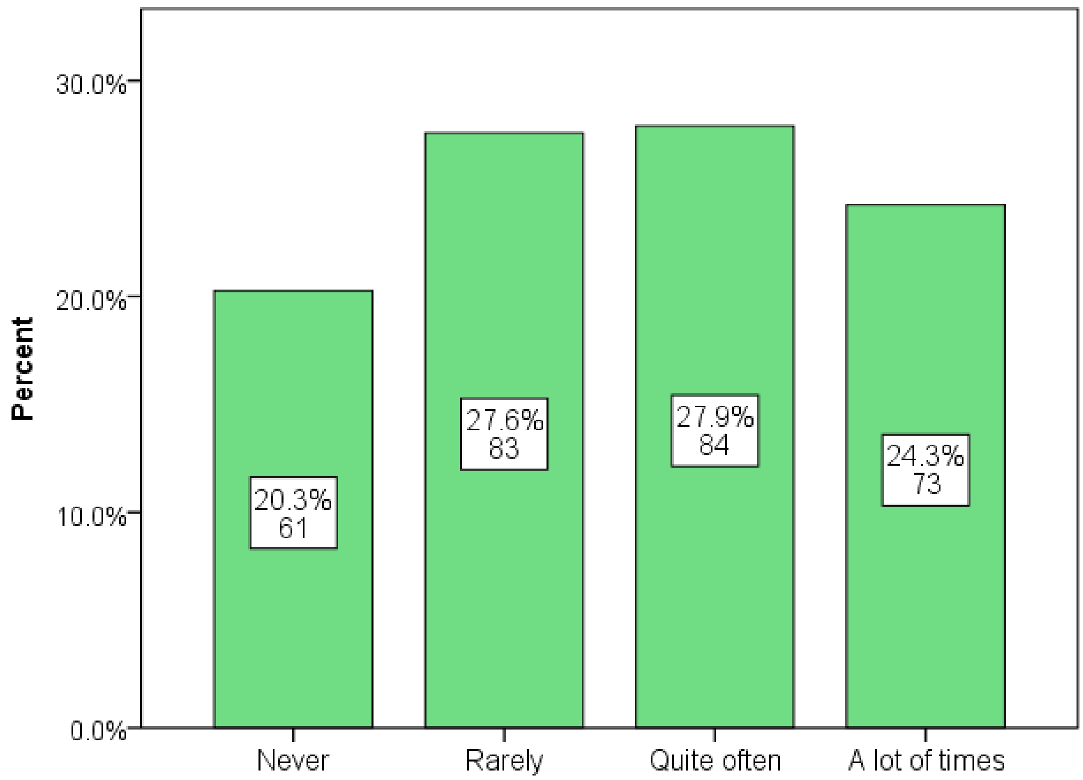

Figure 6: Question 4. When I give an answer it is tested on the IWB in front of the class.

Enabling pupils to test answers by using features of the IWB is a function which has the power to enhance interactivity during teaching (p. 89-93). Answers to this question are spread out almost evenly across the four choices. Thus, it becomes more interesting to check for any in-class tendency towards particular answers.

Table 22: Question 4. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Rarely	17	85.0	85.0	85.0
	Quite often	2	10.0	10.0	95.0
	A lot of times	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y3b	Never	4	21.1	21.1	21.1
	Rarely	3	15.8	15.8	36.8
	Quite often	7	36.8	36.8	73.7
	A lot of times	5	26.3	26.3	100.0
	Total	19	100.0	100.0	
Y4a	Never	7	38.9	38.9	38.9
	Rarely	3	16.7	16.7	55.6
	Quite often	5	27.8	27.8	83.3
	A lot of times	3	16.7	16.7	100.0
	Total	18	100.0	100.0	
Y4b	Rarely	1	6.3	6.3	6.3
	Quite often	5	31.3	31.3	37.5
	A lot of times	10	62.5	62.5	100.0
	Total	16	100.0	100.0	
Y4c	Never	7	28.0	28.0	28.0
	Rarely	4	16.0	16.0	44.0
	Quite often	12	48.0	48.0	92.0
	A lot of times	2	8.0	8.0	100.0
	Total	25	100.0	100.0	
Y4d	Never	3	15.0	15.0	15.0
	Rarely	3	15.0	15.0	30.0
	Quite often	6	30.0	30.0	60.0
	A lot of times	8	40.0	40.0	100.0
	Total	20	100.0	100.0	
Y4e	Never	3	12.5	12.5	12.5
	Rarely	5	20.8	20.8	33.3
	Quite often	3	12.5	12.5	45.8
	A lot of times	13	54.2	54.2	100.0
	Total	24	100.0	100.0	
Y5a	Never	1	5.9	5.9	5.9
	Rarely	2	11.8	11.8	17.6
	Quite often	3	17.6	17.6	35.3
	A lot of times	11	64.7	64.7	100.0
	Total	17	100.0	100.0	
Y5b	Rarely	3	21.4	21.4	21.4

	Quite often	6	42.9	42.9	64.3
	A lot of times	5	35.7	35.7	100.0
	Total	14	100.0	100.0	
Y5c	Never	3	21.4	21.4	21.4
	Rarely	1	7.1	7.1	28.6
	Quite often	7	50.0	50.0	78.6
	A lot of times	3	21.4	21.4	100.0
	Total	14	100.0	100.0	
Y5d	Never	2	12.5	12.5	12.5
	Rarely	3	18.8	18.8	31.3
	Quite often	8	50.0	50.0	81.3
	A lot of times	3	18.8	18.8	100.0
	Total	16	100.0	100.0	
Y6a	Never	6	30.0	30.0	30.0
	Rarely	13	65.0	65.0	95.0
	Quite often	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y6b	Never	10	47.6	47.6	47.6
	Rarely	4	19.0	19.0	66.7
	Quite often	5	23.8	23.8	90.5
	A lot of times	2	9.5	9.5	100.0
	Total	21	100.0	100.0	
Y6c	Never	1	4.3	4.3	4.3
	Rarely	9	39.1	39.1	43.5
	Quite often	9	39.1	39.1	82.6
	A lot of times	4	17.4	17.4	100.0
	Total	23	100.0	100.0	
Y6d	Never	11	64.7	64.7	64.7
	Rarely	3	17.6	17.6	82.4
	Quite often	2	11.8	11.8	94.1
	A lot of times	1	5.9	5.9	100.0
	Total	17	100.0	100.0	
Y6e	Never	3	17.6	17.6	17.6
	Rarely	9	52.9	52.9	70.6
	Quite often	3	17.6	17.6	88.2
	A lot of times	2	11.8	11.8	100.0
	Total	17	100.0	100.0	

Looking at class level, it is clear that in many classes answers are distributed towards specific choices. More precisely, the vast majority of the pupils in each class (70 per cent or more) lean towards either a positive or negative answer. On the one hand, in five classes (Y4b,Y4d,Y5a,Y5b,Y5c) the vast majority quoted that their answers were tested on the IWB “quite often” or “a lot of times”. On the other hand, in four classes (Y3a,Y6a,Y6b,Y6d) the vast majority rather disagreed that their answers were tested on the IWB by answering “rarely” or “never”. Obviously, teachers are using the IWB in different ways as evident in this question.

Overall, the use of IWB is at a rather early stage of use while interactive characteristics of IWB such as testing pupils’ answers remain undeveloped. Such results are in line with the systematic review’s result (p.127-129), indicating that the novelty of the technology seems to impact in both positive and negative ways in learning. Higgins et al. (2005) argue that during the 2nd year of IWB use scores are getting higher while, on the 3rd year they decrease again. Also, Kennewell et al. (2007) argue that there might be a short-term dip in effectiveness whilst gaining expertise in using the IWB.

<u>Question 5: "It is helpful to understand a difficult exercise when I ask the teacher by raising my hand"</u>

Table 23: Question 5. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Strongly disagree	19	6.3	6.3	6.6
Disagree	70	23.3	23.3	29.9
Agree	104	34.6	34.6	64.5
Strongly agree	107	35.5	35.5	100.0
Total	301	100.0	100.0	

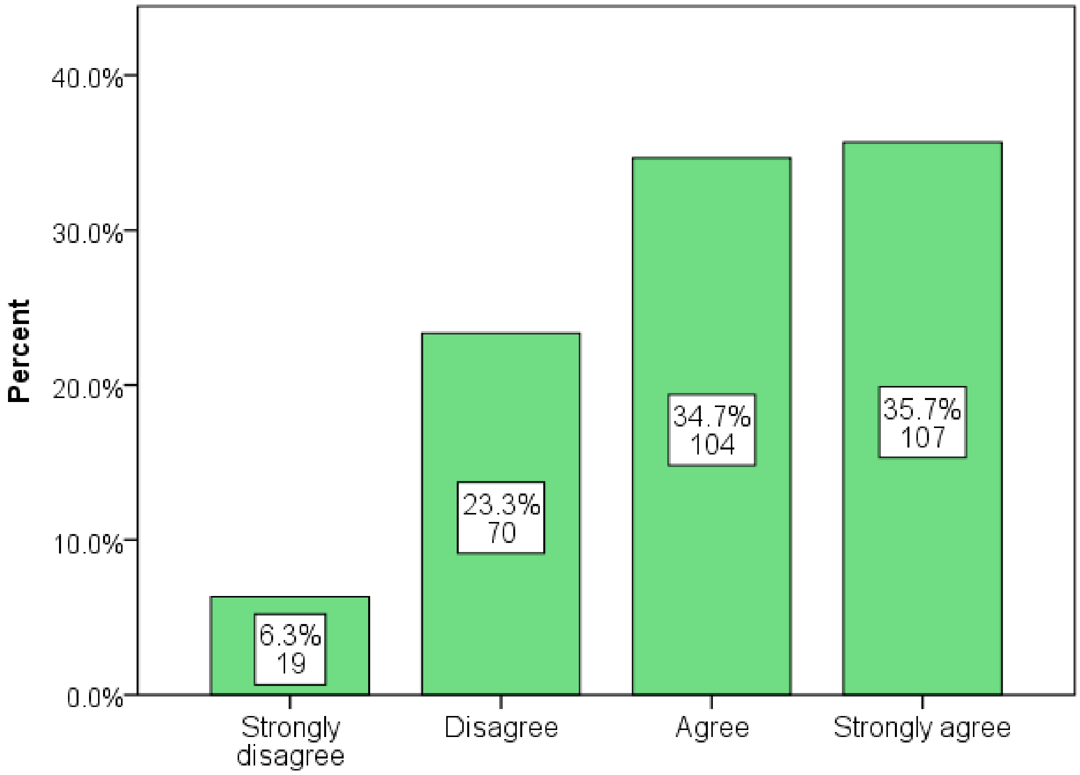

Figure 7: Question 5. It is helpful to understand a difficult exercise when I ask the teacher by raising my hand.

A percentage of 70, 4 per cent of pupils agreed that by asking the teacher it is helpful to improve their understanding especially when they face some difficulties. The number of pupils agreeing on this question is divided among the choices "agree" and "strongly agree".

Table 24: Question 5. Frequencies and percentages by class

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly disagree	4	20.0	20.0	20.0
	Disagree	1	5.0	5.0	25.0
	Strongly agree	15	75.0	75.0	100.0
	Total	20	100.0	100.0	
Y3b	Disagree	2	10.5	10.5	10.5
	Agree	5	26.3	26.3	36.8
	Strongly agree	12	63.2	63.2	100.0
	Total	19	100.0	100.0	
Y4a	Strongly disagree	2	11.1	11.1	11.1
	Disagree	10	55.6	55.6	66.7
	Agree	2	11.1	11.1	77.8
	Strongly agree	4	22.2	22.2	100.0
	Total	18	100.0	100.0	
Y4b	Strongly disagree	1	6.3	6.3	6.3
	Disagree	1	6.3	6.3	12.5
	Strongly agree	14	87.5	87.5	100.0
	Total	16	100.0	100.0	
Y4c	Disagree	3	12.0	12.0	12.0
	Agree	11	44.0	44.0	56.0
	Strongly agree	11	44.0	44.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	1	5.0	5.0	5.0
	Disagree	1	5.0	5.0	10.0
	Agree	7	35.0	35.0	45.0
	Strongly agree	11	55.0	55.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	1	4.2	4.2	4.2
	Disagree	5	20.8	20.8	25.0
	Agree	12	50.0	50.0	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	1	5.9	5.9	5.9
	Disagree	8	47.1	47.1	52.9
	Agree	6	35.3	35.3	88.2
	Strongly agree	2	11.8	11.8	100.0
	Total	17	100.0	100.0	
Y5b	Strongly	3	21.4	21.4	21.4

	disagree				
	Disagree	2	14.3	14.3	35.7
	Agree	6	42.9	42.9	78.6
	Strongly agree	3	21.4	21.4	100.0
	Total	14	100.0	100.0	
Y5c	0	1	7.1	7.1	7.1
	Disagree	2	14.3	14.3	21.4
	Agree	6	42.9	42.9	64.3
	Strongly agree	5	35.7	35.7	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	2	12.5	12.5	12.5
	Disagree	4	25.0	25.0	37.5
	Agree	4	25.0	25.0	62.5
	Strongly agree	6	37.5	37.5	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	2	10.0	10.0	10.0
	Disagree	5	25.0	25.0	35.0
	Agree	11	55.0	55.0	90.0
	Strongly agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	
Y6b	Strongly disagree	1	4.8	4.8	4.8
	Disagree	8	38.1	38.1	42.9
	Agree	6	28.6	28.6	71.4
	Strongly agree	6	28.6	28.6	100.0
	Total	21	100.0	100.0	
Y6c	Disagree	6	26.1	26.1	26.1
	Agree	13	56.5	56.5	82.6
	Strongly agree	4	17.4	17.4	100.0
	Total	23	100.0	100.0	
Y6d	Disagree	4	23.5	23.5	23.5
	Agree	8	47.1	47.1	70.6
	Strongly agree	5	29.4	29.4	100.0
	Total	17	100.0	100.0	
Y6e	Strongly disagree	1	5.9	5.9	5.9
	Disagree	8	47.1	47.1	52.9
	Agree	7	41.2	41.2	94.1
	Strongly agree	1	5.9	5.9	100.0
	Total	17	100.0	100.0	

Interestingly in eight classes (Y3a, Y3b, Y4b, Y4c, Y4d, Y4e, Y5c, Y6d) the vast majority of the pupils reported that it is helpful to ask the teacher by raising their hands; "agree" and “strongly agree” were the most popular answers. On the contrary, in Y4a the vast majority of the pupils disagreed while in Y5a and Y6e pupils’ answers in each class were contradicted.

Overall, results are in contrast to those of the third question where it seems that pupils do not interrupt to ask a question when they do not understand something. However, it seems that pupils’ understanding is enhanced when they get the chance to question during lesson. A fact that reinforces author’s theoretical perspective which stresses the importance of inspiring pupils to question, as well as teacher’s ability to handle pupils’ questions effectively (more details in p. 70-83). Contrasting results in three of the classes might be interpreted by specific teaching characteristics in those classes, such as limited answers to pupils’ queries or a more authoritarian style of teaching.

Question 6: "It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation"

Table 25: Question 6. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Strongly disagree	91	30.2	30.2	30.6
Disagree	128	42.5	42.5	73.1
Agree	58	19.3	19.3	92.4
Strongly agree	23	7.6	7.6	100.0
Total	301	100.0	100.0	

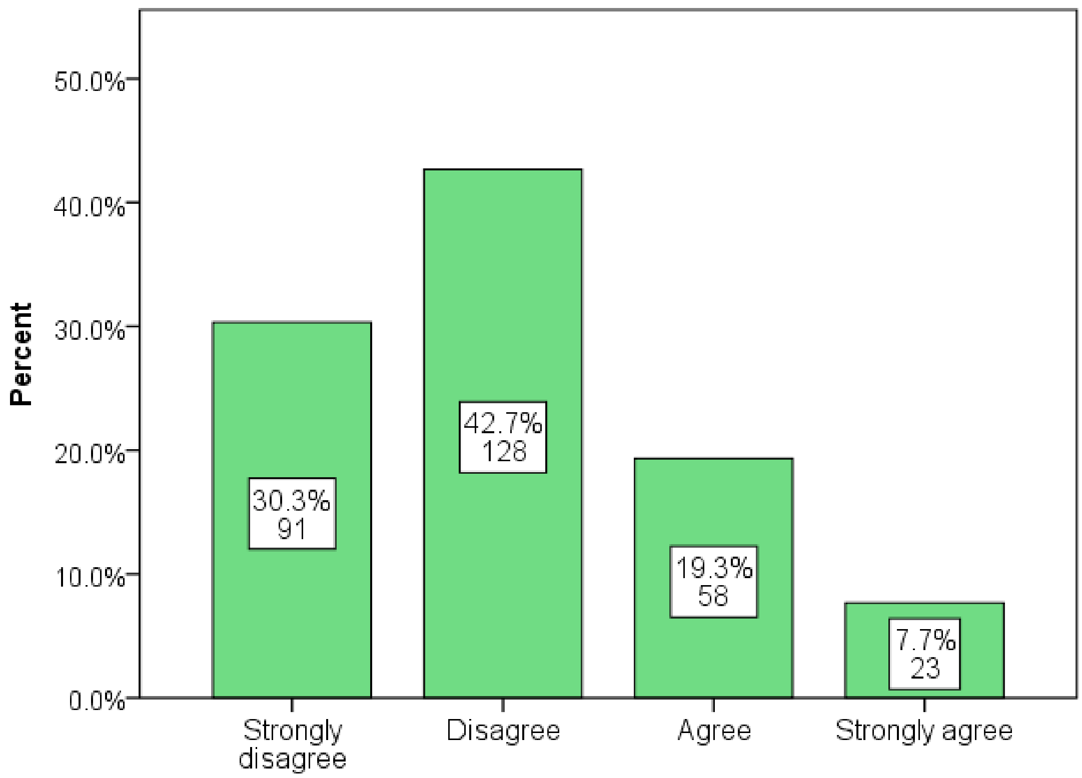

Figure 8: Question 6. It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation.

Interestingly, 73 per cent of pupils do not find it helpful to ask a friend about a difficult exercise. If pupils were familiar with dialogical teaching practices but replied in such a way it would certainly question some aspects of dialogic teaching. Yet, probably this does not seem to be the situation as indicated by the results of this question as well as those of q9.

Table 26: Question 6. -Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly disagree	13	65.0	65.0	65.0
	Disagree	7	35.0	35.0	100.0
	Total	20	100.0	100.0	
Y3b	Strongly disagree	6	31.6	31.6	31.6
	Disagree	5	26.3	26.3	57.9
	Agree	5	26.3	26.3	84.2
	Strongly agree	3	15.8	15.8	100.0
	Total	19	100.0	100.0	
Y4a	Strongly disagree	7	38.9	38.9	38.9
	Disagree	7	38.9	38.9	77.8
	Agree	2	11.1	11.1	88.9
	Strongly agree	2	11.1	11.1	100.0
	Total	18	100.0	100.0	
Y4b	Strongly disagree	5	31.3	31.3	31.3
	Disagree	7	43.8	43.8	75.0
	Agree	4	25.0	25.0	100.0
	Total	16	100.0	100.0	
Y4c	Strongly disagree	10	40.0	40.0	40.0
	Disagree	10	40.0	40.0	80.0
	Agree	5	20.0	20.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	5	25.0	25.0	25.0
	Disagree	12	60.0	60.0	85.0
	Agree	1	5.0	5.0	90.0
	Strongly agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	3	12.5	12.5	12.5
	Disagree	10	41.7	41.7	54.2
	Agree	7	29.2	29.2	83.3
	Strongly agree	4	16.7	16.7	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	5	29.4	29.4	29.4
	Disagree	6	35.3	35.3	64.7
	Agree	4	23.5	23.5	88.2
	Strongly agree	2	11.8	11.8	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	2	14.3	14.3	14.3
	Disagree	5	35.7	35.7	50.0
	Agree	6	42.9	42.9	92.9
	Strongly agree	1	7.1	7.1	100.0
	Total	14	100.0	100.0	
Y5c	0	1	7.1	7.1	7.1

	Strongly disagree	3	21.4	21.4	28.6
	Disagree	6	42.9	42.9	71.4
	Agree	2	14.3	14.3	85.7
	Strongly agree	2	14.3	14.3	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	4	25.0	25.0	25.0
	Disagree	10	62.5	62.5	87.5
	Agree	1	6.3	6.3	93.8
	Strongly agree	1	6.3	6.3	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	5	25.0	25.0	25.0
	Disagree	10	50.0	50.0	75.0
	Agree	3	15.0	15.0	90.0
	Strongly agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	
Y6b	Strongly disagree	5	23.8	23.8	23.8
	Disagree	12	57.1	57.1	81.0
	Agree	3	14.3	14.3	95.2
	Strongly agree	1	4.8	4.8	100.0
	Total	21	100.0	100.0	
Y6c	Strongly disagree	4	17.4	17.4	17.4
	Disagree	10	43.5	43.5	60.9
	Agree	9	39.1	39.1	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	7	41.2	41.2	41.2
	Disagree	3	17.6	17.6	58.8
	Agree	5	29.4	29.4	88.2
	Strongly agree	2	11.8	11.8	100.0
	Total	17	100.0	100.0	
Y6e	Strongly disagree	7	41.2	41.2	41.2
	Disagree	8	47.1	47.1	88.2
	Agree	1	5.9	5.9	94.1
	Strongly agree	1	5.9	5.9	100.0
	Total	17	100.0	100.0	

Rather surprisingly, pupils consistently preferred the choice “disagree”. The only exception is Y5b where pupils were divided between agree and disagree. Once more it becomes clear that classroom talk is at a state far from a *discussion* pattern directed mainly to and from the teacher.

More precisely, Alexander (2004) states that in a dialogic classroom “…children listen to each other…help each other to reach common understanding” (p.28). In line with this, Chapin et al. 2009 found that, many pupils enhance their own understanding by hearing what their classmates think. But any questioning should be initially orchestrated by the teacher so that pupils will also get opportunities to develop their ability to discuss with each other. Indeed, Smith and Higgins (2006) argue that teacher creates such environment through feedback moves (e.g. encouraging peer-peer feedback, using pupils' ideas to direct, and uptake of pupil contributions); refer to 'The importance of feedback' in pp. 81-83. If teacher does not develop questioning techniques and discussions, how would we expect pupils to apply them in between them? Once more, it seems that pupils are not confident in asking and helping each other directly in the classroom setting.

What is more, Pratt (2006), in his investigation of pupils' perspectives on how learning took place in a primary whole class numeracy interactive setting, based on the English National Numeracy Strategy (NNS) in 1999, concluded that sharing ideas amongst pupils constituted a difficult procedure due to insufficient clarity and resistance to conceptual change by the pupils themselves. This issue is further elaborated in the final concluding chapter of this study.

<u>Question 7: "It is helpful to understand a difficult exercise when I pay attention to the lesson"</u>

Table 27: Question 7. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	2	.7	.7	.7
Strongly disagree	3	1.0	1.0	1.7
Disagree	21	7.0	7.0	8.6
Agree	92	30.6	30.6	39.2
Strongly agree	183	60.8	60.8	100.0
Total	301	100.0	100.0	

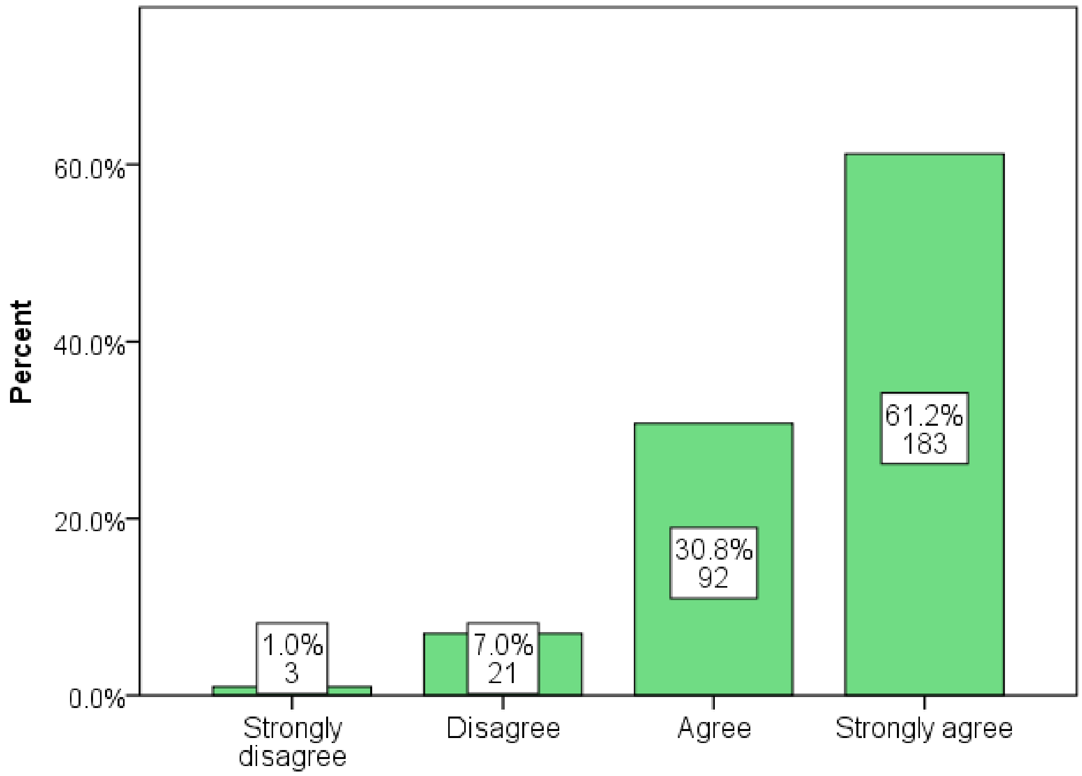

Figure 9: Question 7. It is helpful to understand a difficult exercise when I pay attention to the lesson

The vast majority of pupils (92 per cent) agreed that paying attention to the lesson helps them improve their learning while it is notable that 61,2 per cent of pupils strongly agreed with the statement. Results mirror responses of each class as well. Pupils consider this as the strongest learning ‘strengthener’ since it has the highest number of “strongly agree” responses overall. If paying attention to the lesson was translated as paying attention to the teacher, it would be disappointing to get such results. As repeatedly mentioned, dialogic teaching is far from such teacher-centered schemes. Paying attention to the teacher is certainly an essential part for any kind of teaching, in order to be successful. Yet, if pupils seem to consider it as the most powerful tool to improve their learning it raises concerns about learners level of participation during lessons. Either way, pupils might had in mind the lesson process as a whole when replying to this question.

Table 28: Question 7. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Agree	4	20.0	20.0	20.0
	Strongly agree	16	80.0	80.0	100.0
	Total	20	100.0	100.0	
Y3b	Agree	5	26.3	26.3	26.3
	Strongly agree	14	73.7	73.7	100.0
	Total	19	100.0	100.0	
Y4a	Agree	8	44.4	44.4	44.4
	Strongly agree	10	55.6	55.6	100.0
	Total	18	100.0	100.0	
Y4b	Strongly agree	16	100.0	100.0	100.0
Y4c	0	1	4.0	4.0	4.0
	Disagree	1	4.0	4.0	8.0
	Agree	7	28.0	28.0	36.0
	Strongly agree	16	64.0	64.0	100.0
	Total	25	100.0	100.0	
Y4d	Disagree	1	5.0	5.0	5.0
	Agree	4	20.0	20.0	25.0
	Strongly agree	15	75.0	75.0	100.0
	Total	20	100.0	100.0	
Y4e	Disagree	3	12.5	12.5	12.5
	Agree	12	50.0	50.0	62.5
	Strongly agree	9	37.5	37.5	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	1	5.9	5.9	5.9
	Disagree	5	29.4	29.4	35.3

	Agree	5	29.4	29.4	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	1	7.1	7.1	7.1
	Disagree	3	21.4	21.4	28.6
	Agree	5	35.7	35.7	64.3
	Strongly agree	5	35.7	35.7	100.0
	Total	14	100.0	100.0	
Y5c	0	1	7.1	7.1	7.1
	Disagree	1	7.1	7.1	14.3
	Agree	3	21.4	21.4	35.7
	Strongly agree	9	64.3	64.3	100.0
	Total	14	100.0	100.0	
Y5d	Agree	4	25.0	25.0	25.0
	Strongly agree	12	75.0	75.0	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	1	5.0	5.0	5.0
	Disagree	2	10.0	10.0	15.0
	Agree	8	40.0	40.0	55.0
	Strongly agree	9	45.0	45.0	100.0
	Total	20	100.0	100.0	
Y6b	Disagree	1	4.8	4.8	4.8
	Agree	7	33.3	33.3	38.1
	Strongly agree	13	61.9	61.9	100.0
	Total	21	100.0	100.0	
Y6c	Disagree	3	13.0	13.0	13.0
	Agree	9	39.1	39.1	52.2
	Strongly agree	11	47.8	47.8	100.0
	Total	23	100.0	100.0	
Y6d	Agree	6	35.3	35.3	35.3
	Strongly agree	11	64.7	64.7	100.0
	Total	17	100.0	100.0	
Y6e	Disagree	1	5.9	5.9	5.9
	Agree	5	29.4	29.4	35.3
	Strongly agree	11	64.7	64.7	100.0
	Total	17	100.0	100.0	

Question 8: "It is helpful to understand a difficult exercise when I explain my own thinking to the class"

Table 29: Question 8. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	2	.7	.7	.7
Strongly disagree	42	14.0	14.0	14.6
Disagree	61	20.3	20.3	34.9
Agree	100	33.2	33.2	68.1
Strongly agree	96	31.9	31.9	100.0
Total	301	100.0	100.0	

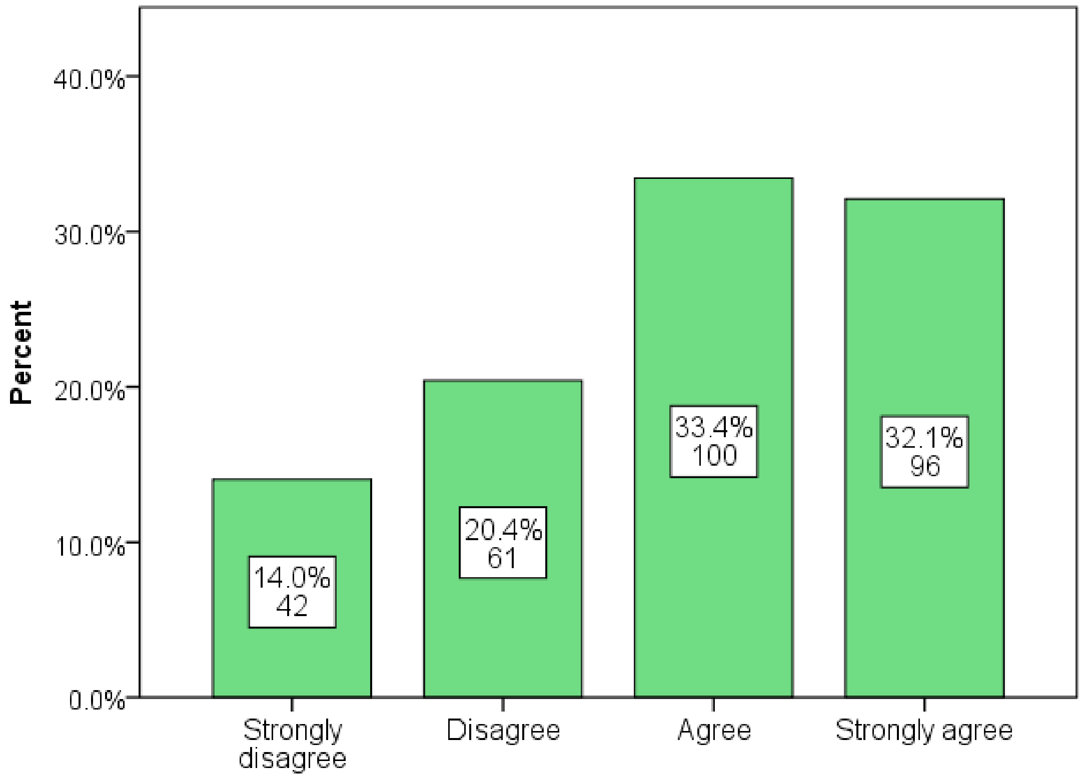

Figure 10: Question. It is helpful to understand a difficult exercise when I explain my own thinking to the class.

Looking at the bar graph, the majority of pupils (65,5 per cent) considered it helpful to explain their thinking aloud while answers are rather spread among the four choices. Once more, look at classroom level results will be enlightening since, as quoted in the analysis of q6, pupils' responses are inevitably related to the type of teaching pupils have experienced. Literally, are they “trained” to explain their thinking to the class?

Table 30: Question 8. Frequencies and percentages by class.

Class		Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a		Agree	3	15.0	15.0	15.0
		Strongly agree	17	85.0	85.0	100.0
		Total	20	100.0	100.0	
Y3b		Strongly disagree	1	5.3	5.3	5.3
		Disagree	4	21.1	21.1	26.3
		Agree	8	42.1	42.1	68.4
		Strongly agree	6	31.6	31.6	100.0
		Total	19	100.0	100.0	
Y4a		Strongly disagree	4	22.2	22.2	22.2
		Disagree	2	11.1	11.1	33.3
		Agree	6	33.3	33.3	66.7
		Strongly agree	6	33.3	33.3	100.0
		Total	18	100.0	100.0	
Y4b		Strongly disagree	2	12.5	12.5	12.5
		Disagree	4	25.0	25.0	37.5
		Agree	6	37.5	37.5	75.0
		Strongly agree	4	25.0	25.0	100.0
		Total	16	100.0	100.0	
Y4c		0	1	4.0	4.0	4.0
		Strongly disagree	4	16.0	16.0	20.0
		Disagree	9	36.0	36.0	56.0
		Agree	7	28.0	28.0	84.0
		Strongly agree	4	16.0	16.0	100.0
		Total	25	100.0	100.0	
Y4d		Disagree	3	15.0	15.0	15.0
		Agree	11	55.0	55.0	70.0
		Strongly agree	6	30.0	30.0	100.0
		Total	20	100.0	100.0	
Y4e		Strongly disagree	4	16.7	16.7	16.7
		Disagree	3	12.5	12.5	29.2
		Agree	8	33.3	33.3	62.5
		Strongly agree	9	37.5	37.5	100.0
		Total	24	100.0	100.0	
Y5a	Valid	Strongly disagree	4	23.5	23.5	23.5
		Disagree	5	29.4	29.4	52.9
		Agree	4	23.5	23.5	76.5
		Strongly agree	4	23.5	23.5	100.0

		Total	17	100.0	100.0	
Y5b	Valid	Strongly disagree	3	21.4	21.4	21.4
		Disagree	4	28.6	28.6	50.0
		Agree	3	21.4	21.4	71.4
		Strongly agree	4	28.6	28.6	100.0
		Total	14	100.0	100.0	
Y5c	Valid	0	1	7.1	7.1	7.1
		Strongly disagree	3	21.4	21.4	28.6
		Disagree	1	7.1	7.1	35.7
		Agree	5	35.7	35.7	71.4
		Strongly agree	4	28.6	28.6	100.0
		Total	14	100.0	100.0	
Y5d	Valid	Strongly disagree	2	12.5	12.5	12.5
		Disagree	4	25.0	25.0	37.5
		Agree	5	31.3	31.3	68.8
		Strongly agree	5	31.3	31.3	100.0
		Total	16	100.0	100.0	
Y6a	Valid	Strongly disagree	3	15.0	15.0	15.0
		Disagree	6	30.0	30.0	45.0
		Agree	8	40.0	40.0	85.0
		Strongly agree	3	15.0	15.0	100.0
		Total	20	100.0	100.0	
Y6b	Valid	Strongly disagree	2	9.5	9.5	9.5
		Disagree	6	28.6	28.6	38.1
		Agree	7	33.3	33.3	71.4
		Strongly agree	6	28.6	28.6	100.0
		Total	21	100.0	100.0	
Y6c	Valid	Strongly disagree	7	30.4	30.4	30.4
		Disagree	5	21.7	21.7	52.2
		Agree	5	21.7	21.7	73.9
		Strongly agree	6	26.1	26.1	100.0
		Total	23	100.0	100.0	
Y6d	Valid	Strongly disagree	2	11.8	11.8	11.8
		Disagree	4	23.5	23.5	35.3
		Agree	4	23.5	23.5	58.8
		Strongly agree	7	41.2	41.2	100.0
		Total	17	100.0	100.0	
Y6e	Valid	Strongly disagree	1	5.9	5.9	5.9
		Disagree	1	5.9	5.9	11.8
		Agree	10	58.8	58.8	70.6
		Strongly agree	5	29.4	29.4	100.0
		Total	17	100.0	100.0	

It seems that the situation is quite the same across the sample apart from three classes; Y3a, Y4d and Y6e. In these classes, almost all pupils strongly agreed that, explaining their thinking to the class constitutes a learning ‘strengthener’. Such results clearly mirror characteristics of a more interactive teaching since pupils get chances to explain their thinking to the class. However in these three classes, pupils reported that they did not interrupt to ask a question about something they did not understand (q3) while in Y3a pupils mentioned that teacher did not use the IWB to test their answers in front of the class (q4). Interactive teaching should be seen as a whole (p. 71-72), interactivity should characterise each part of the teaching procedure while it seems is the other way around, each part of the lesson constitutes a different part of a puzzle lacking consensus.

In conclusion, it seems that pupils understanding was enhanced by explaining their own thoughts but with some hesitation and ambiguity. When teachers ask pupils to articulate a difficulty, half-way through the resulting explanation pupils often get the meaning (Pimm, 1987). Expressing thoughts aloud helps a person to organise his or her thoughts (ibid). But this tendency should synchronize with the ability to hear and comment on others as well. Literally, if they do not find it helpful to ask their classmates on difficulties they face what would be the point of explaining their own thinking to them? As indicated previously (q6), they did not find it helpful to ask their classmates which is contradicted with the results of this question. Thus, it can be hypothesized that pupils think of the teacher as the only receiver of their explanations .

Indeed, pupils in Pratt’s study (2006, mentioned also previously) “tended to view learning in terms of actions taking place between them personally and the teacher” (p. 230) whereas he or she was seen as the authoritative judge of right or wrong. In line, Fisher and Larker (2008) found that for pupils it is very clear that teacher is the one who is in control of the talk.

Question 9: "It is helpful to understand a difficult exercise when I participate in the discussion during lesson"

Table 31: Question 9. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	2	.7	.7	.7
Strongly disagree	18	6.0	6.0	6.6
Disagree	40	13.3	13.3	19.9
Agree	101	33.6	33.6	53.5
Strongly agree	140	46.5	46.5	100.0
Total	301	100.0	100.0	

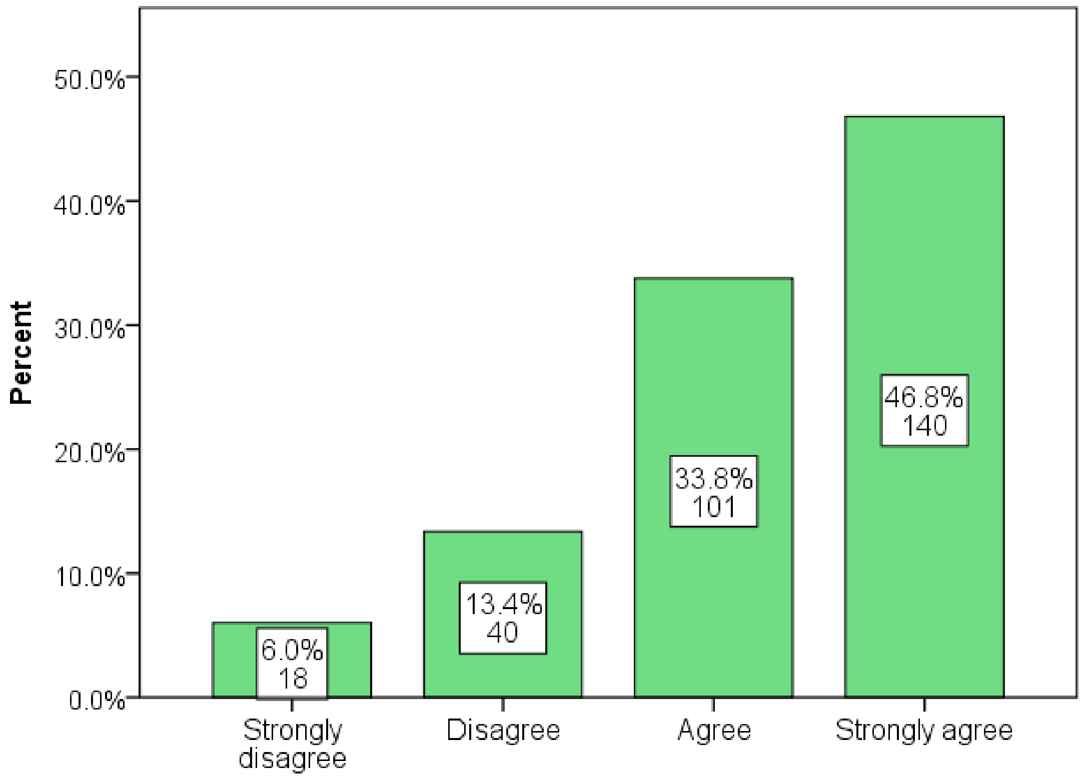

Figure 11: Question 9. It is helpful to understand a difficult exercise when I participate in the discussion during lesson.

In this question it is clear that pupils think that participating in discussion has a positive impact on their understanding since 80, 6 per cent agreed on that. Such results indicate that participating in discussions is valued as a learning 'strengthener by the pupils. But as stated in the second question, the meaning of *discussion* given by the pupils, most probably differs from the one adopted by the writer. However, pupils still think that participating in –any type of- classroom talk improves their understanding.

Table 32: Question 9. Frequencies and percentagges by class

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly disagree	1	5.0	5.0	5.0
	Agree	5	25.0	25.0	30.0
	Strongly agree	14	70.0	70.0	100.0
	Total	20	100.0	100.0	
Y3b	Disagree	2	10.5	10.5	10.5
	Agree	8	42.1	42.1	52.6
	Strongly agree	9	47.4	47.4	100.0
	Total	19	100.0	100.0	
Y4a	Strongly disagree	2	11.1	11.1	11.1
	Disagree	4	22.2	22.2	33.3
	Agree	3	16.7	16.7	50.0
	Strongly agree	9	50.0	50.0	100.0
	Total	18	100.0	100.0	
Y4b	Agree	2	12.5	12.5	12.5
	Strongly agree	14	87.5	87.5	100.0
	Total	16	100.0	100.0	
Y4c	0	1	4.0	4.0	4.0
	Strongly disagree	7	28.0	28.0	32.0
	Disagree	5	20.0	20.0	52.0
	Agree	7	28.0	28.0	80.0
	Strongly agree	5	20.0	20.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	1	5.0	5.0	5.0
	Agree	9	45.0	45.0	50.0
	Strongly agree	10	50.0	50.0	100.0
	Total	20	100.0	100.0	
Y4e	Disagree	4	16.7	16.7	16.7
	Agree	10	41.7	41.7	58.3
	Strongly agree	10	41.7	41.7	100.0
	Total	24	100.0	100.0	
Y5a	Disagree	1	5.9	5.9	5.9
	Agree	9	52.9	52.9	58.8
	Strongly agree	7	41.2	41.2	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	1	7.1	7.1	7.1
	Disagree	7	50.0	50.0	57.1

	Agree	4	28.6	28.6	85.7
	Strongly agree	2	14.3	14.3	100.0
	Total	14	100.0	100.0	
Y5c	0	1	7.1	7.1	7.1
	Disagree	2	14.3	14.3	21.4
	Agree	3	21.4	21.4	42.9
	Strongly agree	8	57.1	57.1	100.0
	Total	14	100.0	100.0	
Y5d	Agree	5	31.3	31.3	31.3
	Strongly agree	11	68.8	68.8	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	2	10.0	10.0	10.0
	Disagree	2	10.0	10.0	20.0
	Agree	5	25.0	25.0	45.0
	Strongly agree	11	55.0	55.0	100.0
	Total	20	100.0	100.0	
Y6b	Disagree	3	14.3	14.3	14.3
	Agree	8	38.1	38.1	52.4
	Strongly agree	10	47.6	47.6	100.0
	Total	21	100.0	100.0	
Y6c	Strongly disagree	1	4.3	4.3	4.3
	Disagree	8	34.8	34.8	39.1
	Agree	9	39.1	39.1	78.3
	Strongly agree	5	21.7	21.7	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	1	5.9	5.9	5.9
	Disagree	1	5.9	5.9	11.8
	Agree	6	35.3	35.3	47.1
	Strongly agree	9	52.9	52.9	100.0
	Total	17	100.0	100.0	
Y6e	Strongly disagree	2	11.8	11.8	11.8
	Disagree	1	5.9	5.9	17.6
	Agree	8	47.1	47.1	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	

Remarkably, in five classes all (Y4b and Y5d) or almost all (Y3a, Y4d, Y5a) of the pupils, "agreed" or "strongly agreed" that participating in discussion improved their understanding. There is only an exception across the sample which is Y5b where pupils were divided between "agree" and "disagree". Interestingly, this class was among the few classes where all pupils reported that they participated rather often in discussions (q2) while they did not think of this fact as helpful for their understanding, perhaps pointing towards a rather ineffective classroom talk. Added to that, this was the only class where pupils' responses were divided into "agree" and "disagree" in q6 ("It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation"), whereas pupils in all the other classes answered negatively to this question. Looking in isolation q6, one might hypothesize that teaching has more characteristics of dialogic teaching compared to all the other classes. Yet, comparing it with results in other questions, one could also conclude that pupils might be dragged into peer-explanations due to insufficient explanations by the teacher.

Once more, it seems that correlating questions in order to extract reliable results underlines the importance of looking at the classroom context during teaching, as already argued in the section 'Looking at discourse as a whole', pp.71-72.

Overall, it becomes more evident moving through the questions that, though pupils stated that they participate in discussions and this was considered helpful for them to understand difficult exercises, they most probably interpreted discussion as a type of classroom talk, an oral exchange which does not seem to fit into an actual *discussion*. Moreover, pupils seem to address characteristics of learning 'strengtheners' according their teacher's instructional methods (e.g. results of Y5b in this question; results of Y3a, Y4d, Y6e in q8).

<u>Question 10: "It is helpful to understand a difficult exercise when teacher explains it while using the IWB"</u>

Table 33: Question 10. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Strongly disagree	19	6.3	6.3	6.6
Disagree	49	16.3	16.3	22.9
Agree	87	28.9	28.9	51.8
Strongly agree	145	48.2	48.2	100.0
Total	301	100.0	100.0	

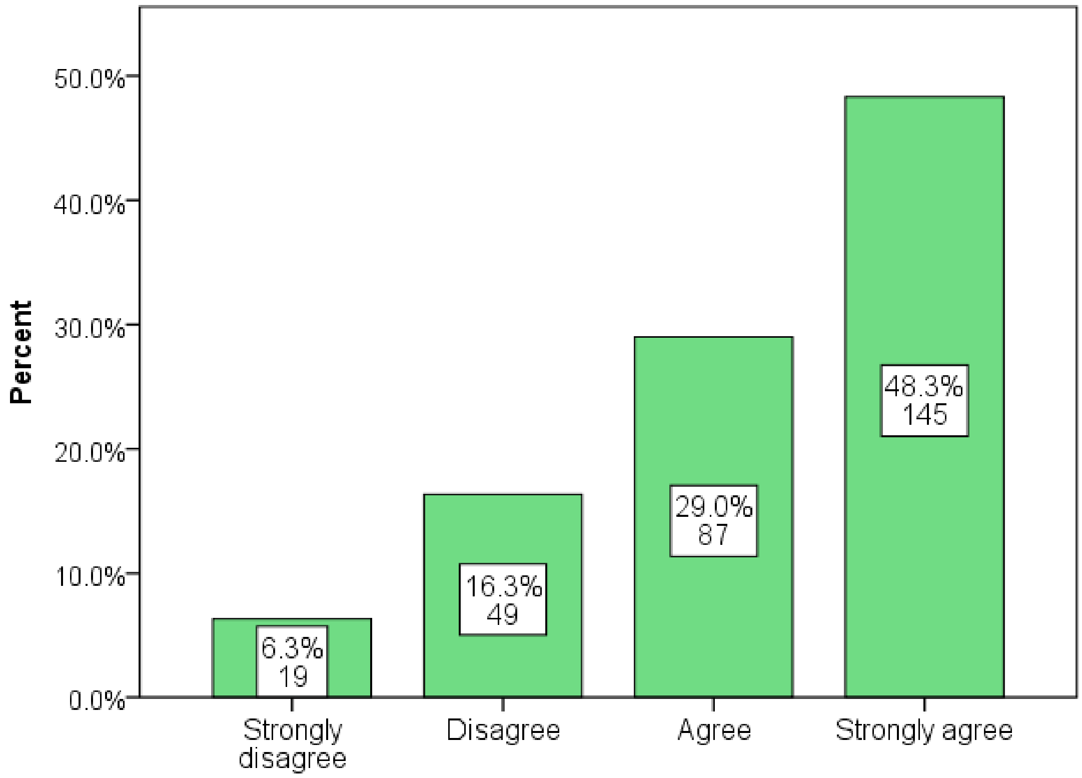

Figure 12: Question 10. It is helpful to understand a difficult exercise when teacher explains it while using the IWB.

Clearly, there is preference towards "strongly agree" since 48,3 per cent pupils chose it. In total 77.3 per cent pupils agreed that when teacher uses the IWB helps them to improve their understanding.

Table 34: Question 10. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Agree	1	5.0	5.0	5.0
	Strongly agree	19	95.0	95.0	100.0
	Total	20	100.0	100.0	
Y3b	Strongly disagree	1	5.3	5.3	5.3
	Disagree	1	5.3	5.3	10.5
	Agree	4	21.1	21.1	31.6
	Strongly agree	13	68.4	68.4	100.0
	Total	19	100.0	100.0	
Y4a	Strongly disagree	5	27.8	27.8	27.8
	Disagree	6	33.3	33.3	61.1
	Agree	5	27.8	27.8	88.9
	Strongly agree	2	11.1	11.1	100.0
	Total	18	100.0	100.0	
Y4b	Strongly disagree	1	6.3	6.3	6.3
	Agree	4	25.0	25.0	31.3
	Strongly agree	11	68.8	68.8	100.0
	Total	16	100.0	100.0	
Y4c	0	1	4.0	4.0	4.0
	Strongly disagree	2	8.0	8.0	12.0
	Agree	4	16.0	16.0	28.0
	Strongly agree	18	72.0	72.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	1	5.0	5.0	5.0
	Disagree	5	25.0	25.0	30.0
	Agree	5	25.0	25.0	55.0
	Strongly agree	9	45.0	45.0	100.0
	Total	20	100.0	100.0	
Y4e	Disagree	1	4.2	4.2	4.2
	Agree	11	45.8	45.8	50.0
	Strongly agree	12	50.0	50.0	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	1	5.9	5.9	5.9
	Disagree	1	5.9	5.9	11.8
	Agree	4	23.5	23.5	35.3
	Strongly agree	11	64.7	64.7	100.0
	Total	17	100.0	100.0	

Y5b	Strongly disagree	1	7.1	7.1	7.1
	Disagree	4	28.6	28.6	35.7
	Agree	6	42.9	42.9	78.6
	Strongly agree	3	21.4	21.4	100.0
	Total	14	100.0	100.0	
Y5c	Disagree	2	14.3	14.3	14.3
	Agree	5	35.7	35.7	50.0
	Strongly agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	1	6.3	6.3	6.3
	Disagree	3	18.8	18.8	25.0
	Agree	4	25.0	25.0	50.0
	Strongly agree	8	50.0	50.0	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	4	20.0	20.0	20.0
	Disagree	10	50.0	50.0	70.0
	Agree	5	25.0	25.0	95.0
	Strongly agree	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y6b	Disagree	4	19.0	19.0	19.0
	Agree	10	47.6	47.6	66.7
	Strongly agree	7	33.3	33.3	100.0
	Total	21	100.0	100.0	
Y6c	Disagree	11	47.8	47.8	47.8
	Agree	8	34.8	34.8	82.6
	Strongly agree	4	17.4	17.4	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	2	11.8	11.8	11.8
	Disagree	1	5.9	5.9	17.6
	Agree	8	47.1	47.1	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	
Y6e	Agree	3	17.6	17.6	17.6
	Strongly agree	14	82.4	82.4	100.0
	Total	17	100.0	100.0	

Quite surprisingly, pupils who answered either “disagree” or “strongly disagree” can be found in three particular classes (Y4a, Y6a and Y6c). Notably, in Y4a pupils also disagreed that it is helpful for them to ask their teacher by raising their hands (q5) which increases the possibility of a lecture style teaching and/or poor teacher feedback within these classes. Under such circumstances it is not a surprise that the use of the IWB did not miraculously change the scene.

Moreover, in Y6a pupils mentioned also that their answers were not tested on the IWB in front of the class (q4). Even though in three other classes pupils reported the same (Y3a, Y6b, Y6d), pupils quoted that it is helpful to understand a difficult exercise when teacher explains it via the IWB (q10), as opposed to Y6a pupils' responses. More importantly, in all of the three classes the majority of pupils agreed that when teacher uses the IWB he/she raises a lot of questions (q11); presented right after. Thus, testing answers on the IWB does not itself constitute a characteristic indicating effective IWB use. Getting the chance to participate in some form of oral exchange through questioning during an IWB lesson seems to have greater potential to influence the quality of IWB use.

Even without testing or checking pupils' answers the teacher might use the IWB to enhance the lesson in many other ways. Either way, among all the other classes the vast majority of the pupils agreed (strongly or not) that the use of the IWB for a difficult or challenging activity by the teacher enhances their understanding; this is further analysed in q17.

Question 11: “When teacher uses the IWB he/she raises a lot of questions”

Table 35: Question 11 Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	2	.7	.7	.7
Strongly disagree	38	12.6	12.6	13.3
Disagree	103	34.2	34.2	47.5
Agree	117	38.9	38.9	86.4
Strongly agree	41	13.6	13.6	100.0
Total	301	100.0	100.0	

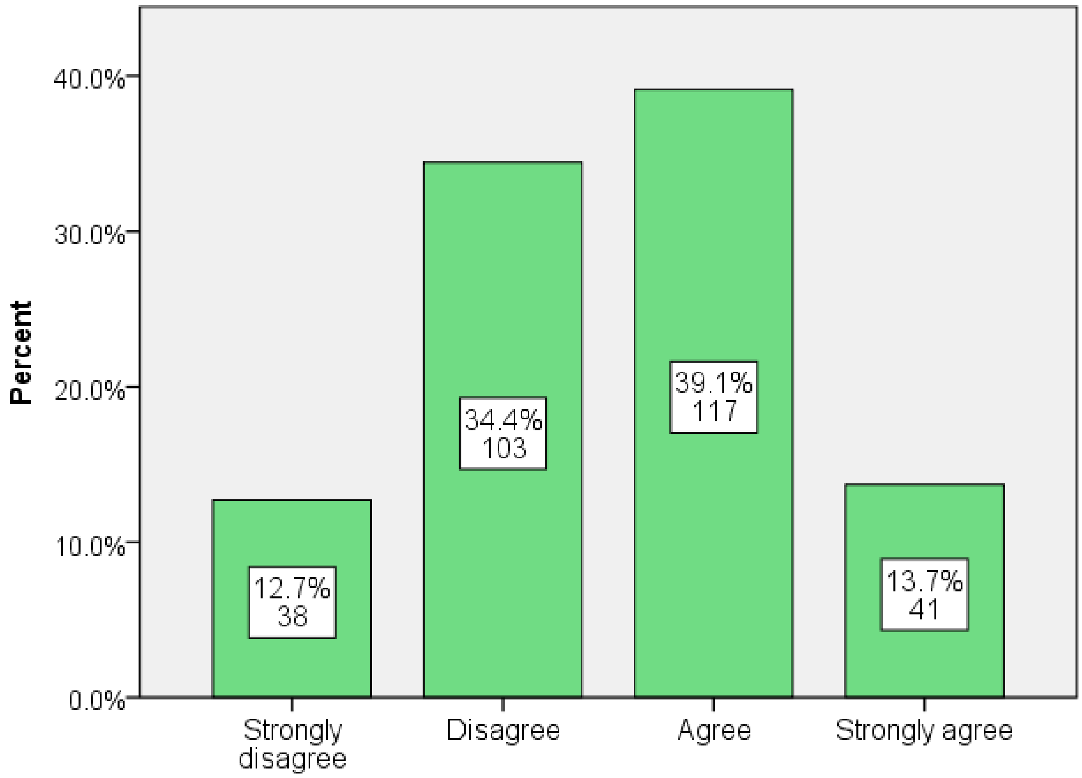

Figure 13: Question 11. When teacher uses the IWB he/she raises a lot of questions.

Obviously results are conflicting with no clear preference towards agree or disagree, while the majority of responses (73,5 per cent) being among the contrasting choices, “agree” and “disagree”. Looking at classroom level will once more indicate whether this exist at a class level as well.

Table 36: Question 11. Frequencies and percentages by class

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly disagree	1	5.0	5.0	5.0
	Disagree	2	10.0	10.0	15.0
	Agree	10	50.0	50.0	65.0
	Strongly agree	7	35.0	35.0	100.0
	Total	20	100.0	100.0	
Y3b	Disagree	3	15.8	15.8	15.8
	Agree	11	57.9	57.9	73.7
	Strongly agree	5	26.3	26.3	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Strongly disagree	3	16.7	16.7	22.2
	Disagree	5	27.8	27.8	50.0
	Agree	6	33.3	33.3	83.3
	Strongly agree	3	16.7	16.7	100.0
	Total	18	100.0	100.0	
Y4b	Strongly disagree	3	18.8	18.8	18.8
	Disagree	9	56.3	56.3	75.0
	Agree	4	25.0	25.0	100.0
	Total	16	100.0	100.0	
Y4c	Strongly disagree	6	24.0	24.0	24.0
	Disagree	9	36.0	36.0	60.0
	Agree	7	28.0	28.0	88.0
	Strongly agree	3	12.0	12.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	1	5.0	5.0	5.0
	Disagree	8	40.0	40.0	45.0
	Agree	11	55.0	55.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	3	12.5	12.5	12.5
	Disagree	8	33.3	33.3	45.8
	Agree	10	41.7	41.7	87.5
	Strongly agree	3	12.5	12.5	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	5	29.4	29.4	29.4
	Disagree	6	35.3	35.3	64.7
	Agree	4	23.5	23.5	88.2
	Strongly agree	2	11.8	11.8	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	2	14.3	14.3	14.3
	Disagree	6	42.9	42.9	57.1
	Agree	4	28.6	28.6	85.7
	Strongly agree	2	14.3	14.3	100.0
	Total	14	100.0	100.0	

Y5c	0	1	7.1	7.1	7.1
	Strongly disagree	2	14.3	14.3	21.4
	Disagree	4	28.6	28.6	50.0
	Agree	5	35.7	35.7	85.7
	Strongly agree	2	14.3	14.3	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	2	12.5	12.5	12.5
	Disagree	4	25.0	25.0	37.5
	Agree	8	50.0	50.0	87.5
	Strongly agree	2	12.5	12.5	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	5	25.0	25.0	25.0
	Disagree	7	35.0	35.0	60.0
	Agree	7	35.0	35.0	95.0
	Strongly agree	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y6b	Strongly disagree	1	4.8	4.8	4.8
	Disagree	6	28.6	28.6	33.3
	Agree	11	52.4	52.4	85.7
	Strongly agree	3	14.3	14.3	100.0
	Total	21	100.0	100.0	
Y6c	Strongly disagree	2	8.7	8.7	8.7
	Disagree	14	60.9	60.9	69.6
	Agree	5	21.7	21.7	91.3
	Strongly agree	2	8.7	8.7	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	2	11.8	11.8	11.8
	Disagree	6	35.3	35.3	47.1
	Agree	9	52.9	52.9	100.0
	Total	17	100.0	100.0	
Y6e	Disagree	6	35.3	35.3	35.3
	Agree	5	29.4	29.4	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	

Indeed, looking at the table it is obvious that for the vast majority of the classes results are conflicting. However, four classes constitute an exception. In Y3a and Y3b the vast majority of pupils agreed, strongly or not, that teacher raised a lot of questions while using the IWB, while on the contrary in Y4b and Y6c disagreed, strongly or not.

Interestingly, pupils' choices remained between "agree" and "disagree" while preference in "strongly agree" and "strongly disagree" were in low levels across the sample. Literally, in each class with no exceptions the most popular choice was either "agree" or "disagree".

Overall, such results raise even more questions since it seems that, in their vast majority pupils' answers are contradicted as to whether teacher raised or not a lot of questions while using the IWB. Accepting the fact that the term "question" was translated similarly by all, it is a possibility that pupils probably took their decision while taking in mind unconsciously other criteria such as having the chance to answer or not. For example, teacher might have been raising many questions during lecture-style lessons. But pupils' avoidance of choices on both "strongly agree" and "strongly disagree" might indicate either a blurred understanding of the question or a blurred connection between the act of questioning and/or its connection to the use of the IWB.

Question 12: "When teacher uses the IWB we begin discussion"

Table 37: Question 12. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	2	.7	.7	.7
Strongly disagree	38	12.6	12.6	13.3
Disagree	78	25.9	25.9	39.2
Agree	103	34.2	34.2	73.4
Strongly agree	80	26.6	26.6	100.0
Total	301	100.0	100.0	

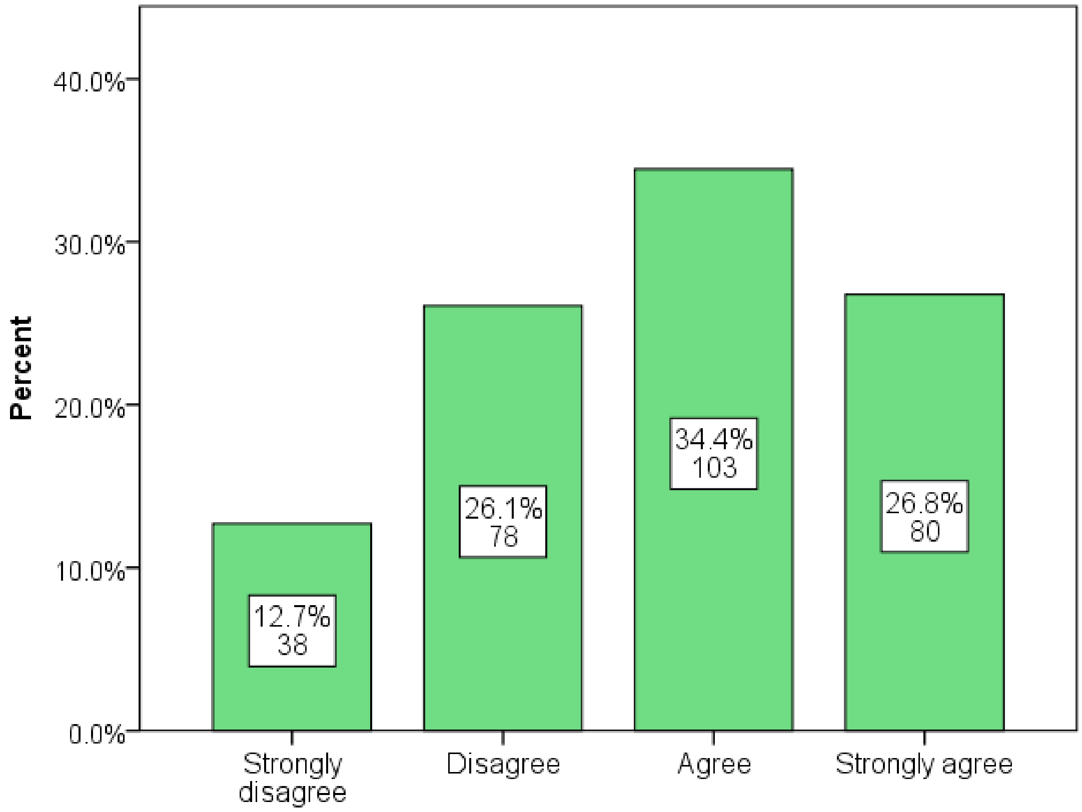

Figure 14: Question 12. When teacher uses the IWB we begin discussion.

Pupils' choices are rather spread up among the four choices while the majority of the responses (34,4 per cent) was "agree". Summing up the four categories into only two broader ones, namely disagree and agree, would have given an advantage to the category "agree" (61,2 per cent) undermining the fact that there is also a predominance when joining the categories "disagree" and "agree". Thus following such gradation including at least four choices has its merit in enhancing reliability of the results. For such contrasting results there is a greater need to look at them at a class level.

Table 38: Question 12. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly disagree	3	15.0	15.0	15.0
	Disagree	2	10.0	10.0	25.0
	Agree	5	25.0	25.0	50.0
	Strongly agree	10	50.0	50.0	100.0
	Total	20	100.0	100.0	
Y3b	Strongly disagree	2	10.5	10.5	10.5
	Disagree	3	15.8	15.8	26.3
	Agree	8	42.1	42.1	68.4
	Strongly agree	6	31.6	31.6	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Strongly disagree	4	22.2	22.2	27.8
	Disagree	2	11.1	11.1	38.9
	Agree	4	22.2	22.2	61.1
	Strongly agree	7	38.9	38.9	100.0
	Total	18	100.0	100.0	
Y4b	Disagree	4	25.0	25.0	25.0
	Agree	3	18.8	18.8	43.8
	Strongly agree	9	56.3	56.3	100.0
	Total	16	100.0	100.0	
Y4c	Strongly disagree	6	24.0	24.0	24.0
	Disagree	10	40.0	40.0	64.0
	Agree	7	28.0	28.0	92.0
	Strongly agree	2	8.0	8.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	4	20.0	20.0	20.0
	Disagree	8	40.0	40.0	60.0
	Agree	8	40.0	40.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	3	12.5	12.5	12.5
	Disagree	7	29.2	29.2	41.7
	Agree	11	45.8	45.8	87.5
	Strongly agree	3	12.5	12.5	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	2	11.8	11.8	11.8

		Disagree	3	17.6	17.6	29.4
		Agree	6	35.3	35.3	64.7
		Strongly agree	6	35.3	35.3	100.0
		Total	17	100.0	100.0	
Y5b		Strongly disagree	1	7.1	7.1	7.1
		Disagree	2	14.3	14.3	21.4
		Agree	4	28.6	28.6	50.0
		Strongly agree	7	50.0	50.0	100.0
		Total	14	100.0	100.0	
Y5c		0	1	7.1	7.1	7.1
		Strongly disagree	3	21.4	21.4	28.6
		Disagree	2	14.3	14.3	42.9
		Agree	4	28.6	28.6	71.4
		Strongly agree	4	28.6	28.6	100.0
		Total	14	100.0	100.0	
Y5d		Strongly disagree	3	18.8	18.8	18.8
		Disagree	2	12.5	12.5	31.3
		Agree	6	37.5	37.5	68.8
		Strongly agree	5	31.3	31.3	100.0
		Total	16	100.0	100.0	
Y6a		Strongly disagree	1	5.0	5.0	5.0
		Disagree	6	30.0	30.0	35.0
		Agree	6	30.0	30.0	65.0
		Strongly agree	7	35.0	35.0	100.0
		Total	20	100.0	100.0	
Y6b		Disagree	9	42.9	42.9	42.9
		Agree	10	47.6	47.6	90.5
		Strongly agree	2	9.5	9.5	100.0
		Total	21	100.0	100.0	
Y6c		Strongly disagree	2	8.7	8.7	8.7
		Disagree	9	39.1	39.1	47.8
		Agree	12	52.2	52.2	100.0
		Total	23	100.0	100.0	
Y6d		Strongly disagree	3	17.6	17.6	17.6
		Disagree	6	35.3	35.3	52.9
		Agree	4	23.5	23.5	76.5
		Strongly agree	4	23.5	23.5	100.0
		Total	17	100.0	100.0	
Y6e	Valid	Strongly disagree	1	5.9	5.9	5.9
		Disagree	3	17.6	17.6	23.5
		Agree	5	29.4	29.4	52.9
		Strongly agree	8	47.1	47.1	100.0
		Total	17	100.0	100.0	

Results at a classroom level take many different forms and cannot be straightforwardly presented. In five classes (Y3a, Y3b, Y5a, Y5b and Y6e) most of the answers were clearly found towards the positive options. More precisely, in classes Y3b and Y5a "agree" was the one chosen by most of the pupils while in Y3a,Y5b and Y6e "strongly agree" was the answer for most of them. Results in Y4c mirrored the overall results into the opposite though edge, literally towards "strongly disagree". Within four classes (Y4d,Y6b,Y6c,Y6d) results were contradicted since the vast majority of the pupils was found by summing up "agree" and "disagree" responses.

At this point a significant contrast is raised between this question (q12) and q2. Even though pupils consistently reported that they participate in discussions (q2), results changed enormously when IWB entered into the scheme; even though it rather seems that pupils refer to a type of classroom talk other than an actual discussion. Also, even in classes where pupils agreed that teacher raised questions when using the IWB (q11) the amount of pupils who answered positively was lower compared to q2. This is the case for all of the five classes mentioned above; Y3a, Y3b, Y5a, Y5b and Y6e.

Looking at the results of q11 and q12, initially it seems that responses are consistent rather than contradictory. The greatest difference is that in q12 there is a 13 per cent increase in the "strongly agree" category; followed by decrease in the categories "disagree" (-8,3 per cent) and "agree" (-4,7per cent). However, bearing in mind the inconsistency of responses at a class level, particularly in q11, any comparison among them would certainly be ambiguous. More clearly though, there is a possibility that pupils share different or blurred meanings on the processes of questioning and discussion; differences among pupils on the same process as well as differences between the meanings a pupil attributes to the two processes. In that case, questioning would be a diverse procedure separated from discussion. Yet, questioning constitutes a powerful vehicle to empower and sustain discussions and dialogues as elaborated in the sections 'Instructional strategy' (see p. 49), and 'Focusing on Quality Instruction from a Process Perspective' (pp.70-83).

Summing up, such results underline the impact of the IWB on the scheme of classroom talk evident in pupils' diverse responses, as opposed to q2, as well as in the ambiguity of pupils' responses in q12. Some concerns are raised regarding the meaning pupils attribute to the processes of questioning and discussion, reinforced by the fact that pupils in this study seem to translate discussion into an oral exchange between a single pupil and his or her teacher.

Question 13: “When teacher uses the IWB I understand the lesson easier”

Table 39: Question 13. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Strongly disagree	8	2.7	2.7	3.0
Disagree	33	11.0	11.0	14.0
Agree	106	35.2	35.2	49.2
Strongly agree	153	50.8	50.8	100.0
Total	301	100.0	100.0	

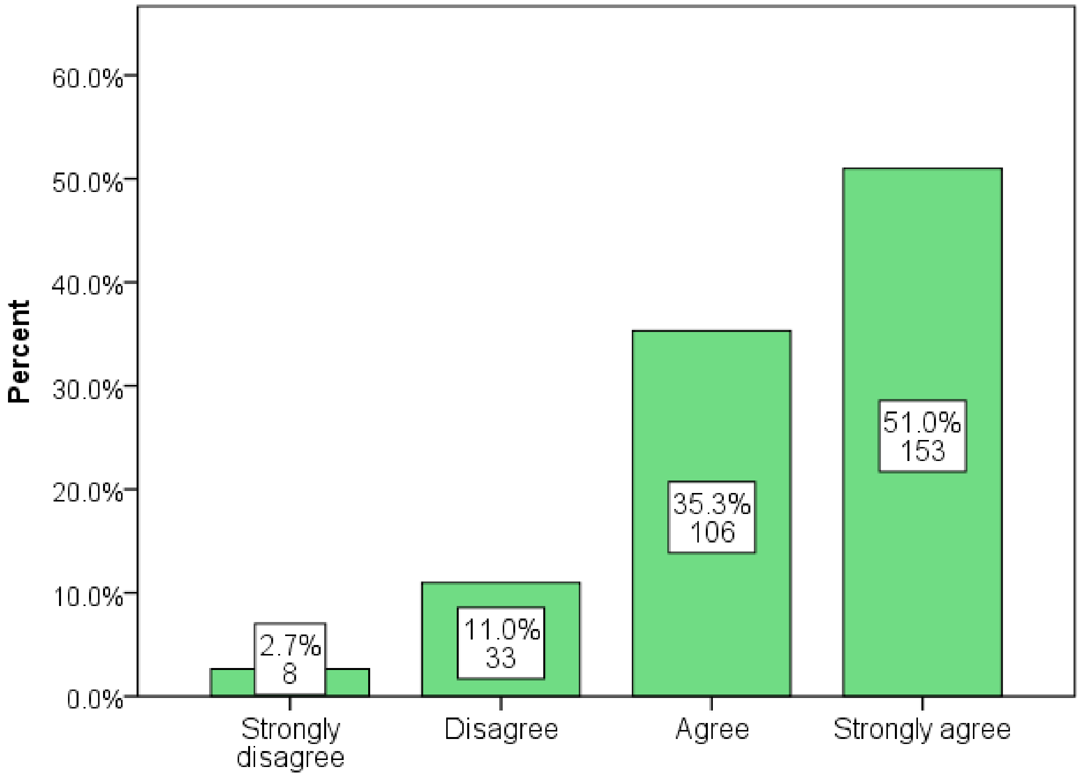

Figure 15: Question 13. When teacher uses the IWB I understand the lesson easier.

There is a clear belief by the vast majority of the pupils (86,3 per cent) that the use of IWB by the teacher impacts positively on their understanding while an outstanding 51 per cent “strongly agreed” to that. In such clear cut graphs, there are less possibilities and need to check whether this scheme fits at a class level as well, but the table below will ensure whether this is the case.

Table 40: Question 13. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly agree	20	100.0	100.0	100.0
Y3b	Agree	6	31.6	31.6	31.6
	Strongly agree	13	68.4	68.4	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Agree	6	33.3	33.3	38.9
	Strongly agree	11	61.1	61.1	100.0
	Total	18	100.0	100.0	
Y4b	Agree	8	50.0	50.0	50.0
	Strongly agree	8	50.0	50.0	100.0
	Total	16	100.0	100.0	
Y4c	Disagree	6	24.0	24.0	24.0
	Agree	9	36.0	36.0	60.0
	Strongly agree	10	40.0	40.0	100.0
	Total	25	100.0	100.0	
Y4d	Disagree	2	10.0	10.0	10.0
	Agree	7	35.0	35.0	45.0
	Strongly agree	11	55.0	55.0	100.0
	Total	20	100.0	100.0	
Y4e	Disagree	4	16.7	16.7	16.7
	Agree	9	37.5	37.5	54.2
	Strongly agree	11	45.8	45.8	100.0
	Total	24	100.0	100.0	
Y5a	Disagree	1	5.9	5.9	5.9
	Agree	3	17.6	17.6	23.5
	Strongly agree	13	76.5	76.5	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	1	7.1	7.1	7.1
	Disagree	1	7.1	7.1	14.3
	Agree	5	35.7	35.7	50.0
	Strongly agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	
Y5c	Disagree	4	28.6	28.6	28.6
	Agree	3	21.4	21.4	50.0
	Strongly agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	1	6.3	6.3	6.3
	Disagree	1	6.3	6.3	12.5
	Agree	7	43.8	43.8	56.3
	Strongly agree	7	43.8	43.8	100.0

	Total	16	100.0	100.0	
Y6a	Strongly disagree	2	10.0	10.0	10.0
	Disagree	3	15.0	15.0	25.0
	Agree	11	55.0	55.0	80.0
	Strongly agree	4	20.0	20.0	100.0
	Total	20	100.0	100.0	
Y6b	Disagree	2	9.5	9.5	9.5
	Agree	13	61.9	61.9	71.4
	Strongly agree	6	28.6	28.6	100.0
	Total	21	100.0	100.0	
Y6c	Strongly disagree	2	8.7	8.7	8.7
	Disagree	5	21.7	21.7	30.4
	Agree	8	34.8	34.8	65.2
	Strongly agree	8	34.8	34.8	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	2	11.8	11.8	11.8
	Disagree	3	17.6	17.6	29.4
	Agree	6	35.3	35.3	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	
Y6e	Disagree	1	5.9	5.9	5.9
	Agree	5	29.4	29.4	35.3
	Strongly agree	11	64.7	64.7	100.0
	Total	17	100.0	100.0	

Not surprisingly, results within each class also were found towards a strongly positive answer. Some minor differences though can be found at a class level, regarding differences in the percentage of “agree” and “strongly agree”. In four classes (Y4b, Y5d, Y6c, Y6d) equal number of pupils chose “agree” and “strongly agree” while in two classes (Y6a, Y6b) the greater proportion can be found in the category “agree”.

Even though in three classes (Y4a, Y6a, Y6c) pupils disagreed that it is helpful to understand a difficult exercise when teacher explains it while using the IWB (q10) they stated in this question that when teacher uses the IWB it is easier for them to understand. This might lead to the inference that, in some cases, features of this technology reinforce learners’ understanding even if the teacher’s own specific explanation may fail to do so.

Thus, results clearly indicate that pupils consider the use of IWB by the teacher as a significant support for their learning. Interpreting broadly and in isolation, the results from this question might indicate that teachers use the IWB effectively since pupils state that their learning is enhanced. Overall analysis however suggests other possible interpretations as presented in q17.

Question 14: "When teacher uses the IWB my answer is tested on the IWB in front of the class"

Table 41: Question 14. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	2	.7	.7	.7
Strongly disagree	37	12.3	12.3	13.0
Disagree	56	18.6	18.6	31.6
Agree	80	26.6	26.6	58.1
Strongly agree	126	41.9	41.9	100.0
Total	301	100.0	100.0	

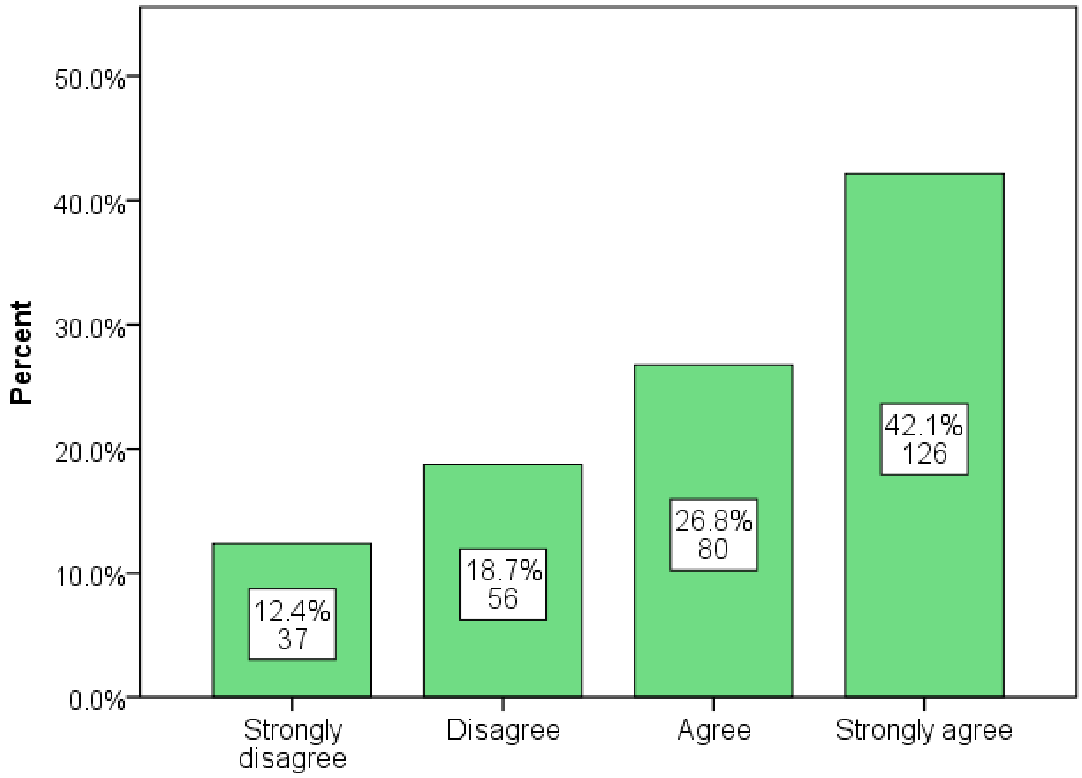

Figure 16: Question 14. When teacher uses the IWB my answer is tested on the IWB in front of the class.

Clearly, the majority of the pupils (68,9 per cent) answered positively in this question but the proportion is not as distinct as in the previous question.

Table 42: Question 15. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly agree	20	100.0	100.0	100.0
Y3b	Strongly disagree	4	21.1	21.1	21.1
	Disagree	2	10.5	10.5	31.6
	Agree	7	36.8	36.8	68.4
	Strongly agree	6	31.6	31.6	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Strongly disagree	3	16.7	16.7	22.2
	Disagree	5	27.8	27.8	50.0
	Agree	3	16.7	16.7	66.7
	Strongly agree	6	33.3	33.3	100.0
	Total	18	100.0	100.0	
Y4b	Disagree	2	12.5	12.5	12.5
	Agree	8	50.0	50.0	62.5
	Strongly agree	6	37.5	37.5	100.0
	Total	16	100.0	100.0	
Y4c	Strongly disagree	3	12.0	12.0	12.0
	Disagree	6	24.0	24.0	36.0
	Agree	7	28.0	28.0	64.0
	Strongly agree	9	36.0	36.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	2	10.0	10.0	10.0
	Disagree	2	10.0	10.0	20.0
	Agree	7	35.0	35.0	55.0
	Strongly agree	9	45.0	45.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	3	12.5	12.5	12.5
	Disagree	3	12.5	12.5	25.0
	Agree	5	20.8	20.8	45.8
	Strongly agree	13	54.2	54.2	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	1	5.9	5.9	5.9
	Disagree	2	11.8	11.8	17.6
	Agree	3	17.6	17.6	35.3
	Strongly agree	11	64.7	64.7	100.0

	Total	17	100.0	100.0	
Y5b	Agree	7	50.0	50.0	50.0
	Strongly agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	
Y5c	0	1	7.1	7.1	7.1
	Strongly disagree	2	14.3	14.3	21.4
	Disagree	2	14.3	14.3	35.7
	Agree	4	28.6	28.6	64.3
	Strongly agree	5	35.7	35.7	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	4	25.0	25.0	25.0
	Disagree	1	6.3	6.3	31.3
	Agree	4	25.0	25.0	56.3
	Strongly agree	7	43.8	43.8	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	5	25.0	25.0	25.0
	Disagree	10	50.0	50.0	75.0
	Agree	3	15.0	15.0	90.0
	Strongly agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	
Y6b	Strongly disagree	4	19.0	19.0	19.0
	Disagree	11	52.4	52.4	71.4
	Agree	4	19.0	19.0	90.5
	Strongly agree	2	9.5	9.5	100.0
	Total	21	100.0	100.0	
Y6c	Disagree	5	21.7	21.7	21.7
	Agree	11	47.8	47.8	69.6
	Strongly agree	7	30.4	30.4	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	6	35.3	35.3	35.3
	Disagree	3	17.6	17.6	52.9
	Agree	2	11.8	11.8	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	
Y6e	Disagree	2	11.8	11.8	11.8
	Agree	5	29.4	29.4	41.2

	Strongly agree	10	58.8	58.8	100.0
	Total	17	100.0	100.0	

The graph above represents the results in less than half of the classes while, as indicated by the table above, there was a diversity in responses at a class level. In half of the classes, the vast majority (more than 70%), agreed or strongly agreed. More precisely, in two classes (Y4b, Y6c) there was greater proportion in the choice "agree" while in other six (Y3a, Y4d, Y4e, Y5a, Y5b, Y6e) "strongly agree" was the most frequent response; in Y3a and Y5b all indicated "strongly agree" as their preference.

Contrastingly, in two classes (Y6a,Y6b) the vast majority disagreed, strongly or not, that their explanations were tested on the IWB. Also, in two other classes (Y4a,Y6d) results are conflicting since pupils answers were split between "agree" and "disagree".

Results of this question can be compared to q4: "When I give an answer it is tested on the IWB in front of the class". The two questions were added to enhance the internal validity of the questionnaire. Having that in mind, one could argue that there are serious concerns regarding the validity of pupils' responses in Y3a and Y6e. In other words, responses of these two classes in q4 and q14 are not aligned.

At the same time in most of the remaining classes even though there were some minor differences in the frequency of responses in each subcategory, overall results for each class between the two questions were in line. It is remarkable though that differences were in line too. In other words, pupils reported consistently that there answers were tested on the IWB more often when it was clear in the question that the teacher was the one who was testing their answers. Literally, q14 included the phrase "when teacher uses the IWB" while in q4 there was no reference as to who is testing the answer on the IWB.

Contradicted results among the two questions in the classes Y3a and Y6e also fit the above scheme. In both classes pupils strongly agreed in their majority that when teacher was using the IWB their answers were tested on the IWB (question 14). At the same time they reported that when they gave an answer it was rarely or never tested on the IWB in front of the class (question 4).

Concluding, while by mistakenly adding two questions which did not mirror the same interpretation, validity of the questionnaire was surprisingly enhanced by the consistent difference in the results among the two questions. Teacher seemed to be the one who was testing pupils answers on the IWB.

Beyond these results, it is also important to mention that looking only at question 14 results are contradicted underlining once more the inhomogeneous use of IWB.

Question 15: "It's easier to understand something when I look or manipulate a shape on the IWB"

Table 43: Question 15. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Strongly disagree	11	3.7	3.7	4.0
Disagree	41	13.6	13.6	17.6
Agree	122	40.5	40.5	58.1
Strongly agree	126	41.9	41.9	100.0
Total	301	100.0	100.0	

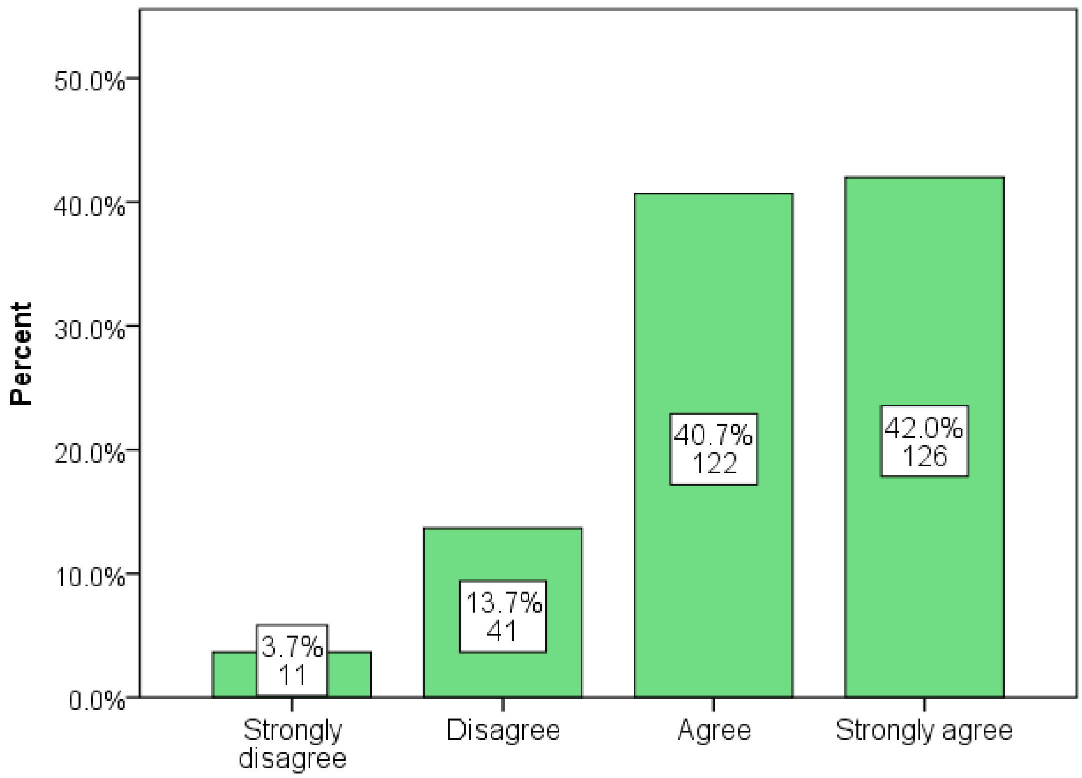

Figure 17: Question 15 - It's easier to understand something when I look or manipulate a shape on the IWB

The vast majority of the pupils (82,7 per cent) agreed more or less to the statement of the question while responses were spread up between "agree" and "disagree".

Table 44: Question 15. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly agree	20	100.0	100.0	100.0
Y3b	Strongly disagree	1	5.3	5.3	5.3
	Disagree	2	10.5	10.5	15.8
	Agree	8	42.1	42.1	57.9
	Strongly agree	8	42.1	42.1	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Strongly disagree	1	5.6	5.6	11.1
	Disagree	1	5.6	5.6	16.7
	Agree	4	22.2	22.2	38.9
	Strongly agree	11	61.1	61.1	100.0
	Total	18	100.0	100.0	
Y4b	Agree	12	75.0	75.0	75.0
	Strongly agree	4	25.0	25.0	100.0
	Total	16	100.0	100.0	
Y4c	Strongly disagree	2	8.0	8.0	8.0
	Disagree	2	8.0	8.0	16.0
	Agree	10	40.0	40.0	56.0
	Strongly agree	11	44.0	44.0	100.0
	Total	25	100.0	100.0	
Y4d	Disagree	3	15.0	15.0	15.0
	Agree	13	65.0	65.0	80.0
	Strongly agree	4	20.0	20.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	1	4.2	4.2	4.2
	Disagree	2	8.3	8.3	12.5
	Agree	8	33.3	33.3	45.8
	Strongly agree	13	54.2	54.2	100.0
	Total	24	100.0	100.0	
Y5a	Disagree	2	11.8	11.8	11.8
	Agree	2	11.8	11.8	23.5
	Strongly agree	13	76.5	76.5	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	1	7.1	7.1	7.1
	Disagree	1	7.1	7.1	14.3
	Agree	7	50.0	50.0	64.3
	Strongly agree	5	35.7	35.7	100.0
	Total	14	100.0	100.0	
Y5c	Disagree	2	14.3	14.3	14.3
	Agree	5	35.7	35.7	50.0
	Strongly agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	

Y5d	Disagree	3	18.8	18.8	18.8
	Agree	8	50.0	50.0	68.8
	Strongly agree	5	31.3	31.3	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	1	5.0	5.0	5.0
	Disagree	11	55.0	55.0	60.0
	Agree	7	35.0	35.0	95.0
	Strongly agree	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y6b	Disagree	3	14.3	14.3	14.3
	Agree	15	71.4	71.4	85.7
	Strongly agree	3	14.3	14.3	100.0
	Total	21	100.0	100.0	
Y6c	Disagree	3	13.0	13.0	13.0
	Agree	15	65.2	65.2	78.3
	Strongly agree	5	21.7	21.7	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	3	17.6	17.6	17.6
	Disagree	4	23.5	23.5	41.2
	Agree	4	23.5	23.5	64.7
	Strongly agree	6	35.3	35.3	100.0
	Total	17	100.0	100.0	
Y6e	Strongly disagree	1	5.9	5.9	5.9
	Disagree	2	11.8	11.8	17.6
	Agree	4	23.5	23.5	41.2
	Strongly agree	10	58.8	58.8	100.0
	Total	17	100.0	100.0	

Once again, overall results of the question represent firmly less than half of the classes but it is obvious that the vast majority of pupils gave a positive answer in this question; either by choosing "agree" or "strongly agree". To be more precise, in five classes (Y4b,Y4d,Y5d,Y6b,Y6c) there was a clear preference towards "agree" while in other three (Y4a,Y4e,Y5a), the preference was towards "strongly agree". Contrastingly though, in Y6a the majority disagreed to the statement while on the other edge in Y3a all chose "strongly agree". Not surprisingly, in Y6a pupils also quoted that their answers were not tested on the IWB (q10) and their understanding was not enhanced when teacher was using the IWB (q13).

Evidently, pupils seem to benefit by looking or manipulating shapes on the IWB while differences in results might indicate differences to the type of IWB use pupils experience, related to teacher’s own level of expertise. This enhances previously raised argument, in q9, that pupils value processes as learning ‘strengtheners’ according the teaching they have experienced.

Question 16: "It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB"

Table 45: Question 16. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Strongly disagree	35	11.6	11.6	12.0
Disagree	64	21.3	21.3	33.2
Agree	114	37.9	37.9	71.1
Strongly agree	87	28.9	28.9	100.0
Total	301	100.0	100.0	

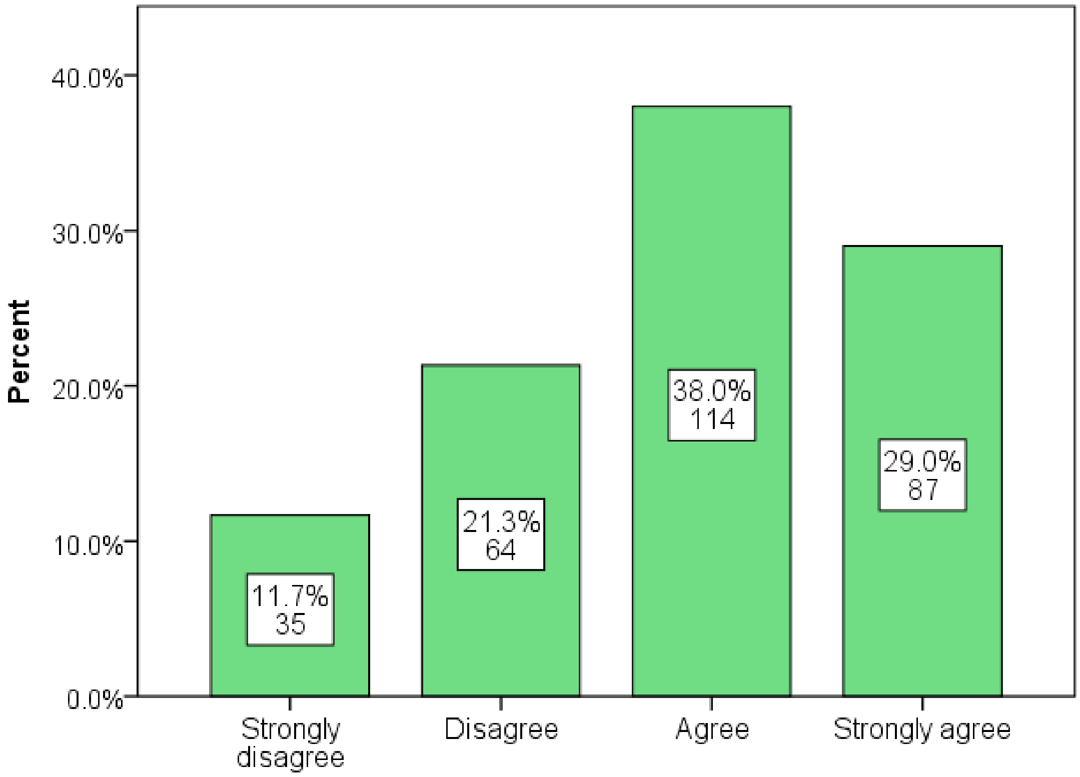

Figure 18: Question 16 - It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB

Most of the pupils (38 per cent) agreed to the above statement, a lot of pupils (29 per cent) strongly agreed while 33 per cent of them disagreed (strongly or not).

Table 46: Question 16. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Strongly disagree	2	10.0	10.0	10.0
	Disagree	2	10.0	10.0	20.0
	Agree	6	30.0	30.0	50.0
	Strongly agree	10	50.0	50.0	100.0
	Total	20	100.0	100.0	
Y3b	Strongly disagree	3	15.8	15.8	15.8
	Disagree	4	21.1	21.1	36.8
	Agree	6	31.6	31.6	68.4
	Strongly agree	6	31.6	31.6	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Strongly disagree	2	11.1	11.1	16.7
	Disagree	1	5.6	5.6	22.2
	Agree	8	44.4	44.4	66.7
	Strongly agree	6	33.3	33.3	100.0
	Total	18	100.0	100.0	
Y4b	Disagree	1	6.3	6.3	6.3
	Agree	12	75.0	75.0	81.3
	Strongly agree	3	18.8	18.8	100.0
	Total	16	100.0	100.0	
Y4c	Strongly disagree	4	16.0	16.0	16.0
	Agree	12	48.0	48.0	64.0
	Strongly agree	9	36.0	36.0	100.0
	Total	25	100.0	100.0	
Y4d	Strongly disagree	3	15.0	15.0	15.0
	Disagree	4	20.0	20.0	35.0
	Agree	11	55.0	55.0	90.0
	Strongly agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	
Y4e	Strongly disagree	2	8.3	8.3	8.3
	Disagree	4	16.7	16.7	25.0
	Agree	11	45.8	45.8	70.8
	Strongly agree	7	29.2	29.2	100.0
	Total	24	100.0	100.0	
Y5a	Strongly disagree	1	5.9	5.9	5.9

	Agree	4	23.5	23.5	29.4
	Strongly agree	12	70.6	70.6	100.0
	Total	17	100.0	100.0	
Y5b	Strongly disagree	2	14.3	14.3	14.3
	Disagree	2	14.3	14.3	28.6
	Agree	3	21.4	21.4	50.0
	Strongly agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	
Y5c	Disagree	5	35.7	35.7	35.7
	Agree	1	7.1	7.1	42.9
	Strongly agree	8	57.1	57.1	100.0
	Total	14	100.0	100.0	
Y5d	Strongly disagree	2	12.5	12.5	12.5
	Disagree	2	12.5	12.5	25.0
	Agree	7	43.8	43.8	68.8
	Strongly agree	5	31.3	31.3	100.0
	Total	16	100.0	100.0	
Y6a	Strongly disagree	7	35.0	35.0	35.0
	Disagree	6	30.0	30.0	65.0
	Agree	6	30.0	30.0	95.0
	Strongly agree	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y6b	Disagree	12	57.1	57.1	57.1
	Agree	6	28.6	28.6	85.7
	Strongly agree	3	14.3	14.3	100.0
	Total	21	100.0	100.0	
Y6c	Strongly disagree	1	4.3	4.3	4.3
	Disagree	10	43.5	43.5	47.8
	Agree	6	26.1	26.1	73.9
	Strongly agree	6	26.1	26.1	100.0
	Total	23	100.0	100.0	
Y6d	Strongly disagree	6	35.3	35.3	35.3
	Disagree	4	23.5	23.5	58.8
	Agree	6	35.3	35.3	94.1
	Strongly agree	1	5.9	5.9	100.0
	Total	17	100.0	100.0	
Y6e	Disagree	7	41.2	41.2	41.2
	Agree	9	52.9	52.9	94.1
	Strongly agree	1	5.9	5.9	100.0
	Total	17	100.0	100.0	

It is obvious that three classes have distinct results , a fact which consequently had its merit in shaping the overall results. Literally, in 12 classes the majority of pupils agreed (strongly or not) when replying to the above question. In eight of those classes(Y3a,Y4a,Y4b,Y4c,Y4e,Y5a,Y5b,Y5d), responses towards “agree” and “strongly agree” reached 70 per cent. The most popular answer though among these classes was “agree” instead of “strongly agree”.

On the contrary, classes Y6a,Y6b and Y6d mirror a totally different in-class situation since most of the pupils disagreed that IWB makes it easier for them, to explain their thinking by manipulating images on it. Moreover, responses in Y6c were also different from the overall results, responses were spread up against and towards the statement.

Concluding, it clearly seems that manipulation of images on IWB makes it easier for pupils to share their explanation and thinking. Looking at the responses across the questionnaire for the four classes whose results contradicted to the overall results of this question, it becomes obvious that pupils’ different belief is clearly connected to the type of IWB they had experienced. In those classes pupils disagreed in many questions regarding certain types of IWB’s use. More particularly they disagreed that, their answers were tested on the IWB (Y6a,Y6b,Y6c), when teacher explained a difficult exercise on the IWB they understood better (Y6a,Y6c), teacher raised a lot of questions when using the IWB (Y6a,Y6b, Y6c).

Similarly, it can be assumed that most of pupils preference towards “agree” rather than “strongly agree” was related to the level, frequency and competence of manipulating images on IWB. For example in classes Y4d and Y6e pupils in their vast majority agreed that it is helpful to explain their thinking to the class (q8) but fewer number of pupils agreed that manipulating images on the IWB makes it easier to share their thoughts.

All the above, perhaps indicate that lesson needs to be transformed in order to maintain the level of interactivity existed prior to the use of IWB. Once more, it becomes evident that pupils' views whether IWB is helpful to explain their thinking is related to the type of IWB use they have experienced; evident also in the previous question.

Question 17: "I understand Mathematics better when teacher uses the IWB"

Table 47: Question 17. Overall frequencies and percentages of responses.

Answer	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	.3	.3	.3
Never	6	2.0	2.0	2.3
Rarely	38	12.6	12.6	15.0
Quite often	133	44.2	44.2	59.1
A lot of times	123	40.9	40.9	100.0
Total	301	100.0	100.0	

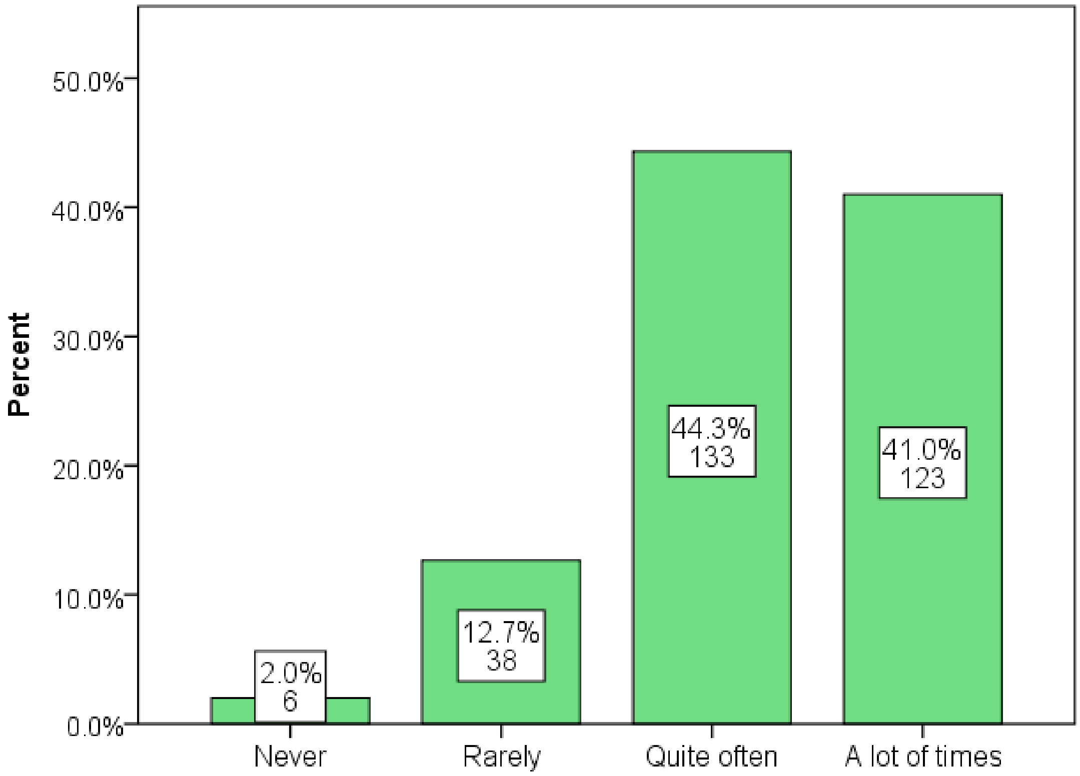

Figure 19: Question 17. I understand Mathematics better when teacher uses the IWB.

An overwhelming number of pupils, spread up between "quite often" and "a lot of times", reported that the use of IWB by the teacher improves their understanding on maths. Approximately the same number of pupils was found in these two categories in the similar question (13) but "strongly agree" had a clear advantage in pupils' choice; explained in more detail as follows.

Table 48: Question 17. Frequencies and percentages by class.

Class	Answer	Frequency	Percent	Valid Percent	Cumulative Percent
Y3a	Quite often	4	20.0	20.0	20.0
	A lot of times	16	80.0	80.0	100.0
	Total	20	100.0	100.0	
Y3b	Never	1	5.3	5.3	5.3
	Quite often	7	36.8	36.8	42.1
	A lot of times	11	57.9	57.9	100.0
	Total	19	100.0	100.0	
Y4a	0	1	5.6	5.6	5.6
	Rarely	3	16.7	16.7	22.2
	Quite often	4	22.2	22.2	44.4
	A lot of times	10	55.6	55.6	100.0
	Total	18	100.0	100.0	
Y4b	Quite often	10	62.5	62.5	62.5
	A lot of times	6	37.5	37.5	100.0
	Total	16	100.0	100.0	
Y4c	Rarely	1	4.0	4.0	4.0
	Quite often	12	48.0	48.0	52.0
	A lot of times	12	48.0	48.0	100.0
	Total	25	100.0	100.0	
Y4d	Never	1	5.0	5.0	5.0
	Rarely	2	10.0	10.0	15.0
	Quite often	9	45.0	45.0	60.0
	A lot of times	8	40.0	40.0	100.0
	Total	20	100.0	100.0	
Y4e	Rarely	2	8.3	8.3	8.3
	Quite often	10	41.7	41.7	50.0
	A lot of times	12	50.0	50.0	100.0
	Total	24	100.0	100.0	
Y5a	Rarely	1	5.9	5.9	5.9
	Quite often	3	17.6	17.6	23.5
	A lot of times	13	76.5	76.5	100.0
	Total	17	100.0	100.0	
Y5b	Rarely	1	7.1	7.1	7.1
	Quite often	7	50.0	50.0	57.1
	A lot of times	6	42.9	42.9	100.0
	Total	14	100.0	100.0	
Y5c	Rarely	2	14.3	14.3	14.3
	Quite often	3	21.4	21.4	35.7
	A lot of times	9	64.3	64.3	100.0
	Total	14	100.0	100.0	

Y5d	Never	1	6.3	6.3	6.3
	Rarely	1	6.3	6.3	12.5
	Quite often	12	75.0	75.0	87.5
	A lot of times	2	12.5	12.5	100.0
	Total	16	100.0	100.0	
Y6a	Rarely	11	55.0	55.0	55.0
	Quite often	8	40.0	40.0	95.0
	A lot of times	1	5.0	5.0	100.0
	Total	20	100.0	100.0	
Y6b	Never	1	4.8	4.8	4.8
	Rarely	5	23.8	23.8	28.6
	Quite often	12	57.1	57.1	85.7
	A lot of times	3	14.3	14.3	100.0
	Total	21	100.0	100.0	
Y6c	Never	1	4.3	4.3	4.3
	Rarely	3	13.0	13.0	17.4
	Quite often	14	60.9	60.9	78.3
	A lot of times	5	21.7	21.7	100.0
	Total	23	100.0	100.0	
Y6d	Never	1	5.9	5.9	5.9
	Rarely	5	29.4	29.4	35.3
	Quite often	7	41.2	41.2	76.5
	A lot of times	4	23.5	23.5	100.0
	Total	17	100.0	100.0	
Y6e	Rarely	1	5.9	5.9	5.9
	Quite often	11	64.7	64.7	70.6
	A lot of times	5	29.4	29.4	100.0
	Total	17	100.0	100.0	

The majority of pupils in each class considered that the IWB improves their learning on maths apart from Y6a. Nearly half of pupils in Y6a, 11 out of 20, reported that they rarely understand maths better when teacher uses the IWB. In previous questions same pupils agreed that they understood the lesson easier when teacher was using the IWB (q13) and disagreed that teacher's explanations during an IWB lesson were helpful (q10). Thus, it can be hypothesized that the teacher had a difficulty or simply did not use the IWB during maths which is coincided with the disagreement of pupils that, manipulating images was not enhancing their learning, refer to q15 and q16. A fact which seems to reinforces a previously stated argument. Literally, pupils can report on procedures which enhance their learning as long as they have experienced them.

Interestingly, in Y4a and Y6c even though pupils disagreed that it is helpful when teacher uses the IWB to explain a difficult exercise (q10), when asked about the use of IWB in general in other questions (q13 and q17), they quoted that it improves their understanding. Similar pattern applies for Y6a as explained above. This could lead to the conclusion that even though a teacher does not use the IWB efficiently in terms of offering sufficient explanations during a difficult exercise, pupils' understanding is still enhanced by the use of IWB throughout the lesson.

In terms of comparing results between q13 and q17, there is clearly an overall consensus among pupils that when teacher uses the IWB it constituted a learning amplifier for them. However, in q17 there was a consistent shift in pupils' choices from the category "strongly agree" to "agree" when related to q10. More precisely, this was the case for 9 of the classrooms; Y4b, Y4c, Y4d, Y5b, Y5d, Y6b, Y6c, Y6d, Y6e. Also, as mentioned already there was also a shift in the responses of Y6a from "agree" to "disagree". Perhaps this happened because the term "mathematics" was used to phrase q17 in contrast to q13. Yet it was stated at the beginning of the questionnaire that they should think about mathematics lessons when filling it. On the one hand, this is an indicator that for younger pupils we should not assume that they will have in mind all the instructions given at beginning of the questionnaire, or it can be avoided if researcher is present and explains to the participants each question. On the other hand, it might indicate that teachers do not use that frequently the IWB during maths or are more capable of using it during other subjects.

Under such circumstances, one might argue that some concerns are raised about the validity of the questionnaire. But the consistent difference in the results between the two questions indicate the opposite; as well as for the set of q4 and q14. Certainly the two set of questions could have been phrased differently to mirror and match to each other better. Either way, though in an extraordinary way, evidence indicate a high level of internal validity.

Summing up, pupils seem to value the use of IWB as a learning ‘strengthener’, even though in some classes pupils reported a rather ineffective IWB use by the teacher when asked about certain aspects of IWB use and applications, as evident in other questions. In line, my dissertation’s results (Appendix 17) indicate that, even though IWB was used mainly as a presentational tool, the vast majority of pupils supported that their learning was enhanced when teacher was using it. In this study, pupils indicated positive views on the impact of IWB on their learning more consistently when they were asked generally about the use of IWB (q13 and q17). Similarly in Beeland’s (2002) evaluative study of IWBs, teachers whose pupils were most positive about the use of IWB made least use of its interactive potential and most use of its facility to present multimedia resources. Under these circumstances, it cannot be assumed that results in this question constitute a positive indicator that pupils’ learning is enhanced by the use of IWB particularly when there is no other data indicating towards that end.

Question 18: "Draw things you always enjoy to do or see during Mathematics"

Pupils' responses shaped and were grouped into the following categories:

ES=Educational Software, C=Calculations, BM=Brainstorm Map, MR=Mathematical Representations (fractions/geometry), GCA=Games of clicking on the Correct Answer, M=Motif V=Video or other image, P=Presentations from second language lesson, PP=PowerPoint, PPown=PowerPoint presentations to the class, MP=Magic Pen, W=Writing

Table 49: Question 18. Overall frequencies and percentages of responses.

Type of activity	Frequency	Percent	Valid Percent	Cumulative Percent
0	13	4.3	4.3	4.3
BM	1	.3	.3	4.7
C	83	27.6	27.6	32.2
ES	7	2.3	2.3	34.6
GCA	27	9.0	9.0	43.5
M	2	.7	.7	44.2
MP	8	2.7	2.7	46.8
MR	82	27.2	27.2	74.1
P	1	.3	.3	74.4
PP	17	5.6	5.6	80.1
PPown	4	1.3	1.3	81.4
R	1	.3	.3	81.7
V	54	17.9	17.9	99.7
W	1	.3	.3	100.0
Total	301	100.0	100.0	

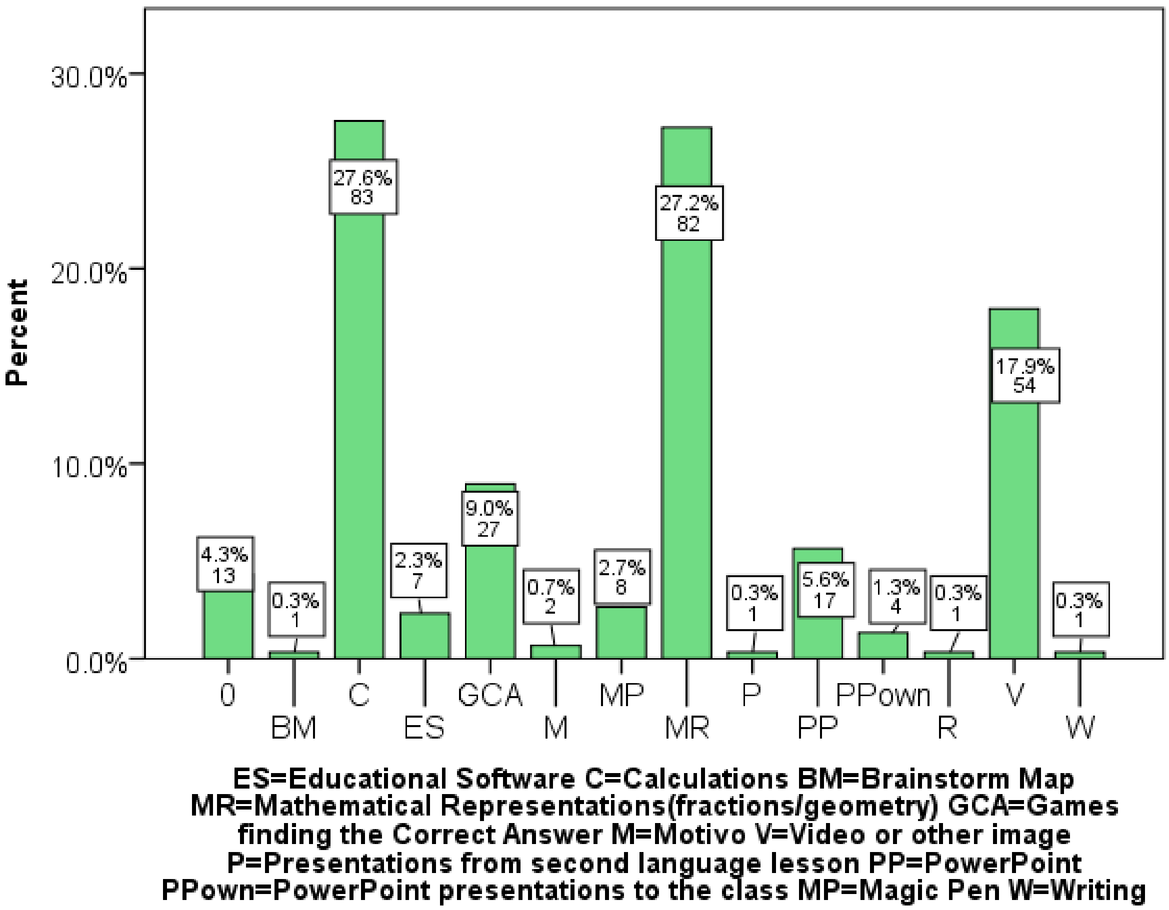

Figure 20: Question 18. Draw things you always enjoy to do or see during Mathematics.

During maths there is a clear preference towards calculations (C) and mathematical representations (MR); 83 and 82 pupils respectively. Based on pupils' drawings, as part of the response in this question, calculations refer to applications of the IWB where pupils get the chance to calculate. Mathematical representations (MR) included fraction and geometry applications, where icons and shapes represented numerical concepts (ex. angle). Watching videos (V) was also an enjoyable application of IWB for many pupils (54), playing mathematical games was also quoted as enjoyable by less pupils (27) and watching PowerPoint presentations by even less pupils (17). All the remaining categories correspond to less than 10 pupils each.

All categories were shaped by pupils' responses since this was an open question. Thus, it truly grasps pupils' own preferences which indicate a particular preference towards applications related to calculations, fractions and geometry. Features of the IWB related particularly to fractions and geometry are considered as having their merit in enhancing learning, such as colouring squares in a shape and measurement of angles (Edwards et al., 2002, cited in Smith et al. 2005). Thus, it is not assumed that this open-ended question has generated unique data.

Interestingly though, this question had a high response considering its open nature, since only 4, 3 per cent of pupils did not draw anything. It is suggested that, drawing as part of pupil's questionnaire can be of a great use in future studies with younger learners, having in mind the complexity in interpreting such data.

Discussion

Thinking about the first question of the questionnaire (q1) , Wegerif (2007, 2008) "postulates that the ground rules and shared enquiry characteristics of exploratory talk (e.g. asking open questions, listening with respect, self-critique) serve to open and maintain a dialogic 'space of reflection." (cited in Hennessy, 2011, p.465). In this study in almost all of the classes they set ground rules for talking but characteristics of dialogic talk seemed to be the missing part of the dialogic teaching puzzle. Certainly the type and application of the ground rules can be questioned since they seem to fail in raising the quality of classroom talk but this issue does not fall into the scope of this study.

More importantly, revising the research question "what do pupils in Cyprus think about the value of dialogic teaching practices for their mathematical learning, with and without an IWB?". Looking at the four remaining questions which had the most consistent results in terms of getting the same replies at a class level across the sample it is quite shocking that they point towards a stereotypical lesson pattern. Rather deceptively pupils indicated that they participate in discussions during maths (q2), as indicated by correlations with other questions as well as the following results. Pupils mentioned in their vast majority that they rarely interrupted to make a question when they did not understand something (q3) while disagreed that asking a friend was helpful to understand a difficult exercise (q6). Added to that, they strongly agreed that paying attention to the lesson enhanced their understanding (q7) which had the highest proportion in "strongly agree" responses among many other factors which were also presented as learning amplifiers.

Certainly, it might be gratifying for many teachers having pupils quoting that paying attention to the lesson is a crucial factor for their learning but upraising it as *the* crucial factor of understanding – at least among the other choices of the questionnaire – raises many concerns. Evidence suggest that there is a strong possibility that teaching in all of the classes might be towards a traditional lecture style type of teaching. It seems difficult for teachers to refrain from this type of teaching and this should be the starting point of transforming teaching.

The most important results of this survey, as mentioned above, were generated from questions that did not target any particular use of IWB (see Table 5 in p. 135). Perhaps, the novelty of the technology in Cyprus justifies the rather 'fuzzy' and sometimes contradictory responses from pupils regarding the use of IWB and its connection with classroom talk. But it is also possible that, since the evidence indicates a traditional approach to teaching, the use of IWB may not have had much of a direct impact on classroom talk other than to generate some contradictions in such a situation. What is more, overall the responses suggest some consistent positive indicators that participants believe that IWB enhances learning. The ambiguity may be because this was the only case when questions referred to general use of the IWB (q13 and q17) as opposed to those which focused on specific applications of the technology (q15 and q16). Using Beauchamp's (2004) argument "there is an inherent danger that the IWB becomes an information presentation platform, rather than another resource for developing questioning and interactive learning" (p.333).

Besides, it has already been stressed that pupils' thinking and reasoning is directly related to the type of questions posed by the teacher (Wood, 2002, cited in Way 2008); refer to 'Instructional strategy' (see p. 49), and 'Focusing on Quality Instruction from a Process Perspective' (pp.70-83).

So it seems that enhancing teachers' pedagogical beliefs and abilities on questioning techniques constitutes a prima facie to orchestrate effectively technological interventions.

Indeed, Schmid (2006) suggests that IWB use is the result of synchronizing inherent characteristics of the technology, teacher's pedagogical beliefs, pupils' own understanding of the potential of IWBs and negotiations between pupils and teacher as to how the technology should be pedagogically exploited.

Interestingly though, this survey indicates that pupils' understanding of the potential of the technology on their own learning might be directly related to the type of teaching they have experienced. The effective use of IWB lies upon the progress made by the teachers in empowering the additional power of the technology to stimulate analysis of the learning process in the teacher, and appreciation of the concepts and applications by the pupils (Miller et al. 2004, cited in Higgins et al. 2007). Having in mind that pupils in this survey, "appreciated" as learning amplifiers characteristics that are linked to stereotypical forms of teaching it is crucial to investigate more rigorously the impact of teaching methods on pupils' conceptualisation about their learning. An issue which contrasts the view of Wells (1999) that pupils set their own goals for the activities based on their own "theories of education" (quoted in the original) which might not be consistent to those of the teacher.

Investigating this issue, Fisher and Larkin (2008) found that pupils' perceptions of "good talk" (quotation marks in the original) are shaped by the expectations of "good talk" pupils assume that teachers hold during any discourse. Pupils "appear to be striving to conform to their interpretation of teachers' expectations" (ibid, p. 14) whereas they do not match to the real expectations set by the teachers. In turn, this generates a concern that there is a difficulty on behalf of the teachers to align their own perceptions on the value of discourse (whatever that is) to their teaching methods since pupils "translate" them differently. Such evidence might offer an explanation as to *why* pupils in this study seem to limit the interpretation of the term discussion to teacher-pupil discourse while excluding any exchanges amongst pupils. Under the same scope, potential differences in pupils' interpretation between questioning and discussion should be also investigated further.

This issue lies at the heart of dialogic teaching since it relates to the development of its ultimate benefits, higher-order thinking and metacognition; interpreted in 'Metacognition and Self-regulation', pp.34-35. Put in brief, it seems that pupils' perceptions on their own learning, literally metacognition, are shaped at a class level by translating teachers' actions. As already pointed out, no generalisations can be made through this study however it certainly constitutes an added-value for future research considering that there is convergence of findings across other small studies too (Fisher and Larkin, 2008; Pratt, 2006) .

Overall, Smith and Higgins (2006) argument still accurately describes the situation as in terms of 'opening' classroom interaction:

> In order to break free from the recitation script, teachers must be released from the burden of having to ask all of the questions and know and evaluate all of the answers. At the same time, pupils must be freed to respond to each other as well as to the teacher, to ask as well as answer questions, and to direct the interaction as well as being directed. In other words, it is important to encourage a more conversational and symmetric interaction… (p. 495)

Irrespective of the technological resources employed – or not - during lessons, this should be the target for developing teaching quality in schools, yet it still seems underdeveloped. Data from this study suggest that this issue could be developed by investigating the reciprocality between teachers' beliefs, teaching methods and pupils' perceptions about their own learning.

The survey pioneered in its field of the investigation. It was the first time in literature, at the moment this thesis was published, where pupils' own beliefs were explored in such a manner. This was an innovative research project for the educational system in Cyprus and is envisaged to initiate further investigations in the field.

Results of the Questionnaire Analysis Using Inferential Statistics

Details on the scope, structure and aim of the analysis that follows have been previously elaborated in the 'Data Analysis' section, (above pp. 142-144).

Investigating differences related to gender

Null hypothesis (tested for each variable /question): There is no difference between boys and girls in terms of their responses.

As evident in the table, there is a significant difference based on gender in terms of pupils' responses only in q10; p-value is smaller than 0.05 thus null hypothesis is rejected. Chi-square tests for each question, in terms of gender, can be found in Appendix 14.

Table 50: Chi-square tests based on gender.

Question (q)	Chi-square (X^2)	*p*-value
q1	$X^2_1 = 0.585$	0.444
q2	$X^2_3 = 0.726$	0.867
q3	$X^2_3 = 2.620$	0.454
q4	$X^2_3 = 0.798$	0.850
q5	$X^2_3 = 2.603$	0.457
q6	$X^2_3 = 4.497$	0.213
q7	$X^2_3 = 2.147$	0.543
q8	$X^2_3 = 3.329$	0.344
q9	$X^2_3 = 3.545$	0.315
q10	$X^2_3 = 14.467$	0.002*
q11	$X^2_3 = 6.542$	0.088
q12	$X^2_3 = 4.594$	0.204
q13	$X^2_3 = 1.297$	0.730
q14	$X^2_3 = 3.233$	0.357
q15	$X^2_3 = 2.142$	0.543
q16	$X^2_3 = 2.127$	0.547
q17	$X^2_3 = 3.128$	0.372

*$p < 0.05$

Exploring gender differences for question 10

Table 51: Gender difference - Question 10: It is helpful to understand a difficult exercise when teacher explains it while using the IWB.

Answer		Gender		Total
		Boy	Girl	
Strongly disagree	Count	14	5	19
	% within Gender	10.4%	3.0%	6.3%
	% of Total	4.7%	1.7%	6.3%
Disagree	Count	24	25	49
	% within Gender	17.8%	15.2%	16.3%
	% of Total	8.0%	8.3%	16.3%
Agree	Count	46	41	87
	% within Gender	34.1%	24.8%	29.0%
	% of Total	15.3%	13.7%	29.0%
Strongly agree	Count	51	94	145
	% within Gender	37.8%	57.0%	48.3%
	% of Total	17.0%	31.3%	48.3%
Total	Count	135	165	300
	% within Gender	100.0%	100.0%	100.0%
	% of Total	45.0%	55.0%	100.0%

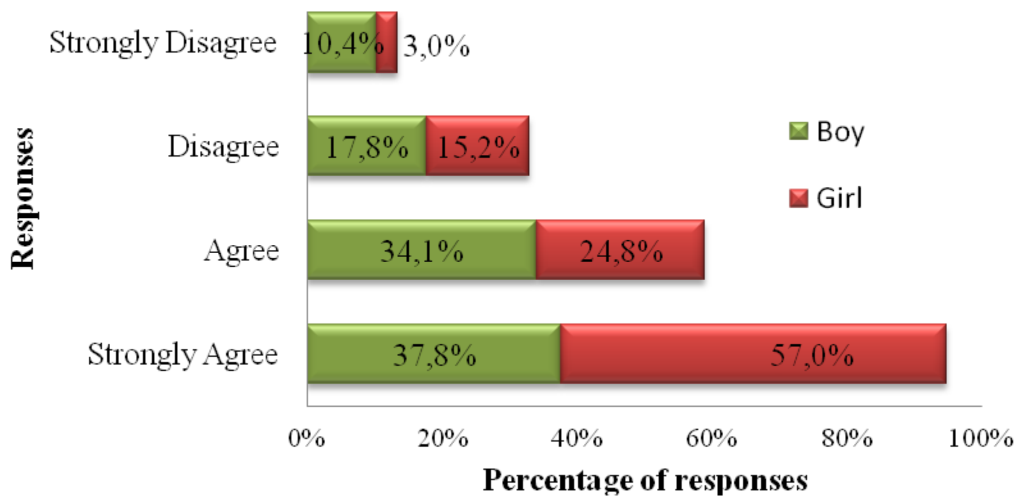

Figure 21: Gender difference - Question 10.

Discussion

Only in the above question, q10, there was a significant difference between boys and girls. Looking at the previous graph, it is evident that girls responded more positively as to whether it is helpful to understand a difficult exercise when teacher explains it using the IWB.

The descriptive analysis of this question, as mentioned previously (p. 184), indicated that only in three classes did pupils respond negatively using “strongly disagree” and “disagree”. So, it is therefore important to look whether in those three classes, (in bold in the table below), there might be some gender imbalance. It may be that the significant gender difference relating to this question is misleading and due to the greater proportion of boys in those classes. This indeed, as indicated in the table below, is the case for Y4a and Y6a.

Table 52: Class - Gender Crosstabulation. Investigating gender balance within each class.

	Gender		
Class	Boy	Girl	Total
Y3a	8	12	20
Y3b	5	14	19
Y4a	**12**	**6**	**18**
Y4b	9	7	16
Y4c	9	16	25
Y4d	8	12	20
Y4e	13	11	24
Y5a	9	8	17
Y5b	3	11	14
Y5c	3	11	14
Y5d	9	7	16
Y6a	**12**	**8**	**20**
Y6b	12	9	21
Y6c	**10**	**13**	**23**
Y6d	7	10	17
Y6e	7	10	17
Total	136	165	301

Exploring responses for those three classes shows that, the higher rate of boys' negative responses may also be related to the classes Y4a, Y6a, and Y6c. More precisely, 38 boys chose either "strongly disagree" or "disagree", of whom 23 belong to those classes. At the same time, in almost all of the remaining classes pupils answered mainly "agree" and "strongly agree" and the majority were girls. So, were differences among classes generated by gender differences? The inferential analysis indicates that the answer to this question is negative, since apart from q10 no other statistically significant gender differences are found.

Moreover, in q10 there is a higher rate of girls' preference towards "strongly agree". A pattern that suits the three classes mentioned above as well, Y4a, Y6a, and Y6c, since only some girls within these classes selected "strongly agree" in q10.

All in all, girls seem to respond more positively in only one question, q10. Such difference *perhaps* becomes statistically significant due to the gender imbalances within classes. An argument strengthened by the results of the systematic review which point out that there are usually no significant gender differences related to the use of IWB in earlier research studies (presented in 'Gender', p. 115-117).

Investigating differences related to the age of pupils

Null hypothesis (tested for each variable /question): There is no difference between year groups in terms of their responses.

Looking at the table below, it is evident that in almost all of the questions responses varied widely, depending on pupils' age. Chi-square tests for each question, in terms of age group, can be found in Appendix 15.

Table 53: Chi-square tests based on age group.

Question (q)	Chi-square (X^2)	*p*-value
q1	$X^2_1 = 24.676$	0.000*
q2	$X^2_3 = 12.301$	0.197
q3	$X^2_3 = 25.411$	0.003*
q4	$X^2_3 = 57.095$	0.000*
q5	$X^2_3 = 44.948$	0.000*
q6	$X^2_3 = 8.986$	0.439
q7	$X^2_3 = 17.941$	0.036*
q8	$X^2_3 = 19.091$	0.024*
q9	$X^2_3 = 10.243$	0.331
q10	$X^2_3 = 33.182$	0.000*
q11	$X^2_3 = 25.174$	0.003*
q12	$X^2_3 = 20.377$	0.016*
q13	$X^2_3 = 34.219$	0.000*
q14	$X^2_3 = 30.234$	0.000*
q15	$X^2_3 = 33.847$	0.000*
q16	$X^2_3 = 58.348$	0.000*
q17	$X^2_3 = 47.583$	0.000*
		*p< 0.05

Question 1

Table 54: Age group difference - Question 1: In my classroom we share rules about classroom talk.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
No	Count	1	23	3	4	31
	% within class	2.6%	22.3%	4.9%	4.1%	10.3%
	% of Total	.3%	7.6%	1.0%	1.3%	10.3%
Yes	Count	38	80	58	94	270
	% within class	97.4%	77.7%	95.1%	95.9%	89.7%
	% of Total	12.6%	26.6%	19.3%	31.2%	89.7%
Total	Count	39	103	61	98	301
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

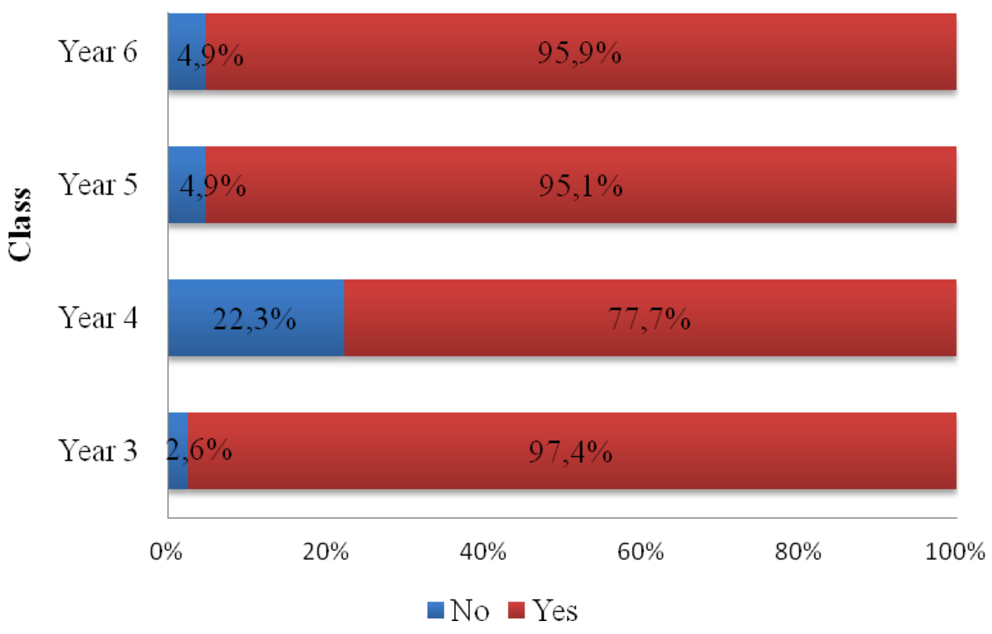

Figure 22: Age group difference - Question 1.

Table 55: Age group difference - Question 3: I interrupt to make a question when I don't understand something.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Never	Count	12	29	7	21	69
	% within class	30.8%	28.2%	11.5%	21.4%	22.9%
	% of Total	4.0%	9.6%	2.3%	7.0%	22.9%
Rarely	Count	18	54	25	59	156
	% within class	46.2%	52.4%	41.0%	60.2%	51.8%
	% of Total	6.0%	17.9%	8.3%	19.6%	51.8%
Quite often	Count	6	17	23	15	61
	% within class	15.4%	16.5%	37.7%	15.3%	20.3%
	% of Total	2.0%	5.6%	7.6%	5.0%	20.3%
A lot of times	Count	3	3	6	3	15
	% within class	7.7%	2.9%	9.8%	3.1%	5.0%
	% of Total	1.0%	1.0%	2.0%	1.0%	5.0%
Total	Count	39	103	61	98	301
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

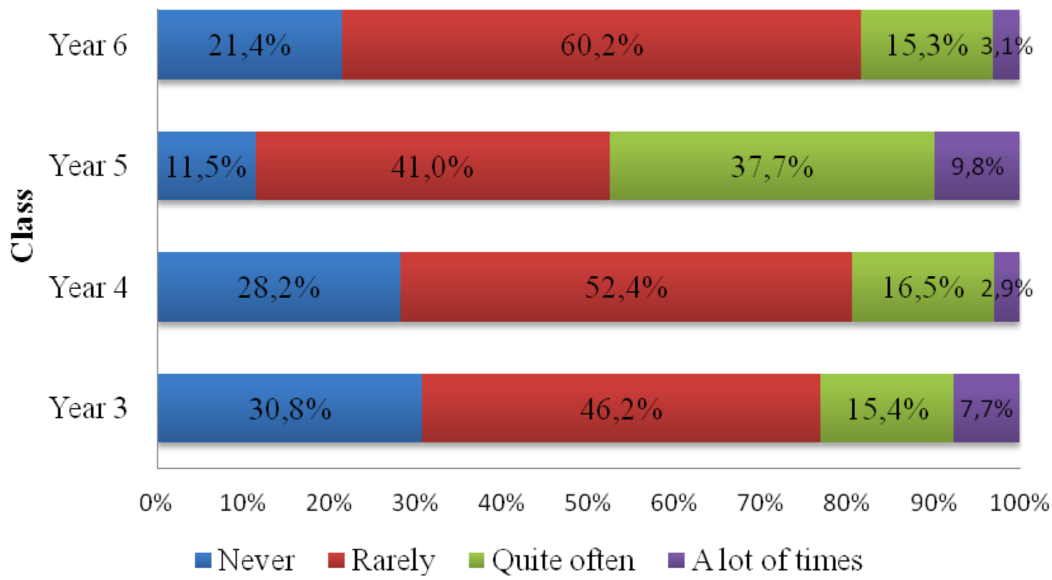

Figure 23: Age group difference - Question 3.

Question 4

Table 56: Age group difference -Question 4: When I give an answer it is tested on the IWB in front of the class.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Never	Count	4	20	6	31	61
	% within class	10.3%	19.4%	9.8%	31.6%	20.3%
	% of Total	1.3%	6.6%	2.0%	10.3%	20.3%
Rarely	Count	20	16	9	38	83
	% within class	51.3%	15.5%	14.8%	38.8%	27.6%
	% of Total	6.6%	5.3%	3.0%	12.6%	27.6%
Quite often	Count	9	31	24	20	84
	% within class	23.1%	30.1%	39.3%	20.4%	27.9%
	% of Total	3.0%	10.3%	8.0%	6.6%	27.9%
A lot of times	Count	6	36	22	9	73
	% within class	15.4%	35.0%	36.1%	9.2%	24.3%
	% of Total	2.0%	12.0%	7.3%	3.0%	24.3%
Total	Count	39	103	61	98	301
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

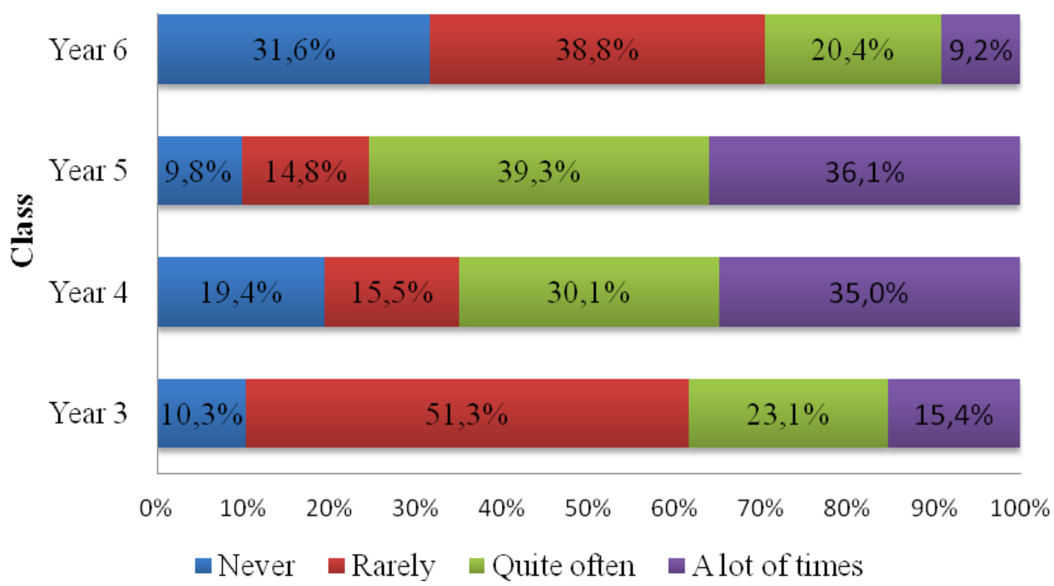

Figure 24: Age group difference – Question 4.

Question 5

Table 57: Age group difference - Question 5: It is helpful to understand a difficult exercise when I ask the teacher by raising my hand.

		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	4	5	6	4	19
	% within class	10.3%	4.9%	10.0%	4.1%	6.3%
	% of Total	1.3%	1.7%	2.0%	1.3%	6.3%
Disagree	Count	3	20	16	31	70
	% within class	7.7%	19.4%	26.7%	31.6%	23.3%
	% of Total	1.0%	6.7%	5.3%	10.3%	23.3%
Agree	Count	5	32	22	45	104
	% within class	12.8%	31.1%	36.7%	45.9%	34.7%
	% of Total	1.7%	10.7%	7.3%	15.0%	34.7%
Strongly agree	Count	27	46	16	18	107
	% within class	69.2%	44.7%	26.7%	18.4%	35.7%
	% of Total	9.0%	15.3%	5.3%	6.0%	35.7%
Total	Count	39	103	60	98	300
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.3%	20.0%	32.7%	100.0%

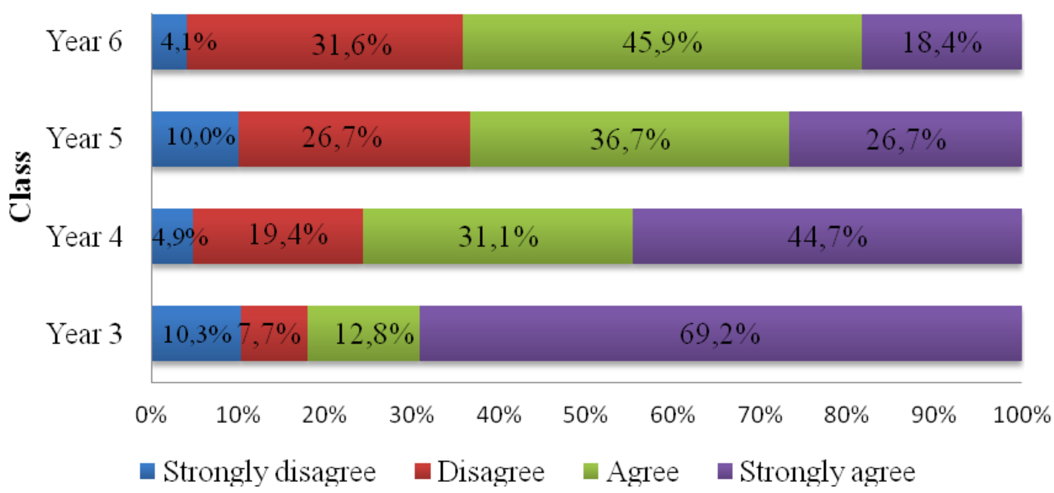

Figure 25: Age group difference - Question 5.

Question 7

Table 58: Age group difference - Question 7: It is helpful to understand a difficult exercise when I pay attention to the lesson.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	0	0	2	1	3
	% within class	.0%	.0%	3.3%	1.0%	1.0%
	% of Total	.0%	.0%	.7%	.3%	1.0%
Disagree	Count	0	5	9	7	21
	% within class	.0%	4.9%	15.0%	7.1%	7.0%
	% of Total	.0%	1.7%	3.0%	2.3%	7.0%
Agree	Count	9	31	17	35	92
	% within class	23.1%	30.4%	28.3%	35.7%	30.8%
	% of Total	3.0%	10.4%	5.7%	11.7%	30.8%
Strongly agree	Count	30	66	32	55	183
	% within class	76.9%	64.7%	53.3%	56.1%	61.2%
	% of Total	10.0%	22.1%	10.7%	18.4%	61.2%
Total	Count	39	102	60	98	299
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

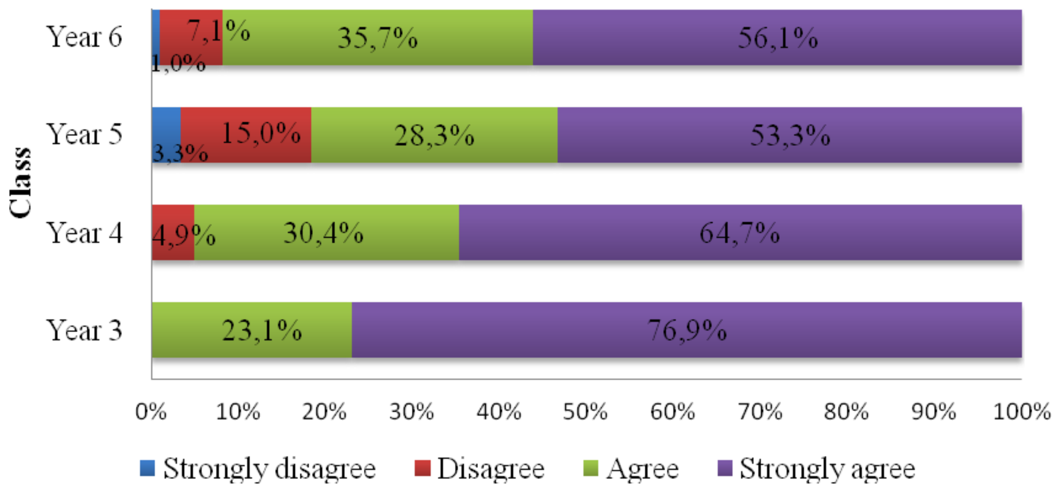

Figure 26: Age group difference - Question 7.

Question 8

Table 59: Age group difference - Question 8: It is helpful to understand a difficult exercise when I explain my own thinking to the class.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	1	14	12	15	42
	% within class	2.6%	13.7%	20.0%	15.3%	14.0%
	% of Total	.3%	4.7%	4.0%	5.0%	14.0%
Disagree	Count	4	21	14	22	61
	% within class	10.3%	20.6%	23.3%	22.4%	20.4%
	% of Total	1.3%	7.0%	4.7%	7.4%	20.4%
Agree	Count	11	38	17	34	100
	% within class	28.2%	37.3%	28.3%	34.7%	33.4%
	% of Total	3.7%	12.7%	5.7%	11.4%	33.4%
Strongly agree	Count	23	29	17	27	96
	% within class	59.0%	28.4%	28.3%	27.6%	32.1%
	% of Total	7.7%	9.7%	5.7%	9.0%	32.1%
Total	Count	39	102	60	98	299
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

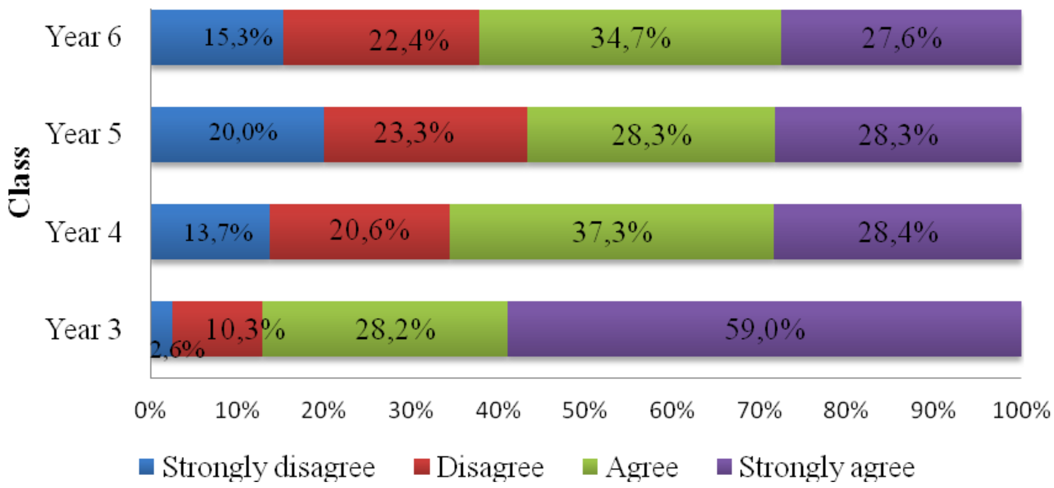

Figure 27: : Age group difference - Question 8.

Question 10

Table 60: Age group difference - Question 10: It is helpful to understand a difficult exercise when teacher explains it while using the IWB.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	1	9	3	6	19
	% within class	2.6%	8.8%	4.9%	6.1%	6.3%
	% of Total	.3%	3.0%	1.0%	2.0%	6.3%
Disagree	Count	1	12	10	26	49
	% within class	2.6%	11.8%	16.4%	26.5%	16.3%
	% of Total	.3%	4.0%	3.3%	8.7%	16.3%
Agree	Count	5	29	19	34	87
	% within class	12.8%	28.4%	31.1%	34.7%	29.0%
	% of Total	1.7%	9.7%	6.3%	11.3%	29.0%
Strongly agree	Count	32	52	29	32	145
	% within class	82.1%	51.0%	47.5%	32.7%	48.3%
	% of Total	10.7%	17.3%	9.7%	10.7%	48.3%
Total	Count	39	102	61	98	300
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

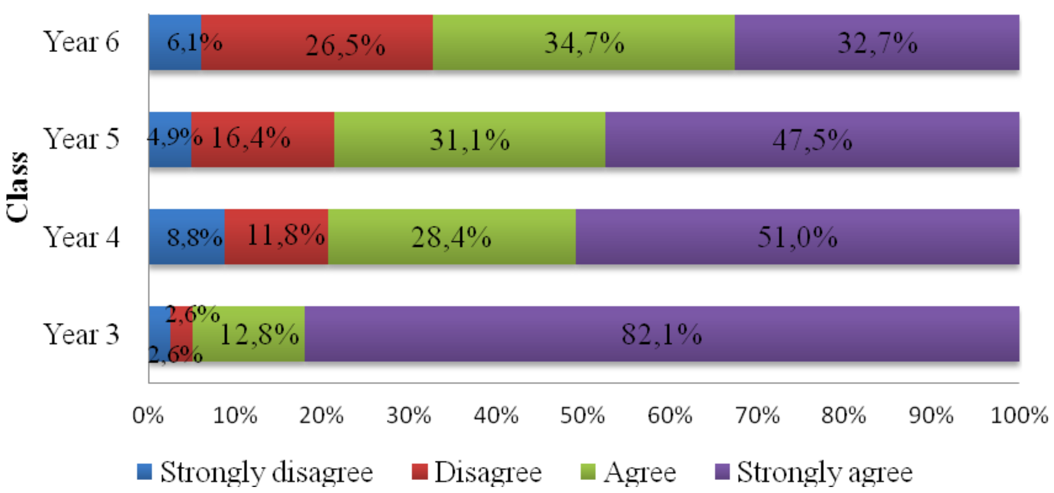

Figure 28: Age group difference - Question 10.

Question 11

Table 61: Age group difference - Question 11: When teacher uses the IWB he/she raises a lot of questions.

Answer		Class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	1	16	11	10	38
	% within class	2.6%	15.7%	18.3%	10.2%	12.7%
	% of Total	.3%	5.4%	3.7%	3.3%	12.7%
Disagree	Count	5	39	20	39	103
	% within class	12.8%	38.2%	33.3%	39.8%	34.4%
	% of Total	1.7%	13.0%	6.7%	13.0%	34.4%
Agree	Count	21	38	21	37	117
	% within class	53.8%	37.3%	35.0%	37.8%	39.1%
	% of Total	7.0%	12.7%	7.0%	12.4%	39.1%
Strongly agree	Count	12	9	8	12	41
	% within class	30.8%	8.8%	13.3%	12.2%	13.7%
	% of Total	4.0%	3.0%	2.7%	4.0%	13.7%
Total	Count	39	102	60	98	299
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

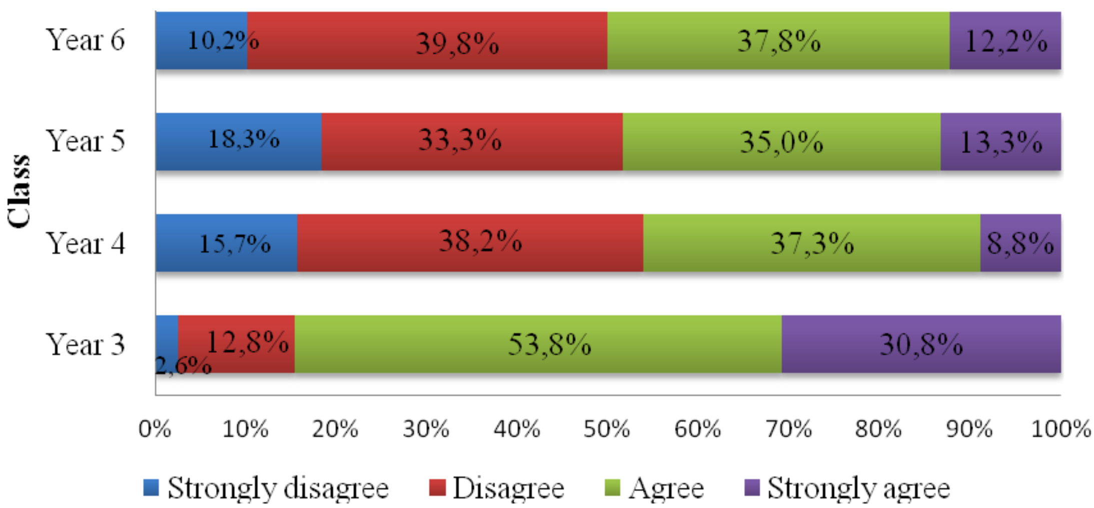

Figure 29: Age group difference - Question 11.

Question 12

Table 62: Age group difference - Question 12: When teacher uses the IWB we begin discussion.

Answer		Class: Year 3	Year 4	Year 5	Year 6	Total
Strongly disagree	Count	5	17	9	7	38
	% within class	12.8%	16.7%	15.0%	7.1%	12.7%
	% of Total	1.7%	5.7%	3.0%	2.3%	12.7%
Disagree	Count	5	31	9	33	78
	% within class	12.8%	30.4%	15.0%	33.7%	26.1%
	% of Total	1.7%	10.4%	3.0%	11.0%	26.1%
Agree	Count	13	33	20	37	103
	% within class	33.3%	32.4%	33.3%	37.8%	34.4%
	% of Total	4.3%	11.0%	6.7%	12.4%	34.4%
Strongly agree	Count	16	21	22	21	80
	% within class	41.0%	20.6%	36.7%	21.4%	26.8%
	% of Total	5.4%	7.0%	7.4%	7.0%	26.8%
Total	Count	39	102	60	98	299
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

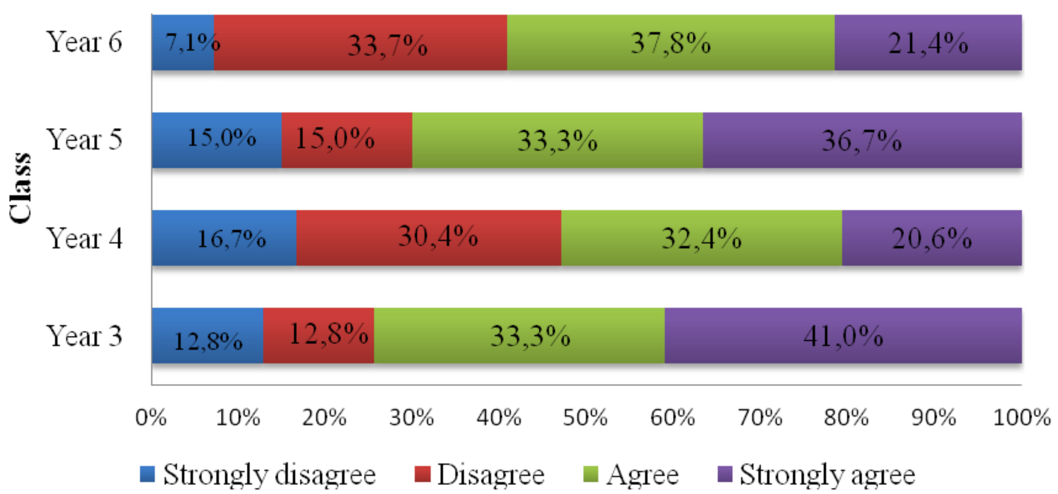

Figure 30: Age group difference - Question 12.

Question 13

Table 63: Age group difference - Question 13: When teacher uses the IWB I understand the lesson easier.

Answer		class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	0	0	2	6	8
	% within class	.0%	.0%	3.3%	6.1%	2.7%
	% of Total	.0%	.0%	.7%	2.0%	2.7%
Disagree	Count	0	12	7	14	33
	% within class	.0%	11.8%	11.5%	14.3%	11.0%
	% of Total	.0%	4.0%	2.3%	4.7%	11.0%
Agree	Count	6	39	18	43	106
	% within class	15.4%	38.2%	29.5%	43.9%	35.3%
	% of Total	2.0%	13.0%	6.0%	14.3%	35.3%
Strongly agree	Count	33	51	34	35	153
	% within class	84.6%	50.0%	55.7%	35.7%	51.0%
	% of Total	11.0%	17.0%	11.3%	11.7%	51.0%
Total	Count	39	102	61	98	300
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

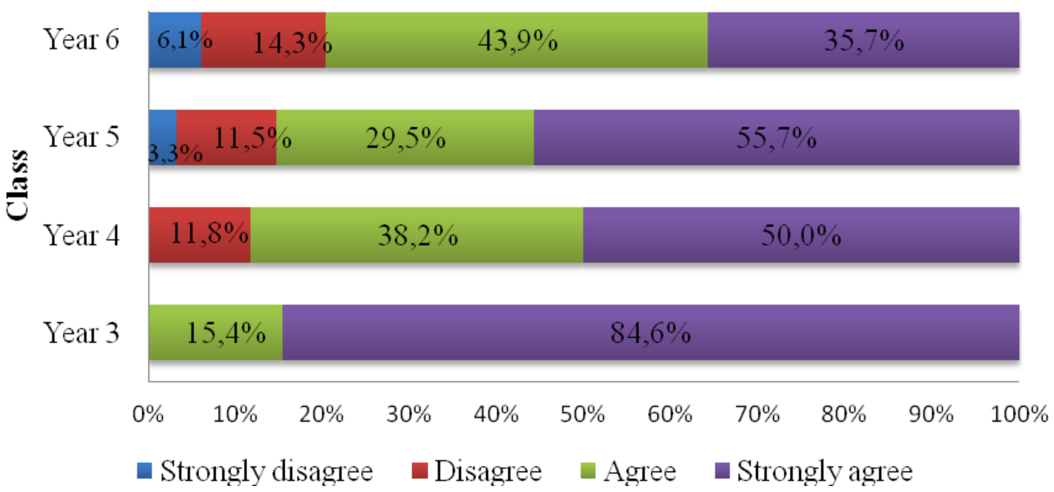

Figure 31: Age group difference - Question 13.

Question 14

Table 64: Age group difference - Question 14: When teacher uses the IWB my explanation is tested on the IWB in front of the class.

Answer		Year 3	Year 4	Year 5	Year 6	Total
		Class				
Strongly disagree	Count	4	11	7	15	37
	% within class	10.3%	10.8%	11.7%	15.3%	12.4%
	% of Total	1.3%	3.7%	2.3%	5.0%	12.4%
Disagree	Count	2	18	5	31	56
	% within class	5.1%	17.6%	8.3%	31.6%	18.7%
	% of Total	.7%	6.0%	1.7%	10.4%	18.7%
Agree	Count	7	30	18	25	80
	% within class	17.9%	29.4%	30.0%	25.5%	26.8%
	% of Total	2.3%	10.0%	6.0%	8.4%	26.8%
Strongly agree	Count	26	43	30	27	126
	% within class	66.7%	42.2%	50.0%	27.6%	42.1%
	% of Total	8.7%	14.4%	10.0%	9.0%	42.1%
Total	Count	39	102	60	98	299
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

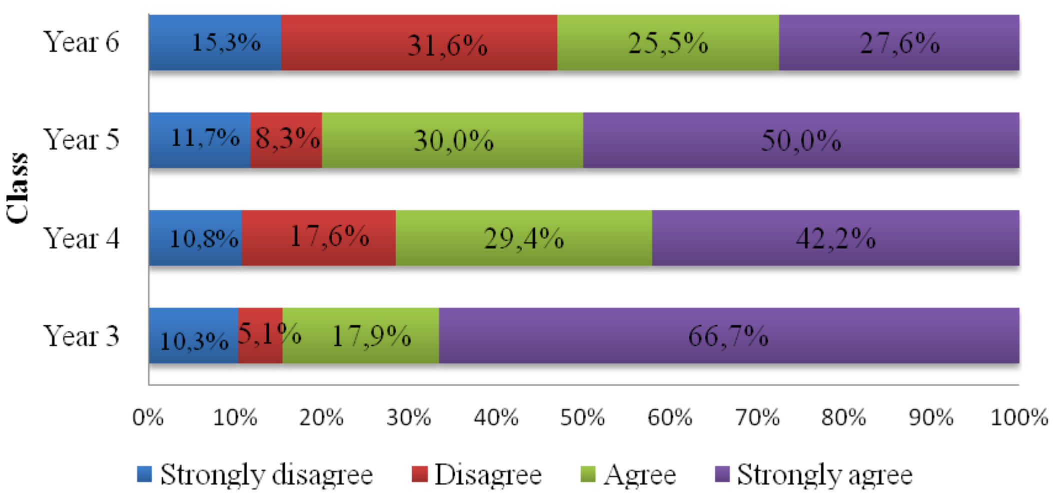

Figure 32: Age group difference - Question 14.

Question 15

Table 65: Age group difference - Question 15: It's easier to understand something when I look or manipulate a shape on the IWB.

Answer		Class: Year 3	Year 4	Year 5	Year 6	Total
Strongly disagree	Count	1	4	1	5	11
	% within class	2.6%	3.9%	1.6%	5.1%	3.7%
	% of Total	.3%	1.3%	.3%	1.7%	3.7%
Disagree	Count	2	8	8	23	41
	% within class	5.1%	7.8%	13.1%	23.5%	13.7%
	% of Total	.7%	2.7%	2.7%	7.7%	13.7%
Agree	Count	8	47	22	45	122
	% within class	20.5%	46.1%	36.1%	45.9%	40.7%
	% of Total	2.7%	15.7%	7.3%	15.0%	40.7%
Strongly agree	Count	28	43	30	25	126
	% within class	71.8%	42.2%	49.2%	25.5%	42.0%
	% of Total	9.3%	14.3%	10.0%	8.3%	42.0%
Total	Count	39	102	61	98	300
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

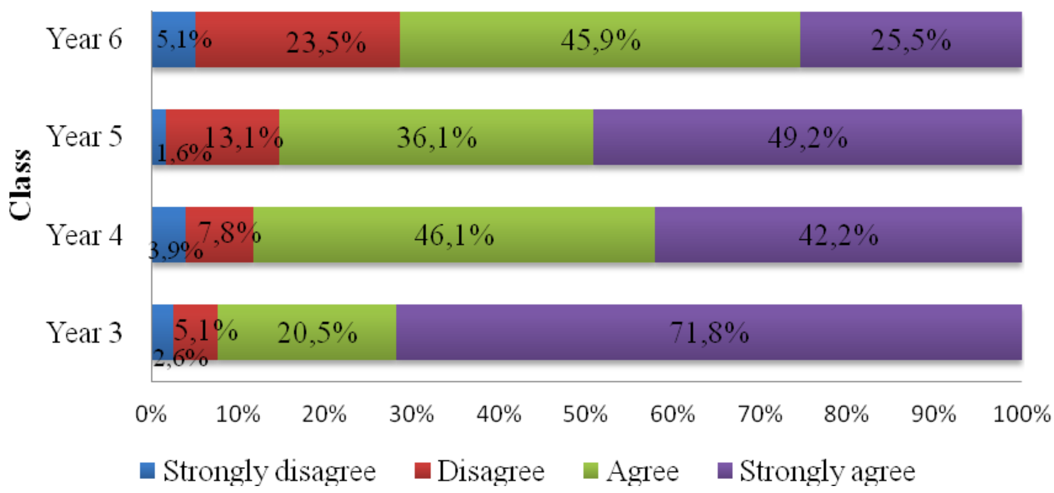

Figure 33: Age group difference - Question 15.

Question 16

Table 66: Age group difference - Question 16: It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB.

Answer		class				Total
		Year 3	Year 4	Year 5	Year 6	
Strongly disagree	Count	5	11	5	14	35
	% within class	12.8%	10.8%	8.2%	14.3%	11.7%
	% of Total	1.7%	3.7%	1.7%	4.7%	11.7%
Disagree	Count	6	10	9	39	64
	% within clas	15.4%	9.8%	14.8%	39.8%	21.3%
	% of Total	2.0%	3.3%	3.0%	13.0%	21.3%
Agree	Count	12	54	15	33	114
	% within class	30.8%	52.9%	24.6%	33.7%	38.0%
	% of Total	4.0%	18.0%	5.0%	11.0%	38.0%
Strongly agree	Count	16	27	32	12	87
	% within class	41.0%	26.5%	52.5%	12.2%	29.0%
	% of Total	5.3%	9.0%	10.7%	4.0%	29.0%
Total	Count	39	102	61	98	300
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

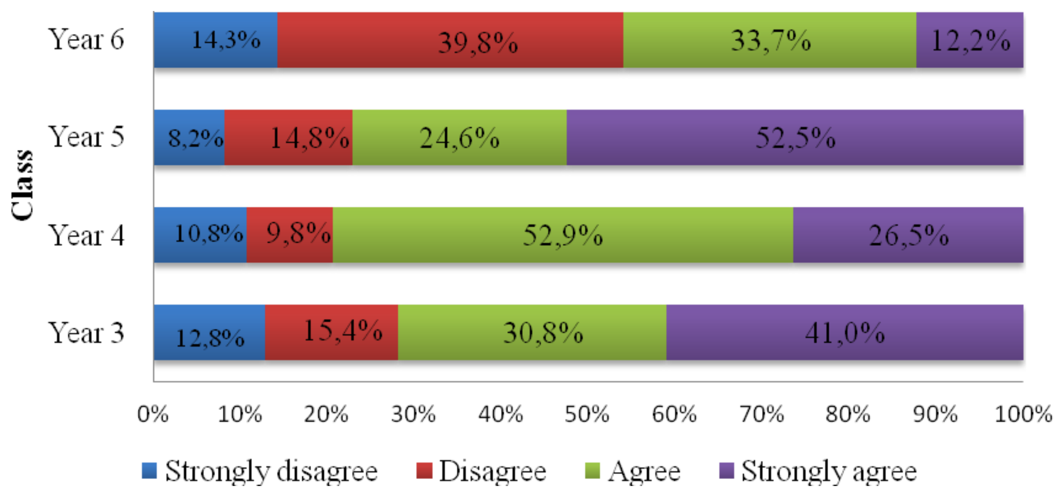

Figure 34: Age group difference - Question 16.

Question 17

Table 67: Age group difference - Question 17: I understand Mathematics better when teacher uses the IWB.

Answer		class				Total
		Year 3	Year 4	Year 5	Year 6	
Never	Count	1	1	1	3	6
	% within class	2.6%	1.0%	1.6%	3.1%	2.0%
	% of Total	.3%	.3%	.3%	1.0%	2.0%
Rarely	Count	0	8	5	25	38
	% within class	.0%	7.8%	8.2%	25.5%	12.7%
	% of Total	.0%	2.7%	1.7%	8.3%	12.7%
Quite often	Count	11	45	25	52	133
	% within clas	28.2%	44.1%	41.0%	53.1%	44.3%
	% of Total	3.7%	15.0%	8.3%	17.3%	44.3%
A lot of times	Count	27	48	30	18	123
	% within class	69.2%	47.1%	49.2%	18.4%	41.0%
	% of Total	9.0%	16.0%	10.0%	6.0%	41.0%
Total	Count	39	102	61	98	300
	% within class	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

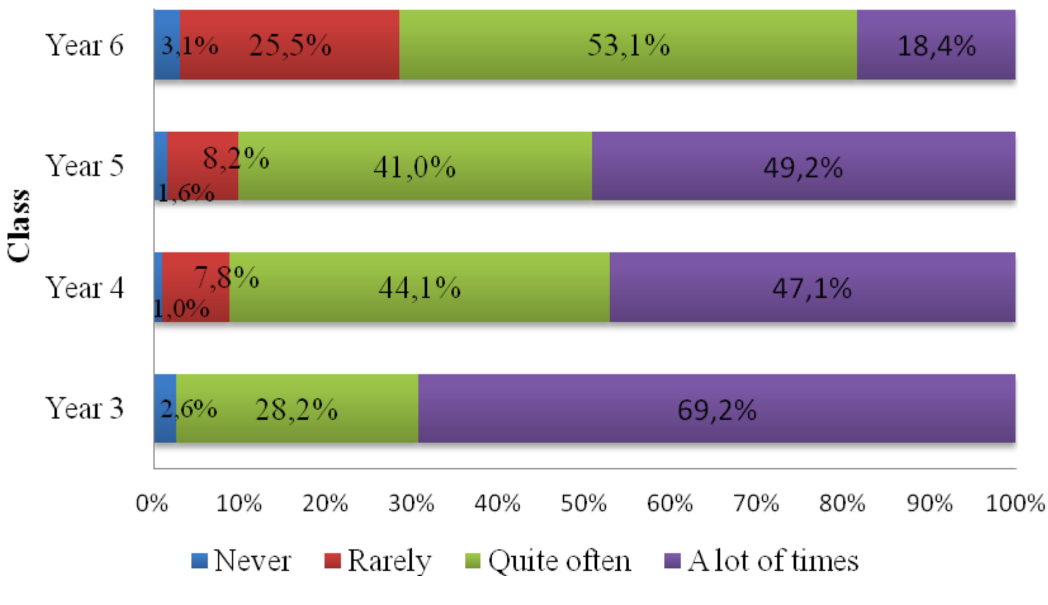

Figure 35: Age group difference - Question 17.

Summary

Interestingly, inferential analysis shows that there is a statistically significant difference in 14 questions/items, based on pupils' age. In q1 though, the difference lies to class level differences rather than the age of pupils. In the overall sample, only two classes had the most negative responses both found in Year 4. Thus, q1 is not considered as having a significant difference in terms of pupils age and will be excluded from the analysis in this section. The remaining 13 questions are further discussed below.

Even though there is a statistically significant difference according participants' age in most of the questions, this does not fit into a consistent pattern, though there is an overall trend by age. Differences cannot be explained by particular variation amongst specific age groups. This is evident by the fact that eight patterns can be generated when exploring differences in each question. Pattern refers to a class order, beginning with those who answered more positively in a question. For example, a pattern "Y3,Y5,Y6,Y4," shows that pupils in Y3 answered positively and in Y4 negatively. The table below includes all the patterns, and the questions that fit into each one of them.

Table 68: Tendencies in answering by age group.

Pattern (positive to negative)	Questions that fit into the pattern
Y3, Y4, Y5, Y6	q5, q10, q13, q15, q17
Y3, Y4, Y6, Y5	q7, q8
Y3, Y5, Y4, Y6	q13, q14
Y5, Y4, Y3, Y6	q4
Y5, Y3, Y4, Y6	q3
Y3, Y4 and Y5 and Y6*	q11
Y3, Y5, Y6, Y4	q12
Y4, Y5, Y3, Y6	q16

*Responses in Y4, Y5, and Y6 are aligned

It is suggested that two main results should be taken into consideration when exploring the above table. First, the pattern "Y3, Y4, Y5, Y6" was the most frequent one. Second, the only persistent pattern observed was between Y3 and Y6, pupils in Y3 replied more positively than in Y6 in all of the (13) questions.

Referring to the last, it is important to be tentative about the age related differences though overall, between Y3 and Y6, indicates that younger pupils tended to respond more positively. However the sample for each age group was not equal; sample size and details can be found in Tables 6-9, p. 140-141. Pupils in Y3 were from (only) two classes and were in total 39. Pupils in Y6 were from five classes and were in total 98. Evidently, the findings need to be cautiously interpreted with such a limited sample.

However, the most frequent pattern observed, “Y3, Y4, Y5, Y6”, is aligned to the above result while indicating differences justified by the age of participants rather than teaching they have experienced. The existence of all the other patterns might be probably due to diversity of teaching practices at a class level rather than age of pupils, presented in detail in the descriptive analysis. It should be noted though that, only samples of Y4 and Y6 can be considered balanced, both including around 100 pupils, as evident in Table 8 in p. 141. Yet, in line to such results, during the National Oracy Project in England and Wales, 1987-1993 (Norman, 1990; 1992), teachers noticed that pupils become more self-critical, and in a negative way, as they grow older.

Overall, there is some evidence that younger pupils tended to be more positive when filling the Likert-scale questionnaire. Unless this is a general trend observed in surveys, younger pupils seemed to report the use of IWB as a learning ‘strenghtener’ more frequently than older pupils. This needs to be further explored with balanced populations across age groups and subjects.

Investigating differences related to school

Null hypothesis (tested for each variable /question): There is no difference amongst schools, in terms of pupils' responses.

Looking at the table below, the null hypothesis is rejected for four of the questions, since p-value is smaller than 0.05; q5,q7,q10, and q17. Chi-square tests for each question, in terms of school, can be found in Appendix 16.

Table 69: Chi-square tests based on school.

Question (q)	Chi-square (X^2)	p-value
q1	$X^2_3 = 4.404$	0.221
q2	$X^2_9 = 13.130$	0.157
q3	$X^2_9 = 16.123$	0.064
q4	$X^2_9 = 15.121$	0.088
q5	$X^2_9 = 42.465$	0.000*
q6	$X^2_9 = 11.913$	0.218
q7	$X^2_9 = 18.469$	0.030*
q8	$X^2_9 = 10.689$	0.298
q9	$X^2_9 = 15.560$	0.077
q10	$X^2_9 = 35.107$	0.000*
q11	$X^2_9 = 11.860$	0.221
q12	$X^2_9 = 15.568$	0.076
q13	$X^2_9 = 16.840$	0.051
q14	$X^2_9 = 15.586$	0.076
q15	$X^2_9 = 9.305$	0.410
q16	$X^2_9 = 15.115$	0.088
q17	$X^2_9 = 19.950$	0.018*
		*p< 0.05

Question 5

Table 70: School difference - Question 5: It is helpful to understand a difficult exercise when I ask the teacher by raising my hand.

Answer		School 1	School 2	School 3	School 4	Total
Strongly disagree	Count	10	5	2	2	19
	% within School	9.4%	6.0%	2.5%	6.9%	6.3%
	% of Total	3.3%	1.7%	.7%	.7%	6.3%
Disagree	Count	34	7	23	6	70
	% within School	32.1%	8.3%	28.4%	20.7%	23.3%
	% of Total	11.3%	2.3%	7.7%	2.0%	23.3%
Agree	Count	31	23	40	10	104
	% within School	29.2%	27.4%	49.4%	34.5%	34.7%
	% of Total	10.3%	7.7%	13.3%	3.3%	34.7%
Strongly agree	Count	31	49	16	11	107
	% within School	29.2%	58.3%	19.8%	37.9%	35.7%
	% of Total	10.3%	16.3%	5.3%	3.7%	35.7%
Total	Count	106	84	81	29	300
	% within School	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	35.3%	28.0%	27.0%	9.7%	100.0%

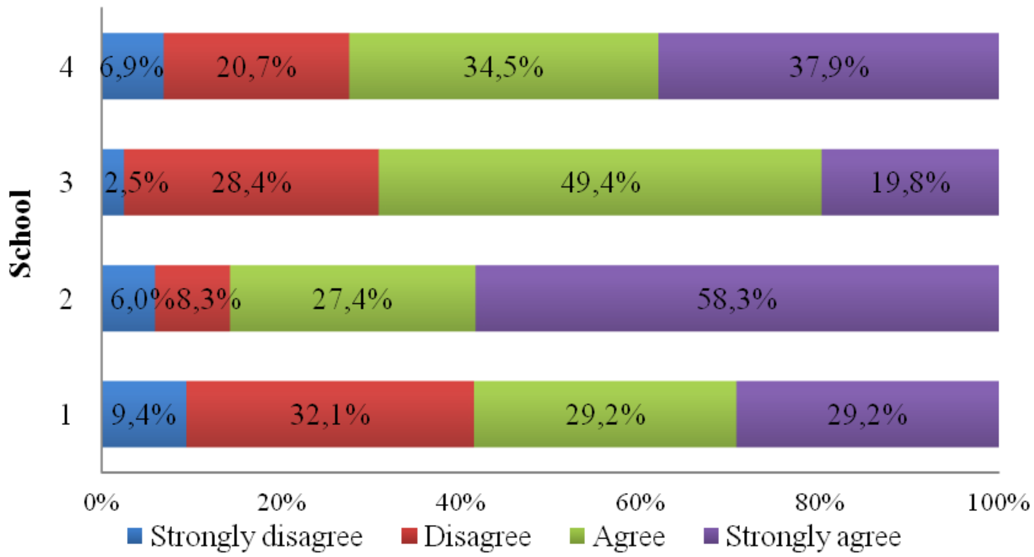

Figure 36: School difference - Question 5.

Question 7

Table 71: School difference - Question 7: It is helpful to understand a difficult exercise when I pay attention to the lesson.

Answer		School 1	School 2	School 3	School 4	Total
Strongly disagree	Count	3	0	0	0	3
	% within School	2.8%	.0%	.0%	.0%	1.0%
	% of Total	1.0%	.0%	.0%	.0%	1.0%
Disagree	Count	11	2	7	1	21
	% within School	10.4%	2.4%	8.6%	3.4%	7.0%
	% of Total	3.7%	.7%	2.3%	.3%	7.0%
Agree	Count	33	20	32	7	92
	% within School	31.1%	24.1%	39.5%	24.1%	30.8%
	% of Total	11.0%	6.7%	10.7%	2.3%	30.8%
Strongly agree	Count	59	61	42	21	183
	% within School	55.7%	73.5%	51.9%	72.4%	61.2%
	% of Total	19.7%	20.4%	14.0%	7.0%	61.2%
Total	Count	106	83	81	29	299
	% within School	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	35.5%	27.8%	27.1%	9.7%	100.0%

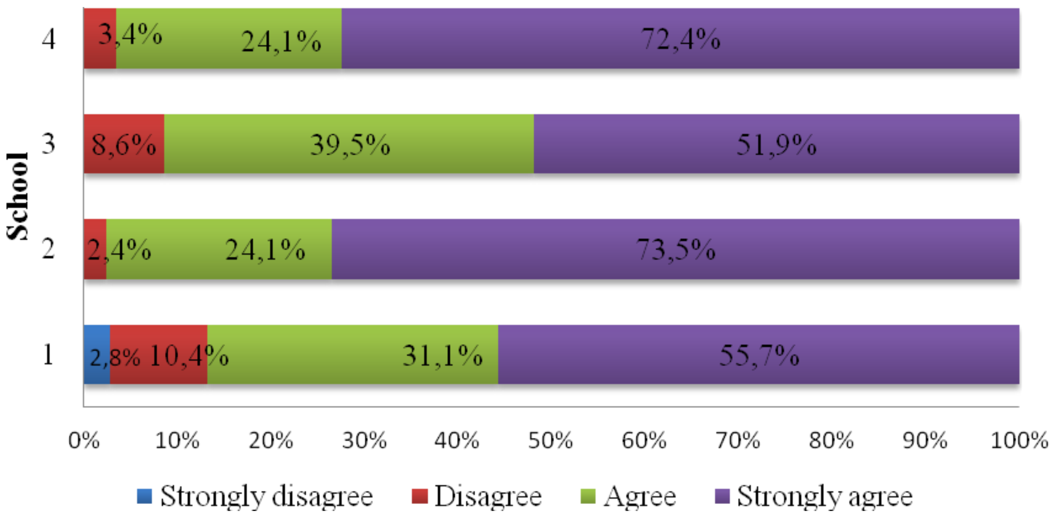

Figure 37: School difference - Question 7.

Question 10

Table 72: School difference - Question 10: It is helpful to understand a difficult exercise when teacher explains it while using the IWB.

Answer		School 1	School 2	School 3	School 4	Total
Strongly disagree	Count	12	4	2	1	19
	% within School	11.3%	4.8%	2.5%	3.3%	6.3%
	% of Total	4.0%	1.3%	.7%	.3%	6.3%
Disagree	Count	25	6	13	5	49
	% within School	23.6%	7.2%	16.0%	16.7%	16.3%
	% of Total	8.3%	2.0%	4.3%	1.7%	16.3%
Agree	Count	34	14	30	9	87
	% within School	32.1%	16.9%	37.0%	30.0%	29.0%
	% of Total	11.3%	4.7%	10.0%	3.0%	29.0%
Strongly agree	Count	35	59	36	15	145
	% within School	33.0%	71.1%	44.4%	50.0%	48.3%
	% of Total	11.7%	19.7%	12.0%	5.0%	48.3%
Total	Count	106	83	81	30	300
	% within School	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	35.3%	27.7%	27.0%	10.0%	100.0%

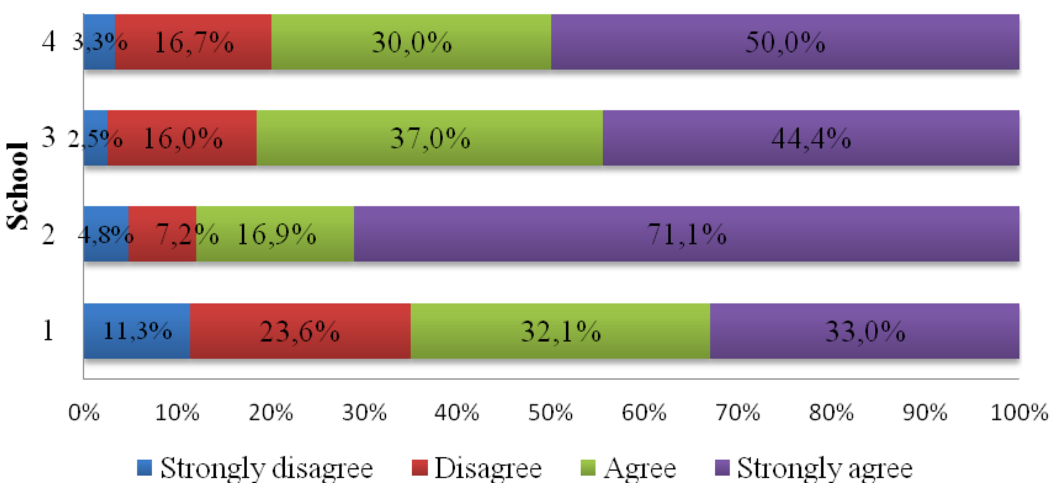

Figure 38: School difference - Question 10.

Question 17

Table 73: School difference - Question 17: I understand Mathematics better when teacher uses the IWB.

Answer		School 1	School 2	School 3	School 4	Total
Never	Count	1	2	2	1	6
	% within School	1.0%	2.4%	2.5%	3.3%	2.0%
	% of Total	.3%	.7%	.7%	.3%	2.0%
Rarely	Count	21	3	11	3	38
	% within School	20.0%	3.6%	13.6%	10.0%	12.7%
	% of Total	7.0%	1.0%	3.7%	1.0%	12.7%
Quite often	Count	44	32	42	15	133
	% within School	41.9%	38.1%	51.9%	50.0%	44.3%
	% of Total	14.7%	10.7%	14.0%	5.0%	44.3%
A lot of times	Count	39	47	26	11	123
	% within School	37.1%	56.0%	32.1%	36.7%	41.0%
	% of Total	13.0%	15.7%	8.7%	3.7%	41.0%
Total	Count	105	84	81	30	300
	% within School	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	35.0%	28.0%	27.0%	10.0%	100.0%

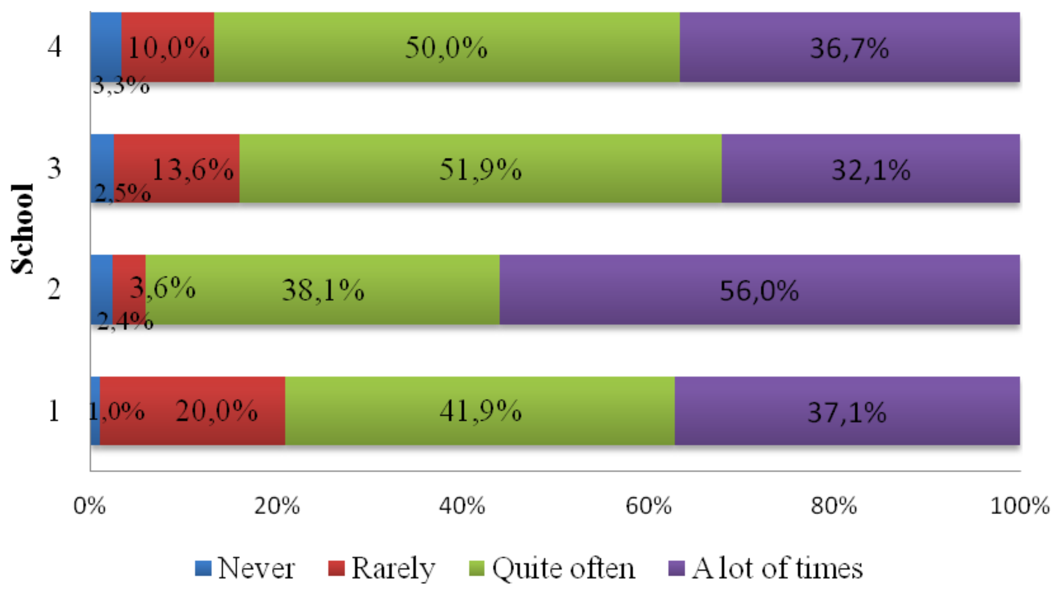

Figure 39: School difference - Question 17.

Summary

In line with the previous section, and as explained above (in p. 247), analysis looked for consistent patterns of more positive or negative responses, based on participants' school. Pupils in School 2 answered more positively as opposed to School 1 and this was statistically significant. The tendency to answer more positively in School 2, can be explained by the fact that sample included only younger pupils, in Y3 and Y4 classes. At the same time, School 1 included pupils in Y4, Y5, and Y6 while having the biggest sample amongst the four schools; refer to Table 6 in p. 140.

Overall, significant differences between schools can be explained by differences in the age of pupils, as presented in the previous section. In order to investigate more rigorously responses of pupils between schools, sample should be balanced in terms of size and age of pupils. The sample for this study did not meet such criteria.

Table 74: Tendencies in answering by school.

Pattern (positive to negative)	**Questions that fit into the pattern**
Schools: 2, 4, 3, 1	q5, q7, q17
Schools: 2, 3, 4, 1	q10

Discussion

Inferential statistics explored for significant differences depended on gender, age of participants, and school.

The most balanced sample was provided for analyses related to gender, but even here gender imbalances between classes seemed to have an impact on results. This said, overall girls' tended to answer more positively, as to whether IWB improves their understanding when teacher is using it (q10), though this cannot be taken as a robust conclusion. Besides, if there was an important gender difference this would be indicated by more than one question. An argument strengthened by the results of the systematic review (pp. 115-117) which point out that there are no significant gender differences related to the use of IWB.

There is some indication that younger pupils replied more positively across the questionnaire, in 13 out of 18 items. Thus, this was not related to questions related to the use of IWB in particular, but was rather a general tendency. This is aligned to results of the National Oracy Project in England and Wales, 1987-1993, where teachers noticed that pupils become more self-critical, and in a negative way, as they grow older (Norman, 1990, 1992). However, comparisons amongst age groups were limited by the unequal sample size. It would be interesting for future studies to investigate responses of age groups when completing questionnaires, across subjects.

Similarly, though significant school differences were found for four questions a more balanced sample size between schools would have offer a more robust conclusion. Put in brief, participating classes of each school were different in terms of age and number of pupils. Thus, some differences can be explained by the age of pupils of each school, as presented in the above paragraph.

All in all, analysis points towards some tentative conclusions about variation in responses by age, by class and by gender. Future research should investigate more rigorously whether there is a pattern amongst pupils to answer more positively to a questionnaire, depending on their age.

STRENGTHS AND LIMITATIONS

Looking in isolation at each of the two methods employed for this study certain improvements can be pointed out.

The systematic review could have been conducted in greater depth by scanning the references of the included studies or by searching through more databases. The review could have looked in more detail at the relationship between the qualitative and quantitative data so as to strengthen the links between types of data in the studies reviewed..

Results from the questionnaire survey could have been strengthened if observations were conducted along with pupils' group interviews, or if factor analysis was employed along with a more detailed questionnaire. Observations could validate correlations between pupils' responses and teaching methods. Group interviews could offer an insight on those responses whose results were rather blurred. More particularly, questions that referred to the use of the IWB as well as the interpretation given to the term discussion by pupils. A more detailed and longer questionnaire could have been an additional, and perhaps more credible, source of data as well. Employing all these methods could form part of a future mixed methods design.

Morever, the third question of the questionnaire could have been phrased differently. "I interrupt to make a question when I don't understand something" could have been replaced to "I raise my hand to make....something". There is a concern that the word "interrupt" inclined pupils towards a rather negative answer. Literally, pupils might hesitated to report that they "interrupt" the lesson. Yet, it is also a possibility that the same results would have been extracted even if the question had been altered. Raising hand to get permission to talk during a lesson is an interruption eitherway. Thus, it is interesting for future research to compare pupils' responses in such questions' phrasings.

Concluding, the specific aims for this study were fullfilled by the application of the specific design which incorporated the two methods as presented throughout this chapter. The contribution of the thesis lies in the combination of the two methods in a novel context in Cyprus.

CONCLUSIONS

In this last chapter of the thesis, a brief summary of the conclusions is provided along with potential explanations and interpretation. Overall conclusions are presented at the beginning of the chapter. Next these conclusions are further discussed by offering potential explanations and interpretation from existing literature. Towards this end, four categories are identified: ‘Aligning formative and summative assessment’, ‘The need for more time to go through the curriculum’, ‘Training teachers towards dialogic teaching’, ‘Theoretically informed practices’. Lastly, suggestions for further research are elaborated in the last section.

Interweaving overall results

This research incorporated two methods in its final design while results can be interwoven towards the same path enhancing the validity and reliability of the applied methodology. In brief, irrespectively of the fact that sample included IWB classes it seems that in Cyprus classroom interaction has not yet refrain from traditional patterns of talk while IWB does not seem to impact on pupils' achievement.

More precisely, the systematic review indicates that, the installation of IWBs does not result in enhancing interactivity or raising achievement. Indeed, investigating the use of IWB through the more detailed questionnaire survey a typical classroom interaction mirrored the most important results while pupils reported a 'fuzzy' or contradictory use of the IWB. This is reinforced by the fact that the most important results of the questionnaire survey in terms of consistency, are in terms of questions that did not refer to the use of IWB. In turn, linking responses among these questions suggested a typical pattern of teaching. Moreover, the systematic review had shown that it is teacher's ability to develop quality interactions that increase the chances of effective teaching rather than the use of the IWB. Yet, pupils across the survey seemed to report the potential of aspects of use as learning amplifiers linked to typical patterns of teaching. This may relate to the nature of their experiences prior to the introduction of IWBs. Such results underpin the importance and potential of teachers' instructional strategies in enhancing pupils' learning. In this study these were characterized by traditional patterns of instruction which may limit the potential of the IWB for more dialogic use.

Overall results are interpreted descriptively in the remaining part of this chapter through connections to existing literature.

Theoretically informed practices

In the literature review of this thesis, it was argued that the use of the IWB should be pedagogically oriented to address characteristics of dialogic teaching (pp. 57-59). The results of my research might be justified through such claims which seem to hold the key to the reform educational practice.

Incorporating technology into educational reform lies in developing instructional practices that exploit technology to improve instruction and learning (Sheingold and Tucker, 1990). But the idea that installing a single piece of instructional technology such as the IWB "could have a profound impact on teaching…is a contentious one" (Lee, 2010, p.140). Indeed, Smith and Higgins (2005) argue that the concept of "interactive pedagogy", or dialogic teaching to synchronize with the terminology of the study, should be first based on realising the value of talking and thinking together. Only under such circumstances will discourse be targeted in terms of learning outcomes rather than on the action of talking. It is in such latent processes that the potential to develop quality talk is concealed.

As it is embedded, it is important to share a common and explicit theoretical base on which teachers' instructional strategies could be based. At present "there is not enough emphasis in educational policy and practice on the value of teaching children how to use language for learning" (Mercer and Littleton, 2007, p.3). In addition a number of studies have shown that pupils can and should be trained to talk effectively during lessons (e.g. Mercer et al. 1999; Reinhart, 2000; Black, 2004; Mercer et al. 2004; Mercer and Sams, 2006).

Learning how pupils learn, and consequently appreciating the value and connection of talking and thinking, should be the driving force of instruction either with or without IWB. The IWB can generate new pedagogical approaches but it should not be assumed as a vehicle to "deliver existing practice in another format" (Beauchamp, 2004, p.343). The aim is not to simply use the IWB but to exploit its functions whenever and for as long as it serves the learning goals of the lesson. As Sunderland et al. (2004) state, theoretical perspectives are at the centre of teaching and learning with or without ICT. They also argue that the broad research on teaching and learning “without ICT” should inform teaching and learning “with ICT” but this has not yet been successfully grasped by policy makers. Indeed, the claim is not about a parthenogenesis of a theory of learning with technology but regards a need to theoretically inform instructional practices that incorporate technological interventions from existing theoretical perspectives.

Training teachers towards dialogic teaching

The importance of including theoretical perspectives in both pre-service and in-service teachers’ training that will enlighten their practices has been made clear above. The findings from this research indicate that teachers’ ability to deliver instruction effectively impacts on pupils’ learning as well as the development of their metacognition. At the same time, their instructional methods are profoundly influenced by conscious or unconscious perceptions of teaching and learning; this increases the importance of informing teachers’ perspectives theoretically. Indeed, teacher’s perceptions of his or her role in relation to pupils has a crucial impact on classroom interaction and consequently the culture of classroom talk (Teo, 2013).

If this is the goal, then teachers’ training should be underpinned by dialogic teaching pedagogical principles. Goodison’s (2003) says that, “the pedagogical principles which determine successful ICT integration into lesson design should themselves apply to staff training” (p.556). Teachers could perhaps be trained to interact with each other in the same way that it is expected they will to interact during lessons. It is certainly important that teachers’ training should share the same theoretical basis of the teaching they will be requested to produce. Indeed, citing Knuck’s (2010) characterisation of effective professional training one can easily align it to the theoretical view developed in this study (see for example, in the chapter 'Theoretical Synopsis').

> Reflection allows the integration of theory and practice and can result in the development of insight and self-discovery. By stimulating self-questioning and causing shifts in assumptions, perspectives are broadened and change is facilitated. (p.131)

In line with this, Black (2004) states that it is crucial to encourage teachers to develop a critical view of their own ways of communicating. A good starting point towards this end is to use videos of diverse teaching practices as a discussion amplifier which can lead to shifts of views towards more interactive strategies. This technique has been broadly applied in research to stimulate teacher's comments during interviews, a process often called video-triggered or video-reflective dialogue. In this approach teachers mainly view instances of their own lessons while being interviewed by a researcher (e.g. English et al., 2002; Hargreaves et al. 2003; Black, 2004; Tanner and Jones, 2007a; Cutrim Schmid, 2010). The same approach was used in Hennessy et al.'s (2011) research but in this case teachers also watched other teachers' lessons during a series of workshops (see also Mercer et al. 2010). There is no doubt that see and hearing your own instructional method offers a unique insight that cannot be achieved through other approaches, while also raising opportunities for self-awareness and self-criticism. Perspectives can be broadened through the affordance to open-up a space for quality interaction through sharing techniques for instructional design: dialogic discussions of one's own teaching. An approach towards that end could be the broadly known lesson study.

Nowadays this becomes even more necessary since instruction can be transformed in so many ways by numerous technological interventions such as the IWB. The multi-modal nature of teaching is reflected in teacher's need to orchestrate activities that incorporate verbal, visual, interpersonal and technological skills (Higgins et al., 2007). Consequently, the diversity of instructional methods should effectively inform educational practice and this can be achieved at the intersection of the individual and the community without undermining the complexity of the instructional process (Enyedy, 2003).

Once teachers' perspectives are theoretically informed and teachers adopt a culture of sharing, accepting or overcoming views and instructional techniques educational practice could be reformed. The need for creative and critical thinking in a shared community of learning should be a priority for both teachers and pupils. Once teachers realise the need for pedagogical change and gain expertise with new technologies such as the IWB, these new technologies can shape changed approaches according to their affordances (Glover et al., 2005; Higgins et al., 2007), but still reflecting their underlying aims for educational practice.

The need for more time to go through the curriculum

Teachers need to have some degree of freedom over the pedagogic strategies they apply, especially in relation to pace and progression through the curriculum (Black, 2004). Many issues point towards that argument emphasizing the importance of creating more flexible and less content oriented curriculums.

Moss et al. (2007) suggest that there is a less strong relationship between speed of delivery and effective teaching in contrast to other suggestions in the research literature; but interestingly a fast-pace was among the observed characteristics of using the IWB. Indeed, teachers struggle with external time and curricular constraints while developing whole-class discussions during mathematics (McGraw, 2002). Similarly, Brown and Hirst (2007) found that teachers developed poor-quality patterns of talk as the only solution in facing the constraints of the school timetable. Kyriacou and Goulding (2004) report that "increased use of 'traditional' whole class teaching with 'pace', is in fact undermining the development of a more reflective and strategic approach to thinking about mathematics" (p.2). Reinhart (2000) also suggests that good discussions take more time but it is tempting for teachers to tell pupils the answers to move on in favor of a faster pace through the curriculum.

At the same time, transforming existing practices in parallel with the introduction of new technological interventions, such as the IWB, stress the need for more time to familiarize and develop new pedagogical contexts. It needs patience to develop dialogical schemes since it perhaps needs several tries to succeed it (Nystrand et al., 2003). Added to that, using an IWB towards that end certainly makes the situation even more complex at least for those that are not experienced in the technology. However, teachers need time to familiarise with the IWB technology on a trial-and-error basis (Cutrim Schmid, 2010) and should be allowed time for exploration with the IWB (Miler and Glover, 2007). Smith (2010) stresses the importance of applying any new approaches on a regular basis while pupils also need time to familiarize with them in order to decide about their effectiveness.

The process of educational transformation becomes more complex as the time goes by since the need for developing dialogic teaching and learning cultures has to synchronize with the constant technological expansion of our era. Overall, "familiarity, confidence and time are assumed to be the keys that unlock this gradual process of transformation" (Moss et al., 2007, p.6). Evidently, in order to provide more time to go through the curriculum it is crucial to rethink about the nature and extent of its content.

Aligning formative and summative assessment

The most important parameter of all is the issue of the relationship between formative and summative assessment. If the argument presented above is valid then the chances of transforming existing approaches are limited. To be more precise, there is a real concern that instructional strategies may shaping the types of formative assessment, but these are actually driven by summative forms of testing which measure mainly the reproduction of specific content and procedures. This argument was developed in the ‘Further discussion’ section of the systematic review, p. 129-131.

For example, Smith (2010) argues that many science teachers concentrate solely on the knowledge they perceive as important for their pupils to succeed in their end-of-key-stage tests. Similarly, Pratt (2006) concludes that pupils perceive the memorisation of “best” methods as the most effective tool to score well in standardised tests. In line with this, Brown and Hirst (2007) indicate that the standardised and external testing system did not permit dialogical patterns of talk to take place during lessons. Beauchamp et al.’s (2010) description encapsulates my argument comprehensively.

> Unfortunately, within the current school system, the emphasis is on the achievement of externally set, pre-specified targets which often require a reproduction of standard procedures, rather than helping pupils to critically apply their learning to novel contexts and improvisation. It may be that until this emphasis is changed, pupils will be largely restricted to playing someone else’s tunes. (p. 155)

This situation might impact on pupils’ metacognition while “programming” them to succeed in tests that measure their ability to memorise particular curriculum content. In turn, as long as any technological intervention is exploited to fit in the above scheme it will only succeed in serving it rather than helping to reframe or revise it.

Contrastingly, critical, reflective and creative thinking skills which are at the heart of the suggested teaching approaches can be undermined through these types of summative tests even though their importance is supposedly increased. As an example of this, the expansion of online and electronic information is often thought to create a need to be more skillful in judging the validity of different sources (Smith, 2010).

Moreover, quality interactions – and thus quality talk– lead to meaningful and enhanced learning. In turn, such practices should ideally be aligned to increase through the use of standardised tests, but in reality the issue is far more complex. Existing literature suggests that the content of summative forms of testing focus mainly on the skill of memorisation and reproduction. Consequently, teachers develop their strategies to secure the success of their pupils in such types of testing. Dialogic teaching aims should surely be reflected in teachers' testing. However, if standardised forms of testing measure pupils' learning solely in terms of their ability to reproduce curriculum content what would be the motive for both teachers and pupils to get involved with dialogic practices? Without aligning existing patterns of summative assessment to dialogic teaching practices and beliefs into a more discursive educational perspective, the situation will remain as it is.

Suggestions for further research

In the light of the aforementioned concerns as well as the results of my research some suggestions can be made regarding the methodology of future research and areas that need further investigation.

Methodological suggestions

- It is important for future systematic reviews or meta-analysis to focus on the methodology of each research study included in the sample. Even though some publications are peer-reviewed or statistical measures indicate significance in the results the methodology and findings might point towards another interpretation; this evident in the review included in this study.
- There is a need for more longitudinal studies to search more carefully for the impact of IWBs on classroom interaction and achievement. At the same time, studies should employ quantitative as well as qualitative methods for exploring classroom interaction (Howe and Abedin, 2013), so that conclusions can be assessed more robustly and comparatively.

Areas for further research

- Investigating the interplay between formative assessment, in terms of instructional design, and summative assessment is crucial in understanding the pervasiveness of traditional teaching patterns.
- Focusing on the reciprocity of teachers' beliefs, teaching methods and pupils' perceptions on their own learning might enlighten research in two ways. On the one hand, finding whether teachers' beliefs are consistent with the applied methods since there is a concern that teachers either do not value the link between talking and thinking, or they are unable to develop instructional strategies that reflect their beliefs. On the other hand, analysing pupils' perceptions of their own learning, in other words metacognition, is crucial since specific metacognitive skills may be shaped by the instructional methods they experience.
- There is a need to answer a number of questions so that a more dialogical teaching process can be applied using a robust design. For example: Which organisational strategies are beneficial for dialogue? What is the relationship between content, quality and length of discussion? How does experience shape dialogic interaction?
- Research should focus on practices that incorporate IWB into a broader design rather than focusing solely on its direct impact. Technology is now more integrated, so interactive tables, personal devices and electronic tablets have their place in today's classroom (e.g. Joyce-Gibbons, 2014).
- Similar studies should be conducted in other cultural settings since results was hugely based in Cyprus educational system.
- Lastly, further studies should explore in more detail whether younger pupils, in primary schools, tend to answer more positively than older pupils, when asked to fill a questionnaire to understand what this implications of this might be more widely.

APPENDICES

Appendix 1

PILOTING OTHER METHODOLOGICAL DESIGNS

The methodology of this study cannot be simply and straightforwardly explained since it has been taken two other forms before reaching its third and final form. The reasons of moving from one methodology to another had arisen during piloting. As Baucal mentioned, as key note speaker at JURE conference 2014, methodologies are good servants but bad masters. Indeed, the methodology, not the method, determines the type of research practice that will best serve the research questions (Hesse-Biber, 2010). As such, it was reformed to serve the research problem in the best possible way. An in-depth analysis of methods is presented only for the third methodological scheme which was the one applied.

Piloting Design A

<u>The aim of the study</u>

The aim was to tackle practical techniques of developing quality talk, in other words dialogues (terms interpreted in pp.36-38 and pp.59-65), in IWB-lessons since existing literature indicates that the use of IWB has not yet been used towards that path (pp.87-88). It is crucial to mention that it was *not* envisaged to confirm such findings, an argument found extensively across literature. Instead, targeting high performing schools was considered as increasing the possibilities to observe effective IWB use; the importance of scoring is discussed in pp.52-54. Having this research framework, the aim was set in answering the following questions.

Research questions

- What type of talk is developed while using the IWB during maths in high performing primary schools?
- What type of IWB use generates and supports the type of talk developed in each case?
- How long do pupils and teachers talk during maths lessons where IWB is being used and what is the context of the talk?
- Why do teachers teach in the way they do, in terms of talking and using the IWB?

Methods

Research methods included questionnaires to pupils (Appendix 2), semi-structured interviews, audio-recorded observations along with observation schedules; priority was given to the observations. Data was gathered for each classroom as following: three observations during three successive maths lessons, by the end of the first observation the last 10-15 minutes would be dedicated in filling the questionnaires while semi-structured interviews (approximately 5min) would take place in schools by the end of the third observation. All methods were designed according the School of Education's Code of Practice on Research Ethics which in turn gave approval to the researcher to begin the study.

Data analysis

In order to analyse the data, it was planned to record the talk that would take place in each class as interval data (e.g. 0-1min, 1-2min, etc), and divided it into three categories: the duration of teacher's questioning, duration of pupils' answer and duration of teacher's talk. In addition, talk would be analysed once more for each case with the variables 'using the IWB' and 'not using the IWB' added to the previous scheme. Finally, using observations schedules, the type of IWB's use would be added as another variable (e.g. presentation, indicating the correct answer, writing, using previously saved material, etc). Semi-structured interviews were conducted in order to enhance validity and reliability of results and also to gather information that could not be otherwise observed. Quantitative data were aggregated and analysed using SPSS, while qualitative data would be analysed using the software ATLAS.ti.

Sampling

Sample included at least ten Year 5 classrooms in high performing schools identified through the Centre for Evaluation and Monitoring (CEM hereafter) at Durham University. The assumption was that through such sample there would be greater possibility to find teachers developing dialogic schemes of talk while using the IWB.

This kind of sampling is called non-probability purposive sampling, following Cohen et al.'s (2000) terminology. Purposive sampling is when researcher handpicks cases on the basis of their typicality, for a specific purpose (ibid) and in this study typicality would be successful integration of IWBs in high performing schools. The assumption was that through such sample there would be greater possibility to find teachers whose style delivers effective talk while using the IWB; though this does not qualify as a criterion of effective teaching as mentioned in pp.53-54. Literally, a particular group would be targeted having full knowledge that it did not represent the wider population since no attempt to generalise was desired.

The high-performing schools were identified through the CEM at Durham University via PIPS, a standardised assessment system that is designed to monitor pupils' educational progress; a project that has taken place in CEM since 1991 (http://www.cemcentre.org/pips/introduction). In June 2011, the researcher was provided with pupils' scores on maths and reading – only from pencil and paper tests - from 177 schools around England. When provided to the researcher for analysis both schools and pupils were coded in numbers by CEM in order to secure their anonymity. Using the Statistical Package for Social Sciences software (SPSS) data were analysed in the following form:

- The file was split (sorted) according the variable "location" so pupils were grouped according their school indicated by codes at this stage

- Through descriptive statistics the mean score was calculated for each pupil in maths and reading
- Finally, once again through descriptive statistics I got the overall mean score for each school through the mean scores of the pupils.

From this analysis 50 schools were selected as having the highest overall mean scores which were forwarded back to CEM in order to decode and contact schools by forwarding a letter requesting permission to contact Year 5 teachers (Appendix 3). Afterwards, schools that were interested in getting more information about the study gave authorisation to CEM to provide me with contact details so that I could contact each school directly.

This procedure began in March in 2012 while in April CEM started getting responses from schools. My aim was to travel in England in May and gather data from schools that were willing to participate. Being a substitute primary school teacher based in Cyprus, May was the only chance of taking a sabbatical leave for this project. So based in England in May 2012 (Newcastle upon Tyne) I started receiving some responses through CEM from schools requesting more information about the research. This procedure ended in April 2012 and resulted in getting contacts for 14 schools.

After giving telephone calls to all of them, an email was forwarded to Year 5 teachers (Appendix 4) in order to provide them with details about the research procedure and the aim of the research. At this point of the study many difficulties started to rise. On the one hand, schools were spread all over England – from south up to north. On the other hand, some schools were willing to participate but mentioned that they did not use the IWB, or that teachers were very busy at that time, or both.

More precisely, 6 schools mentioned that it was a really busy time (most of them mentioned the school play preparation) and 4 schools politely stated that they were not willing to take part in the study; interestingly 7 of those schools mentioned that they did not use the IWB that much. Also, a reply from another school informed us that they did not have an IWB at all. The remaining 3 schools agreed in participating in the project.

However, the three schools were settled in distinct areas (Bolton, Birmingham and Staffordshire) and having in mind the time constraint, it was impossible to arrange dates and travel to all of them. Under such circumstances it was obvious that the study could not be conducted at that time. Instead, it was decided to pilot the selected methods by visiting the school in Birmingham, since it had two Year 5 classes aiming to conduct the research the following year either in Cyprus or in England; in the middle of the school year rather than the end this time.

Results from piloting Design A

The most important result from conducting six observations in two Year 5 classes was that, lessons mirrored those I had observed in 2007 during my Master as part of my dissertation's thesis. Actually, the conclusions of my dissertation can describe the use of IWB that was observed. "Main findings indicate that the IWB is used rather often during the lessons but mainly as a presentation tool for the teacher. Pupils also worked on the board but they are not engaged interactively with the activities by using the board. They mainly go just for a while on the board to indicate or write the correct answer" (Kyriakou, 2007, p.10). As such it was obvious that possibilities to meet dialogic patterns of talk were at a risk level. Consequently, the aim to provide some teaching tips to develop discussion or dialogue schemes while using the IWB would not have been met. Thus, changing our methodological path was considered as the best choice.

However, it is a possibility that the particular methodological design failed to meet the target of the study. The time chosen to contact schools was rather inappropriate since the end of the year it is always a busy period; teachers struggle to cover remaining material within the curriculum and at the same time many of them prepare a school play. Being myself a primary school teacher these facts did not surprise me. But considering the scope of the study only a limited number of teachers would have been enough, as long as some of them would have applied some patterns of dialogic teaching practices.

Thus, targeting teachers was the most difficult part while including high – performing schools in the sample did not seem to increase the possibilities of finding teachers that use the IWB more effectively or maybe the specific sample chosen for piloting failed to do so, by coincidence.

Either way, effective teachers should be targeted by more rigorous methods. For example, in the study of Askew et al. (2003) "Effective Teachers of Numeracy", sample was initially targeted according to pupils' attainment. But afterwards within this sample they applied methods in order to find effective teachers based on rigorous evidence of increases in pupil attainment across a six month period (systematic observations and tests). They also based their selection on recommendations from the head teachers and local advisory staff. Even though this was a 16-month group study funded by the Teacher Training Agency, some methods applied to identify effective teachers can be useful for similar purposes even for smaller scale studies. However, once again the fact that I was doing my research on a part-time basis and the only choice to travel to England was the end of the year, did not offer me many choices to apply such rigorous methods.

Reasonably, changing methodological path was considered as the best scenario while the whole procedure constituted the inspiration of the next methodology.

Piloting - Design B

These experiences urged me to move on to a second design that would be more realistic, in terms of tackling characteristics of effective IWB use. The aim was to apply several types of activities designed for maths and end up with some special characteristics which had the potential to address an activity effectively, in terms of supporting a dialogic environment of teaching. However, after spending a considerable amount of time through many educational sites it was obvious that the majority of the activities were in the form of "drill and practice" offering direct and quick feedback to pupils. Indeed, Olive (2000) quotes that much of the commercial software available for elementary school maths does not enhance “children’s own construction of mathematics with interaction with other children and their teachers” (p.241).

Thus, having no source to “fish” activities or characteristics to form as the basis to design new activities I had to change methodological path once more. Besides, designing effective and truly interactive activities/software for the IWB constitutes itself a distinctive and huge topic for research, in the fields of education and computer science.

Overall, for all the aforementioned reasons a third and final methodological path was applied, as presented in in the section ‘Methodological Design’(pp. 96-97).

Appendix 2

QUESTIONNAIRE ABOUT THE USE OF **INTERACTIVE WHITEBOARD**

DURING **MATHEMATICS** LESSONS

PLEASE CIRCLE THE ANSWER THAT SUITS YOU BEST IN EACH QUESTION

(INTERACTIVE WHITEBOARD = IW)

Are you: Boy Girl (please circle)

1) In my classroom we share rules about classroom talk:

(a) Yes	(b) No

2) During Mathematics I participate in classroom discussions:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

3) I interrupt to make a question when I don't understand something:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

4) When I give an answer it is tested on the IW in front of the class:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

5) How helpful are for you the following when you try to understand a difficult exercise;

Ask the teacher by raising my hand			
Ask a friend of mine to give me an explanation			
Pay attention to the lesson			
Explain my own thinking to the class			
Participate in the discussion during lesson			
Teacher explains it while using the IW			

6) When teacher uses the IW:

He/ She raises a lot of questions	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
We begin discussion	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
I understand the lesson easier	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
My explanation is tested on the IW in front of the class	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

7) It’s easier to understand something when I look or manipulate a shape on the IW:

☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

8) It’s easier for me to explain my thinking to my classmates if I manipulate images on the IW:

☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

9) I understand Mathematics better when:

a) Teacher explains <u>without the IW</u> and no one interrupts.	b) Teacher explains <u>without the IW</u> while we have the chance to say our opinion.	c) Teacher explains by <u>using the IW</u> and no one interrupts.	d) Teacher explains by <u>using the IW</u> while we have the chance to say our opinion.

10) If you have finished with the above questions, draw something on the IW below that you always enjoy to do or see during Mathematics. You might draw more objects and persons as well.

THANK YOU!!!

Appendix 3

QUESTIONNAIRE ABOUT THE USE OF **INTERACTIVE WHITEBOARD**

DURING **MATHEMATICS** LESSONS

PLEASE CIRCLE THE ANSWER THAT SUITS YOU BEST IN EACH QUESTION

(INTERACTIVE WHITEBOARD = IW)

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1) In my classroom we share rules about classroom talk:

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2) During Mathematics I participate in classroom discussions:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

3) I interrupt to make a question when I don't understand something:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

4) When I give an answer it is tested on the IW in front of the class:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

5) How helpful are for you the following when you try to understand a difficult exercise;

Ask the teacher by raising my hand	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
Ask a friend of mine to give me an explanation	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
Pay attention to the lesson	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
Explain my own thinking to the class	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
Participate in the discussion during lesson	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
Teacher explains it while using the IW	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

6) When teacher uses the IW:

He/ She raises a lot of questions	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
We begin discussion	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
I understand the lesson easier	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺
My explanation is tested on the IW in front of the class	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

7) It's easier to understand something when I look or manipulate a shape on the IW:

☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

8) It's easier for me to explain my thinking to my classmates if I manipulate images on the IW:

☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺ ☺

9) I understand Mathematics better when teacher uses the IW:

(a) Never	(b) Rarely	(c) Quite often	(d) A lot of times

10) If you have finished with the above questions, draw something on the IW below that you always enjoy to do or see during Mathematics. You might draw more objects and persons as well.

THANK YOU!!!

Appendix 4

Durham University

School of Education

March 2012

Dear Mr/ Mrs,

I am Artemis Kyriakou, a PhD student in School of Education at Durham University. I am currently involved in research project looking at effective uses of Interactive Whiteboards (IWBs) and Mr Steve Higgins is my supervisor.

I am writing to ask if it would be possible for me to contact teachers of Year 5 pupils, to invite them to participate in this study. If possible, I would like to sit in lessons and conduct video-taped observations during three distinct mathematics teaching periods. At the end of the third observation I would like to give a brief questionnaire, taking no more than 10 minutes, to the children. Also, any time teacher prefers, I would like to spend 10 minutes and discuss his/her opinion regarding ways of teaching effectively mathematics while using the IWB. My aim is to gather from each teacher some teaching tips they use to be more effective in Mathematics. I am hoping to conduct my research after 16th of April. Being a primary school teacher myself, I appreciate that teachers have limited time. I am able to visit the school at times and dates to suit you.

I would like to stress that data will be strictly confidentially retained. Only my supervisor and I will have access to them and the data will be anonymised. I will be very happy to provide you with a copy of my results. Please do get in touch with me (artemis.kyriakou@durham.ac.uk) for any questions.

I do hope you will be able to help, and look forward to hearing from you.

Yours sincerely,
Artemis Kyriakou

Appendix 5

Dear Mr/ Mrs,

I'm Artemis Kyriakou and I'm a part-time PhD student at Durham University while at the same time I work as a primary school teacher in my home country-Cyprus. My focus is on Mathematics' teaching while using the Interactive Whiteboard in Year 5.

My research project is related to effective teaching and your school is considered to be effective according to my analysis of pupils' attainment and thus teachers of the school considered to be effective as well. My aim is to find some characteristics of effective teaching which can be useful to other teachers and researchers. Even the slightest teaching tips within the daily lessons can be extremely helpful for the purposes of this project!

In order to gather information towards that target I should arrange three visits during Mathematics lessons. My focus is on daily lesson schedules and of course there is no need of special planning lessons. The visits should be arranged to the school as following and could take place in three (or more) subsequent days:

1st visit: -Observation during a Mathematics lesson (audio-recorded)
-Brief questionnaire to the pupils (7-10min)

2nd visit: -Observation during a Mathematics lesson (audio-recorded)

3rd visit: - Observation during a Mathematics lesson (audio-recorded)
-Discussion with the teacher regarding his/ her thoughts (5min)

Having in mind the time pressure at this point of the year, being a teacher myself, I would appreciate it if you accept to participate in this project. Please do contact me for any further details or questions you might have.

Many thanks

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Appendix 6 [TABLE 1] Description of studies included

Record of Studies included	Publication	Date/Location	Subject	Sample	Research Methods	Results
1.Bahadur, G, K & and Oogarah, D. (2013). **"**Interactive whiteboard for primary schools in Mauritius: An effective tool or just another trend? Goonesh Kumar Bahadur, University of Mauritius, Mauritius Deorani Oogarah Primary School, Mauritius". *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 9 (1), 19-35.	Journal publication	Africa (Mauritius)	Science (Solar System)	40 pupils (aged 9-10) -3 classes in 5th grade from 2 schools	An educational resource (ER) was developed and applied using the IWB; each class was divided into two groups; one group was taught via the ER and IWB (experimental) and the other via traditional methods without the IWB (control); Pre- and post-tests; observations	Both groups performed equally well, with and without the IWB. Observations indicated more enthusiasm and attention in the experimental group which didn't lead to any further improvement of scores

2.Campbell T.L. (2010). *The effects of Whiteboards on Student Achievement in Fourth grade Mathematics as measured on the Palmetto Achievement Test (PACT) at selected schools in North Central South Carolina,* EdD Thesis, South Carolina State University.	Thesis	2007-2008, South Carolina USA	Mathematics	356 4th grade students from 4 schools	141 students using IWB Vs 215 not using IWB, comparing SAT* (PACT and MAP)	No significant difference in scores (A significant difference in gender for the interaction of gender and IWB use)
3. Diaz J.L. (2012). *A Study of Education Today: Interactive Classroom Educational Technology Strategies (ICETS).* EdD Thesis, Union Institute & University Cincinnati, Ohio	Thesis	2010-2011, Florida USA	English	40 high-school students from a well-resourced school	18 students experimental group (9-week intervention using IWB and a voting system linked to IWB-Activote) Vs 22 control group (same material without IWB), SAT served as pre- and post-test (ACT)	No significant difference in scores (Females in experimental scored slightly better than males in experimental, though not statistically significant)
4. Higgins, S., Falzon, C., Hall, I., Moseley, D, Smith, H., Wall, K. & Smith, F. (2005). *Embedding*	Report	Autumn 2002-Summer 2004, UK	English, Mathematics and Science	a) Year 6 pupils from 67 IWB schools (about 2800 pupils) and	a) Comparing Key Stage 2 national tests for three consecutive years (2002-2004) between the experimental (IWB) and control	a) The introduction of IWB is associated with some improvement in scores during the 2nd year of use, not

ICT in the literacy and numeracy strategies. Final report, University of Newcastle.				55 non-IWB schools (about 2000 pupils) in 6 LEAs** b) 30 Year 5 and Year 6 teachers from same schools	(non-IWB) group b) 184 structured observations with and without IWB by the same teachers in English and Mathematics, in early 2003 and 2004	maintained the following years. Also, it seems IWB improves performance of low-achievers in English b) IWB impacts effectively the type of classroom interaction, particularly when the use of it becomes embedded
5. Huang, T. H., Liu, Y. C., Yan, W. T. & Chen, Y. C. (2009). Using the innovative cooperative Learning model with the interactive whiteboard to primary school students' mathematical class: Statistic vs pie chart and solid diagram. In L. Cameron & J. Dalziel (Eds), *Proceedings of the 4th International LAMS Conference 2009: Opening Up Learning Design*. (pp.84-94). 3-4th December. 2009, Sydney:	Conference paper	Taiwan	Mathematics (statistic and pie chart and solid diagram)	Two 6th grade classrooms-60 pupils-same school	Experimental group-classroom using IWB Vs Control group-classroom using projector, pre- and post-test	The use of IWB is more effective than the overhead projector

LAMS Foundation.						
6. Hwang, W., Chen, N. & Hsu, R. (2006). "Development and evaluation of multimedia whiteboard system for improving mathematical problem solving". *Computers & Education*, 46 (2), 105-121	Journal publication	China (during one semester)	Mathematics (Fractions/ division problem solving)	Thirty eight 6th grade students - same school	Questionnaires, quantity and quality analysis of students' oral analyses	Female students and high achievers were better in oral communication (critiques, arguments and communication)
7. Kennewell, S. et al. (2007). The Use of ICT to Improve Learning and Attainment through Interactive Teaching: Full Research Report ESRC End of Award Report, RES-139-25-0167-A. Swindon: ESRC	ESRC Report- Funded study	UK	Mathematics, English and Science	41 teachers from 21 primary and secondary schools	Video-taped observations of IWB and non-IWB lessons, interviews with teachers and groups of pupils, pre- and post-tests	No significant difference was found based on testing results, however, qualitative results indicated that a greater proportion of dialogic interactivity was indicated by teachers who weren't using IWB
8. Lopez O. (2010). "The Digital Learning Classroom: Improving English Language Learners'	Journal publication	US (2006-2007)	Mathematics and reading of ELL (English Language	213-3rd and 151- 5th grade students in 3 elementary	Pre- and post- testing through SAT (district's tests and TAKS) and comparisons among: ELL in IWB classrooms (experimental group), ELL in non-IWB	IWBs foster performance parity between ELL and regular students, thus closing the achievement gap by raising the achievement of

academic success in mathematics and reading using interactive whiteboard technology". *Computers & Education, 54 (4), 901-915.*			Learners)	schools	classrooms and regular (non-ELL) students in non-IWB classrooms (control groups)	ELL
9. Martin S.(2007). **"**Interactive whiteboards and talking books: a new approach to teaching children to write?" *Literacy,* 41 (1), 26-34.	Journal publication	UK (6-week period)	Literacy (writing)	A 6th grade class-29 pupils	Using interactive Big Books with graphics and sound, random selection of 10 pupils whose writings formed as pre- and post-tests, scheduled observations, questionnaires about pupils' beliefs about their learning	The use of IWB didn't promote the most effective teaching, higher achieving writers benefited more than lower achieving writers, higher achieving girls participated more often in discussion followed by higher achieving boys
10.Masera R.(2010). *Effects of traditional versus tactual/kinesthetic Interactive-Whiteboard Instruction on Primary Students' vocabulary*	Thesis	USA	Literacy (vocabulary)	87 children (45 in nursery school, 42 in 1st grade)	Children were taught and divided in 3 subgroups, 45 sight words were taught in 3 treatments using 3 different methods (traditional, tactual/kinesthetic and IWB), pre- and post-test of short and long	Significant higher achievement (word-recall) when students were instructed through a tactual/kinesthetic approach compared to traditional and IWB

achievement and attitude-test scores. EdD Thesis, St.John's University, New York.					term	approaches
11.Rains C. (2011). *Effect of Interactive Whiteboard Instruction on 5th Grade Standardized Test Scores in the Area of Mathematics.* EdD Thesis, Walden University USA	Thesis	USA	Mathematics	200 5th grade students in one elementary school	Students were divided in 3 groups: using IWB for 3 years (99 students), for 2 years (87) and for 1 year (14); Comparing SAT between groups (CRCT)	Duration of IWB's instruction did not have a significant effect on scores in the areas of numbers and operations, measurement, data analysis, and total math score. However, the group which had been instructed by IWB for 3 years had significantly higher scores in geometry and algebra
12.Somekh et al.(2007). *Evaluation of the Primary Schools Whiteboard Expansion Project.* Manchester Metropolitan	Research report	UK (2004-2006)	Mathematics, English, Science	• 3,156 pupils in Key Stage 1 • 4,116 pupils in Key stage 2	Multilevel analysis at pupils and class level: Comparison of pupils' scores (in national tests) taught with an IWB versus those taught without an IWB, comparison of scores and duration of instruction	The length of time taught with an IWB is a factor leading to attainment gains. In Mathematics, pupils of average and high attainment made greater progress if more

University.					with an IWB. (Here noted only analyses related to scores)	IWB exposure was present during lessons
13. Swan, K., Schenker, A. & Kratcoski A. (2010). Interactive Whiteboards and Student Achievement. In Thomas, M. & Schmid, E., C. (Eds.), *Interactive whiteboards for education : theory, research and practice.* USA: IGI Global.	Book chapter	USA (2006-2007)	Mathematics, Reading/ language arts	All 3rd to 8th grade students in a small urban area – 3152 in total (11 elementary schools, 3 junior high schools, and 1 alternative school)	Comparing SAT (OAT) between 1466 students enrolled in classes with IWB and 1686 students who did not use it; Qualitative comparisons among teachers' use of IWB and students scores based on teachers' weekly online self-reports	Small achievement increase in the IWB group, statistically significant only in Mathematics. Significant differences in teachers of high performing students in the frequency and the way of IWB use; more frequent student-centered approach.
14. Thompson, J. & Flecknoe, M. (2003). "Raising attainment with an interactive whiteboard in Key Stage 2". *Management in Education*, 17 (3), 29-33.	Journal publication	UK	Mathematics	16 pupils in Year 5 (from a low-status school)	Pupils were taught in Maths while using "Easiteach"-teaching tool with Math resources; Comparison of children's scores in SAT (RM Snapshot) at the end of spring term, autumn term and Year 4	Pupils' scores exceeded the expected progress of the year in just two terms. Attainment gains for all pupils and particularly for lower prior attainment pupils
15. Watt, K. (2009). *A comparison of the effects of*	Thesis	USA	Mathematics (Quadratic	72 Year 8 students in a	Students were taught with 2 instructional methods: a) PLS	Both methods appeared to be equally effective in raising

programmed learning sequenced and Interactive Whiteboard instruction on the Mathematics achievement and attitudes of the eighth-grade students. EdD Thesis, St. John's University NY USA			Functions and Trigonometric Ratios)	Middle School	(Programmed Learning Sequenced-Instructional resource that programs content to suit many learning styles) b) IWB Geometer's Sketchpad and TI Smartview software); All students were taught in both types of instructions; Pre- and post tests	Maths' scores
16. Winkler , R. L. (2011). *Investigating the Impact of Interactive Whiteboard Professional Development on Lesson Planning and Student Achievement.* EdD Thesis, Liberty University USA.	Thesis	USA	Mathematics	18 teachers with 311 elementary students from kindergarten, 1st, 4th and 5th grade at the same school.	Students' achievement and teachers participating in a specially designed training related to IWB's effective use (experimental group) versus students' achievement on SAT with no special teacher training other than the usual (control group); pre- and post testing using SAT; pre- and post (training) observations	Observations indicated significant instructional practices between featured trained and non-featured trained teachers after training with the trained group applying more interactive techniques group; differences in scores according to teachers' training were observed only in kindergarten and 5th grade, in favor of students whose teachers

						participated in training

*SAT: Standardised Achievement Tests (Interpreted below)

** LAEs: Local Educational Authorities

TEST (SAT)	INTERPRETATION
PACT	Palmetto Achievement Challenge Tests in English, Mathematics, Science and Social Studies – once a year raw – raw score for each subtest
MAP	Measures of Academic Progress – minimum two times a year - sub score for each test given
ACT	American College Test – multiple questions on reading comprehension
TAKS	Texas Assessment of Knowledge and Skills
CRCT	Criterion Referenced Competency Test (at the State of Georgia)
OAT	Ohio Achievement Test
RM Snapshot	Software Assessment Package - pupils “log in” and work in a set of test questions

Appendix 7 [TABLE 2] Exclusion criteria

Reasons for exclusion	Studies excluded after 1st scan	AEI (Proquest)	ERIC (Proquest)	BEI (Proquest)	WorldCat (FirstSearch)	ECO (FirstSearch)
Focus on teachers' or pupils' beliefs/views/perceptions or motivational aspect of the IWB	6	1	4	1	---	---
Targeted population not applicable (minority pupils, difficult to teach, ELLs*, etc)	2	---	2	---	--	---
Meta-analysis of other reviews	1	---	1	---	---	---
Unofficial data	4	1	3	---	---	---
Studies funded by IWB selling companies- possibility of biased results in favor of IWB	2	---	2	---	---	---
Focus solely on teachers' experience and training	2	1	---	1	---	---
Publication related to an already added paper	1	---	---	---	---	1
TOTAL	18					

***One study focusing on ELLs was added into the final set of studies as explained in the sub-section "Gathering data through online resources"**

Appendix 8 [TABLE 3] Pupils' scoring

STUDIES	Pre-post testing	Control - experimental group	Other strengths	Other Weaknesses	Conclusions/Statistical details
Martin (2007)	X	X		Sample (10 pupils)	IWB **has no** significant effect on scores
Swan et al. (2010)	X	✓	Sampling (3000 pupils)	Unclear, rather blurred methodology	IWB **has no** significant effect on reading/language (p=0.224) but it **has** a significant effect on Maths (p=0.018)
Thompson & Flecknoe (2003)	✓	X		Additional strategies were applied to boost performance, Sample (16 pupils)	IWB **has** an effect on scores, "scoring exceeded the expected progress for the year in just two terms" p.31
Lopez (2010)	✓	✓	Excellent statistical analysis, structured well-explained methodology, sampling (364 students)	Comparison between ELLs **using the IWB** and regular students **not using the IWB** doesn't seem useful (2nd research question)	For ELLs: IWB **has no** clear effect on Maths and Reading. Statistical tests (t-test, chi-square and effect size) conflict in all cases comparing ELL students using and not using the IWB. (Also, not surprisingly, the disparity in scores between ELL and regular students not using the IWB is statistically proven to be significant)
Diaz (2012)	✓	✓	Nicely done; with a clearly explained methodology. Emphasizing a particular use of IWB.	Sample (40 pupils in total)	IWB **has no** significant effect on scores (p=0.119).

Bahadur & Oogarah (2013)	✓	✓	Nicely done; has a clear methodology. Emphasizing a particular use of IWB.	Sample (40 pupils in total)	IWB **has no** significant effect on scores [T-value (2.262) is greater than the T-calculated values (-0.137. 0.330 and 0.56)]
Masera (2010)	✓	✓	Nicely done; has a clearly explained methodology	_	IWB **has no** significant effect in scores. IWB group scored lower than the other groups ($p<0.001$ for short term word recall, $p<0.01$ for long term word recall)
Kennewell et al. (2007)	✓	✓	ESRC funded large-scale study has a strong methodological body, sampling (41 teachers from 21 schools)	_	IWB **has no** significant effect on pupils' scores. (Statistical details were not available in the particular publication)
Winkler (2011)	✓	✓	Nicely done; has a clearly explained methodology. Sample (18 teachers, 311 students)	_	IWB **has a** significant effect on the trained teachers' group in nursery school ($p=0.001$) and 5^{th} grade ($p<0.0005$)

Appendix 9 [TABLE 4] Length of time of IWB experience

STUDIES	Pre-post testing	Control - experimental group	Other strengths	Other Weaknesses	Conclusions/Statistical details
Rains (2011)	X	X		Sampling groups based on the years of IWB use are unequal. (Using the IWB for: 1 year-99 pupils, 2 years-87 pupils, 3 years-14 pupils). Poor statistical analysis lacking significant levels.	IWB use has a significant effect only on Geometry and Algebra (ANOVA). Thus, there are is no significant evidence to conclude otherwise other than that IWB use **has no** significant effect on scores
Campbell (2010)	✓	✓	Nice and well-explained study	No statistical analysis regarding scoring among all pupils (only among certain groups based on gender, income and ethnicity)	By comparing the improvement from pre to post test mean scores among the two groups of pupils, it is obvious that IWB **has no** significant effect.
Higgins et al. (2005)	✓	✓	Sampling (5000 pupils Year 6 pupils), well-designed, strong methodological body with additional methods applied to enhance validity, excellent statistical analysis	---	IWB is associated with some improvement in scores during 2nd year of use (effect size 0.09) which is not sustained the 3rd year (effect size -0.10). Thus, we can conclude that IWB **has no** significant effect on scores.
Somekh et al.(2007)	✓	X	Sampling (7000 pupils), Detailed statistical analysis	Confusing and difficult to understand methodology: Scoring is presented as point scores equating to expected months of learning. Data presentation	IWB **has** a significant effect on scores. Validity and reliability of the statistical analysis are strongly questioned

	in the beginning does not correspond to the detailed analysis; non-IWB group is not included as presented in the beginning. Each pupil's progress was paradoxically compared to his/her own length of exposure to IWB use. Without a sustained and similar exposure, at least among classes of pupils, findings are controversial and complicated to analyse

Appendix 10 [TABLE 5] Gender

QUANTITATIVE STUDIES	Pre-post testing	Control - experimental group	Other strengths	Other Weaknesses	Conclusions/Statistical details
Campbell (2010)	✓	✓	Coherent and clear-cut methodology	---	There is **no significant difference** related to the use of IWB and its effect on scoring (p=0.48 at 0.0001 level of significance)
Diaz (2012)	✓	✓	Nice and well-explained study	Sampling-small groups Males: 9 using IWB versus 11 not using IWB Females: 9 using IWB versus 11 not using IWB	There is **no significant difference** related to the use of IWB and its effect on scoring (p=0.197 at 0.05 level of significance)
Higgins (2005)	✓	✓	(as previously mentioned)	---	There is **no significant difference** related to the use of IWB and its effect on scoring. This was concluded through multivariate analyses of variance through general linear model procedure in SPSS
QUALITATIVE STUDIES	**Pre-post testing**	**Control - experimental group**	**Other strengths**	**Other Weaknesses**	**Conclusions/Statistical details**
Martin (2007)	X (Behaviour was not observed before the intervention)	X	- Focusing on a particular IWB use – Interactive Big Books with graphics and sound - 12 observation sessions	Small sample - 17 pupils (girls: 2 low and 5 high achievers, boys: 5 low and 5 high achievers)	**Girls participated most frequently** by putting their hand up or by being invited to comment

MIXED METHOD STUDIES	Pre-post testing	Control - experimental group	Other strengths	Other Weaknesses	Conclusions/Statistical details
Hwang et al. (2006)	X	X	- Clear focus: Investigating a web-based multimedia system which includes voice-recording in order to promote mathematical problem solving - Nicely done - Qualitative measures were coded and statistically analysed	---	**Female students** were **better** at **oral communication** in ($p=0.016$ while $p<0.05$). While there was no difference between genders in answering correctly ($p=0.087$) females were better in offering an explanation for their answer.

Appendix 11 [TABLE 6] Pupils' abilities in terms of scoring

STUDIES	Pre-post testing	Control - experimental group	Other strengths	Other Weaknesses	Conclusions/Statistical details
Martin (2007)	[PRESENTED IN TABLE 6]				**High achievers participate more in discussions** during IWB use. Such results cannot be related to IWB use since there was no control group in the scheme
Hwang et al. (2006)	[PRESENTED IN TABLE 6]				**High achievers participate more in discussions** during IWB use. Such results cannot be related to IWB use since there was no control group in the scheme
Higgins et al. (2005)	[PRESENTED IN TABLE 6]				After a full year of IWB use there is a **16% decrease in the proportion of lower-achieving pupils in English in the IWB group** and **11% decrease in the control group** ($p < 0.01$). **In Science the proportion of low-achievers was increased by 24% in the IWB group** while **in the control group was increased only by 2%** ($p < 0.05$).
Masera (2010)	[PRESENTED IN TABLE 8]				For the lower achievers a significant effect for teaching method was found in short-term scores ($p<0.01$) and long-term scores ($p<0.05$) **Lower-achieving pupils did significantly worse when using the IWB** while **higher-achieving pupils had the same scores across all methods**

Appendix 12 [TABLE 7] Comparing IWB with other resources and techniques

STUDIES	Pre-post testing	Traditional method group added in the comparison	Other strengths	Other Weaknesses	Conclusions/Statistical details
Masera (2010)	✓	✓	Structured methodology Enhanced validity: ➢ Two rounds of post-tests: short term and long term ➢ All pupils were taught with three distinct instruction methods	---	Significantly highest short and long-term word recall when students were taught via Tactual/Kinesthetic method compared to Traditional ($p<0.01$short-term, $p<0.5$ long-term at 0.05 level of significance) or compared to IWB ($p<0.001$ for both short and long-term recall at 0.05 level of significance). The **IWB seemed to be the less effective instructional method**
Huang et al. (2004)	✓	X	Nicely done Enhanced validity: ➢ Comparing pre-testing scores between the two groups resulted in no significant difference ($p= 0.752$)	---	There was a **significantly positive difference in IWB group post-testing** which increased its overall scoring by 10 points, while projector group increased its overall scoring by only 2 points ($p=0.003$)
Watt (2009)	✓	X	Enhanced validity: ➢ Comparing pre-testing scores between the two groups resulted in no significant difference ($p= 0.752$) ➢ Groups were taught with both methods under investigation	---	There was **no significant effect related to either method** ($p=0.053$), indicating that both methods (PLS and IWB) were equally effective in raising scores

Appendix 13 [TABLE 8] Classroom Interaction

STUDIES	Pre-post observations	Control - experimental group	Other strengths	Other Weaknesses	Conclusions/Statistical details
Higgins et al. (2005)	✓	✓	Sampling (184 observations/30 teachers) In two phases, two subsequent years. Most teachers were observed four times: once using IWB during Maths, once without it; once using the IWB during literacy, once without it. Fifteen teachers were observed in 2003 and 2004. Any discourse movement was directly coded via a handheld computerized system	---	In the **IWB classes evaluation was twice** the amount of evaluation in the other classes **($p<0.001$) while uptake questions and presentations from pupils were lower ($p<0.001$ and $p<0.05$ respectively)**
Kennewell et al. (2007)	✓	✓	Each observation was recorded by two cameras, one focused on the front of the classroom and one on capturing pupil activity Phase I: data came from both IWB and non-IWB classes (distinct groups of teachers) Phase II: only from IWB	---	**In Phase I "no significant difference" was found between IWB and non-IWB** lessons **but** there was a trend **across the** teachers not using **IWB** to demonstrate a **greater proportion of dialogic teaching.** But the **same teachers appeared to be less effective in Phase II**. **Differences in attainment** across a whole sample were found to be **related to the level of interactivity in teaching**

Swan et al. (2010)	X	X	---	IWB use was compared by using teachers’ own reports through an online system	**Teachers of high-achieving students** were **using the IWB more often** than the others
Winkler (2011)	X	✓	During observations, two forms of data were gathered, observation rubrics and observation checklists. Rubrics (4 to 20 points): a more interactive lesson resulted in higher scoring Checklists: teachers’ schematic, inventive and constructive skills in a form of positive scoring	---	

Appendix 14 [Chi-square Tests for Gender]

[Q1] In my classroom we share rules about classroom talk * Gender

Crosstab

			Gender		Total
			Boy	Girl	
In my classroom we share rules about classroom talk	No	Count	12	19	31
		% within Gender	8.8%	11.5%	10.3%
		% of Total	4.0%	6.3%	10.3%
	Yes	Count	124	146	270
		% within Gender	91.2%	88.5%	89.7%
		% of Total	41.2%	48.5%	89.7%
Total		Count	136	165	301
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.585[a]	1	.444		
Continuity Correction[b]	.330	1	.566		
Likelihood Ratio	.591	1	.442		
Fisher's Exact Test				.568	.284
N of Valid Cases	301				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.01.
b. Computed only for a 2x2 table

[Q2] During Mathematics I participate in classroom discussions * Gender

Crosstab

			Gender		Total
			Boy	Girl	
During Mathematics I participate in classroom discussions	Never	Count	1	2	3
		% within Gender	.7%	1.2%	1.0%
		% of Total	.3%	.7%	1.0%
	Rarely	Count	16	23	39
		% within Gender	11.8%	13.9%	13.0%
		% of Total	5.3%	7.6%	13.0%

	Quite often	Count	56	70	126
		% within Gender	41.2%	42.4%	41.9%
		% of Total	18.6%	23.3%	41.9%
	A lot of times	Count	63	70	133
		% within Gender	46.3%	42.4%	44.2%
		% of Total	20.9%	23.3%	44.2%
Total		Count	136	165	301
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.726[a]	3	.867
Likelihood Ratio	.732	3	.866
N of Valid Cases	301		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.36.

[Q3] I interrupt to make a question when I don't understand something * Gender Crosstab

			Gender		
			Boy	Girl	Total
I interrupt to make a question when I don't understand something	Never	Count	35	34	69
		% within Gender	25.7%	20.6%	22.9%
		% of Total	11.6%	11.3%	22.9%
	Rarely	Count	66	90	156
		% within Gender	48.5%	54.5%	51.8%
		% of Total	21.9%	29.9%	51.8%
	Quite often	Count	30	31	61
		% within Gender	22.1%	18.8%	20.3%
		% of Total	10.0%	10.3%	20.3%
	A lot of times	Count	5	10	15
		% within Gender	3.7%	6.1%	5.0%
		% of Total	1.7%	3.3%	5.0%

Total		Count	136	165	301
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.620[a]	3	.454
Likelihood Ratio	2.639	3	.451
N of Valid Cases	301		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.78.

[Q4] When I give an answer it is tested on the IW in front of the class * Gender

Crosstab

			Gender		Total
			Boy	Girl	
When I give an answer it is tested on the IW in front of the class	Never	Count	25	36	61
		% within Gender	18.4%	21.8%	20.3%
		% of Total	8.3%	12.0%	20.3%
	Rarely	Count	39	44	83
		% within Gender	28.7%	26.7%	27.6%
		% of Total	13.0%	14.6%	27.6%
	Quite often	Count	40	44	84
		% within Gender	29.4%	26.7%	27.9%
		% of Total	13.3%	14.6%	27.9%
	A lot of times	Count	32	41	73
		% within Gender	23.5%	24.8%	24.3%
		% of Total	10.6%	13.6%	24.3%
Total		Count	136	165	301
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.798[a]	3	.850
Likelihood Ratio	.800	3	.849
N of Valid Cases	301		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 27.56.

[Q5] It is helpful to understand a diffucult exercise when I ask the teacher by raising my hand * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It is helpful to understand a diffucult exercise when I ask the teacher by raising my hand	Strongly disagree	Count	12	7	19
		% within Gender	8.8%	4.3%	6.3%
		% of Total	4.0%	2.3%	6.3%
	Disagree	Count	31	39	70
		% within Gender	22.8%	23.8%	23.3%
		% of Total	10.3%	13.0%	23.3%
	Agree	Count	46	58	104
		% within Gender	33.8%	35.4%	34.7%
		% of Total	15.3%	19.3%	34.7%
	Strongly agree	Count	47	60	107
		% within Gender	34.6%	36.6%	35.7%
		% of Total	15.7%	20.0%	35.7%
Total		Count	136	164	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.3%	54.7%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.603[a]	3	.457
Likelihood Ratio	2.602	3	.457
N of Valid Cases	300		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.61.

[Q6] It is helpful to understand a diffucult exercise when I ask a friend of mine to give me an explanation * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It is helpful to understand a diffucult exercise when I ask a friend of mine to give me an explanation	Strongly disagree	Count	49	42	91
		% within Gender	36.0%	25.6%	30.3%
		% of Total	16.3%	14.0%	30.3%
	Disagree	Count	53	75	128
		% within Gender	39.0%	45.7%	42.7%
		% of Total	17.7%	25.0%	42.7%
	Agree	Count	26	32	58
		% within Gender	19.1%	19.5%	19.3%
		% of Total	8.7%	10.7%	19.3%
	Strongly agree	Count	8	15	23
		% within Gender	5.9%	9.1%	7.7%
		% of Total	2.7%	5.0%	7.7%
Total		Count	136	164	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.3%	54.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.497[a]	3	.213
Likelihood Ratio	4.508	3	.212
N of Valid Cases	300		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.43.

[Q7] It is helpful to understand a diffucult exercise when I pay attention to the lesson * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It is helpful to understand a diffucult exercise when I pay attention to the lesson	Strongly disagree	Count	2	1	3
		% within Gender	1.5%	.6%	1.0%
		% of Total	.7%	.3%	1.0%

	Disagree	Count	8	13	21
		% within Gender	5.9%	7.9%	7.0%
		% of Total	2.7%	4.3%	7.0%
	Agree	Count	46	46	92
		% within Gender	34.1%	28.0%	30.8%
		% of Total	15.4%	15.4%	30.8%
	Strongly agree	Count	79	104	183
		% within Gender	58.5%	63.4%	61.2%
		% of Total	26.4%	34.8%	61.2%
Total		Count	135	164	299
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.147[a]	3	.543
Likelihood Ratio	2.151	3	.542
N of Valid Cases	299		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.35.

[Q8] It is helpful to understand a diffucult exercise when I explain my own thinking to the class * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It is helpful to understand a diffucult exercise when I explain my own thinking to the class	Strongly disagree	Count	14	28	42
		% within Gender	10.4%	17.1%	14.0%
		% of Total	4.7%	9.4%	14.0%
	Disagree	Count	27	34	61
		% within Gender	20.0%	20.7%	20.4%
		% of Total	9.0%	11.4%	20.4%
	Agree	Count	46	54	100
		% within Gender	34.1%	32.9%	33.4%
		% of Total	15.4%	18.1%	33.4%

	Strongly agree	Count	48	48	96
		% within Gender	35.6%	29.3%	32.1%
		% of Total	16.1%	16.1%	32.1%
Total		Count	135	164	299
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.329[a]	3	.344
Likelihood Ratio	3.386	3	.336
N of Valid Cases	299		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 18.96.

[Q9] It is helpful to understand a diffucult exercise when I participate in the discussion during lesson * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It is helpful to understand a diffucult exercise when I participate in the discussion during lesson	Strongly disagree	Count	6	12	18
		% within Gender	4.4%	7.3%	6.0%
		% of Total	2.0%	4.0%	6.0%
	Disagree	Count	14	26	40
		% within Gender	10.4%	15.9%	13.4%
		% of Total	4.7%	8.7%	13.4%
	Agree	Count	50	51	101
		% within Gender	37.0%	31.1%	33.8%
		% of Total	16.7%	17.1%	33.8%
	Strongly agree	Count	65	75	140
		% within Gender	48.1%	45.7%	46.8%
		% of Total	21.7%	25.1%	46.8%
Total		Count	135	164	299
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.2%	54.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.545[a]	3	.315
Likelihood Ratio	3.602	3	.308
N of Valid Cases	299		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.13.

[Q10] It is helpful to understand a diffucult exercise when teacher explains it while using the IW * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It is helpful to understand a diffucult exercise when teacher explains it while using the IW	Strongly disagree	Count	14	5	19
		% within Gender	10.4%	3.0%	6.3%
		% of Total	4.7%	1.7%	6.3%
	Disagree	Count	24	25	49
		% within Gender	17.8%	15.2%	16.3%
		% of Total	8.0%	8.3%	16.3%
	Agree	Count	46	41	87
		% within Gender	34.1%	24.8%	29.0%
		% of Total	15.3%	13.7%	29.0%
	Strongly agree	Count	51	94	145
		% within Gender	37.8%	57.0%	48.3%
		% of Total	17.0%	31.3%	48.3%
Total		Count	135	165	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.0%	55.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.467[a]	3	.002
Likelihood Ratio	14.687	3	.002
N of Valid Cases	300		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.55.

[Q11] When teacher uses the IWB he/she raises a lot of questions * Gender

Crosstab

			Gender		Total
			Boy	Girl	
When teacher uses the IWB he/she raises a lot of questions	Strongly disagree	Count	11	27	38
		% within Gender	8.1%	16.6%	12.7%
		% of Total	3.7%	9.0%	12.7%
	Disagree	Count	54	49	103
		% within Gender	39.7%	30.1%	34.4%
		% of Total	18.1%	16.4%	34.4%
	Agree	Count	51	66	117
		% within Gender	37.5%	40.5%	39.1%
		% of Total	17.1%	22.1%	39.1%
	Strongly agree	Count	20	21	41
		% within Gender	14.7%	12.9%	13.7%
		% of Total	6.7%	7.0%	13.7%
Total		Count	136	163	299
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.5%	54.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.542[a]	3	.088
Likelihood Ratio	6.706	3	.082
N of Valid Cases	299		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 17.28.

[Q12] When teacher uses the IWB we begin discussion * Gender

Crosstab

			Gender		Total
			Boy	Girl	
When teacher uses the IWB we begin discussion	Strongly disagree	Count	13	25	38
		% within Gender	9.6%	15.3%	12.7%
		% of Total	4.3%	8.4%	12.7%
	Disagree	Count	32	46	78
		% within Gender	23.5%	28.2%	26.1%
		% of Total	10.7%	15.4%	26.1%
	Agree	Count	54	49	103
		% within Gender	39.7%	30.1%	34.4%
		% of Total	18.1%	16.4%	34.4%
	Strongly agree	Count	37	43	80
		% within Gender	27.2%	26.4%	26.8%
		% of Total	12.4%	14.4%	26.8%
Total		Count	136	163	299
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.5%	54.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.594[a]	3	.204
Likelihood Ratio	4.633	3	.201
N of Valid Cases	299		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 17.28.

[Q13] When teacher uses the IWB I understand the lesson easier * Gender

Crosstab

			Gender		Total
			Boy	Girl	
When teacher uses the IWB I understand the lesson easier	Strongly disagree	Count	4	4	8
		% within Gender	2.9%	2.4%	2.7%
		% of Total	1.3%	1.3%	2.7%

	Disagree	Count	12	21	33
		% within Gender	8.8%	12.8%	11.0%
		% of Total	4.0%	7.0%	11.0%
	Agree	Count	50	56	106
		% within Gender	36.8%	34.1%	35.3%
		% of Total	16.7%	18.7%	35.3%
	Strongly agree	Count	70	83	153
		% within Gender	51.5%	50.6%	51.0%
		% of Total	23.3%	27.7%	51.0%
Total		Count	136	164	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.3%	54.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.297[a]	3	.730
Likelihood Ratio	1.314	3	.726
N of Valid Cases	300		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 3.63.

[Q14] When teacher uses the IWB my explanation is tested on the IWB in front of the class * Gender

Crosstab

			Gender		Total
			Boy	Girl	
When teacher uses the IWB my explanation is tested on the IWB in front of the class	Strongly disagree	Count	18	19	37
		% within Gender	13.2%	11.7%	12.4%
		% of Total	6.0%	6.4%	12.4%
	Disagree	Count	31	25	56
		% within Gender	22.8%	15.3%	18.7%
		% of Total	10.4%	8.4%	18.7%
	Agree	Count	34	46	80
		% within Gender	25.0%	28.2%	26.8%
		% of Total	11.4%	15.4%	26.8%

	Strongly agree	Count	53	73	126
		% within Gender	39.0%	44.8%	42.1%
		% of Total	17.7%	24.4%	42.1%
Total		Count	136	163	299
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.5%	54.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.233[a]	3	.357
Likelihood Ratio	3.225	3	.358
N of Valid Cases	299		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 16.83.

[Q15] It's easier to understand something when I look or manipulate a shape on the IWB * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It's easier to understand something when I look or manipulate a shape on the IWB	Strongly disagree	Count	7	4	11
		% within Gender	5.1%	2.4%	3.7%
		% of Total	2.3%	1.3%	3.7%
	Disagree	Count	19	22	41
		% within Gender	14.0%	13.4%	13.7%
		% of Total	6.3%	7.3%	13.7%
	Agree	Count	57	65	122
		% within Gender	41.9%	39.6%	40.7%
		% of Total	19.0%	21.7%	40.7%
	Strongly agree	Count	53	73	126
		% within Gender	39.0%	44.5%	42.0%
		% of Total	17.7%	24.3%	42.0%
Total		Count	136	164	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.3%	54.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.142[a]	3	.543
Likelihood Ratio	2.144	3	.543
N of Valid Cases	300		

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.99.

[Q16] It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB * Gender

Crosstab

			Gender		Total
			Boy	Girl	
It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB	Strongly disagree	Count	19	16	35
		% within Gender	14.0%	9.8%	11.7%
		% of Total	6.3%	5.3%	11.7%
	Disagree	Count	27	37	64
		% within Gender	19.9%	22.6%	21.3%
		% of Total	9.0%	12.3%	21.3%
	Agree	Count	54	60	114
		% within Gender	39.7%	36.6%	38.0%
		% of Total	18.0%	20.0%	38.0%
	Strongly agree	Count	36	51	87
		% within Gender	26.5%	31.1%	29.0%
		% of Total	12.0%	17.0%	29.0%
Total		Count	136	164	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.3%	54.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.127[a]	3	.547
Likelihood Ratio	2.124	3	.547
N of Valid Cases	300		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.87.

[Q17] I understand Mathematics better when teacher uses the IW * Gender Crosstab

			Gender		Total
			Boy	Girl	
I understand Mathematics better when teacher uses the IW	Never	Count	4	2	6
		% within Gender	2.9%	1.2%	2.0%
		% of Total	1.3%	.7%	2.0%
	Rarely	Count	21	17	38
		% within Gender	15.4%	10.4%	12.7%
		% of Total	7.0%	5.7%	12.7%
	Quite often	Count	59	74	133
		% within Gender	43.4%	45.1%	44.3%
		% of Total	19.7%	24.7%	44.3%
	A lot of times	Count	52	71	123
		% within Gender	38.2%	43.3%	41.0%
		% of Total	17.3%	23.7%	41.0%
Total		Count	136	164	300
		% within Gender	100.0%	100.0%	100.0%
		% of Total	45.3%	54.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.128[a]	3	.372
Likelihood Ratio	3.126	3	.373
N of Valid Cases	300		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.72.

Appendix 15 [Chi-square Tests for Age Group]

[Q1] In my classroom we share rules about classroom talk * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q1] In my classroom we share rules about classroom talk	No	Count	1	23	3	4	31
		% within classnew	2.6%	22.3%	4.9%	4.1%	10.3%
		% of Total	.3%	7.6%	1.0%	1.3%	10.3%
	Yes	Count	38	80	58	94	270
		% within classnew	97.4%	77.7%	95.1%	95.9%	89.7%
		% of Total	12.6%	26.6%	19.3%	31.2%	89.7%
Total		Count	39	103	61	98	301
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.676[a]	3	.000
Likelihood Ratio	23.579	3	.000
Linear-by-Linear Association	5.007	1	.025
N of Valid Cases	301		

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.02.

[Q2] During Mathematics I participate in classroom discussions * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q2] During Mathematics I participate in classroom discussions	Never	Count	0	1	0	2	3
		% within classnew	.0%	1.0%	.0%	2.0%	1.0%
		% of Total	.0%	.3%	.0%	.7%	1.0%
	Rarely	Count	2	19	5	13	39
		% within classnew	5.1%	18.4%	8.2%	13.3%	13.0%
		% of Total	.7%	6.3%	1.7%	4.3%	13.0%
	Quite often	Count	20	43	30	33	126
		% within classnew	51.3%	41.7%	49.2%	33.7%	41.9%
		% of Total	6.6%	14.3%	10.0%	11.0%	41.9%

	A lot of times	Count	17	40	26	50	133
		% within classnew	43.6%	38.8%	42.6%	51.0%	44.2%
		% of Total	5.6%	13.3%	8.6%	16.6%	44.2%
Total		Count	39	103	61	98	301
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.301[a]	9	.197
Likelihood Ratio	13.476	9	.142
Linear-by-Linear Association	.388	1	.534
N of Valid Cases	301		

a. 4 cells (25.0%) have expected count less than 5. The minimum expected count is .39.

[Q3] I interrupt to make a question when I don't understand something * classnew Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q3] I interrupt to make a question when I don't understand something	Never	Count	12	29	7	21	69
		% within classnew	30.8%	28.2%	11.5%	21.4%	22.9%
		% of Total	4.0%	9.6%	2.3%	7.0%	22.9%
	Rarely	Count	18	54	25	59	156
		% within classnew	46.2%	52.4%	41.0%	60.2%	51.8%
		% of Total	6.0%	17.9%	8.3%	19.6%	51.8%
	Quite often	Count	6	17	23	15	61
		% within classnew	15.4%	16.5%	37.7%	15.3%	20.3%
		% of Total	2.0%	5.6%	7.6%	5.0%	20.3%
	A lot of times	Count	3	3	6	3	15
		% within classnew	7.7%	2.9%	9.8%	3.1%	5.0%
		% of Total	1.0%	1.0%	2.0%	1.0%	5.0%
Total		Count	39	103	61	98	301
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.411[a]	9	.003
Likelihood Ratio	23.949	9	.004
Linear-by-Linear Association	.694	1	.405
N of Valid Cases	301		

a. 3 cells (18.8%) have expected count less than 5. The minimum expected count is 1.94.

[Q4] When I give an answer it is tested on the IW in front of the class * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q4] When I give an answer it is tested on the IW in front of the class	Never	Count	4	20	6	31	61
		% within classnew	10.3%	19.4%	9.8%	31.6%	20.3%
		% of Total	1.3%	6.6%	2.0%	10.3%	20.3%
	Rarely	Count	20	16	9	38	83
		% within classnew	51.3%	15.5%	14.8%	38.8%	27.6%
		% of Total	6.6%	5.3%	3.0%	12.6%	27.6%
	Quite often	Count	9	31	24	20	84
		% within classnew	23.1%	30.1%	39.3%	20.4%	27.9%
		% of Total	3.0%	10.3%	8.0%	6.6%	27.9%
	A lot of times	Count	6	36	22	9	73
		% within classnew	15.4%	35.0%	36.1%	9.2%	24.3%
		% of Total	2.0%	12.0%	7.3%	3.0%	24.3%
Total		Count	39	103	61	98	301
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.2%	20.3%	32.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	57.095[a]	9	.000
Likelihood Ratio	58.940	9	.000
Linear-by-Linear Association	10.549	1	.001
N of Valid Cases	301		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.90.

[Q5] It is helpful to understand a diffucult exercise when I ask the teacher by raising my hand * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q5] It is helpful to understand a difficult exercise when I ask the teacher by raising my hand	Strongly disagree	Count	4	5	6	4	19
		% within classnew	10.3%	4.9%	10.0%	4.1%	6.3%
		% of Total	1.3%	1.7%	2.0%	1.3%	6.3%
	Disagree	Count	3	20	16	31	70
		% within classnew	7.7%	19.4%	26.7%	31.6%	23.3%
		% of Total	1.0%	6.7%	5.3%	10.3%	23.3%
	Agree	Count	5	32	22	45	104
		% within classnew	12.8%	31.1%	36.7%	45.9%	34.7%
		% of Total	1.7%	10.7%	7.3%	15.0%	34.7%
	Strongly agree	Count	27	46	16	18	107
		% within classnew	69.2%	44.7%	26.7%	18.4%	35.7%
		% of Total	9.0%	15.3%	5.3%	6.0%	35.7%
Total		Count	39	103	60	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.3%	20.0%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	44.948[a]	9	.000
Likelihood Ratio	46.406	9	.000
Linear-by-Linear Association	16.980	1	.000
N of Valid Cases	300		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 2.47.

[Q6] It is helpful to understand a diffucult exercise when I ask a friend of mine to give me an explanation * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q6] It is helpful to understand a difficult exercise when I ask a	Strongly disagree	Count	19	30	14	28	91
		% within classnew	48.7%	29.1%	23.3%	28.6%	30.3%
		% of Total	6.3%	10.0%	4.7%	9.3%	30.3%

friend of mine to give me an explanation	Disagree	Count	12	46	27	43	128
		% within classnew	30.8%	44.7%	45.0%	43.9%	42.7%
		% of Total	4.0%	15.3%	9.0%	14.3%	42.7%
	Agree	Count	5	19	13	21	58
		% within classnew	12.8%	18.4%	21.7%	21.4%	19.3%
		% of Total	1.7%	6.3%	4.3%	7.0%	19.3%
	Strongly agree	Count	3	8	6	6	23
		% within classnew	7.7%	7.8%	10.0%	6.1%	7.7%
		% of Total	1.0%	2.7%	2.0%	2.0%	7.7%
Total		Count	39	103	60	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.3%	20.0%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.986[a]	9	.439
Likelihood Ratio	8.618	9	.473
Linear-by-Linear Association	1.430	1	.232
N of Valid Cases	300		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 2.99.

b.

[Q7] It is helpful to understand a diffucult exercise when I pay attention to the lesson * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q7] It is helpful to understand a difficult exercise when I pay attention to the lesson	Strongly disagree	Count	0	0	2	1	3
		% within classnew	.0%	.0%	3.3%	1.0%	1.0%
		% of Total	.0%	.0%	.7%	.3%	1.0%
	Disagree	Count	0	5	9	7	21
		% within classnew	.0%	4.9%	15.0%	7.1%	7.0%
		% of Total	.0%	1.7%	3.0%	2.3%	7.0%
	Agree	Count	9	31	17	35	92
		% within classnew	23.1%	30.4%	28.3%	35.7%	30.8%
		% of Total	3.0%	10.4%	5.7%	11.7%	30.8%

	Strongly agree	Count	30	66	32	55	183
		% within classnew	76.9%	64.7%	53.3%	56.1%	61.2%
		% of Total	10.0%	22.1%	10.7%	18.4%	61.2%
Total		Count	39	102	60	98	299
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.941[a]	9	.036
Likelihood Ratio	19.536	9	.021
Linear-by-Linear Association	6.890	1	.009
N of Valid Cases	299		

a. 6 cells (37.5%) have expected count less than 5. The minimum expected count is .39.

[Q8] It is helpful to understand a diffucult exercise when I explain my own thinking to the class * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q8] It is helpful to understand a difficult exercise when I explain my own thinking to the class	Strongly disagree	Count	1	14	12	15	42
		% within classnew	2.6%	13.7%	20.0%	15.3%	14.0%
		% of Total	.3%	4.7%	4.0%	5.0%	14.0%
	Disagree	Count	4	21	14	22	61
		% within classnew	10.3%	20.6%	23.3%	22.4%	20.4%
		% of Total	1.3%	7.0%	4.7%	7.4%	20.4%
	Agree	Count	11	38	17	34	100
		% within classnew	28.2%	37.3%	28.3%	34.7%	33.4%
		% of Total	3.7%	12.7%	5.7%	11.4%	33.4%
	Strongly agree	Count	23	29	17	27	96
		% within classnew	59.0%	28.4%	28.3%	27.6%	32.1%
		% of Total	7.7%	9.7%	5.7%	9.0%	32.1%
Total		Count	39	102	60	98	299
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.091[a]	9	.024
Likelihood Ratio	19.563	9	.021
Linear-by-Linear Association	7.751	1	.005
N of Valid Cases	299		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.48.

[Q9] It is helpful to understand a diffucult exercise when I participate in the discussion during lesson * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q9] It is helpful to understand a difficult exercise when I participate in the discussion during lesson	Strongly disagree	Count	1	10	1	6	18
		% within classnew	2.6%	9.8%	1.7%	6.1%	6.0%
		% of Total	.3%	3.3%	.3%	2.0%	6.0%
	Disagree	Count	2	13	10	15	40
		% within classnew	5.1%	12.7%	16.7%	15.3%	13.4%
		% of Total	.7%	4.3%	3.3%	5.0%	13.4%
	Agree	Count	13	31	21	36	101
		% within classnew	33.3%	30.4%	35.0%	36.7%	33.8%
		% of Total	4.3%	10.4%	7.0%	12.0%	33.8%
	Strongly agree	Count	23	48	28	41	140
		% within classnew	59.0%	47.1%	46.7%	41.8%	46.8%
		% of Total	7.7%	16.1%	9.4%	13.7%	46.8%
Total		Count	39	102	60	98	299
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.243[a]	9	.331
Likelihood Ratio	11.331	9	.254
Linear-by-Linear Association	1.725	1	.189
N of Valid Cases	299		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 2.35.

[Q10] It is helpful to understand a diffucult exercise when teacher explains it while using the IW * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q10] It is helpful to understand a difficult exercise when teacher explains it while using the IW	Strongly disagree	Count	1	9	3	6	19
		% within classnew	2.6%	8.8%	4.9%	6.1%	6.3%
		% of Total	.3%	3.0%	1.0%	2.0%	6.3%
	Disagree	Count	1	12	10	26	49
		% within classnew	2.6%	11.8%	16.4%	26.5%	16.3%
		% of Total	.3%	4.0%	3.3%	8.7%	16.3%
	Agree	Count	5	29	19	34	87
		% within classnew	12.8%	28.4%	31.1%	34.7%	29.0%
		% of Total	1.7%	9.7%	6.3%	11.3%	29.0%
	Strongly agree	Count	32	52	29	32	145
		% within classnew	82.1%	51.0%	47.5%	32.7%	48.3%
		% of Total	10.7%	17.3%	9.7%	10.7%	48.3%
Total		Count	39	102	61	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.182[a]	9	.000
Likelihood Ratio	34.908	9	.000
Linear-by-Linear Association	17.043	1	.000
N of Valid Cases	300		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 2.47.

[Q11] When teacher uses the IWB he/she raises a lot of questions * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q11] When teacher uses the IWB he/she raises a lot of questions	Strongly disagree	Count	1	16	11	10	38
		% within classnew	2.6%	15.7%	18.3%	10.2%	12.7%
		% of Total	.3%	5.4%	3.7%	3.3%	12.7%
	Disagree	Count	5	39	20	39	103
		% within classnew	12.8%	38.2%	33.3%	39.8%	34.4%
		% of Total	1.7%	13.0%	6.7%	13.0%	34.4%

	Agree	Count	21	38	21	37	117
		% within classnew	53.8%	37.3%	35.0%	37.8%	39.1%
		% of Total	7.0%	12.7%	7.0%	12.4%	39.1%
	Strongly agree	Count	12	9	8	12	41
		% within classnew	30.8%	8.8%	13.3%	12.2%	13.7%
		% of Total	4.0%	3.0%	2.7%	4.0%	13.7%
Total		Count	39	102	60	98	299
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.174[a]	9	.003
Likelihood Ratio	26.034	9	.002
Linear-by-Linear Association	4.150	1	.042
N of Valid Cases	299		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 4.96.

[Q12] When teacher uses the IWB we begin discussion * classnew

Crosstab

			classnew				
			Year 3	Year 4	Year 5	Year 6	Total
[q12] When teacher uses the IWB we begin discussion	Strongly disagree	Count	5	17	9	7	38
		% within classnew	12.8%	16.7%	15.0%	7.1%	12.7%
		% of Total	1.7%	5.7%	3.0%	2.3%	12.7%
	Disagree	Count	5	31	9	33	78
		% within classnew	12.8%	30.4%	15.0%	33.7%	26.1%
		% of Total	1.7%	10.4%	3.0%	11.0%	26.1%
	Agree	Count	13	33	20	37	103
		% within classnew	33.3%	32.4%	33.3%	37.8%	34.4%
		% of Total	4.3%	11.0%	6.7%	12.4%	34.4%
	Strongly agree	Count	16	21	22	21	80
		% within classnew	41.0%	20.6%	36.7%	21.4%	26.8%
		% of Total	5.4%	7.0%	7.4%	7.0%	26.8%
Total		Count	39	102	60	98	299
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.377[a]	9	.016
Likelihood Ratio	21.158	9	.012
Linear-by-Linear Association	.056	1	.812
N of Valid Cases	299		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 4.96.

[Q13] When teacher uses the IWB I understand the lesson easier * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q13] When teacher uses the IWB I understand the lesson easier	Strongly disagree	Count	0	0	2	6	8
		% within classnew	.0%	.0%	3.3%	6.1%	2.7%
		% of Total	.0%	.0%	.7%	2.0%	2.7%
	Disagree	Count	0	12	7	14	33
		% within classnew	.0%	11.8%	11.5%	14.3%	11.0%
		% of Total	.0%	4.0%	2.3%	4.7%	11.0%
	Agree	Count	6	39	18	43	106
		% within classnew	15.4%	38.2%	29.5%	43.9%	35.3%
		% of Total	2.0%	13.0%	6.0%	14.3%	35.3%
	Strongly agree	Count	33	51	34	35	153
		% within classnew	84.6%	50.0%	55.7%	35.7%	51.0%
		% of Total	11.0%	17.0%	11.3%	11.7%	51.0%
Total		Count	39	102	61	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	34.219[a]	9	.000
Likelihood Ratio	41.139	9	.000
Linear-by-Linear Association	22.494	1	.000
N of Valid Cases	300		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is 1.04.

[Q14] When teacher uses the IWB my explanation is tested on the IWB in front of the class * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q14] When teacher uses the IWB my explanation is tested on the IWB in front of the class	Strongly disagree	Count	4	11	7	15	37
		% within classnew	10.3%	10.8%	11.7%	15.3%	12.4%
		% of Total	1.3%	3.7%	2.3%	5.0%	12.4%
	Disagree	Count	2	18	5	31	56
		% within classnew	5.1%	17.6%	8.3%	31.6%	18.7%
		% of Total	.7%	6.0%	1.7%	10.4%	18.7%
	Agree	Count	7	30	18	25	80
		% within classnew	17.9%	29.4%	30.0%	25.5%	26.8%
		% of Total	2.3%	10.0%	6.0%	8.4%	26.8%
	Strongly agree	Count	26	43	30	27	126
		% within classnew	66.7%	42.2%	50.0%	27.6%	42.1%
		% of Total	8.7%	14.4%	10.0%	9.0%	42.1%
Total		Count	39	102	60	98	299
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.1%	20.1%	32.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.234[a]	9	.000
Likelihood Ratio	31.122	9	.000
Linear-by-Linear Association	13.306	1	.000
N of Valid Cases	299		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 4.83.

[Q15] It's easier to understand something when I look or manipulate a shape on the IWB * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q15] It's easier to understand something when I look or manipulate a shape on the IWB	Strongly disagree	Count	1	4	1	5	11
		% within classnew	2.6%	3.9%	1.6%	5.1%	3.7%
		% of Total	.3%	1.3%	.3%	1.7%	3.7%
	Disagree	Count	2	8	8	23	41
		% within classnew	5.1%	7.8%	13.1%	23.5%	13.7%
		% of Total	.7%	2.7%	2.7%	7.7%	13.7%

	Agree	Count	8	47	22	45	122
		% within classnew	20.5%	46.1%	36.1%	45.9%	40.7%
		% of Total	2.7%	15.7%	7.3%	15.0%	40.7%
	Strongly agree	Count	28	43	30	25	126
		% within classnew	71.8%	42.2%	49.2%	25.5%	42.0%
		% of Total	9.3%	14.3%	10.0%	8.3%	42.0%
Total		Count	39	102	61	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.847[a]	9	.000
Likelihood Ratio	34.251	9	.000
Linear-by-Linear Association	19.611	1	.000
N of Valid Cases	300		

a. 4 cells (25.0%) have expected count less than 5. The minimum expected count is 1.43.

[Q16] It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB * classnew

Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q16] It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB	Strongly disagree	Count	5	11	5	14	35
		% within classnew	12.8%	10.8%	8.2%	14.3%	11.7%
		% of Total	1.7%	3.7%	1.7%	4.7%	11.7%
	Disagree	Count	6	10	9	39	64
		% within classnew	15.4%	9.8%	14.8%	39.8%	21.3%
		% of Total	2.0%	3.3%	3.0%	13.0%	21.3%
	Agree	Count	12	54	15	33	114
		% within classnew	30.8%	52.9%	24.6%	33.7%	38.0%
		% of Total	4.0%	18.0%	5.0%	11.0%	38.0%
	Strongly agree	Count	16	27	32	12	87
		% within classnew	41.0%	26.5%	52.5%	12.2%	29.0%
		% of Total	5.3%	9.0%	10.7%	4.0%	29.0%
Total		Count	39	102	61	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	58.348[a]	9	.000
Likelihood Ratio	57.003	9	.000
Linear-by-Linear Association	12.481	1	.000
N of Valid Cases	300		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 4.55.

[Q17] I understand Mathematics better when teacher uses the IW * classnew Crosstab

			classnew				Total
			Year 3	Year 4	Year 5	Year 6	
[q17] I understand Mathematics better when teacher uses the IW	Never	Count	1	1	1	3	6
		% within classnew	2.6%	1.0%	1.6%	3.1%	2.0%
		% of Total	.3%	.3%	.3%	1.0%	2.0%
	Rarely	Count	0	8	5	25	38
		% within classnew	.0%	7.8%	8.2%	25.5%	12.7%
		% of Total	.0%	2.7%	1.7%	8.3%	12.7%
	Quite often	Count	11	45	25	52	133
		% within classnew	28.2%	44.1%	41.0%	53.1%	44.3%
		% of Total	3.7%	15.0%	8.3%	17.3%	44.3%
	A lot of times	Count	27	48	30	18	123
		% within classnew	69.2%	47.1%	49.2%	18.4%	41.0%
		% of Total	9.0%	16.0%	10.0%	6.0%	41.0%
Total		Count	39	102	61	98	300
		% within classnew	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.0%	34.0%	20.3%	32.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.583[a]	9	.000
Likelihood Ratio	52.112	9	.000
Linear-by-Linear Association	35.205	1	.000
N of Valid Cases	300		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .78

Appendix 16 [Chi-square Tests for School]

[Q1] In my classroom we share rules about classroom talk * school

Crosstab

			School				Total
			1	2	3	4	
In my classroom we share rules about classroom talk	No	Count	9	13	8	1	31
		% within School	8.5%	15.5%	9.9%	3.3%	10.3%
		% of Total	3.0%	4.3%	2.7%	.3%	10.3%
	Yes	Count	97	71	73	29	270
		% within School	91.5%	84.5%	90.1%	96.7%	89.7%
		% of Total	32.2%	23.6%	24.3%	9.6%	89.7%
Total		Count	106	84	81	30	301
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.2%	27.9%	26.9%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.404[a]	3	.221
Likelihood Ratio	4.641	3	.200
N of Valid Cases	301		

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 3.09.

[Q2] During Mathematics I participate in classroom discussions * school

Crosstab

			School				Total
			1	2	3	4	
During Mathematics I participate in classroom discussions	Never	Count	0	1	2	0	3
		% within School	.0%	1.2%	2.5%	.0%	1.0%
		% of Total	.0%	.3%	.7%	.0%	1.0%
	Rarely	Count	20	10	7	2	39
		% within School	18.9%	11.9%	8.6%	6.7%	13.0%
		% of Total	6.6%	3.3%	2.3%	.7%	13.0%

	Quite often	Count	35	42	35	14	126
		% within School	33.0%	50.0%	43.2%	46.7%	41.9%
		% of Total	11.6%	14.0%	11.6%	4.7%	41.9%
	A lot of times	Count	51	31	37	14	133
		% within School	48.1%	36.9%	45.7%	46.7%	44.2%
		% of Total	16.9%	10.3%	12.3%	4.7%	44.2%
Total		Count	106	84	81	30	301
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.2%	27.9%	26.9%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.130[a]	9	.157
Likelihood Ratio	14.087	9	.119
N of Valid Cases	301		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .30.

[Q3] I interrupt to make a question when I don't understand something *school

Crosstab

			School				Total
			1	2	3	4	
[q3] I interrupt to make a question when I don't understand something	Never	Count	27	23	17	2	69
		% within School	25.5%	27.4%	21.0%	6.7%	22.9%
		% of Total	9.0%	7.6%	5.6%	.7%	22.9%
	Rarely	Count	49	42	50	15	156
		% within School	46.2%	50.0%	61.7%	50.0%	51.8%
		% of Total	16.3%	14.0%	16.6%	5.0%	51.8%
	Quite often	Count	26	13	12	10	61
		% within School	24.5%	15.5%	14.8%	33.3%	20.3%
		% of Total	8.6%	4.3%	4.0%	3.3%	20.3%
	A lot of times	Count	4	6	2	3	15
		% within School	3.8%	7.1%	2.5%	10.0%	5.0%
		% of Total	1.3%	2.0%	.7%	1.0%	5.0%

Total	Count	106	84	81	30	301
	% within School	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	35.2%	27.9%	26.9%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.123[a]	9	.064
Likelihood Ratio	16.923	9	.050
N of Valid Cases	301		

a. 3 cells (18.8%) have expected count less than 5. The minimum expected count is 1.50.

[Q4] When I give an answer it is tested on the IW in front of the class *school
Crosstab

			School				Total
			1	2	3	4	
[q4] When I give an answer it is tested on the IW in front of the class	Never	Count	24	14	18	5	61
		% within School	22.6%	16.7%	22.2%	16.7%	20.3%
		% of Total	8.0%	4.7%	6.0%	1.7%	20.3%
	Rarely	Count	26	27	26	4	83
		% within School	24.5%	32.1%	32.1%	13.3%	27.6%
		% of Total	8.6%	9.0%	8.6%	1.3%	27.6%
	Quite often	Count	25	27	17	15	84
		% within School	23.6%	32.1%	21.0%	50.0%	27.9%
		% of Total	8.3%	9.0%	5.6%	5.0%	27.9%
	A lot of times	Count	31	16	20	6	73
		% within School	29.2%	19.0%	24.7%	20.0%	24.3%
		% of Total	10.3%	5.3%	6.6%	2.0%	24.3%
Total		Count	106	84	81	30	301
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.2%	27.9%	26.9%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.121[a]	9	.088
Likelihood Ratio	14.789	9	.097
N of Valid Cases	301		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.08.

[Q5] It is helpful to understand a diffucult exercise when I ask the teacher by raising my hand *school

Crosstab

			School				Total
			1	2	3	4	
[q5] It is helpful to understand a diffucult exercise when I ask the teacher by raising my hand	Strongly disagree	Count	10	5	2	2	19
		% within School	9.4%	6.0%	2.5%	6.9%	6.3%
		% of Total	3.3%	1.7%	.7%	.7%	6.3%
	Disagree	Count	34	7	23	6	70
		% within School	32.1%	8.3%	28.4%	20.7%	23.3%
		% of Total	11.3%	2.3%	7.7%	2.0%	23.3%
	Agree	Count	31	23	40	10	104
		% within School	29.2%	27.4%	49.4%	34.5%	34.7%
		% of Total	10.3%	7.7%	13.3%	3.3%	34.7%
	Strongly agree	Count	31	49	16	11	107
		% within School	29.2%	58.3%	19.8%	37.9%	35.7%
		% of Total	10.3%	16.3%	5.3%	3.7%	35.7%
Total		Count	106	84	81	29	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.3%	28.0%	27.0%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.465[a]	9	.000
Likelihood Ratio	43.887	9	.000
N of Valid Cases	300		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 1.84.

[Q6] It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation *school

Crosstab

			School				Total
			1	2	3	4	
[q6] It is helpful to understand a difficult exercise when I ask a friend of mine to give me an explanation	Strongly disagree	Count	29	34	21	7	91
		% within School	27.4%	40.5%	25.9%	24.1%	30.3%
		% of Total	9.7%	11.3%	7.0%	2.3%	30.3%
	Disagree	Count	47	34	31	16	128
		% within School	44.3%	40.5%	38.3%	55.2%	42.7%
		% of Total	15.7%	11.3%	10.3%	5.3%	42.7%
	Agree	Count	22	11	22	3	58
		% within School	20.8%	13.1%	27.2%	10.3%	19.3%
		% of Total	7.3%	3.7%	7.3%	1.0%	19.3%
	Strongly agree	Count	8	5	7	3	23
		% within School	7.5%	6.0%	8.6%	10.3%	7.7%
		% of Total	2.7%	1.7%	2.3%	1.0%	7.7%
Total		Count	106	84	81	29	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.3%	28.0%	27.0%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.913[a]	9	.218
Likelihood Ratio	11.801	9	.225
N of Valid Cases	300		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 2.22.

[Q7] It is helpful to understand a difficult exercise when I pay attention to the lesson *school

Crosstab

			School				Total
			1	2	3	4	
[q7] It is helpful to understand a difficult exercise when I pay attention to the lesson	Strongly disagree	Count	3	0	0	0	3
		% within School	2.8%	.0%	.0%	.0%	1.0%
		% of Total	1.0%	.0%	.0%	.0%	1.0%

	Disagree	Count	11	2	7	1	21
		% within School	10.4%	2.4%	8.6%	3.4%	7.0%
		% of Total	3.7%	.7%	2.3%	.3%	7.0%
	Agree	Count	33	20	32	7	92
		% within School	31.1%	24.1%	39.5%	24.1%	30.8%
		% of Total	11.0%	6.7%	10.7%	2.3%	30.8%
	Strongly agree	Count	59	61	42	21	183
		% within School	55.7%	73.5%	51.9%	72.4%	61.2%
		% of Total	19.7%	20.4%	14.0%	7.0%	61.2%
Total		Count	106	83	81	29	299
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.5%	27.8%	27.1%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.469[a]	9	.030
Likelihood Ratio	19.862	9	.019
N of Valid Cases	299		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .29.

[Q8] It is helpful to understand a difficult exercise when I explain my own thinking to the class *school

Crosstab

			School				Total
			1	2	3	4	
[q8] It is helpful to understand a difficult exercise when I explain my own thinking to the class	Strongly disagree	Count	18	5	14	5	42
		% within School	17.0%	6.0%	17.3%	17.2%	14.0%
		% of Total	6.0%	1.7%	4.7%	1.7%	14.0%
	Disagree	Count	27	16	13	5	61
		% within School	25.5%	19.3%	16.0%	17.2%	20.4%
		% of Total	9.0%	5.4%	4.3%	1.7%	20.4%

	Agree	Count	34	29	27	10	100
		% within School	32.1%	34.9%	33.3%	34.5%	33.4%
		% of Total	11.4%	9.7%	9.0%	3.3%	33.4%
	Strongly agree	Count	27	33	27	9	96
		% within School	25.5%	39.8%	33.3%	31.0%	32.1%
		% of Total	9.0%	11.0%	9.0%	3.0%	32.1%
Total		Count	106	83	81	29	299
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.5%	27.8%	27.1%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.689[a]	9	.298
Likelihood Ratio	11.614	9	.236
N of Valid Cases	299		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 4.07.

[Q9] It is helpful to understand a difficult exercise when I participate in the discussion during lesson *school

Crosstab

			School				Total
			1	2	3	4	
[q9] It is helpful to understand a difficult exercise when I participate in the discussion during lesson	Strongly disagree	Count	5	9	4	0	18
		% within School	4.7%	10.8%	4.9%	.0%	6.0%
		% of Total	1.7%	3.0%	1.3%	.0%	6.0%
	Disagree	Count	17	7	14	2	40
		% within School	16.0%	8.4%	17.3%	6.9%	13.4%
		% of Total	5.7%	2.3%	4.7%	.7%	13.4%
	Agree	Count	31	29	33	8	101
		% within School	29.2%	34.9%	40.7%	27.6%	33.8%
		% of Total	10.4%	9.7%	11.0%	2.7%	33.8%
	Strongly agree	Count	53	38	30	19	140
		% within School	50.0%	45.8%	37.0%	65.5%	46.8%
		% of Total	17.7%	12.7%	10.0%	6.4%	46.8%

Total		Count	106	83	81	29	299
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.5%	27.8%	27.1%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.560[a]	9	.077
Likelihood Ratio	16.899	9	.050
N of Valid Cases	299		

a. 4 cells (25.0%) have expected count less than 5. The minimum expected count is 1.75.

[Q10] It is helpful to understand a difficult exercise when teacher explains it while using the IWB *school

Crosstab

			School				Total
			1	2	3	4	
[q10] It is helpful to understand a difficult exercise when teacher explains it while using the IW	Strongly disagree	Count	12	4	2	1	19
		% within School	11.3%	4.8%	2.5%	3.3%	6.3%
		% of Total	4.0%	1.3%	.7%	.3%	6.3%
	Disagree	Count	25	6	13	5	49
		% within School	23.6%	7.2%	16.0%	16.7%	16.3%
		% of Total	8.3%	2.0%	4.3%	1.7%	16.3%
	Agree	Count	34	14	30	9	87
		% within School	32.1%	16.9%	37.0%	30.0%	29.0%
		% of Total	11.3%	4.7%	10.0%	3.0%	29.0%
	Strongly agree	Count	35	59	36	15	145
		% within School	33.0%	71.1%	44.4%	50.0%	48.3%
		% of Total	11.7%	19.7%	12.0%	5.0%	48.3%
Total		Count	106	83	81	30	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.3%	27.7%	27.0%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	35.107[a]	9	.000
Likelihood Ratio	35.828	9	.000
N of Valid Cases	300		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 1.90.

[Q11] When teacher uses the IWB he/she raises a lot of questions * school

Crosstab

			School				Total
			1	2	3	4	
[q11] When teacher uses the IWB he/she raises a lot of questions	Strongly disagree	Count	19	8	7	4	38
		% within School	18.1%	9.5%	8.6%	13.8%	12.7%
		% of Total	6.4%	2.7%	2.3%	1.3%	12.7%
	Disagree	Count	39	22	34	8	103
		% within School	37.1%	26.2%	42.0%	27.6%	34.4%
		% of Total	13.0%	7.4%	11.4%	2.7%	34.4%
	Agree	Count	36	39	29	13	117
		% within School	34.3%	46.4%	35.8%	44.8%	39.1%
		% of Total	12.0%	13.0%	9.7%	4.3%	39.1%
	Strongly agree	Count	11	15	11	4	41
		% within School	10.5%	17.9%	13.6%	13.8%	13.7%
		% of Total	3.7%	5.0%	3.7%	1.3%	13.7%
Total		Count	105	84	81	29	299
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.1%	28.1%	27.1%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.860[a]	9	.221
Likelihood Ratio	11.802	9	.225
N of Valid Cases	299		

a. 2 cells (12.5%) have expected count less than 5. The minimum expected count is 3.69.

[Q12] When teacher uses the IWB we begin discussion * school

Crosstab

			School				Total
			1	2	3	4	
[q12] When teacher uses the IWB we begin discussion	Strongly disagree	Count	8	15	9	6	38
		% within School	7.6%	17.9%	11.1%	20.7%	12.7%
		% of Total	2.7%	5.0%	3.0%	2.0%	12.7%
	Disagree	Count	26	23	25	4	78
		% within School	24.8%	27.4%	30.9%	13.8%	26.1%
		% of Total	8.7%	7.7%	8.4%	1.3%	26.1%
	Agree	Count	33	28	32	10	103
		% within School	31.4%	33.3%	39.5%	34.5%	34.4%
		% of Total	11.0%	9.4%	10.7%	3.3%	34.4%
	Strongly agree	Count	38	18	15	9	80
		% within School	36.2%	21.4%	18.5%	31.0%	26.8%
		% of Total	12.7%	6.0%	5.0%	3.0%	26.8%
Total		Count	105	84	81	29	299
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.1%	28.1%	27.1%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.568[a]	9	.076
Likelihood Ratio	15.756	9	.072
N of Valid Cases	299		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 3.69.

[Q13] When teacher uses the IWB I understand the lesson easier * school

Crosstab

			School				Total
			1	2	3	4	
[q13] When teacher uses the IWB I understand the lesson easier	Strongly disagree	Count	3	0	4	1	8
		% within School	2.9%	.0%	4.9%	3.3%	2.7%
		% of Total	1.0%	.0%	1.3%	.3%	2.7%

			1	2	3	4	Total
	Disagree	Count	7	8	13	5	33
		% within School	6.7%	9.5%	16.0%	16.7%	11.0%
		% of Total	2.3%	2.7%	4.3%	1.7%	11.0%
	Agree	Count	46	22	28	10	106
		% within School	43.8%	26.2%	34.6%	33.3%	35.3%
		% of Total	15.3%	7.3%	9.3%	3.3%	35.3%
	Strongly agree	Count	49	54	36	14	153
		% within School	46.7%	64.3%	44.4%	46.7%	51.0%
		% of Total	16.3%	18.0%	12.0%	4.7%	51.0%
Total		Count	105	84	81	30	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.0%	28.0%	27.0%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.840[a]	9	.051
Likelihood Ratio	18.575	9	.029
N of Valid Cases	300		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .80.

[Q14] When teacher uses the IWB my explanation is tested on the IWB in front of the class *school

Crosstab

			School				Total
			1	2	3	4	
[q14] When teacher uses the IWB my explanation is tested on the IWB in front of the class	Strongly disagree	Count	13	9	9	6	37
		% within School	12.4%	10.7%	11.1%	20.7%	12.4%
		% of Total	4.3%	3.0%	3.0%	2.0%	12.4%
	Disagree	Count	30	10	13	3	56
		% within School	28.6%	11.9%	16.0%	10.3%	18.7%
		% of Total	10.0%	3.3%	4.3%	1.0%	18.7%
	Agree	Count	28	21	23	8	80
		% within School	26.7%	25.0%	28.4%	27.6%	26.8%
		% of Total	9.4%	7.0%	7.7%	2.7%	26.8%

	Strongly agree	Count	34	44	36	12	126
		% within School	32.4%	52.4%	44.4%	41.4%	42.1%
		% of Total	11.4%	14.7%	12.0%	4.0%	42.1%
Total		Count	105	84	81	29	299
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.1%	28.1%	27.1%	9.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.586[a]	9	.076
Likelihood Ratio	15.161	9	.087
N of Valid Cases	299		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 3.59.

[Q15] It's easier to understand something when I look or manipulate a shape on the IWB *school

Crosstab

			School				Total
			1	2	3	4	
[q15] It's easier to understand something when I look or manipulate a shape on the IWB	Strongly disagree	Count	3	3	5	0	11
		% within School	2.9%	3.6%	6.2%	.0%	3.7%
		% of Total	1.0%	1.0%	1.7%	.0%	3.7%
	Disagree	Count	18	7	11	5	41
		% within School	17.1%	8.3%	13.6%	16.7%	13.7%
		% of Total	6.0%	2.3%	3.7%	1.7%	13.7%
	Agree	Count	47	31	31	13	122
		% within School	44.8%	36.9%	38.3%	43.3%	40.7%
		% of Total	15.7%	10.3%	10.3%	4.3%	40.7%
	Strongly agree	Count	37	43	34	12	126
		% within School	35.2%	51.2%	42.0%	40.0%	42.0%
		% of Total	12.3%	14.3%	11.3%	4.0%	42.0%
Total		Count	105	84	81	30	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.0%	28.0%	27.0%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.305[a]	9	.410
Likelihood Ratio	10.338	9	.324
N of Valid Cases	300		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is 1.10.

[Q16] It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB *

Crosstab

			School				Total
			1	2	3	4	
[q16] It's easier for me to explain my thinking to my classmates if I manipulate images on the IWB	Strongly disagree	Count	12	12	9	2	35
		% within School	11.4%	14.3%	11.1%	6.7%	11.7%
		% of Total	4.0%	4.0%	3.0%	.7%	11.7%
	Disagree	Count	22	10	25	7	64
		% within School	21.0%	11.9%	30.9%	23.3%	21.3%
		% of Total	7.3%	3.3%	8.3%	2.3%	21.3%
	Agree	Count	39	35	32	8	114
		% within School	37.1%	41.7%	39.5%	26.7%	38.0%
		% of Total	13.0%	11.7%	10.7%	2.7%	38.0%
	Strongly agree	Count	32	27	15	13	87
		% within School	30.5%	32.1%	18.5%	43.3%	29.0%
		% of Total	10.7%	9.0%	5.0%	4.3%	29.0%
Total		Count	105	84	81	30	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.0%	28.0%	27.0%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.115[a]	9	.088
Likelihood Ratio	15.720	9	.073
N of Valid Cases	300		

a. 1 cells (6.3%) have expected count less than 5. The minimum expected count is 3.50.

[Q17] I understand Mathematics better when teacher uses the IWB * school

Crosstab

			School				Total
			1	2	3	4	
[q17] I understand Mathematics better when teacher uses the IW	Never	Count	1	2	2	1	6
		% within School	1.0%	2.4%	2.5%	3.3%	2.0%
		% of Total	.3%	.7%	.7%	.3%	2.0%
	Rarely	Count	21	3	11	3	38
		% within School	20.0%	3.6%	13.6%	10.0%	12.7%
		% of Total	7.0%	1.0%	3.7%	1.0%	12.7%
	Quite often	Count	44	32	42	15	133
		% within School	41.9%	38.1%	51.9%	50.0%	44.3%
		% of Total	14.7%	10.7%	14.0%	5.0%	44.3%
	A lot of times	Count	39	47	26	11	123
		% within School	37.1%	56.0%	32.1%	36.7%	41.0%
		% of Total	13.0%	15.7%	8.7%	3.7%	41.0%
Total		Count	105	84	81	30	300
		% within School	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	35.0%	28.0%	27.0%	10.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.950[a]	9	.018
Likelihood Ratio	21.220	9	.012
N of Valid Cases	300		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .60.

Appendix 17

INTERACTIVE WHITEBOARDS: Level of use and interaction within the primary classroom, MA Thesis, Lancaster University, 2007

ABSTRACT

This dissertation examines the use of the IWB in the primary school classroom in terms of frequency and type of use in order to raise issues for further investigation and not to generalise. More precisely, the evaluation looked to identify any impact on classroom interaction in terms of pupils' participation and type of talk during IWB's use. In addition, this study's aim was to explore how often the IWB is used during lessons and in which ways it is used.

In order to reach this research's targets, a small-scale questionnaire survey was set out using targeted groups. Five primary classrooms of Year 5 and Year 6 coming from four different schools, participated in the research. For four of them one hour observation was carried out and questionnaires were filled by the teachers; both pupils and teachers filled the questionnaire by the end of each observation. In the fifth classroom, only pupils' questionnaires were filled and returned. In total 141 questionnaires were filled by pupils as the main source of gathering data, while observations and teachers' questionnaire served as additional data.

Main findings indicate that the IWB is used rather often during the lessons but mainly as a presentation tool for the teacher. Pupils also work on the board but they are not engaged interactively with the activities by using the board. They mainly go just for a while on the board to indicate or write the correct answer. However, the vast majority of the pupils supported that their learning is enhanced when the teacher uses the IWB and this is considered to be the most important result. The IWBs have a great potential to support an interactive learning environment which is yet underdeveloped but pupils seem to benefit even at this level of IWB's use.

Appendix 18 – Conferences and Publications Related to this Thesis

1. Kyriakou, A. & Higgins, S. (submitted). Unraveling the use of Interactive Whiteboards in schools by looking at Student Achievement and Classroom Interaction: A Systematic Review, *Review of Education.*

2. Kyriakou, A. (in preparation) Pupils' views on the perceived value of dialogue: discussing connections to the applied teaching methods. *Education 3-13: International Journal of Primary, Elementary and Early Years Education*.

3. Kyriakou, A. (2015) Towards quality classroom interaction: investigating the impact and potential of the IWB, *International Conference Teacher Professionalism & Educational Change: Possibilities for Policy and Practice*, European University Cyprus, September 11-12 2015.

4. Kyriakou, A. (2014) Looking at IWBs Inside Out: A Systematic Review, *Conference of Junior Researchers of EARLI: Learning and Instruction Inside Out*, Nicosia, Cyprus, June 30-July 4 2014.

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