Chapter One
Introduction to the Study

Doing Mathematics in Different Places: an Exploration of Young People's Activities as they make Independent Use of a Web-Based Discussion Board

Libby Jared
PhD Thesis

King's College London
Supervisor Dr Mary Webb

Each chapter has been edited to enable it, as far as is feasible, to 'standalone'.

The chapter numbers and numbering of sub-headings has been left unchanged from the original Thesis.

However, each edited chapter has its own page numbering and any cross-references *within* the chapters and *between* chapters on the NRICH website use these (new) page numbers followed by specifying the page number(s) in the original Thesis chapters.

Where appropriate, references may be given to other chapters (not included on the website) within the full Thesis, either by specifying the Section or providing the Thesis page number(s).

If in a chapter reference is made to any appendices, then the relevant appendix is attached at the end of that chapter.

Each chapter has its own list of references.

[The Thesis title, abstract and acknowledgement pages together with a table of contents for these edited chapters and glossary from the Thesis are also included. The table of contents of the full Thesis appears after Chapter Fifteen].

Dr Libby Jared
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I feel the atmosphere is very good, and it's great to be able
to talk and discuss with other talented mathematicians - an opportunity
which I don't really have at school. [School Student – talking about AskNRICH]

1.0 Preamble

I begin with a declaration … I confess that this research has evolved from my particular mathematical interests over the last 30 plus years, both within and beyond the classroom door. I was a member of SPODE, a small group of teachers and lecturers who published material [Green & Jared 1992; Jared 1992] promulgating an approach to mathematics teaching using real-life problems. I was involved with the local Royal Institution Mathematics Masterclasses [RIMM], a series of Saturday morning workshops given by university mathematicians to challenge and interest the 'brightest' 13-year-old pupils from the county's schools. I also belonged to a small group of people who helped to set up NRICH, established initially as a project and website to make (problem-solving) mathematics interesting/challenging to a wide audience including RIMM attendees seeking further stimulus to continue their mathematical development.

In contrast to being excited about mathematics, the following two deliberating eye-catching paper titles based on in-school studies: ' *"I would rather die": reasons given by 16-year-olds for not continuing their study of mathematics'* [Brown, Brown & Bibby 2008] and *'Is Mathematics T.I.R.E.D?* [**T**edious, **I**solated, **R**ote-Learning, **E**litist, **D**e-Personalised]: *A profile of quiet disaffection in the Secondary Classroom'* [Nardi & Steward 2003] imply that this excitement is distinctly absent in many classrooms. Compare this state of affairs with a quotation taken from an out-of-school experience: *'Now I've got the first one* [a trigonometrical equation solved] *I'm motoring through the exercises. Who would have thought trigonometry could be this much fun.'* [Post on AskNRICH Web-board]. This student had a school-based mathematics problem that they were unable to solve

unaided. With the encouragement of peers[1] the student was led to finding the solution for themselves and obviously appreciated the experience and demonstrated their enthusiasm for the subject. Perhaps put more correctly: my interpretation of this post is that he/she appreciates the experience and conveys an air of enthusiasm apparently missing in other (classroom) environments as the catchy paper titles cited above imply.

So ... What is it about AskNRICH that leads to posts like this? What is going on within AskNRICH? What are the people posting on AskNRICH up to? Well ...

1.1 Introduction

This thesis investigates how young people[2] are engaging with and doing mathematics via the Internet outside of the school environment/location. There are two connected parts to the research; the first provides contextual background for the second. The first, referred to as the Initial Study, used the NRICH website to replicate my earlier evaluative studies of NRICH [Jared 1997, 1998]. This established the current practice of NRICH problems being undertaken in a home context and students' perceptions of doing mathematical problem-solving in school. The second, substantive part is referred to as the Main Study. It explored how young people used AskNRICH, the web-board forum area of NRICH, to pursue serious mathematical study away from the classroom, with like-minded peers from anywhere in the world. Affectionately known throughout this thesis as *The AskNRICHers*, the quality of work they do and how they do it is, I believe, worthy of sharing. 'The AskNRICHers: an everyday story of virtual folk' is a story worth telling.

1.2 Rationale

Bentley's proposition of school education existing beyond the conventional classroom [Bentley 1998] had led to the phrase "a curriculum without walls" coined by Furlong, Furlong, Facer and Sutherland [2000: 108]. Although speculative, this suggested that the

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[1] The word peer is used here to represent like-minded others who are not necessarily of the same age.
[2] The terms young (people), children, pupils or students are used variously throughout this thesis, depending upon the emphasis of a home or school environment. All are referring to that part of the population aged between 11 and 18. AskNRICH is an open site and thus has the potential to be used by people of all ages. The vast majority of users however are those who are of school and [studying at] university age.

Internet would bring about a change in home/school work patterns. Stahl, Koschmann and Suthers [2006: 410] report that Computer-Supported Collaborative Learning [CSCL] arose in the 1990s, as a means to making learning more interactive and social. Whilst CSCL would include both face-to-face and distance e-learning opportunities, they were not premised on a web-based technology. Moreover, when I started out on this research, as far as I am aware, there had been little (if any) research into individuals using a school curriculum subject, either in the way that the AskNRICHers do or simply choosing to do NRICH problems at home (and alone). Indeed, as few innovations had been developed that expanded students' use of the Internet [Schofield 2006: 529], the idea that the home environment potentially has an increased part to play in curriculum study than previously had remained speculative. I believed it would be worthwhile exploring AskNRICH not only because it is an artefact that spans the dual environments of home and school, but also since exploration would yield data relating to the situation of, and practices within a virtual world. It would provide a concrete example of the practices of a group of young people connecting together in the digital age, who clearly enjoy doing mathematics per se in and/or out of school.

1.3 Introducing NRICH and AskNRICH: A Classroom in the Air

NRICH describes itself as a mathematics 'net-workshop' which offers pupils of all ages who enjoy the challenges of mathematics, the opportunity to participate either with friends in a school mathematics club or individually (via school or home). NRICH problems are based on topics that would be met within the English mathematics curricula and is recognised as a valuable Internet resource that teachers can use [Hodgen & Wiliam 2006; Koshy & Casey 1997]. AskNRICH is a virtual world that allows young people (the AskNRICHers) to 'meet' with other interested 'soulmates' and engage in doing mathematics. As the opening quotation to this chapter illustrates, it is a place invoking a 'clubbable' atmosphere in pursuit of an universally based school and university subject pursued from many centuries past to the present day.

The AskNRICH web-board has three main mathematics sections on open access, differentiated by the level of mathematics under discussion. The research in this thesis examines the first two sections aimed at mathematics study at pre-university level.

Participation in AskNRICH is purely voluntary. The level of work that the school-aged AskNRICHers engage with can be beyond that on a 'normal' school mathematics syllabus. Hence the work should be viewed as mathematical studies undertaken whilst individuals are still attending school. This might be work met as part of an ordinary mathematics lesson which they wished to pursue further, either as it had been set as homework or as additional practice. However, it is often work undertaken that offers challenge and is at a level of difficulty far in excess of that normally intended for their chronological age and, as such, is more commonly met post school level. In this respect the work the AskNRICHers engage in takes on the attributes of any 'hobby' such as stamp collecting, train spotting or playing football which are all done for pleasure or for their own sake. Thus AskNRICH is being used primarily at home and although any content posted could in a sense be connected to a fixed syllabus, a specific curriculum or subject course, the content is only there because it is intrinsically important to the poster.

Thus the AskNRICHers exclusively determine the web-board's topic and content. There is no teacher/lecturer direction, mathematical problems only appear when someone has started a thread because they need help with the solution, knowing that there will be other AskNRICHers who 'know the answer'. A member of the NRICH staff acts as moderator, maintaining a watching eye on the exchanges, and incidentally responding to mathematical problems in precisely the same way as other AskNRICHers. The web-board's posting protocols require the person seeking help to share their thoughts and any progress made, although having made none is acceptable. Similarly the person offering help is required not to just give the answer even with working-out. This creates a particular type of discursive talk rooted in 'Inquiry/Socratic Dialogue' [Collins & Stevens 1982].

The properties of AskNRICH just outlined engender its special, in the sense of singular and distinct, nature, summarised in Table 1.1, that makes it unique[3], as far as could be ascertained, amongst Computer Mediated Communication [CMC] forums for an academic subject, reported in the literature. The implications of this for the research on AskNRICH are introduced later [see Section 1.5].

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[3] … at least at the time that AskNRICH was established.

1	contributors can be (and often are) of secondary school age
2	participants belong voluntarily
3	the web-board is primarily used for learning an academic subject, only at home, for 'pleasure' and is thus not institutionally-based or part of any set syllabus, curriculum or subject course
4	topics are only raised if they are of importance to the individual making the initial post
5	there is no teacher/lecturer led element

Table 1.1 The Special Nature of AskNRICH

1.4 Background to the Research

This research was conceived through reflection upon findings of two earlier evaluative studies [Jared 1997, 1998] of the NRICH website. The second evaluation provided a (personal) seminal finding that some children, who were accessing the mathematics problems at home, were only working on them at home. There were young people choosing to do mathematics curriculum work in their free time at home. That is, the earlier studies led to the discovery of 'home-aloners' doing curriculum mathematics as a 'hobby' and to my subsequent proposals of different *"sites of learning"* [Jared 2005: 135] and the concept of a *"pupil learning place"* [Jared 2004: 66]. These two proposals are directly related to Bentley's [1998] proposition mentioned above and might be considered as an example of a "curriculum without walls" [Furlong et al. 2000: 108].

The evaluative studies did not investigate whether mathematics problems had previously been undertaken at home before the arrival of the Internet, but the NRICH website was initiated through the founders' beliefs that establishing such a site would provide greater opportunities for working on mathematics problems outside the school setting [Beardon, Jared & Way 1999]. If the Internet can provide an individual with the choice to continue school and/or subject related work voluntarily, it follows that there is a potential shift in the teaching and learning practices between the dual environments of school and home. Moreover, accompanying such a shift is the opportunity for an individual to have greater control of their education. Put simply, in school a pupil is generally reliant on the teacher to 'dictate' the work to be studied. At home, the Internet with an apparent wealth of educational resources, provides the individual with greater freedom to choose what work they would like to do and when to do it [Henri 1992; Mason & Kaye 1989]. AskNRICH

could clearly provide an appropriate vehicle for exploring a teaching and learning 'community'[4] amongst school-aged students away from the school environment.

The next section presents a brief reasoned discussion of three key areas: CMC forums [CMCs]; various types of community and classroom practices, consideration of whose relationship to AskNRICH had consequences in shaping the Main Study at various stages: before, during and even towards the end of it.

1.5 Framing the Research for the Main Study

At the beginning of the Main Study the medium of AskNRICH dictated a consideration of CMC literature. As will become clear in Section 1.5.2 a lengthy examination of different types of community was undertaken until the middle of the exploratory stage of the study. Section 1.5.3 explains the role of theoretical frameworks of classroom practices in the completion of the study.

1.5.1 CMC Forums

There is a plethora of literature on analysis of CMC forum discussions. Reviews [for example, De Wever, Schellens, Valcke & Van Keer 2006; Rourke, Anderson, Garrison & Archer 2003; Steffans & Underwood 2008] reveal the variety of approaches and frameworks used in analysis of CMCs. However, these forums, almost exclusively critical thinking debates in a formal, higher education setting, have little in common with AskNRICH because they share few, if any, of the properties of AskNRICH set out in Table 1.1 above. Moreover, the activities undertaken within AskNRICH are not the type of collaborative, co-constructed or co-operative problem-solving prevalent in the studies reported in the literature, although examples of this might incidentally occur. It is for this reason that, wherever possible in this thesis the term CMC will be used in preference to CSCL, although the two are used interchangeably in the literature [De Wever et al. 2006].

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[4] At this stage the word community should be considered only in the sense of a group of people sharing experiences and interests and who communicate with each other in pursuing these interests [Mercer 2000: 105].

As a consequence of these differences between AskNRICH and other CMCs, the final decision on how to analyse AskNRICH required considerable investigation.

1.5.2 Types of Communities

When I embarked on the exploration of AskNRICH, I imagined that I would be determining the type of learning *community* that it best fitted. Indeed, over the years, in conversations with teachers and other educators about AskNRICH, I have found that it has been implicitly assumed that AskNRICH forms some kind of community (usually with the words 'of practice' appended) where participants can do (and learn) mathematics. Although NRICH was set up with the words 'online Maths Club' forming part of its title which must therefore have implied to some extent a sense of belonging, as the exploration progressed it became increasingly clear that characterising AskNRICH in terms of a community was inadequate and would not capture its true essence.

Theories about learning communities predate widespread use of the Internet having their roots in physical, for example Lave & Wenger [1991] Communities of Practice, and not virtual locations [Sawyer 2006]. Proponents of e-learning have subsequently appropriated these theories into the virtual world [Bruckman 2006a, 2006b].

Some types of communities such as, for example, knowledge building communities [Scardamalia & Bereiter 2006] and Communities of Inquiry [Garrison & Anderson 2003; Garrison, Anderson, & Archer 2000], are predicated on participants building knowledge together. Both of these types of community rely on a collaboration model in which the initiating problem is generally one set by an 'outsider' for all the group, no-one starts out knowing the answer and participants collaborate to build knowledge in order to find an solution/conclusion. AskNRICHers post a problem with the sole purpose of receiving help in solving it for themselves, knowing that other AskNRICHers will have the solution. Thus knowledge is not being built *together*.

In Communities of Practice [Lave & Wenger 1991] the apprenticeship model involves people working with more knowledgeable peers who at least have a lot more expertise and

might well know the answer. There is the potential within AskNRICH for such "legitimate peripheral participation" [p29]. However, the situation in AskNRICH is not quite this simple, not least in that at the end of an exchange, individuals are 'isolated' by home location and ultimately left alone to make final sense of meanings.

Bruckman [2006b: 465] appropriates Papert's [1980] proposal of a 'technological samba community', derived from a kind of Brazilian Social Club where participants of all ages, all experiences and disparate skills at different levels travel to a specific location annually to 'dance together', for her own e-learning community. Whilst the spontaneity and egalitarianism at least might resonate with AskNRICH, in AskNRICH the performance is more of a continuous, daily, normal occurrence.

Thus the different type of collaboration that goes on within AskNRICH makes matching it to a specific community type problematical. Furthermore, it became increasingly clear that the fluid nature of the 'membership' of AskNRICH undermines the use of any community model. Consequentially other models had to be considered leading to an examination of Gee's Affinity Spaces [Gee 2004, 2005] whose model was subsequently appropriated and developed further.

1.5.3 Classroom Practices

As a consequence of the recent nature of technological innovations that enable AskNRICH to exist, there is little directly relevant historical literature about doing 'school' mathematics in such an environment to draw on. AskNRICH as a 'classroom-in-the-air' should by definition have distinct differences from the bounded school-based classroom. Nevertheless, both have the underlying purpose of learning (and teaching) mathematics and indeed, at the end of the exploration stage of the study, some theoretical frameworks developed within and for the classroom were used to make sense of AskNRICH. In this respect van Lier's [1996] work on Pedagogical Interactions and Conversations-for-Education and the work of others all rooted in a Vygotskian perspective was central. However, this was preceded by an iterative research process in which various theoretical frameworks reported in the research literature were explored in parallel with the ongoing exploration of AskNRICH, as explained in the next section.

1.6 Research Design

In this section I set out my epistemological view and the theoretical perspective that of necessity is shaped by using AskNRICH as the artefact. Although the earlier section entitled 'Framing the Research' discussed key factors that informed the research, this section continues by including further aspects of AskNRICH that impinge on the framework. An outline of the research goals and questions is provided followed by a description of how these goals and questions were addressed. An overall summary of the research framework and design is then portrayed in a diagrammatic form. The section concludes by reporting on the ethical considerations required to conduct the research.

1.6.1 Epistemology and Theoretical Perspective

I came to this study with an epistemological viewpoint that is, according to Crotty's [1998: 5] categorisations, one of constructionism, the view that there is no one universal truth [Robson 2002], a common perspective within the field of human sciences. The purpose throughout was to construct meaning, either from the "state-of-the-actual" [Selwyn 2008: 84] established in the Initial Study or, through the exploration in the Main Study, where making meaning of the results of the actions and activities of the AskNRICHers would be reliant substantially on using written text. Thus the theoretical perspective is within the interpretive paradigm [Brown 2001; Crotty 1998; Denzin 2001; Heywood & Stonach 2006] and as far as the Main Study is concerned, within the field of hermeneutics [Bleicher 1980; Schmidt 2006].

Both the development of an analytical approach and the exploration of AskNRICH proceeded in parallel, although interacting with each other, each traversing a series of multiple, iterative loops combining both inductive and deductive steps [Cohen, Manion & Morrison 2007], with further returns to the literature to seek out theories that could be tested against current findings. The eventual characterisation was established through a further development based on theories put forward by van Lier and Gee [as indicated in Section 1.5 above]. Thus the research process was simultaneously complex, challenging, interesting and rewarding.

Working with AskNRICH as the artefact has further consequences, not yet mentioned, in undertaking the research in the way that I did. In this respect, the following section is a return to the discussion of how using AskNRICH as an artefact influenced further developments of the research programme's rationale.

1.6.2 Working with the AskNRICH Artefact

It was inappropriate to act as an active participant of the web-board since that could influence the outcome of the research. Neither was it appropriate to initiate posts that would seek personal details due to child safety policies and the guarantees of non-contact that AskNRICH gives its participants. It was therefore not possible to undertake an ethnographic study in the truest sense of the word. I was one step removed from the participants. However by logging onto the site daily over several months, it was possible to witness, as a non-participant observer, the day-to-day practices of the participants posting their messages. So although not ethnographic, the research clearly did involve substantially more than simply reading 'printed' texts in a detached manner and the interpretations were made with increasingly developed knowledge of the participants' practices and actions through, and by, their posted messages.

Although the medium brought with it the restrictions just explained, it nevertheless simultaneously brought advantages. AskNRICH provides the conduit for young people to communicate out-of-school, across the globe. Thus the interactivities and activities are unrestricted by both the time imposed on a school timetabled lesson and the confines of a physical classroom. Message exchanges between the AskNRICHers (as with any other virtual CMC) can be made over a longer, contemplative and asynchronous time-frame beyond that available within a normal school lesson where activities are compressed within a time-limited frame. The threads are complete entities: started by a request for help, concluded only when that request for help has been satisfied and, in between, on-going for however long it takes to arrive at that conclusion. In other words there is no school bell ringing to curtail the lesson. Similarly, the medium naturally provides the posters the opportunity (if not indeed a necessity) to write their messages clearly. Such deliberative written exchanges are in marked contrast to transcriptions of verbal exchanges that take place within the bustle of normal daily classroom routine. Thus, as early CMC researchers

such as Henri [1992] and Rennie and Mason [2004] point out, in this respect such research brings a different perspective to that provided by classroom research.

Thus the restrictions actually pave the way to gaining an insight into a way of exploring collaborative work, however that eventually comes to be defined, between like-minded peers in a new situation both in terms of location and people involved. Whilst it is impossible to get 'inside the head' of the participants, it is possible to investigate the teaching and learning roles emerging through the exchanges that run through the message threads.

1.6.3 Overview of the Research Goals

Table 1.2 below details the specific research goals (**RG**) and associated research questions (**RQ**).

Initial Study	
RG1: To investigate pupils' general perceptions of doing mathematics in school and of using NRICH type problems in home/school settings	
Research Questions	**RQ1**: What are the common practices of using NRICH problems in the home context?
	RQ2: What views do students using an on-line mathematics resource (NRICH) have concerning their experience of school mathematics?
Main Study	
RG2: To develop an analytical approach appropriate to the nature of AskNRICH	
Research Questions	**RQ3**: Can existing methods / frameworks for analysing Computer Mediated Communication forums be employed in analysing AskNRICH?
	RQ4: How should the exploration of AskNRICH be organised (planned, structured and executed)?
RG3: To undertake the exploration of the AskNRICH artefact	
Research Questions	**RQ5**: What does AskNRICH offer to participants to enable them to pursue their mathematical practices?
	RQ6: What are participants' common practices when using the AskNRICH web-board?
	RQ7: What results from participants' practices when using the AskNRICH web-board?
Overarching Research Objective: **To characterise the network that constitutes AskNRICH, a virtual world that allows people to meet within it and engage in doing mathematics**	

Table 1.2 Research Goals and Research Questions

The overarching research objective (**RO**) was to establish a characterisation of AskNRICH. Three subsidiary goals had to be pursued in order to achieve this overarching goal. The first of these was to collect data from NRICH users on doing mathematics in school and at home as a preliminary to, and to provide valuable background for, the main body of research. The second goal, to develop an analytical approach appropriate to the nature of AskNRICH was a pre-requisite to allow work towards the third goal, the exploration of the web-board itself, to be undertaken.

The first research goal (**RG1**) originated from the wish to establish whether the findings of my decade-old evaluative studies, referred to above, continued to be correct i.e. some school students are doing mathematics 'in different places'. Thus the Initial Study was designed as a 'follow-up' investigation, culminating in a web-survey, into pupils' general perceptions of doing mathematics in school and using NRICH type problems in home/school environments. In order to address research questions **RQ1** and **RQ2**, findings from the web-survey, along with a small number of face-to-face and email interviews were analysed using a set of widely accepted and commonly used qualitative and quantitative methods. Thus the "state-of-the-actual" [Selwyn 2008: 84] was established and in the process the then seminal finding of the earlier evaluative studies re-established.

On its own the Initial Study, substantially reliant on the web-survey, could not provide the comprehensive dataset necessary for a complete portrayal of working in different locations due to the very limited contact available with the respondents. It was neither ethically possible to make 'stranger contact' nor could pupils be sought out and then contacted via their teacher since, as re-confirmed in the Initial Study, many pupils apparently do not disclose their out-of-school mathematical activity to them. However the content of the AskNRICH web-board where the mathematics being undertaken is clearly visible would reveal how pupils were working on their mathematics in an out-of-school context. Thus the Main Study was designed to be a systematic and in-depth exploration that offered a view of the how, what and why of the AskNRICHers' doing mathematics away from the classroom. Furthermore, the Initial and Main Studies taken together would contribute to the 'different locations' referred to in the thesis title.

The aim of the Main Study was to 'make sense', of the working practices of these young people who, working on their own, at home and alone, communicate, only in a virtual space, in both a teaching and/or learning sense, with like-minded peers. The Study would necessitate working with non-contactable 'unknown', albeit known to exist, 'actors'. The amount of data available was vast constituting some 50,000 messages in 6,000 text-based threads.

Developing an analytical approach to be able to do this exploration became the second research goal (**RG2**). Its associated questions **RQ3**, looking at whether there were existing methods/frameworks for analysing CMCs that could be adopted or adapted for analysing AskNRICH, and **RQ4**, how the exploration should be organised and executed, are, in essence, methodological [see Table 1.2]. Establishing the process with which to explore was crucial to achieving the exploration.

Addressing **RQ3** was dependent upon an extensive literature review [Thesis Chapter Five]. This confirmed the seemingly different nature [see Table 1.1] of AskNRICH and the need for an analytical approach [reported upon at length in Thesis Chapter Six] incorporating some new elements. In order to address **RQ4**, two important aspects of the analytical approach had to be determined: how to manage the subject content in order to uncover the activities and nature of the work, and how to impose order on the vast amount of data available to be processed. This was resolved through an evolutionary, iterative process developed alongside the organisation of the exploration of AskNRICH.

The exploration of AskNRICH addressed the third research goal (**RG3**) through three particular research questions: what AskNRICH offers to participants to enable them to pursue their mathematical practices, **RQ5**; what are the common practices, **RQ6**; and what results from these practices, **RQ7** [see Table 1.2]. The goal was achieved through exploration of AskNRICH from three Perspectives[5]: the first Perspective examined two exemplar threads, the second was a case study that followed the postings of one particular

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[5] The word Perspective is used here in the sense of an orientation of a view of AskNRICH and should not be confused with the use of the word to describe a methodological theoretical standpoint.

AskNRICHer over an eighteen-month period, and the third investigated three different threads that been posted by different AskNRICHers all wishing to solve the same problem.

As previously stated, all three research goals fed into the overarching objective of characterising the virtual world of AskNRICH. All three goals were addressed fully and the overarching objective achieved. Achieving this objective has provided the opportunity to make a contribution to the body of knowledge within both Internet (CMC) related studies and (mathematics) education, as well as the exploration itself making a contribution to the field of educational research processes involving CMCs.

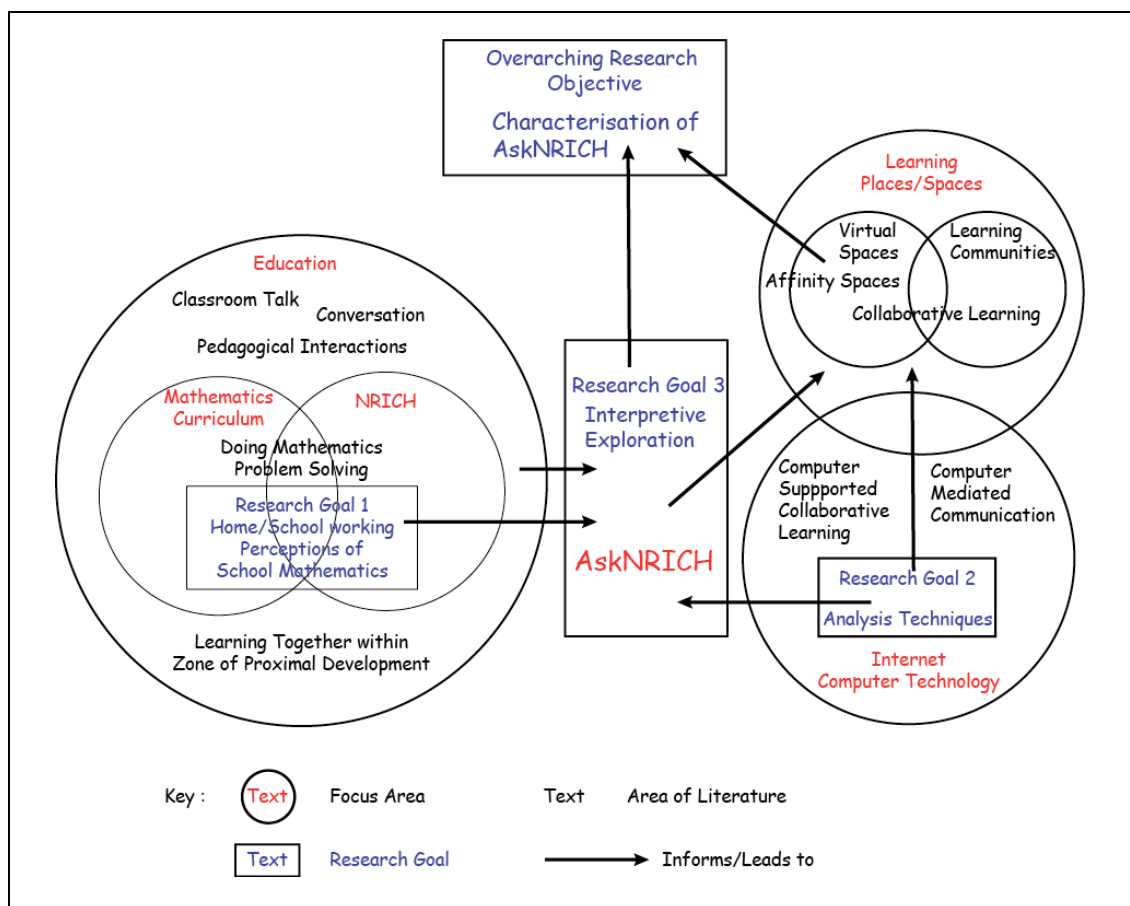### 1.6.4 Framework Summary Diagram

Figure 1.1 Interconnections between Focus Areas, Research Goals and Selected Literature

Figure 1.1 illustrates the framework within which the research was conducted. Firstly it encapsulates the background and framework of the study as presented above; the text within the circles indicates the relevant areas of literature used for the study. Secondly it shows the

interconnections (linked by arrows) between the different research goals (placed within rectangles).

1.6.5 Ethical Considerations

All of the research was carried out following the revised ethical guidelines for educational research issued by the British Educational Research Association [BERA 2004] and whilst holding a valid CRB certificate. However, the great care necessary when electronic communications are involved, requires special mention in the context of this study. Thus the following measures were adopted. No email addresses were sought or obtained directly from respondents to the web-survey. Where email communication was entered into with members of AskNRICH, this was first initiated between the AskNRICH Moderator and the individual and, for those aged under 16, no correspondence was entered into until telephone contact had been made with parents. All face-to-face interviewees gave written agreement before any interview took place. All material taken from the AskNRICH web-board and quoted within this thesis was taken from the openly accessible sections and, as such, is in the public domain. At all stages of the research, the Director and other members of NRICH (and AskNRICH) have been aware of this work and were in full agreement with the measures adopted. Garrison & Anderson [2003: 146-149] provides an account of ethical issues within an e-learning context.

1.7 Outline of Thesis Chapters

This thesis is constructed of four parts, corresponding to each of the Research Goals, with the related supporting literature introduced and reviewed cumulatively through the thesis. The first part starts with a review of literature on the state of school mathematics [Chapter Two] and then describes the mixed methods methodology [Chapter Three] used in the Initial Study, whose findings are set out [Chapter Four]. The second part presents a study, supported by a review of a range of studies on the analysis of CMCs [Chapter Five], of the methodological requirements for the exploration of AskNRICH, and the decisions leading to the derivation of a new analytical approach developed for the exploration [Chapter Six]. The third part describes the Main Study starting with a review of literature on peer interactions [Chapter Seven]. Chapter Eight provides background and contextual information about the

web-board and the AskNRICHers. The three following Chapters [Nine, Ten and Eleven] report the findings of analysis of AskNRICH from each of three Perspectives: a detailed study of two exemplar threads; a case study of all of one AskNRICHer's posts; and an examination of how AskNRICHers' learning together could be considered as emulating the work of professional mathematicians. Chapter Twelve takes stock of the findings from the preceding chapters. In the fourth part, literature on types of collaboration is reviewed and the concept of an Affinity Space is set out [Chapter Thirteen], feeding into the final Characterisation of AskNRICH [Chapter Fourteen]. The thesis' conclusions, claims and limitations are set out in Chapter Fifteen: Conclusions and Reflections.

[The NRICH website holds edited versions of Chapters One (this one), Eight to Twelve, Fourteen and Fifteen].

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