Online Mathematics Enrichment: an evaluation of the NRICH project

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This report was produced under contract for the University of Cambridge, UK as represented by the Millennium Mathematics Project. The views expressed are those of the authors and do not necessarily represent the views of the Millennium Mathematics Project. The research award is recorded as University of Southampton Research Award E20R901.

Published in October 1999
by the Centre for Research in Mathematics Education, School of Education, University of Southampton, Highfield, Southampton SO17 1BJ, UK
http://www.crme.soton.ac.uk

ISBN: 085432 701 0

British Library of Cataloguing in Publication Data
A catalogue record for this report is available from the British Library.

Printed by: University of Southampton Design & Print Centre

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Acknowledgments

The evaluation team would like to record its thanks to the following people for their help and support in the conduct of the evaluation:

- all the members of the NRICH project team for their advice and for technical support on the design, implementation and recording of various components of the data collection

- the pupils, teachers and other education professionals who gave their time to complete questionnaires and participate in interviews, both face-to-face and by e-mail.

While the report has been checked by NRICH personnel for factual accuracy concerning the establishment and conduct of the NRICH project, any omissions or errors of design, implementation or interpretation of the evaluation are the responsibility of the evaluation team as authors of this report.

Data Protection, Confidentiality, and Intellectual Property Rights

Web Page Addressees

All the web page addresses in this report were valid at the time of writing (October 31 1999).

Executive Summary

This Executive Summary forms part of the final report of the findings of the independent external evaluation of the NRICH online mathematics project. The evaluation was commissioned by the University of Cambridge, UK as represented by the Millennium Mathematics Project. The evaluation was carried out by the evaluation team from the University of Southampton, UK, during 1998-99. Data collection took place between April and September 1999. An interim report, based on one element of the evaluation, was presented at the NRICH conference held in July 1999.

1. The NRICH online mathematics enrichment project began in 1996 with the aim of establishing a permanent national UK centre for curriculum enrichment in mathematics. The project aims to provide mathematical learning support for very able children of all ages through the publication of a regular web-based 'magazines' featuring mathematical problems, puzzles, articles and games. University mathematics students act as peer teachers providing an electronic answering service. The centre also offers support, advice and inservice training to teachers, and resources for mathematics clubs. The NRICH website can be found at http://nrich.maths.org.uk/
2. Internal evaluations of the project, carried out in 1997 and 1998, suggested that an increasing number of people were accessing the NRICH project website. The evaluations also indicated that teachers using the NRICH materials were generally satisfied with the type of problems presented, and that pupils who worked on the problems developed a richer view of mathematics.
3. The objectives of the external evaluation were to assess how the use of the NRICH website facilities enhances the mathematical development of children who have the potential to go on to study mathematical subjects at university, how the features of the website are used by teachers to help meet the special educational needs of exceptionally able children in mathematics, and the particular contribution of Information Communications Technology to the above. These objectives were derived from the aims of the NRICH project.
4. The evaluation design incorporated a range of methods to provide data on the evaluation objectives. The various elements of the evaluation were an analysis of the responses to questionnaires completed by pupils, teachers, and other interested parties (such as parents) who access the NRICH website, a critical review of the NRICH website, together with selected case studies of school, classroom and pupil use of the NRICH project facilities.
5. Analysis of questionnaires completed by 199 pupils, 450 teachers, and 67 'friends of NRICH' (such as parents) revealed that most NRICH users lived in England. This was particularly true of teachers. Over two-thirds of the pupils using NRICH were boys. Approximately the same proportion was white. A large proportion of users accessed NRICH at home. The majority of teachers worked in the state sector (both primary and secondary); ten percent were from private schools. The majority of users of all types were relatively new to NRICH, having been accessing the website for six months or less. The most frequent reason for accessing the NRICH website was to use it as a source of interesting mathematical problems. Most users were not

registered with NRICH (a no-fee option open to all). The NRICH site was complimented by all categories of user as providing interesting problems, being attractively presented and generally easy to navigate.

6. The NRICH website was judged by the evaluation team to score highly on each of the website evaluation criteria. The new design of the site, launched in July 1999, was judged to be attractive, functional, easy to navigate, and contain high-quality materials. NRICH compared very favourably with other sites that provide mathematical puzzles, games and problems, and/or an answering service. The NRICH server statistics showed an increase in accesses to the site which was likely to be the result of more people accessing the NRICH site more often.
7. In each of the three case study schools, at least one teacher made regular and often frequent use of the NRICH website, though none made use of the wider NRICH facilities available to registered teachers. NRICH was mainly used a source of interesting mathematical problems. Pupil usage of NRICH in the schools was much more varied. Only a very few pupils were aware of NRICH and had accessed the site themselves. While there was some evidence of impact on more able pupils, none of the teachers were able to quantify this impact but all praised NRICH as a very valuable resource.
8. The three selected case profiles of pupil usage of NRICH revealed that these particular pupils accessed NRICH no more than once a month. All found the ‘one-to-one’ facility, where they could pose questions to University students, helpful and informative. Such exchanges often left the pupils wanting to know more, a situation the pupils viewed as positive. While few of the exchanges were related to the mathematical problems provided on the NRICH site, all these pupils valued the opportunity of being able to ask questions and receive replies.
9. The main impact of NRICH on the more able pupils was in terms of helping them to gain a wider appreciation of mathematics and raising the profile of mathematics as a subject that could be interesting enough to pursue either within or outside school or for further study. Quantifying this impact was beyond the scope of this evaluation. Teachers mostly accessed NRICH to find problems to use in their teaching. The teachers used a variety of approaches to meet the needs of their more able pupils. Some used the NRICH problems with groups of more able children withdrawn from their regular classrooms. Some teachers used NRICH problems as extension material once regular classwork was complete. For some, NRICH was one resource amongst many. Only a few organised an extra-curricular mathematics club based solely around NRICH. The contribution of information communications technology (ICT) to both the enhancement of pupils’ mathematical development and to how teachers made use of the NRICH facilities was associated with the functionality and accessibility of the NRICH site. The interaction that was possible through using ICT was seen as a particular advantage of the NRICH project.

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October 1999

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1. Introduction

This report presents the findings of the independent external evaluation of the NRICH online mathematics project. The evaluation was commissioned by the University of Cambridge, UK as represented by the Millennium Mathematics Project. The evaluation was carried out by the evaluation team from the University of Southampton, UK, during 1998-99. Data collection took place between April and September 1999. An interim report, based on one element of the evaluation, was presented at the NRICH conference held in July 1999.

1.1 *Meeting the Needs of the More Able Learner*

The particular needs of the more able learner across the school curriculum have been an issue of concern for some time and have been recently highlighted in the UK by the appointment by the Department for Education and Employment of a new advisory group on gifted and talented children (DfEE press release 413/98, September 4th 1998), and the publication of the House of Commons Education and Employment Committee report *Highly Able Children* (House of Commons Education and Employment Committee 1999) and an Ofsted-funded research review, *Educating the Very Able*, (Freeman 1998). Most recently, the DfEE initiative 'Excellence in Cities' has included a "gifted and talented children strand" aimed at supporting inner-city schools to make effective provision for their most able children (DfEE 1999). As part of this initiative there is a requirement that every school has a clear policy to ensure that its most able pupils are fully stretched to achieve their potential. Funding is available for mentoring programmes and for 'Gifted And Talented Summer Schools', which are being piloted in 1999. 'World class tests', designed to challenge the most able, initially in mathematics and problem- solving, are also under development by the UK Qualifications and Curriculum Authority.

As Freeman (1998 p44) describes, enrichment "is the deliberate rounding out of the basic curriculum subjects with ideas and knowledge that enable a pupil to be aware of the wider context of a subject area". It is an approach that is consistently advocated for the more able (see, for example, Eyre and Marjoram 1990, Koshy and Casey 1997, Shore 1991). Enrichment has also been recommended in various ways in the teaching and learning of mathematics over a number of years (see, for example, House 1987, Kennard 1996, Sheffield 1999, Straker 1983).

1.2 *Online Mathematics Enrichment*

The central aims of the NRICH online mathematics enrichment project are to "promote an interest in mathematics, to raise the standards of achievement in school mathematics, to assist the mathematical development of children who have the potential to go on to study mathematical subjects at university, and to support the special educational needs of exceptionally able children" (NRICH statement of aims). The principle method of meeting these aims is through the provision of online mathematics 'magazines' enhanced by university students acting as peer-teachers providing an electronic answering service for learners. The web address[1] for the NRICH website is http:\\nrich.maths.org.uk. Work on the project began in 1996 and the project was internally evaluated in 1997 and 1998 (Jared 1997, 1998). The development phase of

[1] or URL, uniform (previously 'universal') resource locator.

the NRICH project ended in August 1999. A second phase began in September 1999, under the umbrella of the newly-established Millennium Mathematics Project[2].

The establishment of an online mathematics enrichment project is a timely development for two reasons. First, there is increasing availability and sophistication of information and communication technology (ICT). In the UK, the use of such technology is being encouraged by central government initiatives such as the National Grid for Learning (DfEE 1997) and the use of the New Opportunities Fund to provide ICT training for teachers and school librarians. Second, there exist a range of concerns regarding, for instance, the overall quality of the teaching and learning of mathematics, the specification of the mathematics curriculum, the uptake of mathematics post-16, and provision for the more able pupil in mathematics (see, for example, London Mathematical Society *et al* 1995). Many of these concerns are not limited to the UK, but, following the results of the Third International Mathematics and Science Study, are present in many other countries (see, for example, Schmidt *et al* 1999).

The NRICH online mathematics project is an attempt to harness the 'information highway' both through the publication of web-based magazines published monthly and the provision of e-mail discussion facilities and a pupil answering service. More details of the project, including its mission statement and its aims and objectives are provided in Appendix A of this report. The previous internal evaluations (Jared 1997, 1998) have provided valuable information on the progress in establishing the project. The 1998 evaluation showed that 'hits' on the NRICH website reached around 24000 a month from February 1998 onwards (although website statistics in the form of 'hits' need to be treated with caution as they do not say anything about user impact). Another indication of the impact so far of the NRICH project is that, by May 1998, 408 teachers and 251 pupils had registered with NRICH, a no-fee option giving them access to the NRICH e-mail facilities. A questionnaire, available on the NRICH website during May and June 1998, was completed by 48 teachers and this indicated satisfaction with the appropriateness of the mathematics problems that appear in the monthly magazine. Data from a similar questionnaire completed by 68 pupils suggested that NRICH was being successful in enhancing the pupil view of mathematics by showing that mathematics can be fun and that mathematical problems can be approached in a variety of ways.

These earlier internal evaluations indicated that the NRICH project might profitably consider how best to convey the NRICH objectives to its intended audience, and give further thought to the presentation of some of the mathematical problems and solutions and the promotion and management of the e-mail mailing lists.

2. Aims and Objectives of the 1998-99 External Evaluation

The aim of the independent external evaluation undertaken during 1998-9 was to examine what the NRICH project had achieved to date in order to inform the future development of the project. In particular, the intention was to audit the success of the project in meeting some of its stated aims. The evaluation also sought to document any unanticipated outcomes of the project. The aims of the NRICH project are reproduced in appendix A of this report.

[2] For details of the Millennium Mathematics Project see http://mmp.maths.org/

The evaluation focused on the success of the NRICH online mathematics project in the following areas (all taken from the aims and objectives of the NRICH project):

- assisting the mathematical development of children who have the potential to go on to study mathematical subjects at university,
- supporting the special educational needs of exceptionally able children,
- developing the use of Information Communications Technology to provide interactive links to the NRICH Centre and to facilitate links between schools and between individual children.

Correspondingly, the objectives of the evaluation of the NRICH project were to assess:

1. how the use of the NRICH website enhances the mathematical development of children who have the potential to go on to study mathematical subjects at university
2. how the features of the website are used by teachers to help meet the special educational needs of exceptionally able children in mathematics
3. the particular contribution of Information Communications Technology to the above

Given the inter-related form of objectives, the evaluation was planned as a number of complementary elements, outlined in the following section.

3. Evaluation Design and Methodology

3.1 *Research on Teacher and Pupil Usage of ICT*

The design of the evaluation was informed by previous research on teacher and pupil usage of ICT. Data from surveys on the use of information and communication technology (ICT) in schools show that, despite continuing investment in resources, the percentage of headteachers reporting that ICT is making a significant contribution to teaching in their institutions has fallen in the period 1988-98 (Lynch 1999). In secondary schools it is down from a peak of 40% in 1990 to nearer 20% in 1998. In primary schools it is down from a peak of about 30% in 1992 to nearer 15% in 1998. One reason suggested for this is that, through rapid technological development, a significant proportion of teachers indicate that they feel they lack the appropriate capability in their ICT use. For example a recent Technology Colleges Trust survey found in 1997 that “fewer that one-fifth of teachers had sufficient confidence and competence in the use of generic IT applications to enable them to apply applications or to develop IT capability in pupils” (quoted in Lynch 1999).

Another reason may relate to teachers’ access to appropriate levels of resource. For example, in terms of access to the internet, Jervis and Steeg (1998) found that while 83% of secondary schools had some form of internet access, most had a connection for one or two stand-alone computers, often in ‘staff-only’ areas. The most frequent reason for limiting pupil access was logistic: a lack of machines with internet access. While the recent DfEE survey also showed that 83% of secondary schools have internet access, for primary schools the comparative figure is 17% (DfEE 1998). On the other hand there is evidence that access is rapidly developing. According to the British Educational Communications Technology Agency (BECTa), in a period of two years, secondary school access has doubled and primary school access has grown six fold, while the National Grid for Learning website is getting over a million ‘hits’ per week

(Lynch 1999). By October 1999, the Times Educational Supplement was reporting that 93% of secondary schools were connected to the internet, with the corresponding figure in primary schools being 62% (TES, 15 October 1999).

Despite these headline figures, a further reason for the lack of impact of ICT to date may relate to the type of equipment generally available in schools. For example, the recent Research Machines survey found that although Britain leads the world in the provision of ICT in schools, being the only G7 nation where all schools have a least one computer and with the highest percentage of secondary schools with one or more multimedia machines, almost 40 per cent of British school computers are at least 5 years old (Research Machines 1999). Such machines are unlikely to have internet capability. Thus, while an increasing number of schools are becoming connected to the 'information highway', for individual teachers there may still be considerable practical barriers to their effective use of internet-based resources.

3.2 *Design Rationale*

Given that teacher competency, levels of resources, and internet access are likely to improve over the short to medium term (the first through the UK 'New Opportunities Fund' provided ICT training for teachers, the latter two through UK government-supported resource and infrastructure provision), the external evaluation of the NRICH project focused on the *regular* users of the NRICH site, ones for whom competency and access were not likely to be major issues. Regular users were also judged to be likely to be registered with NRICH and thereby users of the wider NRICH facilities (such as the e-mail bulletin boards and the answering service). A wider focus for the evaluation would have spread the evaluation resource too thinly and, in so doing, have revealed only what is already known, that competency and access are the major limiting factors. Focusing on regular users allowed for richer data to be gathered on their usage which should be of more use in informing future development of the NRICH project. At the same time, analysis of regular users allowed some informed inferences to be made about who is *not* accessing the site, which is also likely to be of use in informing the further development of the project.

Taking into account the evaluation objectives, and the requirements of validity and reliability, the design of the evaluation needed to encompass a range of methods. Where appropriate, the research techniques exploited the functionality of the internet as, by definition, regular NRICH users are internet users. For example, the world wide web is increasingly being used for survey research. Bertot and McClure (1996) point to both the advantages and disadvantages of web-based questionnaires while the research of Buchanan and Smith (1999) suggests the possible superiority of web-generated data. Schmidt (1997) outlines the steps that can be taken to minimise any potential problems with generating data in this way. Similar issues arise in using electronic mail for interviewing (Roselle and Neufeld 1998).

In planning the overall design of the evaluation, due attention was paid to ethical considerations. A conscious decision was made to avoid using any personal information on individuals that those individuals, purposefully or not, had provided to NRICH through registering with NRICH or communicating electronically with the NRICH website. The precise design of the evaluation, and more detail on the validation of the

research and on the ethical considerations which informed the design, implementation and reporting of the research, are covered in detail in the following sections.

3.3 *Evaluation Design*

The evaluation design incorporated a range of methods to provide data on the evaluation objectives. The four elements of the evaluation were website impact, website evaluation, short case studies, and case profiles. Each of these elements is described and justified below.

3.3.1 **Element 1: website impact**

In order to gauge the usage of NRICH, the major component of the evaluation was a set of three questionnaires mounted on the NRICH site to coincide with the publication of a new edition of the online magazine. Three versions of the questionnaire were developed, one for school pupils or students to complete, one for school or college teachers, and one for others who accessed the NRICH site (parents, local authority advisors, higher education staff, etc). The questionnaires were mounted on the NRICH website during May 1999 (from 1 May 1999 to 6 June 1999).

There is much to recommend web-based questionnaires, particularly when the target population is well-defined (Schmidt 1997), as NRICH users are. Amongst the benefits are access to a large sample of individuals, depending on how the questionnaire is administered. For this research project, and with the assistance of the NRICH technical team, the NRICH website was arranged so that anyone accessing the NRICH site at any point during the designated period would be presented with the questionnaire at the time of access in the form of a ‘pop-up window’. The intention of this admittedly intrusive technique was to maximise the number of completed questionnaires and hence generate a more representative set of data. NRICH users were forewarned by a notice mounted on the website during the previous month and asked for their cooperation.

A second benefit of web-based questionnaires is that data from the questionnaires is logged as the questionnaires are completed thus removing any problems associated with data entry (for instance, transcription errors). A third benefit, according to the research of Buchanan and Smith (1999), is obtaining increased levels of honesty and self-revelation through using computer-based questionnaires. Despite these advantages there are well-documented potential problems (Buchanan and Smith 1999, Schmidt 1997). These include incomplete responses, unacceptable or frivolous responses, and multiple submissions from the same respondent.

Such potential problems mean that close attention was paid to the data set generated by the questionnaires. It was anticipated that the use of the ‘pop-up window’, which appeared *whenever someone accessed the NRICH website*, was likely to increase the number of incomplete responses. The use of a ‘cookie’, a small data file sent by the NRICH server to any computer which accesses the NRICH site, was considered. This would allow the NRICH server to distinguish between computers that had accessed the NRICH site, and hence been presented with the ‘pop-up’ questionnaire, and those that had not. The ‘cookie’ could be set so that only the first access through a particular computer would get the ‘pop-up’ questionnaire. The advantage of such a mechanism is that the ‘pop-up’ questionnaire does not appear *every time* the NRICH site is accessed by a user using a given computer. However, the use of a ‘cookie’ in this way only

distinguishes between computers and not between users. It would mean that only the first user gets the questionnaire; other users of the same computer would not. As it was likely that school use of NRICH entailed several users using the same computer at various times, and because, for the home user and for some schools, many 'internet service providers' route their web traffic through a 'webcache' or 'proxy' servers[3], which would appear to the NRICH server as just one 'user', the use of a 'cookie' would likely severely intrude on the number of users who were presented with the questionnaire. In addition, it is known that many users set their web browser to reject the downloading of cookies (through some concern about the intrusive nature of cookies, plus possible security and virus issues) (Stout 1997, p84-86). Since NRICH has not, this far, made much use of 'cookies, such a use for the questionnaires may have deterred some users from using the NRICH website again because these users had concerns about the use of 'cookies'. This was not an acceptable outcome. The decision of the evaluation team was to reject the use of a 'cookie' and accept a potentially high number of incomplete responses as regular users, who were repeatedly presented with the questionnaire, or internet browsers who just happened on the site, clicked on 'questionnaire complete' as a way of getting rid of the 'pop-up window'.

The questionnaires were constructed to provide data on the usage and impact of NRICH. Standard techniques were adopted to develop and test the questionnaires (Oppenheim 1992, Dillman 1999), with piloting of both paper versions and electronic versions in advance of formally mounting them on the NRICH website. As a result of the piloting, some modification was made to the form and length of the questionnaires. In particular, questions relating to the socio-economic class of the pupils were omitted to shorten the pupil questionnaire. Similarly, some questions were compacted together to reduce the number of different sorts of questions even though this could affect the clarity of a few of the individual questions. NRICH users were advised some time in advance as to the purpose of the questionnaires and how they would appear on the NRICH site. Confidentiality of the response data was guaranteed. Through these methods the ethical issues associated with such data collection techniques were addressed.

The questionnaires covered type of access, form of usage of NRICH material, and evaluative comment on the material. The questionnaires also sought information on the type of school and household (or other location) where NRICH material was accessed. Respondents could also provide their NRICH ID (if known), as a way of ascertaining what proportion of the registered users completed the questionnaire, and offer to be contacted again by e-mail to provide follow-up information. Again, respondents were assured of the confidentiality of this data. The results of the analysis of the questionnaires are presented in section 4 of this report. The questionnaires are provided in Appendix B.

3.3.2 **Element 2: website evaluation**

With internet-based resources developing apace, there now exist a range of websites that provide mathematics problems, solutions, and assistance. Thus an important

[3] a technique involving holding a copy of recently accessed data, in a way designed to speed up subsequent access to the same data by anyone routed through that server.

element of the design focused on comparing the NRICH provision with other internet-based mathematics problem-solving sites. A range of website evaluation procedures are available and suitable criteria were adapted from those described by Branch *et al* (1999), Coe and Land (1998), Shneiderman (1997), and by Testa (1998). In addition, this part of the evaluation included an analysis of the frequency and nature of the accesses to the NRICH website, accompanied by trends over time, using techniques described by Bertot *et al* (1997), Buchanan and Lukaszewski (1997) and Stout (1997).

The world wide web has been variously described as a 'junkyard' or 'like a library where everything has been thrown on the floor'. In the absence of universally recognised web standards, evaluative criteria for Web sites have been developed and these generally include the following factors:

- Authority
- Accuracy
- Currency
- Navigation and Design
- Applicability and Content
- Scope
- Audience Level
- Quality of Writing

Associated with each of these factors is a list of questions that serve to focus the evaluative judgement. The full evaluative criteria are given in Appendix C. The results of applying these criteria to the NRICH site are presented in section 5.

An analysis of the frequency and nature of the accesses to the NRICH website, accompanied by trends over time, is possible because Web servers, in general, provide a log (or logs) in which site accesses and events are stored. The format of these records can vary, depending on the server, but generally include:

- date and time records, making it possible to determine the most common access times and days
- visitor domains, indicating where visitors are accessing the site from
- the files accessed or downloaded
- errors and alerts, providing a measure of site reliability

It has to be stressed, however, that such log files are far from straightforward to interpret in their raw form (Bertot *et al* 1997, Buchanan and Lukaszewski 1997, Stout 1997). It is particularly important, for example, to try to distinguish between 'hits' (downloads of single item files from an HTML page - of which there can be many[4]) and 'accesses' (downloads of complete web pages). As a consequence of this, and because many internet providers route their internet traffic through 'proxy' servers[5], the logs from any particular website do not easily or accurately trace the number of users, but rather they reflect the number of accesses by the referring server. More importantly, however, such logs do not say anything about what was done with the information obtained from the website by the person accessing the site. Indeed, the person may have hardly glanced at the content, never mind made any use of it. Data from the log files of the NRICH server are presented and interpreted in section 5 of this report.

[4] each image on a page can count an a separate file, for example.

[5] a technique involving holding a copy of recently accessed data, in a way designed to speed up subsequent access to the same data by anyone routed through that server.

3.3.3 **Element 3: short case studies**

The intention of this element of the evaluation was to provide evidence of the impact of NRICH on the quality of teaching and learning in the classroom and to ascertain how schools supported the more able pupil in mathematics. This was achieved primarily through interviewing a small, random sample of teachers and pupils in schools and observing classes at work. The focus was on teachers in England who made up over 75% of respondents to the questionnaire (see Section 4.2). As a first step, a stratified list of teachers, who had been accessing NRICH for six months or more, was prepared from those who, when completing the teacher questionnaire, had offered to provide further information (a total of 63 teachers from England out of the 343 who had completed the questionnaire). Only 14 of these teachers said that they were registered with NRICH, a no-fee option giving them access to the NRICH e-mail facilities. The stratification employed was primary, secondary, and private school. Details of the numbers of teachers contacted and the results of this contact are given in Table 1.

Table 1: Number of teachers contacted for school visits

	Teachers offering to be contacted	Incorrect e-mail addresses	Nil responses	Offers of more information but not visits	Offers to visit the school	Schools visits made
Primary schools	25	2	10	9	4	2
Secondary schools	28	2	18	3	5	2
Private schools	10	0	9	0	1	1

A total of 25 teachers from middle, junior or infant schools were identified as having been accessing NRICH for six months or more. These 25 teachers were contacted by e-mail and asked if a visit to their school might be arranged. Four responded positively. From ten there was no response to the e-mail and two addresses provided were incorrect. The remaining were happy to provide further information by e-mail but said, for various reasons, that a school visit would not be possible.

Twenty-eight secondary school teachers, who had been accessing NRICH for six months or more, indicated, at the time of completing the teacher questionnaire, that they were willing to provide further information. These 28 teachers were contacted by e-mail and asked if a visit to their school might be arranged. Five responded positively. From eighteen there was no response to the e-mail and two addresses provided were incorrect. As with the primary teachers, the remaining were happy to provide further information by e-mail but said, for various reasons, that a school visit was not convenient. The corresponding figures from private schools were that 10 offered to be contacted. When e-mailed only one responded positively to arranging a school visit. One address was invalid; no response was obtained from the other teachers. Teachers from 16-19 or further education colleges and from Special schools who indicated that they were happy to be contacted by e-mail were not included in this element of the evaluation.

A total of five schools were visited, two primary, two secondary, and one private school. One school was visited twice. Data, in the form of audio-taped interviews and associated notes with teachers and pupils where possible, classroom observation notes where possible, and the records of e-mail interviews, were collected. Interview and observation schedules are given in Appendix D. It was not possible to collect the same amount and quality of information in each school. Consequently, three short case studies are presented in section 6; one of a primary school, one of a secondary school, and one of a private school. A further short case study focusing on a secondary 11-18 school that uses both PASSMaths[6] and NRICH will become available when the evaluation of the PASSMaths project, being carried out by the evaluation team at the time of writing, is completed and published.

3.3.4 **Element 4: case profiles**

Element 4 of the evaluation was planned to be in the form of reasonably indepth accounts of the experiences of a small sample of pupils in accessing the NRICH website, particularly their experience in using the 'one-to-one' facility where they can talk over a mathematical problem with someone studying mathematics at university (one of the distinctive features of the NRICH website). The intention was to attempt to provide an element of longitudinal data to inform evaluation objectives 1 and 3.

In order to use this 'one-to-one' facility, and 'NRICHtalk', where pupils can engage in discussion with other pupils, pupils have to register with NRICH, a straightforward process with no cost involved. The pupil questionnaire asked pupils to indicate if they were registered and, further, if they were happy to provide further information. A total of 199 pupil responses to the pupil questionnaire were accepted for analysis (see section 4.1 for further details) but of these only twelve of the pupils who said that they were prepared to be contacted for further information said that they were registered with NRICH (see Table 2 below).

Table 2: Number of pupils contacted for further information

	Registered with NRICH		
Happy to be e-mailed	not specified	yes	Totals
not specified	121	8	129
yes	58	12	70
Totals	179	20	199

Of these twelve pupils who said that they were registered with NRICH, seven were from the UK and these were contacted by e-mail first. They were asked if they would be prepared to share with the evaluation team their experience of using NRICH. Two made an initial reply in the affirmative but then only one reply was received from one of these pupils to follow-up messages. No reply to the first message was received from any of the other five pupils.

[6] PASSMaths is an online mathematics magazine aimed at a slightly older audience than NRICH. As of September 1999 it, like NRICH, is a component of the Millennium Mathematics Project.

Consequently, the selection was widened to include all 70 pupils who had provided an e-mail address in the hope that some of them might be registered with NRICH even though they did not state this on the questionnaire. From these 70 messages, four replies were received; from the remaining no reply was received (three e-mail addresses were invalid). Of the four pupils who replied, two were registered with NRICH and had used 'one-to-one' and 'NRICHtalk', although one of them not for almost a year and not now as the person had left school. The other two replies were from pupils who were not registered and had never used any of the NRICH bulletin boards.

Through these efforts, some data was gathered on the use made of NRICH by three pupils, one a home user of primary age, one a secondary school pupil who accessed NRICH from the school IT suite, and one a student at a 16-19 college who accessed NRICH at home. Unfortunately, the available data is not rich enough to provide individual case profiles, but some account of the experiences of the NRICH user is provided in section 7 of this report.

3.4 *Validation Procedures*

The validity and reliability of the evaluation were established through the following:

- the use of multiple sources of data
- the use of multiple methods of data collection
- the use of multiple perspectives on the central evaluation objectives

As stated above, standard techniques were employed to ensure the validity and reliability of the questionnaires and interviews.

3.5 *Ethical Procedures*

Ethical guidelines were followed at all times during the planning, implementing, analysing and reporting phases of this evaluation. As a principle of research ethics, the design of this external evaluation consciously avoided any use of personal information on individuals that those individuals had, purposefully or not, provided by communicating electronically with the NRICH website or with any of the NRICH team.

The internet is well-known as an open system. All forms of internet communication, be it web browsing or e-mail, are logged somewhere or other. For example, just as web servers keep a log of web traffic, e-mail servers keep a store of all their e-mail traffic. Thus it is theoretically possible to trawl through the e-mail correspondence on any of the NRICH e-mail facilities. This includes the 'one-to-one' service (where pupils can discuss any mathematical problem, 'one-to-one', with someone studying mathematics at university) and 'NRICHtalk' where pupils can discuss mathematics with other pupils. In the design of this evaluation the position was taken that such correspondence was private to those taking part and therefore should not be used as a source of data for the evaluation under any circumstances. Similarly, although counts were made of registrations with NRICH (both by teachers and by pupils), the personal information provided by these individuals was never part of the evaluation.

Ethical principles of confidentiality, informed consent, and no harm to the individual were maintained during the implementation phase of the evaluation. Data sifting and analysis followed standard procedures to ensure no bias was inadvertently introduced.

4. Website Impact

4.1 *Introduction*

This segment is the largest in this report. It presents the analysis of the responses to the three questionnaires addressed to users of the NRICH website: pupils or students, school or college teachers, and other interested people (such as parents, University lecturers, local education authority employees, *etc*). Each of these groups of people is considered in turn, beginning with the pupil perspective. Detailed results are presented for each group. Summaries can be found at the end of each section (see sections 4.2.5, 4.3.5, and 4.4.3). An overall summary is given in section 4.6.

4.2 *The Pupil Perspective*

A total of 513 responses to the pupil questionnaire were received. As noted in section 3.3.1, close scrutiny was paid to the data in order to sift out, from the data for analysis, incomplete responses, unacceptable or frivolous responses, and multiple submissions from the same respondent. It was anticipated that a considerable number of incomplete responses to the questionnaires would be received. The close inspection of the original data was designed to improve the validity of the data set used for analysis and hence the reliability of any conclusions drawn from the analysis. The result of this process are given below in Table 3, showing that 199 responses were finally accepted for analysis.

Table 3: Responses to the pupil questionnaire

total number of responses to pupil questionnaire	513
unspecified in every field	95
unspecified in almost every field (at the most, three answers specified)	156
added a comment that they had just found the site	17
clearly frivolous respondents (typically only a few responses given and these clearly not serious)	26
non-pupils (eg student teachers)	20
number of pupil responses accepted for analysis	199

The analysis that follows examines the following:

- country of domicile of pupils
- pupil gender and ethnicity
- pupil age
- type of school
- where they access NRICH from
- how often they make use of the various NRICH facilities
- what they think of NRICH and its facilities

The results are presented in some detail. A summary is provided in section 4.2.5.

4.2.1 **About the pupils**

Just over half of the pupils who answered the questionnaire were from England (Table 4). Almost 57% of pupil respondents were from the UK as a whole. Australian pupils were the next highest category (over 95% of them attending private schools[7]).

Table 4: Distribution of pupil respondents by country

England	102	51.26%
Australia	38	19.10%
Singapore	13	6.53%
USA	7	3.52%
Scotland	6	3.02%
Hong Kong	5	2.51%
Wales	5	2.51%
India	3	1.51%
The Republic of Congo	2	1.01%
Argentina	1	0.50%
Bangladesh	1	0.50%
Brunei	1	0.50%
Italy	1	0.50%
Kuwait	1	0.50%
Norway	1	0.50%
Turkey	1	0.50%
not specified	11	5.53%

[7] According to Anderson (1993), private school enrolments in Australia are proportionally higher than any other Anglo-American country in the world and are growing, while elsewhere in the world they are static or declining.
Anderson, D (1993), Public Schools in Decline: implications of the privatization of schools in Australia, in H Beare and W Lowe Boyd (Eds), *Restructuring Schools*. Falmer: London.

Over two-thirds of all the pupils who answered the pupil questionnaire were boys (Table 5). Almost two-thirds of all the pupil respondents were white. The next highest ethnic group was Chinese. Around a third (11) of the Chinese pupils came from Singapore. The next largest group of Chinese pupils (8) came from Australia. Almost half of all the pupils who responded to the questionnaire were white boys. The next highest category was white girls at 19.1%.

Table 5: Gender and ethnicity of pupil respondents

	boy /male	girl /female	not specified	Total
White	91	38	1	130 (65.3%)
Chinese	25	6	0	31 (15.6%)
Other Asian Group	8	0	0	8 (4.0%)
Indian	4	3	0	7 (3.5%)
Mixed Race	3	1	0	4 (2.0%)
Black - African	1	3	0	4 (2.0%)
Other groups	2	1	0	3 (1.5%)
Bangladesh	0	3	0	3 (1.5%)
Black - Caribbean	2	0	0	2 (1.0%)
Pakistani	0	1	0	1 (0.5%)
unspecified	0	0	6	6 (3.0%)
Total	136 (68.3%)	56 (28.1%)	7 (3.5%)	199 (100%)

Considering UK pupils (Table 6), 58% of pupil respondents were boys compared to 38% girls. Girls make up a greater proportion of the UK pupil respondents than that of all pupil respondents (38% compared to 28%), but the proportion still falls below that of girls in the school pupil age range in the UK.

Just over 80% of all the UK pupil respondents who completed the pupil questionnaire gave their ethnicity as white (Table 5). A small number of respondents (4.5%) did not specify their ethnicity. Of those UK pupils who did specify their ethnicity (107 pupils), 84% were white. This proportion is in line with national UK statistics on ethnic groups in formal education. The UK Department for Education and Employment figures on pupil ethnicity in England, published in June 1999, showed that 88.2% of primary aged pupils and 88.5% of secondary age pupil were white (DfEE 1999). The numbers of UK pupil respondents to the NRICH pupil questionnaire from other ethnic groups may suggest that there is a possible over-representation of certain groups (such as Chinese and other Asian), coupled with a possible under-representation of other ethnic groups,

such as black Caribbean heritage and Pakistani pupils. However, the numbers of respondents is certainly far too small to draw any firm conclusions on this point.

The largest single category of UK pupil respondent was white boys (just over 48% of all UK pupil respondents). The second highest category was white girls at just over 31%.

Table 6: Gender and ethnicity of pupil respondents from the UK

	boy /male	girl /female	not specified	Total NRICH	NRICH specified	Ethnicity primary[8]	Ethnicity secondary	Ethnicity of UK population[9]
White	54	35	1	90 (80.4%)	84.1%	88.2%	88.5%	94.5%
Other Asian Group	6	0	0	6 (5.4%)	5.6%	2.1%	1.8%	0.4%
Chinese	1	2	0	3 (2.7%)	2.8%	0.3%	0.4%	0.3%
Indian	1	1	0	2 (1.8%)	1.9%	2.3%	2.7%	1.5%
Mixed Race	1	1	0	2 (1.8%)	1.9%	-	-	0.5%
Bangladeshi	0	1	0	1 (0.9%)	0.9%	1.0%	0.9%	0.3%
Black - African	0	1	0	1 (0.9%)	0.9%	1.2 %	1.0%	0.4%
Black - Caribbean	1	0	0	1 (0.9%)	0.9%	1.6%	1.4%	0.9%
Other groups	1	0	0	1 (0.9%)	0.9%	0.9%	0.7%	0.3%
Pakistani	0	1	0	1 (0.9%)	0.9%	2.5%	2.6%	0.9%
unspecified	0	0	4	4 (3.6%)	n/a	n/a	n/a	n/a
Total	65 (58.0%)	42 (37.5%)	5 (4.5%)	112 (100%)	107 (100%)	100%	100%	100%

[8] Source: DfEE Statistics report sfr15, *Minority Ethnic Pupils in Maintained Schools by Local Education Authority Area in England: January 1999 (Provisional)*. 30 June 1999.
[9] Source: Owen, D (1992-1995), *1991 Census Statistical Papers 1-9*, Centre for Research in Ethnic Relations, University of Warwick/CRE.

Almost three quarters of the pupils who answered the questionnaire were of secondary school age. The data is given in Table 7. Of the pupils aged 10 and under, almost two thirds were boys (12 out of 19). In the 11-16 age range, over 70% of the pupils were boys. The proportion of males to females in the group aged over 16 was similar to that of the 11-16 range.

Table 7: Age distribution of pupil respondents

age 10 or under	19	9.5%
11 - 16	146	73.4%
age over 16	30	15.1%
not specified	4	2%
Total	199	100%

The students attended a range of institutions, with the largest number, although less than 30% of the total, attending secondary comprehensive schools (Table 8). Pupils from private preparatory schools came a close second (34 of these pupils, over 70%, were from Australia). The data on the type of school is shown in Table 8.

Table 8: Type of school attended by pupil respondents

Secondary comprehensive	56	28.14%
Private (preparatory)	47	23.62%
Primary (junior or infant)	30	15.08%
16-19 college	20	10.05%
Secondary selective	20	10.05%
Private (upper)	14	7.04%
Middle	9	4.52%
5-17 private college	1	0.50%
not specified	2	1.01%
Total	199	100.00%

Most of the pupils lived in a city (Table 9).

Table 9: Type of area where pupil respondents lived

in a large city	116	58.29%
in a small town	66	33.17%
in the countryside	16	8.04%
unspecified	1	0.50%
Total	199	100.00%

Most of the pupils who completed the questionnaire attended a mixed school, as shown in Table 10. Over half (57%) of those attending a boys school were from private

preparatory schools in Australia, with just under twenty percent (12 pupils) from England, half of them from secondary selective schools. All the female pupil respondents attending a girls school, apart from one (who was from Bangladesh), were from England. The female English pupil respondents attending a girls school were evenly split between state and private education. The largest group (by 1) were those from private upper schools (5 respondents). No data on the socio-economic class of pupils was collected for this evaluation as such data is not very straightforward to collect reliably and feedback from the piloting of the pupil questionnaire suggested that it was too long for some pupils and that some questions should be omitted.

Table 10: Gender mix of school attended by pupil respondents

mixed school	120	60.30%
boys school	63	31.66%
girls school	16	8.04%
Total	199	100.00%

4.2.2 How pupils access NRICH

In total, some 48% of pupils accessed NRICH at school, with most school access taking place in an IT room (Table 11). Almost exactly the same proportion of the pupils accessed NRICH at home. Fourteen pupils (7%) said they accessed NRICH from more than one place, almost all of them citing both school and home. There was no difference in the pattern of place of access between boys and girls. Very few of the pupil respondents accessed NRICH from a public library or other public access location. For those pupils accessing NRICH from home, the socio-economic status of the family allows not only the purchase of an internet-capable computer but also pays for internet provision and associated telephone costs.

Table 11: Place of access to NRICH by pupil respondents

at home	95	47.74%
in the IT room	50	25.13%
in my mathematics classroom	32	16.08%
in the school library	10	5.03%
in another classroom (not mathematics)	4	2.01%
in the public library	2	1.01%
In the Town Hall	2	1.01%
at a university	1	0.50%
at work with my mum	1	0.50%
not specified	2	1.01%
Total	199	100.00%

The ‘resource bank’ was the part of the NRICH site most used by the pupils, with almost 25% of them saying that they access that part of the site “most weeks” (Table 12). A few pupils claimed to use some NRICH facilities almost every day, but for the majority it was less than once a month, if then. There was little difference between the relative usage of these parts of NRICH by girls and boys.

Table 12: Pupil respondent use of the general NRICH facilities

	most days	most weeks	once a month	less than once a month	never	not specified	Total
Ask NRICH	11 (5.5%)	28 (14%)	25 (12.6%)	66 (33.2%)	60 (30.1%)	9 (4.5%)	199 (100%)
Emailing list	10 (5%)	19 (9.5%)	25 (12.6%)	57 (28.6%)	74 (37.2%)	14 (7%)	199 (100%)
Games	12 (6%)	37 (18.6%)	45 (22.6%)	49 (24.6%)	39 (19.6%)	17 (8.5%)	199 (100%)
Resource bank	10 (5%)	49 (24.6%)	38 (19.1%)	45 (22.6%)	34 (17.1%)	23 (11.6%)	199 (100%)
Send solutions with teacher’s help	6 (3%)	14 (7%)	18 (9%)	55 (27.6%)	82 (41.2%)	24 (12.1%)	199 (100%)
Send solutions on own	13 (6.5%)	27 (13.6%)	26 (13.1%)	56 (28.1%)	53 (26.6%)	24 (12.1%)	199 (100%)

Where pupils sent in solutions, most did so on their own rather than with the assistance of a teacher (Table 12). Many pupils reported never sending in a solution, whether assisted by a teacher or not. Just over half of the pupils (52%) who said they sent in solutions on their own most weeks or most days accessed NRICH from their homes. Almost a third of this group of pupils (40 pupils), who said they sent in solutions that frequently, attended private preparatory schools, the largest single category. These 40 pupils were almost evenly split between those from Australia, England and Singapore (just under a third from each of these three countries); 82.5% of them were boys.

Table 13 shows the data on frequency of usage by primary, middle and preparatory pupils of those elements of the NRICH site aimed at primary age pupils. All the different primary elements were accessed by pupils, with the first two problem sections in the table possibly having a very slight edge in popularity due to the age profile of the pupil respondents ('Let me Try' is primarily aimed at 5-8 years olds and there were few pupil respondents in that age range).

Table 13: Usage of the primary NRICH facilities by primary pupils

	most days	most weeks	once a month	less than once a month	never	not specified	Total
Bernard's Bag (open problems)	3 (3.5%)	17 (19.8%)	15 (17.4%)	21 (24.4%)	25 (29.1%)	5 (5.8%)	86 (100%)
Penta Problems	5 (5.8%)	15 (17.4%)	15 (17.4%)	16 (18.6%)	29 (33.7%)	6 (7.0%)	86 (100%)
Let Me Try	4 (4.7%)	13 (15.1%)	11 (12.8%)	18 (20.9%)	30 (34.9%)	10 (11.6%)	86 (100%)
Kids Mag	5 (5.8%)	14 (16.3%)	8 (9.3%)	23 (26.7%)	30 (34.9%)	6 (7.0%)	86 (100%)

Usage by secondary pupils of the sections of the NRICH aimed at that age of pupil is given in Table 14. There was not a great deal of difference in the relative popularity of the various elements in the table, although the 'monthly problems' and the 'tough nuts' were especially popular with pupils from selective schools in England, with pupils from English secondary comprehensive schools only just behind. Just over 73% of the pupils who said that they accessed the 'tough nuts' that often were boys. The corresponding figure for the monthly problems was 80%. Girls, in general, said they accessed the 'monthly problems' and 'tough nuts' rather less frequently (usually less than once a month) compared with boys.

Table 14: Usage of the secondary NRICH facilities by secondary pupils

	most days	most weeks	once a month	less than once a month	never	not specified	Total
News	5 5.6%	16 17.8%	14 15.6%	27 30.0%	21 23.3%	7 7.8%	90 100.0%
Articles	4 4.4%	16 17.8%	18 20.0%	27 30.0%	16 17.8%	9 10.0%	90 100.0%
Monthly Six Problems	8 8.9%	13 14.4%	20 22.2%	25 27.8%	16 17.8%	8 8.9%	90 100.0%
More Challenging Problems/Tough nuts	9 10.0%	17 18.9%	14 15.6%	27 30.0%	14 15.6%	9 10.0%	90 100.0%

4.2.3 **What pupils think of NRICH**

Almost two-thirds of pupils agreed or strongly agreed that the NRICH website was well-designed, although around 25% claimed to find the website difficult to use (Table 15). There were mixed views on the ease of use of 'askNRICH'.

Table 15: Pupil respondents' views of the NRICH website

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Don't know	not specified	Total
NRICH website is well-designed	36 (18.1%)	91 (45.7%)	28 (14.1%)	10 (5%)	14 (7%)	7 (3.5%)	13 (6.5%)	199 (100%)
NRICH is difficult to use	11 (5.5%)	39 (19.6%)	37 (18.6%)	67 (33.7%)	19 (9.5%)	12 (6%)	14 (7%)	199 (100%)
ask NRICH is difficult to use	16 (8%)	18 (9%)	55 (27.6%)	33 (16.6%)	17 (8.5%)	43 (21.6%)	17 (8.5%)	199 (100%)

Pupils have positive views about the NRICH facilities, although many of the pupil respondents (20%) were unable to express a view about 'one-to-one' (Table 16). Almost half the pupil respondents (47.3%) agreed or strongly agreed that NRICH made them feel part of a club. A similar proportion looked forward to each monthly edition. The articles got a mixed reception, but the problems and the games were well-liked. Seeing their solutions published was popular with a large proportion of pupils (half of all the pupils agreed or strongly agreed that they liked seeing their solutions published).

Table 16: Pupil respondents' views of the NRICH website

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Don't know	not specified	Total
One-to-One (ask a mathematician) is the best facility	23 (11.6%)	35 (17.6%)	53 (26.6%)	17 (8.5%)	14 (7%)	40 (20.1%)	17 (8.5%)	199 (100%)
NRICH makes me feel part of a mathematics club	29 (14.6%)	65 (32.7%)	37 (18.6%)	22 (11.1%)	20 (10.1%)	10 (5%)	16 (8%)	199 (100%)
I look forward to new NRICH	30 (15.1%)	64 (32.2%)	39 (19.6%)	20 (10.1%)	18 (9%)	12 (6%)	16 (8%)	199 (100%)
I never read the articles	23 (11.6%)	31 (15.6%)	45 (22.6%)	50 (25.1%)	23 (11.6%)	9 (4.5%)	18 (9%)	199 (100%)
The problems are the best	56 (28.1%)	64 (32.7%)	36 (18.1%)	8 (4%)	13 (6.5%)	7 (3.5%)	15 (7.5%)	199 (100%)
I don't understand why games are included	10 (5%)	12 (6%)	29 (14.6%)	40 (20.1%)	81 (40.7%)	10 (5%)	17 (8.5%)	199 (100%)
I like seeing my solutions published	74 (37.2%)	23 (11.6%)	43 (21.6%)	4 (2%)	12 (6%)	23 (11.6%)	20 (10.1%)	199 (100%)

Most pupils were referred to NRICH by their teacher, with a majority of those expressing an opinion indicating that NRICH was better than the mathematics they did in school (Table 17). Few pupils said they were at a school where there was a ‘maths club’ that used NRICH, although more pupils used NRICH at school than said that they did not (44% compared to 36%). Most of the pupil respondents claimed to find mathematics easy and did not think that the NRICH problems were too hard. Some pupils were able to work with friends on the NRICH problems (25%), but more did not (41%).

Table 17: Pupil respondents’ views on aspects of the NRICH website

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Don't know	not specified	Total
My teacher suggested that I try NRICH	57 (28.6%)	59 (29.6%)	18 (9%)	22 (11.1%)	28 (14.1%)	4 (2%)	11 (5.5%)	199 (100%)
NRICH is better than the maths I do at school	45 (22.6%)	49 (24.6%)	49 (24.6%)	20 (10.1%)	13 (6.5%)	11 (5.5%)	12 (6%)	199 (100%)
at the school maths club we always use NRICH	14 (7%)	17 (8.5%)	24 (12.1%)	53 (26.6%)	61 (30.7%)	18 (9%)	12 (6%)	199 (100%)
I usually find mathematics easy	52 (26.1%)	59 (29.6%)	34 (17.1%)	21 (10.6%)	14 (7%)	5 (2.5%)	14 (7%)	199 (100%)
I never use NRICH in school	37 (18.6%)	35 (17.6%)	25 (12.6%)	33 (16.6%)	54 (27.1%)	1 (0.5%)	14 (7%)	199 (100%)
I always work with a friend on NRICH	17 (8.5%)	33 (16.6%)	51 (25.6%)	34 (17.1%)	42 (21.1%)	5 (2.5%)	17 (8.5%)	199 (100%)
all the NRICH problems too hard	12 (6%)	29 (14.6%)	49 (24.6%)	52 (26.1%)	31 (15.6%)	11 (7%)	15 (7.5%)	199 (100%)

A majority of pupils thought that NRICH had made them more interested in mathematics and more likely to continue studying mathematics (Table 18). Opinion was more divided on whether friends think they are mad to like NRICH and whether or not a print version of NRICH would be preferable to the web-based version.

Table 18: Pupil respondents' views of the impact of NRICH website

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Don't know	not specified	Total
NRICH has made me more interested in mathematics	31 (15.6%)	62 (31.2%)	40 (20.1%)	20 (10.1%)	20 (10.1%)	10 (5%)	16 (8%)	199 (100%)
my friends think I am mad to like NRICH	26 (13.1%)	28 (14.1%)	40 (20.1%)	25 (12.6%)	37 (18.6%)	23 (11.6%)	20 (10.1%)	199 (100%)
using NRICH has made me want to continue studying mathematics	34 (17.1%)	49 (24.6%)	45 (22.6%)	23 (11.6%)	25 (12.6%)	8 (4%)	15 (7.5%)	199 (100%)
I would prefer NRICH to be a printed magazine	36 (18.1%)	33 (16.6%)	39 (19.6%)	29 (14.6%)	34 (17.1%)	11 (7%)	17 (8.5%)	199 (100%)

Finally, only 20 of the pupil respondents (10% of all those responding) said that they were registered with NRICH (Table 19). Given that by October 1999, a total of more than 1300 pupils had registered with NRICH (cumulative registrations in the period October 1997-October 1999; data supplied by NRICH), this low number is somewhat surprising. There are a number of possible explanations. Amongst these are that:

- many of the respondents chose not to reveal that they were registered (one example of this was uncovered by the follow-up e-mail to some 70 pupil respondents even though only four replies were received),
- many of the registered pupils no longer access the NRICH site
- while the NRICH site provides a straightforward method of registering, there is no mention of how to de-register

These last two points could suggest that the cumulative number of pupils registered with NRICH may not be not a reliable indicator of how many pupils, and of what type, access the NRICH website.

Table 19: Number of pupil respondents registered with NRICH

Registered with NRICH	
yes	20 (10.1%)
not specified	179 (89.9%)
Totals	199 (100%)

The low number of pupil respondents who were registered with NRICH had a knock-on effect on another component of the evaluation, the case profiles of pupils who make use of the wider NRICH facilities such as the e-mail answering service. As described in section 3.2.4, the effect was to severely limit the number of pupils who could be contacted to provide further information on their experience of using NRICH. This was not anticipated at the planning stage of this evaluation, as, with a planned focus on the regular NRICH user, a higher number of registered pupils were expected to complete the questionnaire.

4.2.4 **Pupils' comments on NRICH**

Just under a quarter of the pupil respondents added a comment to their questionnaire (43 respondents out of 199). Almost every comment was complimentary. Some were short ("Excellent!!", "I like it lots"). Many other were quite long.

Below are some typical examples of **complimentary** comments:

> *"All the Nrich problems are challenging to me, not like the problems I do at school. Doing the problems has made me feel how it feels to be stuck on a mathematics problem and do not know how to do it."*
> 11 year old boy from Singapore.

> *"I really like this site and think it is great, although my friends don't like maths that much I am trying to wean them onto this site because it is really interesting and helps me with my maths."*
> 12 year old girl from England.

> *"I think N-rich is really cool and has made me think differently about mathematics."*
> 12 year old boy from the USA.

> *"I use Nrich every week in our maths club. It's a great site!"*
> 13 year old boy from England.

> *"Well, it's better than school maths!"*
> 12 year old boy from a private preparatory school.

> *"NRICH is cool. It does not just do the simple types of mathematics but it does problem solving aswell. It is really fun and is great to log onto during breaks."*
> 12 year old girl from a private upper school in England.

> *"The problems are often challenging, but are still good fun."*
> 11 year old boy from an Australian private preparatory school.

> *"Thank you for your help. As an [adult] outreach student, it is hard to find help for math problems when the teacher is too busy to help."*
> 41 year old female student at an American college in a small town.

Some pupils chose to make **suggestions**. Below are some typical examples:

> *"I think the problems should be in three different groups. Easy, Medium, Hard."*
> 12 year old boy.

> *"It is great fun and my class love it. It is really easy to use but I wish the games were changed more often."*

12 year old girl from an English private upper school.

"It would be good if the NRICH site could give you a demonstration on a problem you may not know what sort of technique to use."
11 year old boy from an Australian private preparatory school.

"The nrich graphics are bad otherwise it is good."
11 year old boy

"Needs to have more colour, it is a bit drab and boring. I mean, we are mathematicians but we do have style."
11 year old boy from a private upper school in Wales.

From two Australian private schools came the following comments:

"I only use nrich because I have to."
12 year old boy from an Australian private preparatory school.

"I really don't like maths at school but I am in the A group (top) so we use NRICH once a week. It's better than doing other written maths."
A different 12 year old boy from an Australian private preparatory school.

The above pupil comments illustrate how important NRICH was to many of the pupils who accessed the site. The suggestions to improve the NRICH facilities reflect a mature consideration of the site and fit with some of the outcomes of other components of this external evaluation. For instance, some of the pupils interviewed for the case studies, reported in section 6 of this report, and for the case profiles, reported in section 7 of this report, commented that more instant feedback on their solutions (like that provided by some forms of mathematics software packages that they use, for example) would be very helpful. Likewise, the website evaluation, reported in the next section of this report, found an improvement in the design of the site following the new layout launched in July 1999.

A few of the comments from pupil respondents indicated that NRICH is, in some cases, becoming part of the scheme of work that pupils have to follow, presumably in mathematics lessons, but possibly as part of an Information Technology course. This may be something that increases as more schools come 'online' and curriculum managers seek internet-based activities for courses of various kinds.

4.2.5 Summary of the pupil perspective

Almost 60% of the pupils who answered the questionnaire lived in the United Kingdom, and almost all of them in England. Australian pupils were the next highest category at just under 20%. All but two of the pupil respondents from Australia attended private schools.

Over two-thirds of all the pupils who answered the pupil questionnaire were boys. Almost the same proportion were white. The next largest ethnic group (at just over 15% of the pupils) was Chinese, with around a third of these pupils coming from Singapore.

Of UK pupils, 58% were boys compared to 38% girls. This proportion of girls is below that of girls in the school pupil age range in the UK. About 84% of UK pupils who responded to the questionnaire were white, compared to a school population that is about 88% white. While the number of respondents in different categories was far too

small to draw any firm conclusions, it is possible that there is some over-representation of certain groups of UK pupils (such as Chinese and other Asian), along with some possible under-representation of other groups, such as girls (in general), pupils of black Caribbean heritage, and Pakistani pupils. No data on the socio-economic class of pupils was collected as part of this evaluation.

Almost three quarters of the pupils who answered the questionnaire were of secondary school age. Most lived in a city and attended a mixed school. The students attended a range of institutions, with the largest number, although less than 30% of the total, attending secondary comprehensive schools. Pupils from private preparatory schools came a close second (over 70% of such pupils were from Australia).

Just under half the pupils accessed NRICH at school, usually in an IT room; almost exactly the same proportion of pupils said they accessed NRICH at home. A few said they accessed NRICH from both school and home. There was no difference in the pattern of access between boys and girls. Very few of the pupil respondents accessed NRICH from a public library or other public access location.

A few pupils claimed to use some NRICH facilities almost every day, but for the majority it was less than once a month. In both the primary and secondary parts of NRICH, it was the problems that most attracted the interest in pupils. Almost two-thirds of pupils agreed or strongly agreed that the NRICH website was well-designed, although around 25% claimed to find the website difficult to use.

Pupils had positive views about all the NRICH facilities, with almost half agreeing or strongly agreeing that NRICH made them feel part of a club. Seeing their solutions published was popular with a large proportion of pupils.

Most pupils were referred to NRICH by their teacher. Quite a number thought that NRICH was better than the mathematics they did in school. Some pupils were able to work with friends on the NRICH problems (25%), but many more did not (41%), perhaps reflecting the fact that many pupils access NRICH from home. A majority of pupils thought that NRICH had made them more interested in mathematics and more likely to continue studying mathematics. Only a small minority of the pupil respondents said that they were registered with NRICH.

Just under a quarter of the pupil respondents added a comment to their questionnaire. Virtually every comment was positive and illustrated how important NRICH was to many of the pupils who accessed the site.

4.3 *The Teacher Perspective*

A total of 999 responses to the teacher questionnaire were received. As noted in section 3.3.1, close scrutiny was paid to the data in order to sift out, from the data for analysis, incomplete responses, unacceptable or frivolous responses, and multiple submissions from the same respondent. It was anticipated that a considerable number of incomplete responses to the questionnaires would be received. The close inspection of the original data was designed to improve the validity of the data set used for analysis and hence the reliability of any conclusions drawn from the analysis. The result of this process are given below in Table 20, showing that 450 teacher responses were finally accepted for analysis.

Table 20: Responses to the teacher questionnaire

total number of responses to the teacher questionnaire	999
unspecified in every field	157
unspecified in almost every field (at the most, three answers specified)	392
number of teacher responses accepted for analysis	450

The analysis that follows examines the following:

- country of domicile of the teachers
- type and phase of school, its status, location and number of pupils
- the use made of NRICH by teachers
- what teachers think of NRICH and its facilities

The results are presented below in some detail. A summary is provided in section 4.3.5.

4.3.1 **About the teachers**

The overwhelming majority of teachers who answered the questionnaire were from England (Table 21). 82% of teacher respondents were from the UK as a whole. US teachers were the next highest category, but at less than 5% of the total.

Table 21: Country of domicile of teacher respondents

school country	Total	%
England	343	76.22%
USA	22	4.89%
Australia	15	3.33%
Scotland	14	3.11%
Wales	8	1.78%
New Zealand	5	1.11%
Canada	4	0.89%
Northern Ireland	4	0.89%
Singapore	4	0.89%
Malaysia	2	0.44%
Switzerland	2	0.44%
Belgium	1	0.22%
Cyprus	1	0.22%
Finland	1	0.22%
Hong Kong	1	0.22%
Ireland	1	0.22%
Isle of Man	1	0.22%
Italy	1	0.22%
Japan	1	0.22%
Jersey	1	0.22%
Mexico	1	0.22%
Norway	1	0.22%
Pakistan	1	0.22%
Philippines	1	0.22%
Saudi Arabia	1	0.22%
Sweden	1	0.22%
United Arab Emirates	1	0.22%
not specified	11	2.44%
Total	450	100.00%

Around a third of the teacher respondents worked in secondary comprehensive schools (Table 22). About the same proportion were from primary (junior or infant) schools.

Table 22: Type of school where teacher respondents taught

Secondary comprehensive	153	34.00%
Primary (junior or infant)	152	33.78%
Middle	29	6.44%
Private (upper)	29	6.44%
Secondary selective	20	4.44%
16-19 college	17	3.78%
Private (preparatory)	13	2.89%
University Initial Teacher Education	6	1.33%
F E college	5	1.11%
Special	4	0.89%
13-18 comprehensive	3	0.67%
Private international 5-18	2	0.44%
Secondary Modern	2	0.44%
14-18 Selective	1	0.22%
graduate school	1	0.22%
homeschool	1	0.22%
kindergarten	1	0.22%
Local Education Authority	1	0.22%
Private 3-16	1	0.22%
Private College	1	0.22%
Private internet school	1	0.22%
Private Secondary	1	0.22%
not specified	6	1.33%
Total	450	100.00%

More than half the teachers worked in a school run by a local education authority (Table 23). Around 10% were from private schools (over 70% of which were located in England).

Table 23: Employer of teacher respondents

Local Education Authority (state) school	242	53.78%
Private school	45	10.00%
Grant maintained/foundation school	36	8.00%
Voluntary aided or controlled (Church) school	31	6.89%
Further education college	14	3.11%
self-employed (primary supply teacher)	1	0.22%
not specified	81	18.00%
Total	450	100.00%

Most of the teachers worked in a suburban school (Table 24). About half the teachers who worked in inner city schools (29 out of 67) worked in primary schools.

Table 24: Location of teacher respondents' schools

Suburban	153	34.00%
Urban	127	28.22%
Rural	95	21.11%
Inner-city	67	14.89%
not specified	8	1.78%
Total	450	100.00%

The primary teachers tended to work in schools of between 200 and 499 pupils while the secondary teachers were evenly split between those who worked in schools of under 1000 pupils and those who worked in schools of over 1000 pupils (Table 25).

Table 25: Size of teacher respondents' schools

	LEA	Private	Grant maintained /foundation	Voluntary aided or controlled	Further education	Primary Supply Teacher	not specified	Total
200 - 499	81	16	2	17	1	1	21	139 (30.0%)
1000 or more	62	3	17	2	10	0	21	115 (25.6%)
500 - 999	57	15	14	4	2	0	22	114 (25.3%)
less than 200	26	9	0	6	0	0	10	51 (11.3%)
not specified	16	2	3	2	1	0	7	31 (6.9%)
Total	242	45	36	31	14	1	81	450 (100%)

The overwhelming proportion of teachers worked in mixed gender schools (Table 26).

Table 26: Pupil gender mix in teacher respondents' schools

Mixed (all years)	391	86.89%
Girls	25	5.56%
Boys	22	4.89%
Mixed (some years)	5	1.11%
not specified	7	1.56%
Total	450	100.00%

Many teachers (almost 30% of the respondents) had found NRICH through browsing the web (Table 27) . Just under 20% had learnt about NRICH from colleagues. Articles in journals and magazines, and inservice courses were also major sources.

Table 27: How the teachers had learnt about NRICH

from browsing the web	130	28.89%
from a colleague	84	18.67%
from an article in a journal	79	17.56%
from a leaflet	65	14.44%
from an INSET course	52	11.56%
direct from NRICH personnel	6	1.33%
from the pilot project in Norfolk	5	1.11%
from a pupil	3	0.67%
from the National Numeracy Project	3	0.67%
from a professional association	3	0.67%
from a University lecturer	2	0.44%
from a poster	1	0.22%
from an Exhibition	1	0.22%
from a Seminar	1	0.22%
not specified	15	3.33%
Total	450	100.00%

Just over 60% of the teachers were relatively new to NRICH, having only been accessing the website for six months or less (Table 28).

Table 28: Length of time teacher respondents' had been accessing NRICH

a month	179	39.78%
six months	110	24.44%
a year	58	12.89%
a year or two	54	12.00%
more than two years	10	2.22%
not specified	39	8.67%
Total	450	100.00%

4.3.2 How teachers access NRICH

The overwhelmingly majority of teachers were accessing NRICH from home (Table 29). Relatively few accessed NRICH from their own use in their classroom. Around a tenth reported accessing NRICH from more than one place, usually both home and school.

Table 29: Where teacher respondents' access NRICH

home	276	61.33%
IT suite	49	10.89%
departmental office/room	44	9.78%
school staffroom	31	6.89%
school library	15	3.33%
classroom	8	1.78%
laptop	1	0.22%
university	1	0.22%
not specified	25	5.56%
Total	450	100.00%

The most used general NRICH facility was the resource bank of problems (Table 30). Sizeable proportions of teachers (up to or over 40%) said that they never used 'ask NRICH', or any of the bulletin boards, or sent in pupils' solutions. Around half of the teachers who said that they never used these facilities were relatively new to NRICH, as were around the same proportion who said they accessed these sections of NRICH either most days or most weeks.

Table 30: Teacher respondents' usage of the general NRICH facilities

	most days	most weeks	once a month	less than once a month	never	not specified	Total
ask NRICH	9 (2.0%)	36 (8.0%)	52 (11.6%)	124 (27.6%)	178 (39.6%)	51 (11.3%)	450 (100%)
e-mail bulletin boards	6 (1.3%)	17 (3.8%)	17 (3.8%)	114 (25.3%)	214 (47.6%)	82 (18.0%)	450 (100%)
games	9 (2.0%)	43 (9.6%)	125 (27.8%)	128 (28.4%)	67 (14.9%)	78 (17.3%)	450 (100%)
resource bank (of problems)	8 (1.8%)	71 (15.8%)	107 (23.7%)	134 (29.8%)	50 (11.1%)	80 (17.8%)	450 (100%)
send in pupil solutions	2 (0.4%)	8 (1.8%)	21 (4.7%)	91 (20.2%)	209 (46.4%)	119 (26.4%)	450 (100%)

Table 31 shows the data on frequency of usage by primary, middle and preparatory school teachers of those elements of the NRICH site aimed at primary age pupils. All the elements were popular, with the problems having the slight edge. Most primary, middle and preparatory school teachers who completed the questionnaire accessed NRICH once a month or less.

Table 31: Primary teachers' use of the primary NRICH facilities

	most days	most weeks	once a month	less than once a month	never	not specified	Total
Bernard's Bag (open problems)	3 (1.5%)	31 (16.0%)	81 (41.7%)	58 (29.9%)	8 (4.1%)	13 (6.7%)	194 (100%)
Penta Problems	3 (1.5%)	28 (14.4%)	76 (39.2%)	56 (28.9%)	11 (5.6%)	20 (10.3%)	194 (100%)
Let Me Try	3 (1.5%)	32 (16.5%)	57 (29.4%)	56 (28.9%)	21 (10.8%)	25 (12.9%)	194 (100%)
Kids Mag	2 (1.0%)	25 (12.9%)	54 (27.8%)	57 (29.4%)	29 (14.9%)	27 (13.9%)	194 (100%)
Primary Staffroom	2 (1.0%)	19 (7.8%)	46 (23.7%)	60 (30.9%)	29 (14.9%)	38 (19.6%)	194 (100%)

Usage by secondary teachers of the sections of the NRICH aimed at secondary age pupils is given in Table 32. The 'monthly problems' and the 'tough nuts' were especially popular, with around two-thirds of all secondary teachers accessing them at least once a month. Around half of all secondary teachers also checked the news and the articles at least once a month.

Table 32: Secondary teachers' use of the secondary NRICH facilities

	most days	most weeks	once a month	less than once a month	never	not specified	Total
Main news	5 (2.4%)	22 (10.5%)	74 (35.2%)	45 (21.4%)	28 (13.3%)	36 (17.1%)	210 (100%)
Articles	3 (1.4%)	30 (14.3%)	80 (38.1%)	48 (22.9%)	22 (10.5%)	27 (12.9%)	210 (100%)
Monthly problems	7 (3.3%)	35 (16.7%)	109 (51.9%)	41 (19.5%)	9 (4.3%)	9 (4.3%)	210 (100%)
Challenging problems/ tough nuts	5 (2.4%)	25 (11.0%)	105 (50.0%)	42 (20.0%)	12 (5.7%)	21 (10.0%)	210 (100%)

Over 60% of all the teachers (both primary secondary) looked forward to each new NRICH issue (Table 33). The teachers were aware of most of the NRICH facilities. While two thirds agreed or strongly agreed that the problems were the best part of NRICH, half said the 'Resource Bank' was not the only part of NRICH they used, and a similar proportion disagreed (some strongly) that they never read the articles. Nevertheless, some 43% were unsure about 'One-to-One' (perhaps because it is aimed more at pupils and so they did not have personal experience of it), and more than a third agreed or strongly agreed that sending in pupil solutions was too time consuming.

Table 33: Teachers' views of NRICH facilities

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know	not specified	Total
I always look forward to new NRICH monthly editions	49 (10.8%)	233 (51.8%)	40 (8.9%)	7 (1.6%)	59 (13.1%)	62 (13.8%)	450 (100%)
I never read the articles on the main site	13 (2.19)	87 (19.3%)	205 (45.6%)	42 (9.3%)	39 (8.7%)	64 (14.2%)	450 (100%)
The problems are the best part	89 (19.8%)	212 (47.1%)	47 (10.4%)	3 (0.7%)	45 (10.0%)	54 (12.0%)	450 (100%)
Sending in solutions is too time consuming	22 (4.9%)	144 (32.0%)	89 (19.8%)	14 (3.1%)	105 (23.3%)	76 (16.9%)	450 (100%)
The Resource Bank is the only part of NRICH I regularly use	12 (2.7%)	98 (21.8%)	180 (40.0%)	44 (9.8%)	46 (10.2%)	70 (15.6%)	450 (100%)
I don't have the time to use the NRICH bulletin boards	37 (8.2%)	196 (43.6%)	87 (19.3%)	6 (1.3%)	72 (16.0%)	52 (11.6%)	450 (100%)
One-to-One is the best facility provided by NRICH	8 (1.8%)	62 (13.8%)	105 (23.3%)	14 (3.1%)	195 (43.3%)	66 (14.7%)	450 (100%)

Two thirds of teachers said they mainly used NRICH as a source of problems for use in teaching with their classes, with few saying they mainly used NRICH for homework (Table 34). Almost half said that they had encouraged their pupils to access NRICH independently of school. Most teachers reported not having a Maths Club based around NRICH.

The teachers did not only recommend NRICH to their more able pupils. A majority agreed (many strongly) that NRICH was particularly good for pupils who have a talent for mathematics.

Table 34: Teachers' use of NRICH facilities

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know	not specified	Total
I mainly use NRICH as a source of problems to use in my teaching	73 (16.2%)	230 (51.1%)	62 (13.8%)	3 (0.7%)	24 (5.3%)	58 (12.9%)	450 (100%)
I never suggest to my pupils to access NRICH independently	13 (2.9 %)	79 (17.6%)	182 (40.4%)	81 (18.0%)	25 (5.6%)	70 (15.6%)	450 (100%)
My school has a maths club based around the NRICH facilities	14 (3.1%)	52 (11.6%)	196 (43.6%)	79 (17.6%)	28 (6.2%)	81 (18.0%)	450 (100%)
I only recommend NRICH to the most able pupils in my classes	8 (1.8%)	85 (18.9%)	199 (44.2%)	49 (10.9%)	32 (7.1%)	77 (17.1%)	450 (100%)
I mostly use NRICH for setting homework	4 (0.8%)	30 (6.7%)	223 (51.8%)	85 (18.9%)	28 (6.2%)	80 (17.8%)	450 (100%)
My pupils will never have heard of NRICH	25 (5.6%)	101 (22.4%)	171 (38.0%)	35 (7.8%)	33 (7.3%)	85 (18.9%)	450 (100%)
NRICH is particularly good for those pupils of mine that have a talent for mathematics	47 (10.4%)	203 (45.1%)	62 (13.8%)	13 (28.9%)	44 (9.8%)	81 (18.0%)	450 (100%)

4.3.3 **What teachers think of NRICH**

Almost 85% of teachers agreed or strongly agreed that the NRICH website was well-designed, with only around 10% claiming to find the website difficult to use (Table 35). Just over 40% agreed or strongly agreed that NRICH made them feel that they can share issues with other mathematics teachers, although over a quarter said "don't know". Few teachers thought NRICH would be better as a printed magazine. A majority of teachers thought that using NRICH had made their pupils more interested in mathematics, although around 20% said that they didn't know.

Table 35: Teachers' view of the NRICH website

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know	not specified	Total
the NRICH website is well-designed	106 (23.6%)	269 (59.8%)	8 (1.8%)	2 (0.4%)	27 (3.8%)	38 (8.4%)	450 (100%)
it is difficult to find what you are looking for on NRICH website	4 (0.8%)	42 (9.3%)	255 (56.7%)	88 (19.6%)	21 (4.7%)	40 (8.9%)	450 (100%)
NRICH makes me feel I can share issues with other teachers	13 (2.9%)	171 (38.0%)	66 (14.7%)	9 (2.0%)	125 (27.8%)	66 (14.7%)	450 (100%)
There is no advantage for NRICH to on the www. It would be better as a printed magazine.	7 (1.6%)	24 (5.3%)	185 (41.1%)	125 (27.8%)	32 (7.1%)	77 (17.1%)	450 (100%)
NRICH is just an entertaining pastime	7 (1.6%)	38 (8.4%)	186 (41.3%)	108 (24.0%)	37 (8.2%)	74	450 (100%)
Using NRICH with my pupils has made them more interested in mathematics	37 (8.2%)	184 (40.9%)	39 (8.7%)	7 (1.6%)	98 (21.8%)	85 (18.9%)	450 (100%)

Finally, 23 of the teachers who completed the questionnaire said that they were registered with NRICH (see table 36), only 5% of all those responding. As with the results of the pupil questionnaire, this low proportion is a little surprising, particularly as between October 1997 and October 1999, a total of more than 1400 teachers had registered with NRICH (cumulative registrations in the period October 1997-October 1999; data supplied by NRICH). There are a number of possible explanations. Amongst these are that:

- many of the teacher respondents chose not to reveal that they were registered
- many of the registered teachers no longer access the NRICH site
- while the NRICH site provides a straightforward method of registering, there is no mention of how to de-register

These last two points given above might indicate that the cumulative number of teachers registered with NRICH may not be not a reliable indicator of how many teachers access the NRICH website (and where from), nor how they use it.

Table 36: Number of teacher respondents registered with NRICH

Registered with NRICH		
yes	23	5.1%
not specified	427	94.9%
Total	450	100%

As with the low number of pupil respondents who said that they were registered with NRICH, the low number of registered teacher respondents had an impact on another element of the evaluation, the case studies of school and classroom usage of NRICH. As described in section 3.2.3, the effect was to severely limit the number of teachers who could be contacted with a view to gaining further information on their experience of using NRICH. This was not anticipated at the planning stage of this evaluation, as, with a planned focus on the regular NRICH user, a higher number of registered teachers were expected to complete the questionnaire.

4.3.4 **Teachers' comments on NRICH**

About 15% of the teacher respondents added a comment to their questionnaire (65 respondents out of 450). Almost every comment was complimentary. Some were short ("it's really great"), others were quite long.

Below are some typical examples of the longer **complimentary** comments:

> *"Thanks! It even has me entertained with the puzzles."*
> Teacher in an English secondary comprehensive school.

> *"NRICH has increased my personal interest and enjoyment of maths as a teacher (and Maths coordinator). I am about to start a maths club based on NRICH activities."*
> Teacher in an English inner-city primary school.

> *"I think this is a wonderful site and I only wish I had more time to access it. I use the problems with more able children who are withdrawn from the classroom all across the Junior age range, but I also use them with a Maths Club I ran that is open to every pupil."*
> Teacher in an English suburban primary school.

Many teachers particularly commented on how they made **use** of NRICH. Below are some examples:

> *"I download the problems pages once a month to put on the school intranet. I make pupils aware of its presence but I have no way of monitoring how frequently it is used. I also print out problems from to time for use as additional problems for class use."*
> Teacher from an English private preparatory school.

> *"I use some of the Monthly Six for my Year 10 top set [highest attaining 14/15 year olds] for occasional homeworks, as an alternative to homeworks from out of their textbooks."*
> Teacher in an English secondary comprehensive school.

"I was using NRICH for Booster classes long before the Government came up with the idea!!"
Teacher in an English urban primary school.

"Since discovering this site about 6 months ago I have downloaded problems and shared them with my students and my staff. Some of my staff have shared the problems with their students. Students have visited the site from their own computers."
Teacher in an Australian secondary comprehensive school.

"I use it to back up activities, or as an 'extra fun' item. The children enjoy the challenges, whatever their ability."
Teacher in an English rural primary school.

"Mostly, as a teacher, I just refer students to the site. Some have used it and even sent in solutions! Keep up the good work!"
Teacher in an English secondary comprehensive school.

"The reason that I do not recommend NRICH to my pupils is that it is an important resource for me to use in the class. There are very few maths resource books that contain interesting (for the pupils) investigations."
Teacher in an English suburban primary school.

Many of the teachers commented on **pupils reaction** to NRICH. Below are some typical examples:

"The more challenging exercises have gone down a storm. We will be using Bernard's Bag across the school next year!"
Teacher in an English suburban primary school.

"I use it [NRICH] as a resource for class problem solving and investigation lessons, changing the problems as needed to suit the children. The children enjoy the problems, and are enthusiastic about Maths as a result."
Teacher in an English rural primary school.

"Students think of these problems as 'real' and interesting - not like doing real work! Brilliant - if that's what they think, I'm all for it, especially when it produces fantastic results!"
Teacher in a rural English secondary comprehensive school.

"The children enjoy finding the problems on the internet and it gives their work an extra boost if they think they can send in their answers."
Teacher in an English urban primary school.

"The harder problems are personally rewarding to staff as well as students. I'd like to get my students to send in their answers, but they aren't always keen to write them up properly once they have solved the problem."
Teacher in a suburban English secondary comprehensive school.

"The problems have generated interest in Maths."
Teacher in an English private upper school.

Some of the teachers had suggestions for ways of **developing** aspects of NRICH. Some examples are given below:

"The monthly problems could perhaps be grouped into 2 problems for Primary (11-12 years old), 2 problems for Lower Secondary (13-14 years old) and 2 for Upper Secondary (15-16 years old). So that pupils of all ages can participate every month."
Teacher in a primary school in Singapore.

"I find NRICH to be a valuable resource of ideas, communication and resources delivered through the perfect medium. (and for many students a motivating medium). I would like to see, however, more material for the lower ability secondary students".
Teacher in an English secondary comprehensive school.

"A fantastic service that should not just focus on the more able. You have a good model in NRICH - I wish somebody would do as good a job for the whole range of abilities."
Teacher in an English secondary comprehensive school.

"More low achievers material would be appreciated."
Teacher in a rural English secondary comprehensive school.

Some teachers took the opportunity to report **difficulties** they had experienced or limitations on their use of NRICH. Below are some typical examples (not counting those who reported only limited internet access):

"My class love the puzzles etc and have tried to send in solutions only to find that you didn't receive them or they became scrambled - perhaps this could be made fool proof so children can do everything themselves and be successful and get a reply."
Teacher in a Japanese private preparatory school.

"I have attempted to register but have not received a reply."
Teacher in an English secondary comprehensive school.

"I use nrich spasmodically. I try and look at in during half-terms and holidays, otherwise I don't have the time. I find I don't have as much time within the curriculum as I would like to use some of the problems."
Teacher in an English private school.

"I think this is a wonderful site and I only wish I had more time to access it."
Teacher in an English suburban primary school.

"I would use this site more if I had quicker access to it in my classroom."
Teacher in an American suburban primary school.

The above teacher comments illustrate how important NRICH was to many of the teachers who responded to the questionnaire. The range of comments resonate with some of the outcomes of other components of this external evaluation. For example, a number of the teacher comments refer to the value attached to sending in solutions to the problems provided on the NRICH website, yet the website evaluation reported in the next section suggests that it is not at all clear from the website that solutions are welcomed, nor how (or where) these might be sent in to NRICH. A number of teachers referred to using NRICH mainly as a source of teaching ideas (and, in one case, the teacher admitted to preferring not to tell the class about the source!). Other teachers used NRICH problems with a wide range of pupils (one teacher commented, "I use 'Let

me try' with infants and low ability pupils very successfully."), or mentioned finding it difficult to fit in NRICH in a busy schedule or scheme of work. All these issues surfaced in the selected case studies reported in section 6 of this report.

4.3.5 **Summary of the teacher perspective**

The overwhelming majority of teachers who answered the questionnaire were from England. US teachers were the next highest category, but at less than 5% of the total.

Around a third of the all the teachers worked in secondary comprehensive schools. About the same proportion were from primary (junior or infant) schools. More than half the teachers worked for a local education authority. Around 10% were from private schools (over 70% of which were located in England). Most of the teachers worked in a suburban school. About half the teachers who worked in inner city schools (29 out of 67) worked in primary schools. The primary teachers tended to work in schools of between 200 and 499 pupils while the secondary teachers were evenly split between those who worked in schools of under 1000 pupils and those who worked in schools of over 1000 pupils. The overwhelming proportion of teachers worked in mixed schools (both boys and girls).

Many of the teachers (almost 30% of the respondents) had found NRICH through browsing the web. Just under 20% had learnt about NRICH from colleagues. Articles in journals and magazines, and inservice courses were also major sources. Most of the teachers were relatively new to NRICH, having only been accessing the website for six months or less.

The overwhelmingly majority of teachers accessed NRICH from home. Relatively few accessed NRICH (for their own use) in their classrooms. The NRICH facility most used by teachers was the 'resource bank' of problems. Sizeable proportions of teachers (around 40%) said that they never used 'ask NRICH', or any of the bulletin boards, or sent in pupils' solutions. Those relatively new to NRICH comprised half of the teachers who said that they never used these facilities, *and* almost exactly the same proportion who said they accessed these facilities either most days or most weeks.

Most of the teachers at primary, middle or preparatory schools accessed NRICH once a month or less. All the elements of NRICH aimed at such teachers were popular, with the mathematical problems having the slight edge. Teachers in secondary and upper schools accessed NRICH more often than their primary colleagues. The 'monthly problems' and the 'tough nuts' were especially popular, with around two-thirds of all secondary teachers accessing them at least once a month. Approximately half of all secondary teachers also checked the news and the articles at least once a month.

A clear majority of all the teachers (both primary secondary) looked forward to each new NRICH issue, with most being aware of the variety of NRICH facilities. While the majority said they mainly used NRICH as a source of problems for use in teaching with their classes, few said they primarily used NRICH for homework. Almost half said that they had encouraged pupils to access NRICH independently of school. Most teachers said that they did not have a Maths Club for pupils based around NRICH.

The teachers recommended NRICH not only to their more able pupils in mathematics but more widely. Nevertheless, a majority agreed (many strongly) that NRICH was particularly good for pupils who have a talent for mathematics. Almost 85% of teachers

agreed or strongly agreed that the NRICH website was well-designed, while only around 10% claimed to find the website difficult to use. Many teachers thought that NRICH made them feel that they could share issues with other mathematics teachers. Few teachers thought NRICH would be better as a printed magazine. Only a tiny proportion of the teachers who completed the questionnaire said that they were registered with NRICH.

A majority of teachers thought that using NRICH had made their pupils more interested in mathematics. About 15% of the teacher respondents added a comment to their questionnaire. Virtually every comment was positive and illustrated how important NRICH was to many of the teachers who accessed the site, and hence to their pupils.

4.4 *The Perspective of the 'Friends of NRICH'*

A total of 281 responses were received to the questionnaire addressed to the various 'friends of NRICH' (those respondents who classified themselves as neither school pupils or students, nor school or college teachers). As noted in section 3.3.1, close scrutiny was paid to the data in order to sift out, from the data for analysis, incomplete responses, unacceptable or frivolous responses, and multiple submissions from the same respondent. It was anticipated that a considerable number of incomplete responses to the questionnaires would be received. The close inspection of the original data was designed to improve the validity of the data set used for analysis and hence the reliability of any conclusions drawn from the analysis. The result of this process are given below in Table 37, showing that 67 responses were accepted for analysis.

Table 37: Responses to the 'friends of NRICH' questionnaire

total number of responses to the 'friends' questionnaire	281
unspecified in every field	36
unspecified in almost every field (at the most, three answers specified)	101
commented that they had only just found the site	63
clearly frivolous respondents (typically only a few responses given and these clearly not serious)	14
number of 'friends' responses accepted for analysis	67

The analysis that follows examines the following:

- who the 'friends of NRICH' are and where they live
- what the 'friends of NRICH' think of NRICH and its facilities and how it could be improved

The results are presented below in some detail. A summary is provided in section 4.4.3.

4.4.1 **Who are the 'friends of NRICH'?**

Most 'friends of NRICH' were parents (Table 38). Just under a quarter were adults interested in or studying mathematics.

Table 38: The types of 'NRICH friend'

a parent	31	46.27%
an adult interested in mathematics	15	22.39%
a lecturer in higher education	6	8.96%
an inspector	6	8.96%
a student teacher	5	7.46%
a school governor	2	2.99%
an adult studying mathematics	1	1.49%
not specified	1	1.49%
Total	67	100.00%

Over half of the 'friends of NRICH' lived in England (Table 39). The next largest group, although less than 15% of the total, resided in the USA.

Table 39: Place of domicile of 'friends of NRICH'

England	40	59.70%
USA	10	14.93%
Australia	4	5.97%
Wales	2	2.99%
Denmark	1	1.49%
India	1	1.49%
Isle of man	1	1.49%
New Zealand	1	1.49%
Oman	1	1.49%
Singapore	1	1.49%
not specified	5	7.46%
Total	67	100.00%

As with the teachers, most ‘friends of NRICH’ had found NRICH from browsing the web (Table 40). Colleagues, and articles in journals and magazines, were also important ways that they found out about NRICH.

Table 40: How the ‘friends of NRICH’ found out about the site

browsing the web	32	47.76%
a colleague	9	13.43%
an article in a journal	9	13.43%
a school teacher	4	5.97%
a family friend	2	2.99%
an INSET course	2	2.99%
another family member	2	2.99%
Gifted and Talented email group (Australia)	2	2.99%
a University lecturer	1	1.49%
recommended by National Association of Gifted Children	1	1.49%
reviewing NRICH for a professional teaching journal	1	1.49%
not specified	2	2.99%
Total	67	100.00%

Most of the ‘friends’ were relatively new to NRICH (Table 41). Almost 78% had been accessing NRICH for six months or less.

Table 41: How long the ‘friends of NRICH’ had been accessing the site

a month	33	49.3%
six months	19	28.4%
a year	9	13.4%
a year or two	1	1.5%
not specified	5	7.5%
Total	67	100%

Two thirds of NRICH's 'friends' access the site from home; one third from their place of work (Table 42).

Table 42: Where the 'friends of NRICH' accessed the site from

home	44	65.67%
work	21	31.34%
home and work	1	1.49%
University	1	1.49%
Total	67	100.00%

4.4.2 What the 'friends of NRICH' think of NRICH

All but one of the 'friends of NRICH' respondents indicated on the questionnaire how they made use of NRICH. Almost all the parents said that they used NRICH as a source of interesting mathematics to do with their own children. Four of the parents (two from England and two from the USA) said that they were educating their children at home, and two others said that they worked for an advice service or group for the home educated.

Amongst the comments from **parents** were the following:

> *"I look for interesting math problems for my 8 year old son. Not that he is a genius, but the usual additions and subtractions which he gets as homework bore him."*
> Parent from Oman.

> *"As educational fun for my 10 year daughter".*
> Parent from England.

> *"Me and my 10 year old son have a monthly contest as to who can answer the most questions correctly!"*
> Parent from England.

The adults interested in or studying mathematics used NRICH as a source of **interesting problems**. The comment below is typical of this category of 'friend if NRICH':

> *"I enjoy testing my very rusty knowledge on the problems".*
> An adult from England interested in mathematics.

There were also other uses made of NRICH. One adult was using the website as a source of mathematical ideas for their daughter who was just starting out as a newly qualified teacher in England. Other categories of 'friends of NRICH', such as University lecturers and local authority inspectors, were also using the site as a source of mathematical ideas.

More than 80% of the 'friends of NRICH' made some comment about what they liked about NRICH. The most commonly complimented aspects of NRICH, with comments

coming from all categories of 'friend', related to the range of activities, the **presentation** and the interaction facility. Below are some typical comments:

> *"Interesting problems, attractively presented, with variety each month. Good range of skills required in each set."*
> Parent from England.

> *"The problems are clear, thought provoking and fun."*
> Parent from England.

> *"It shows how maths can be presented in a positive, enjoyable and effective way".*
> School governor from England.

> *"The questions are stimulating and enjoyable and the range of difficulty admirable. The site layout is clear and easy to navigate, and pages load quickly."*
> Parent from England.

> *"The site is visually attractive, well organised, navigation seems straightforward. The breakdown amongst areas seems sensible. I like it very much that children can get into direct discussions with University students."*
> An adult interested in mathematics from England.

Several of the adults interested in mathematics mentioned the **personal growth** aspect. Below are examples of this type of comment:

> *"I enjoy the clear solutions for the mid-level problems and the articles."*
> An adult interested in mathematics from the USA.

> *"It fuels my interests in Mathematics and spurs me on to continue learning new methods of solving problems."*
> An adult interested in mathematics from Singapore.

Only one 'friend of NRICH' respondent mentioned the **more able pupil** in mathematics:

> *"It is suitable for gifted children. My daughter attends school and is significantly under-challenged, so she benefits by using it [NRICH] at home."*
> Parent from England.

Less than half of the 'friends of NRICH' chose to comment on ways in which they thought NRICH could be improved and a number of these were to the effect that they could not think of anything or that they had not been accessing NRICH long enough to properly suggest an improvement. The suggestions that were made included the following (in no special order):

- enrichment in science and English language
- having the problems translated into other languages
- a zipped (compressed) archive containing each month's pages, text and graphics, so these could be downloaded in one go and browsed later off-line
- information on new developments in Mathematics, eg solution found for Fermat's Last Theorem, etc

- regular e-mail message to users to inform them of a new edition, how harder puzzles are going, etc

4.4.3 Summary of the perspective of the 'friends of NRICH'

Most of the people who completed the 'friends of NRICH' questionnaire were parents. Just under a quarter were adults interested in or studying mathematics. Over half of the 'friends of NRICH' lived in England. The next largest group, although less than 15% of the total, resided in the USA. As with the teachers, most had found NRICH from browsing the web. Colleagues, and articles in journals and magazines, were also important sources of knowledge. Most of the 'friends' were relatively new to NRICH. Over three quarters had been accessing NRICH for six months or less. Two thirds of NRICH's 'friends' accessed the site from their home; one third from their place of work.

Almost all the parents said that they used NRICH as a source of interesting mathematics to do with their own children. Four of the parents (out of 31) said that they were educating their children at home, and two others said that they worked for an advice service or group for the home educated. Other categories of 'friends of NRICH', such as adults interested in mathematics, University lecturers and local authority inspectors, used NRICH as a source of mathematical ideas.

When asked what they liked about NRICH, all categories of 'friend' commented on the range of activities, the presentation and the interaction facility. The NRICH site was complimented as providing interesting problems and being attractively presented and easy to navigate. Only one 'friend of NRICH', a parent, specifically mentioned the suitability of NRICH for the more able pupil in mathematics. The 'friends' made a number of helpful suggestions for improving the NRICH service that might be profitably considered by the NRICH team.

4.5 *Registrations with NRICH*

Registration with NRICH is a straightforward process and is open to all. It brings additional benefits associated with the NRICH bulletin board system, an electronic message database where NRICH users can read or send messages. These messages are archived so that earlier messages can be read. Some parts of the NRICH bulletin board system are open to all. For some parts, users need to register. Straightforward instructions on how to register online at the NRICH website are provided at the site.

The NRICH bulletin board system has the following public areas available to any user of the NRICH website:

- Announcements: where the NRICH team post announcements of general interest.
- The Statue of Anonymous[10]: a 'moderated' facility for reading or joining in mathematical discussions. New topics for discussion can also be posted. All contributions are read by a member of the NRICH team before being posted on the bulletin board.

NRICH also provides several 'closed' (or semi-closed) discussion areas. In order to make full use of these facilities, NRICH users have to register. These discussion areas include:

- One-to-one: pupils wanting to discuss a problem can post a message. NRICH has a team of students studying mathematics at university who monitor this particular list and send a suitable reply. Only registered pupils can use this facility.
- Open discussion: anyone can read these discussions. Only registered users can post messages.
- NRICHtalk: only open to registered users.
- TeacherTalk: only open to registered teachers.
- TechTalk: similar to the Open discussions, anyone can read these messages. Anyone can post a message too, but those from unregistered users are vetted.

The NRICH project maintains a database of users that have registered with NRICH. A table of the cumulative totals of registrations are given below (Table 43). This data is also presented graphically in Figure 1 below. The data was provided by the NRICH project.

Table 43 shows steady a growth in registrations over the period October 1997 to October 1999. By October 1999, nearly 1400 pupils and just over that number of teachers had registered with NRICH.

[10] Named after a famous statue in Budapest where a group of school children with a serious interest in mathematics used to meet. A number of these children went on to become leading mathematicians of the 20th century, including Erdos, Turan, Tibor, and Szekeres.

Table 43: Registrations with NRICH (data supplied by NRICH)

Date/Month		Pupils	Pupils cumulative		Teachers	Teachers cumulative		Mature	Mature cumulative
Oct-97		42	42		26	26			
Nov-97		39	81		96	122			
Dec-97		37	118		46	168			
Jan-98		22	140		41	209			
Feb-98		17	157		41	250			
Mar-99		21	178		68	318			
Apr-98		52	230		38	356			
May-98		27	257		50	406			
Jun-98		21	278		29	435			
Jul-98		43	321		23	458			
Aug-98		7	328		8	466			
Sep-98		19	347		24	490			
Oct-98		123	470		95	585			
Nov-98		71	541		63	648			
Dec-98		38	579		46	694			
Jan-99		81	660		87	781			
Feb-99		60	720		54	835			
Mar-99		129	849		81	916			
Apr-99		34	883		52	968		7	7
May-99		59	942		56	1024		15	22
Jun-99		78	1020		55	1079		17	39
Jul-99		93	1113		71	1150		15	54
Aug-99		48	1161		49	1199		16	70
Sep-99		92	1253		126	1325		32	102
Oct-99		103	1356		113	1438		36	138

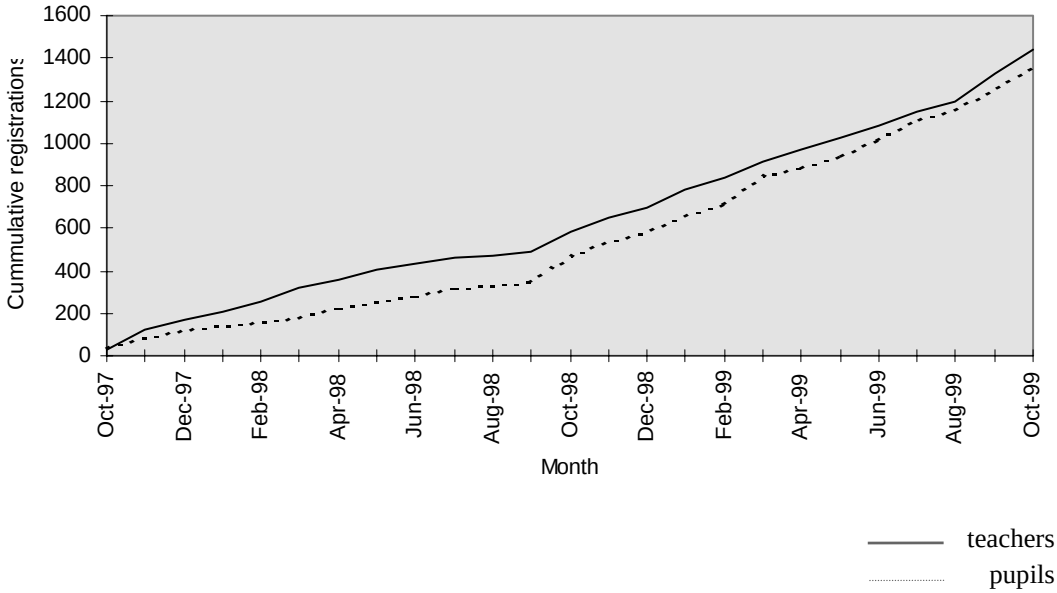

Figure 1: Cumulative NRICH registrations

4.6 *Summary of the Findings from the Questionnaire Data*

Analysis of the questionnaires revealed that most NRICH users (including pupils, teachers, and 'friends of NRICH', such as parents) lived in England. This was particularly true of teachers. Over two-thirds of all the pupils who accessed NRICH were boys. Approximately the same proportion was white. The next largest ethnic group was Chinese pupils. About half of all pupils accessed NRICH at school, usually in an IT room, with almost exactly the same proportion of the pupils accessing NRICH at home. There was no difference in this pattern of access between boys and girls.

The majority of teachers who accessed the NRICH site worked in the state sector; 10% were from private schools. Under half of the teachers worked in the primary or middle schools, with a slightly larger proportion from secondary schools (state and private). The majority of all NRICH users were relatively new to NRICH, having been accessing the website for six months or less; most accessed NRICH from home. The most frequent use of NRICH was as a source of interesting mathematical problems.

Nearly 1400 pupils, and just over this number of teachers, had registered with NRICH by October 1999. Most users of the NRICH site were not registered with NRICH. Only some of the registered users who accessed the site made much use of the bulletin board facilities. The NRICH site was complimented by all categories of user as providing interesting problems, being attractively presented and generally easy to navigate.

5. Website Evaluation

5.1 *Introduction*

This element of the evaluation involved submitting the NRICH site to critical review and comparing it to two other selected websites that also provide regular mathematical problems and/or some form of answering service. In addition, data from the log of accesses to the NRICH website are used to examine some aspects of the use of the NRICH site during the period September 1998 to August 1999.

5.2 *A Critical Review of the NRICH Website*

The website evaluation criteria used by the evaluation team to review the NRICH site were adapted from those described by Branch *et al* (1999), Coe and Land (1998), Shneiderman (1997), and by Testa (1998). The criteria cover the following:

- Authority
- Accuracy
- Currency
- Navigation and Design
- Applicability and Content
- Scope
- Audience Level
- Quality
- Awards

Associated with each of these factors is a list of questions that serve to focus the evaluative judgement. The full evaluative criteria are given in Appendix C.

A new design for the NRICH website was launched in July 1999. This critical review was undertaken both before and after the launch of the new design. Only the results of the review of the new design are presented below as the new design was a marked improvement on the old design and, now that the old design no longer exists, information on the old design is unnecessary. For each criteria, the NRICH website was examined using the questions given in Appendix C and a judgement made as to the rating of the NRICH site on a four point scale (unsatisfactory, satisfactory, good, high)

Authority: the NRICH website was judged to have a high authority rating. The source of the information is given, there is a statement of the aims and objectives of the site, the authors of the materials can be contacted and represent an established academic institution.

Accuracy: the NRICH website was judged to have a high accuracy rating. The material is from a reliable source. There is no advertising that might conflict with the aims of the site.

Currency: the NRICH website was judged to have a high currency rating. Material is updated monthly. The date of updating is clearly visible. Archives of past materials are well-maintained.

Navigation and Design: the NRICH website was judged to have a high rating for navigation and design. The resource is organised into manageable chunks of information that can be browsed easily. There is a contents column or index that describes what is contained within the site. There are good navigational links within the pages. Links are clearly labelled and images are used that support the navigation process. A search facility is available for both mathematical topic and keyword. Both online help and interactive help (for example, through e-mail contacts) are provided. Pages in a form suitable for printing are available when appropriate. There is some difference in design, feel, and navigation between the part of the site referred to as 'NRICHprimary' and the rest of the site which has the potential to interfere with easy navigation of the site.

Applicability and Content: the NRICH website was judged to have a high rating for applicability and content. The material is relevant to the intended audience and there is good coverage of the relevant content with suitable variation in how the content is presented.

Scope: the NRICH website was judged to have a high rating for scope. The purpose of what is included on the NRICH site is clear and matches the mission statement of the project.

Audience Level: the NRICH website was judged to have a good rating for audience level. Much of the site is clearly aimed at pupils, yet the part of the site referred to as 'NRICHprimary' has pages called 'teacher's notes'.

Quality: the NRICH website was judged to have a high rating for quality. The material is well-written with complex ideas introduced and discussed with clarity. Good use is made of illustrations and diagrams.

Awards: the NRICH website makes no mention of awards but then there are issues of authenticity associated with website awards. There may be as many as 800 possible different 'awards' that a website can be granted. There are no guarantees about the credibility of such awards.

5.3 ***Comparing the NRICH Provision***

There are many websites that provide mathematical puzzles, games and problems. The NRICH site itself, for example, lists 40 sites world-wide in its section of links to other mathematics sites. Not all these particular sites provides a comparable service to NRICH. One website, the (US) Math Forum, funded by the US National Science Foundation, has features called 'Problems of the Week' and 'Ask Dr. Math'.

The Math Forum's 'Problems of the Week' can be found at the following web address: http://forum.swarthmore.edu/pow/ The 'Problems of the Week' are designed to provide "creative, non-routine challenges for students in grades three through twelve. Problem-solving and mathematical communication are key elements of every problem." Separate problems are provided for elementary school pupils, middle school pupils, and, for high school students, on geometry, algebra, discrete mathematics, and

trigonometry and calculus. Solutions can be submitted and the website includes an archive of past problems and student solutions (categorised and searchable). The Math Forum claims that during the 1998-99 school year, more than 18,500 students submitted solutions to the 'Problems of the Week' with over 4,500 schools participating.

'Ask Dr. Math' is an answering service in which 'Dr. Math' replies to questions from pupils and their teachers about school mathematics. Questions can be about homework, puzzles, mathematics contest problems, or any other mathematical topic. The archive of past questions and answers is categorised and searchable. Categorisation is by school level then mathematical topic. The Math Forum claims that over 5,000 questions are already answered. The 'Ask Dr. Math' service does not promise to answer every question posed by pupils or their teachers.

A UK-based mathematics answering service is provided by 'Maths Help'. The aim of this website is to provide "free help and advice with problems in Mathematics and Statistics at GCSE, A-level, BTEC, GNVQ and Foundation year degree level". The website for 'Maths Help' can be found at the following web address:
http://www.maths-help.co.uk/index.html
The site claims to be run "by a partnership of experienced mathematics teachers who believe that the Internet has huge potential as a source of information and a means of communication in the field of education". They say that "other websites which offer help with maths tend to be based in universities, and often use university students to reply to the queries". They claim that using people who are not qualified teachers to reply to the problems can mean that the answers are "sometimes too technical and could go over the heads of the reader". Maths Help is available round the clock and aims to provide a response by e-mail within 24-48 hours. The professed mission of 'Maths Help' is to become "the website of choice for UK students of mathematics at upper secondary and tertiary level by September 2000".

Elements of the Math Forum's 'Problems of the Week' and 'Ask Dr. Math' were judged to be good or high on many of the website evaluation criteria. NRICH scored better in terms of navigation and design, and quality of the provision. The UK-based answering service 'Maths Help' scored poorly in terms of authority. It is unclear from the site who the authors are - only an anonymous 'webmaster' e-mail address is provided.

5.4 *NRICH Server Statistics*

Records of the 'hits' (in terms of requests for pages) on the NRICH website are archived by the NRICH server, as is other data (such as where visitors are accessing the site from, the files accessed or downloaded, errors and alerts, *etc*). The data are available on the NRICH website at the following pages:
http://nrich.maths.org/stats98.html
http://nrich.maths.org/stats-to-6Sep99.html

In this section, only the number of 'hits' on the NRICH server are considered. Even so, as mentioned in section 3.3.2, server log files are far from straightforward to interpret (Bertot *et al* 1997, Buchanan and Lukaszewski 1997, Stout 1997). For example, many internet providers route their internet traffic through 'proxy' or 'cache' servers so that the NRICH server logs do not easily or accurately trace the number of users, but rather

they reflect the number of accesses by the referring servers. As the number of 'cache' servers is continuing to increase, comparing statistics, even over the time scale of a year, may well not be reliable.

Table 44 below shows the total 'hits' for each month for the period September 1998 to August 1999. The same data is also presented in a line graph (Figure 2).

Table 44: Accesses to the NRICH site by month from September 1998 to August 1999

Month	NRICH website hits
Sep-98	16364
Oct-98	19074
Nov-98	34347
Dec-98	33547
Jan-99	25939
Feb-99	47648
Mar-99	76210
Apr-99	68387
May-99	87184
Jun-99	65599
Jul-99	82279
Aug-99	44661

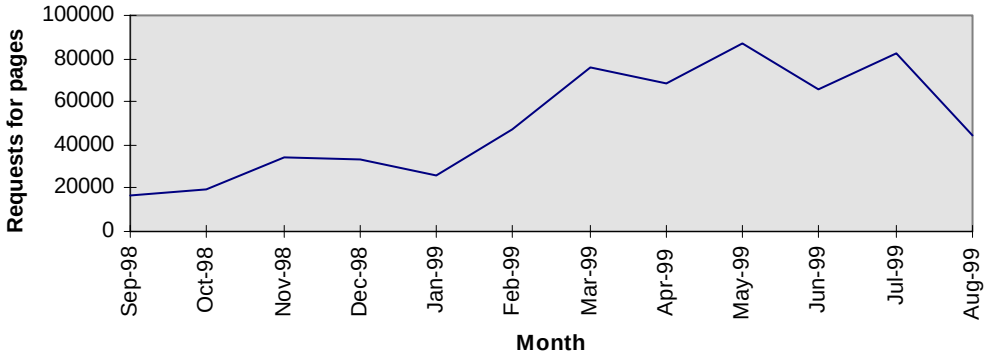

Figure 2: Accesses to the NRICH site by month from September 1998 to August 1999

The NRICH server statistics show that 'hits' on the NRICH site have risen from around 25000 a month to more than 60000 a month over the year from September 1998 to August 1999. This is likely to be the result of more people accessing the NRICH site more often. An unquantifiable element is also no doubt due to the increase in web 'browsing' as internet access becomes more common. The results from the questionnaires (section 4) indicate that most of those accessing the NRICH site to make use of the materials had been doing so for a relatively short time, with 'browsing the web' being the most common way of finding the site. The large number of incomplete questionnaire returns, which had to be eliminated from the analysis, may be a further indication that a proportion of the 'hits' on the NRICH site may be from browsers just happening on the site. As indicated above, though, the increasing use of 'cache' servers could just as well mean that the server logs underestimate the 'hits' on the site as

multiple uses accessing the site through the same ‘cache’ server do not show as separate ‘hits’.

At the time of writing, a new format of server log record has been made available on the NRICH site. This new format provides greater detail on the accesses to the NRICH site but uses a slightly different method of recording the ‘hits’ data. The result is slightly different data to that presented above. This is another example of how web site server statistics need to be treated with some caution. The new NRICH server statistics are at http://nrich.maths.org/logs/

5.5 *Summary*

The NRICH website was judged by the evaluation team to score highly on each of the website evaluation criteria. The new design of the site, launched in July 1999, was judged to be attractive, functional, easy to navigate, and contain high-quality materials. NRICH compared very favourably with other sites that provide mathematical puzzles, games and problems, and/or an answering service. The NRICH server statistics show an increase in accesses to the site which is likely to be the result of more people accessing the NRICH site more often.

6. Selected Short Case Studies

6.1 *Introduction*

This element of the evaluation provides additional evidence of the uptake, use, and ICT provision in schools that access NRICH. The evidence is in the form of three short case studies of schools where at least one teacher had been accessing the NRICH website for at least six months. Every effort was made to obtain a stratified random sample of such schools (the stratification being primary, secondary, and private school). However, for each stratification, the population from which the sample had to be chosen was too small for the sample to be considered properly random. Section 3.2.3 of this report describes in more detail how the selection of schools was made.

Five schools were visited, two primary, two secondary, and one private school, all in England. The schools were located in different types of area: inner-city, urban, suburban, and rural. Data were collected in the form of audio-taped interviews with teachers and pupils where possible, classroom observation notes where possible, and the records of e-mail conversations. Interview and observation schedules are given in Appendix D.

It did not prove possible to collect the same amount and quality of data in all five schools. Accordingly, short case studies are presented below of three schools, one of a primary school, one of a secondary school, and one of a private school. In each case, a draft of the case study description was checked by the teacher at the particular school for factual accuracy and to ensure that neither the individual school nor any individual teacher or pupil could be identified, the latter as part of the guarantee of anonymity for all those interviewed and observed.

6.2 *Case study 1: inner-city primary school*

This average-sized inner-city mixed primary school is surrounded by mostly 19th century housing in a densely populated area just south of the centre of a major UK conurbation. The socio-cultural and ethnic backgrounds of the pupils are very varied. A significant proportion of the pupils come from less affluent homes and around half are from black or Asian ethnic groups. Many of the pupils are eligible for free school meals. A significant number of pupils in each year group have special educational needs.

Although not a pilot school for the UK national numeracy project, the school began adopting the approach specified in the National Numeracy Strategy (NNS) about a year before this was required to be introduced. Interviews with the curriculum co-ordinator for mathematics and classroom observations showed that staff at the school employ a good range of teaching methods based around the three-part lesson stipulated in the NNS. Pupils are enthusiastic and well motivated. The results of national assessments in mathematics show that pupil attainment is close to being in line with the national average. The curriculum co-ordinator for mathematics works hard to support staff through advice and professional development opportunities. Lessons are carefully planned and make frequent and effective use of resources, including the use of

information technology when appropriate. Every class has a computer with a basic package of software. A newly developed ICT area is beginning to provide more sophisticated ICT opportunities for pupils including access to the internet. Teachers are generally confident about using ICT and pupils at all ages are keen and interested.

The school mostly uses NRICH as a source of ideas for extending its more able pupils in mathematics. The school's local education authority has encouraged its schools to develop provision for the more able for some time and the school is aware of the Government's 'Excellence in Cities' initiative (DfEE 1999) with its "gifted and talented children strand". The curriculum co-ordinator provides printed out copies of what she considers to be suitable problems for the various classes and individual class teachers choose from these as they see fit. Most of the teachers use the NRICH problems occasionally to 'stretch' the more able in mathematics when they have finished their regular classwork. A few NRICH problems have been incorporated into the school's scheme of work for mathematics. Some of the mathematical problems have also been the source of "off the cuff" surprise lessons which have enlivened the routines of both the teachers and their pupils. Occasionally a class has really taken to a particular problem and on one occasion a solution was sent into NRICH. The pupils in that particular class were very excited to see their solution published on the NRICH site.

With the school now connected to the internet, some pupils have accessed the NRICH site 'online' and this is seen as a good new facility. The curriculum co-ordinator for mathematics is concerned that software provision in mathematics in the school is not as good as she would like and the advantage of accessing NRICH is that the pupils are using a computer to do mathematics but without the cost associated with purchasing software. She would like to see the NRICH site being more 'interactive', and hence appearing to the pupil user to be more like a piece of conventional software, but appreciates that this might not be technically possible. The school has also been involved with an internet initiative sponsored by a major UK supermarket chain which made it relatively straightforward for the school to publish material about its locality on the world wide web. The curriculum co-ordinator wonders whether it would be possible for NRICH to develop the facility where pupils (or schools) could publish their solutions on the world wide web for other pupils (or schools) to see[11].

Although the curriculum co-ordinator is registered with NRICH she makes little use of the e-mail facilities, mostly through lack of time. None of the pupils at the school are registered as yet, primarily because use of NRICH, particularly online, is still something relatively new and online usage has associated costs and is not especially fast (the school does not have an ISDN line[12], for instance). The staff are currently somewhat wary of internet use by pupils that is not closely supervised. Parental permission is beginning to be routinely sought for all internet usage by pupils. The staff are also mindful of concerns about pupils of primary age corresponding with strangers by e-mail

[11] These opportunities are beginning in other school subjects. The Research and Graduate School of Education at the University of Southampton is home to *ScI-Journal*, an award-winning on-line publication for science students giving them the opportunity to publish work done in their school or college science classes so that other science students around the world can read it. The web address of *ScI-Journal* is http://www.soton.ac.uk/~plf/ScI-Journal/index.html

[12] Integrated Services Digital Network: an ISDN telephone line is digital and can carry far more information than a standard (analogue) UK telephone line. An internet connection via an ISDN line can appear to be up to four times faster than a connection through a standard (analogue) telephone line. Currently, an ISDN line costs far more to install and rent than a standard telephone line.

even when the authenticity of those ‘strangers’ is not really in doubt. As the staff become more experienced and more confident with using the internet they think that they will begin to use e-mail more.

Despite the curriculum co-ordinator’s comments on limited usage of NRICH, she does think that it has had some impact on the teaching and learning in the school. Class teachers look forward to seeing new interesting problems and the more able pupils have enjoyed the challenges and the opportunities, when these have been possible to arrange, to discuss their strategies and solutions with other children in the school of a similar level of attainment. Staff have also got together, on occasion, to discuss various NRICH problems and how children go about solving them. The curriculum co-ordinator would like to build on the use the school makes of NRICH but, she says, this has to fit with the school’s developing implementation of the National Numeracy Strategy (NNS). She has some concerns that the NNS means less opportunity for fitting in the sort of problems available through NRICH. She does have a clear picture of the developments she would like to make, but, she says she would like a little respite from Government initiatives and a period of stability in which to reflect further.

6.3 *Case study 2: suburban secondary school*

While this larger-than-average-sized 11-16 age-group mixed secondary school is located on the outskirts of a large village, it serves a catchment area that includes the commuter belt of a medium sized English city and a nearby large town. In effect it could be classified as a suburban school. The proportion of higher social class households in the area served by the school is above the national norm. There are few pupils at the school eligible for free school meals. Most of the pupils in the school are white, with a very few from other ethnic groups. There are few pupils with statemented special needs.

Mathematics is taught by a well-qualified, hardworking team in a specialist suite of classrooms. Classroom displays of pupils’ work and of aspects of mathematics and the work of mathematicians are of a very high standard. The department runs two extra-curricular mathematics clubs for pupils each week, one with a varied programme open to all pupils, one that focuses more on mathematical games and is aimed primarily at the less able pupil. Teaching quality is very high and planning at both classroom and departmental level is very thorough. Classes are set by attainment at entry to the school at age 11 and there is a detailed scheme of work for each of three attainment groups: the most able 10-20%, the intermediate level (most pupils), and the foundation level (the least able 10% or so). The results of the national attainment tests in mathematics at the end of Key Stage 3 (pupils aged 14) show performance is above the national average. At age 16, pupil mathematics attainment is generally in line with, and sometimes above, the national average. The higher attaining pupils have the opportunity to study for and enter the separate GCSE qualification in Statistics. Most of the school's pupils go on to further study at nearby 16-19 colleges.

Provision for information technology in the school is good overall, the school having recently acquired an impressive new ICT suite in a new specialist extension. The school is currently bidding to the Department for Education and Employment to become a specialist technology school (an annual competition bringing substantial additional funding). The suite of mathematics classrooms is some distance from the ICT suite and

the IT facilities within the mathematics area are somewhat dated with the machines available for pupil use not capable of internet access. The single computer located in the mathematics department office for staff use is more up-to-date but the mathematics area is not networked so internet access is not possible from there. The mathematics department makes good use of graphing calculators and a graph-plotting package available on the computers in the mathematics suite. Timetable pressure on the school's ICT suite is fairly intense which restricts spontaneous usage. The mathematics department's usage of the suite is quite innovative with a mathematics resources intranet[13] having been developed by staff giving pupils opportunity to search for information relating to various topics in mathematics.

The school's local education authority has encouraged its schools to develop provision for the more able for some time and the school has an 'able pupil policy' that targets the top 10-20% of each year group. The mathematics team is aware that the school has a few exceptionally able pupils in mathematics. While these pupils, themselves, do not wish to be publicly identified as 'exceptionally able', the department provides extension material as part of their top level scheme of work with the aim of broadening and deepening the understanding these pupils have of mathematics.

Mathematical problems taken from the NRICH website constitute just one source of material that contributes to that available to teachers to supplement the regular scheme of work. Other resources, both printed and internet-based, are also used as sources of supplementary extension material. One of the mathematics teachers in the department prints off what he considers to be suitable short problems or puzzles from the NRICH website, usually from his home, and these are shared with the other teachers in the department. This is usually done weekly and often generates enthusiastic and animated discussion at break time in the mathematics department office, particularly when an item presents a new way of approaching a standard topic. Some NRICH items have been incorporated into the various mathematics schemes of work, others are just added to extensive resource banks that teachers can draw on as they see fit. The more challenging problems and the 'tough nuts' are generally seen as things that take time away from an already crowded curriculum that already contains the right amount of such material. In general, NRICH is seen (and used) as a source of useful problems, not something that replaces what the mathematics department does in terms of 'publishing' pupil solutions, providing assistance to pupils, or running a mathematics 'club'. The department values NRICH greatly as a source of interesting problems, but only as one source amongst the many that the department uses to enliven its mathematics teaching and the mathematical experience of its pupils.

The teacher who prints off the NRICH materials is registered with NRICH but has found little need to access those additional NRICH facilities available to those who choose to register. On occasion, the NRICH site has been mentioned to interested parents at parental evenings and it is thought likely that some of them would have accessed the site. To date, and for the reasons outlined above, pupil usage of NRICH in the school is not extensive. The department does have well-developed plans to improve its own ICT resources, in which case more usage of NRICH may result. Such developments, however, depend on the availability of sufficient funding, and it is not yet clear to the department when such funds are likely to become available.

[13] An 'intranet' provides similar services *within* an organisation to those provided by the internet outside it, but without necessarily being connected to the internet

6.4 *Case study 3: small-town private school*

This medium-sized girls 11-18 private (fee-paying) school takes both day and boarding pupils and is located in an attractive, small market town. While a limited number of scholarships are available, most pupils come from families well able to afford the fees that the school charges. Entry to the school is competitive with examinations taking place in the January prior to entry to the school in the following September. Most of the pupils in the school are white, with a very few being from other ethnic groups. The school emphasises academic achievement in an atmosphere that is generally relaxed. Relationships between pupils and staff are polite but not overly formal.

Mathematics is taught by a well-qualified team of teachers in general classrooms. The school is not able to provide specialist mathematics classrooms and so the mathematics facilities within the classrooms are limited. None of the general classrooms have very much storage space nor are themselves equipped with computers. Mathematics teaching is relatively formal and focuses on techniques, skills and developing mathematical thinking. Most teaching is based on textbooks, with some practical work and use of ICT (both in the form of computers and graphic calculators) where this is seen to be useful. Over 90% of the pupils gain a grade C or above in GCSE mathematics at the age of 16, a much higher percentage than the national norm. The number of pupils opting to study mathematics at advanced level (A-level) in the sixth form (16-18 year olds) has increased in recent years, with up to 20% of students in the cohort taking the subject. The ‘Further Mathematics’ A-level only operates when there is demand and this does not happen every year. Each year around 95% of the students go on to University. In most recent years no more than one or two students have chosen to study mathematics or a closely related subject.

ICT facilities in the school have improved in the last five years or so with the development of an ICT room with internet access and the provision of a computer in the staffroom also with internet access. Staff and pupils are able to have their own school e-mail addresses.

Neither the school nor the mathematics department make specific additional provision for the exceptionally able, in mathematics or any other subject, above and beyond the specialist teaching provided for the top setted classes. Early entry for mathematics GCSE (at age 15 rather than 16) is being tried for the most able, with successful pupils likely to begin some A-level modules in the following year. The mathematics department runs a lunchtime mathematics ‘club’ for year 7 pupils (11-12 year olds) with a variety of activities such as mathematical models, games and codes. An annual mathematics event is organised for students in the sixth form (16-18 year olds) in conjunction with the private school for boys in the town.

One use made of NRICH is as a source of mathematical problems. The ‘monthly problems’ are displayed on a prominent noticeboard in the school, along with other news of a mathematical nature. As well as this, a ‘Puzzle of the Week’ of a more ‘soundbite’ nature is posted on the noticeboard (‘Penta Problems’ have been used as a source for this). Pupils are encouraged to submit a solution to the mathematics department with the attraction of a small prize. The mathematics department is trying a lunchtime ‘maths club’ for year 8 and 9 pupils (12-14 year olds) based around the NRICH problems, but only a small number attend, partly because of pressure of time in the lunch hour.

Pupils at the school are aware of the NRICH site and some have accessed it, mostly at school during breaktime or lunchtime access to the schools' ICT room. A few have accessed NRICH from home, but only once or twice. Pressure on the ICT resources within the school, and the large range of competing activities, means that pupil's own access to NRICH has been infrequent. The site is generally liked by pupils but for them it appears as only one computer usage out of many. Making the website more interactive so that problems could be solved online was one suggestion made that would improve the site in the eyes of the pupils. A few pupils have sent in solutions with one being published by NRICH the following month. Some pupils have registered with NRICH and one has made use of 'askNRICH' as a way of getting help on a particular problem on one occasion. She received a helpful reply about three days later.

Students studying mathematics in the sixth form (16-18 year olds) have been introduced, by one of the teachers, to the PASSMaths website, an online mathematics magazine aimed at a slightly older audience than NRICH that is now also a component of the Millennium Mathematics Project. These students found the site interesting but had not found occasion to return to it. They did make use of the internet in some of their studies, mainly as a source of information when they were asked to do research for one of their subjects. Examples of such internet access were given for science, geography and history. None of the students said they were ever asked to do such research for A-level mathematics as it was not that type of subject.

The teacher who accesses the NRICH site is registered with NRICH but rarely if ever makes use of any of the wider NRICH facilities. Of the e-mail messages that she receives from the NRICH bulletin boards, she finds she has not got enough time to read them all. She has not, as yet, made any contribution herself. She has only on rare occasions sent in pupil solutions to the NRICH problems.

The biggest impact of NRICH at the school has been on the staff. Puzzles have always formed part of the mathematics curriculum at the school, but the NRICH problems and puzzles have provided the staff with new and interesting ideas. That NRICH publishes monthly, in colour, and on the internet where it is accessible (and, unlike a magazine, does not get buried under other paperwork or in the boot of the car), is a further big attraction. Direct impact on pupils is judged to be more limited. The posting of weekly puzzles on the noticeboard has successfully raised the profile of mathematics in the school and some pupils are beginning to respond. The staff were pleased with what they have been able to achieve in the relatively short time (around 6 months) that they had been using NRICH and are grateful to the NRICH project for being a vital source of mathematical problems and puzzles for them.

6.5 *Summary of the selected short case studies*

Two of the teachers who were the main people interviewed for these three case studies had been accessing the NRICH website for about six months; the other teacher for a year or two. One had found NRICH from an article in a journal, one had been told about the NRICH website by a professional colleague not in the same school, and one had found the site while browsing the web. All three teachers were registered with NRICH but had made little, if any, use of the wider NRICH facilities.

All the three teachers made regular and often frequent use of the NRICH website. In two cases NRICH materials were primarily accessed as a source of ideas to support the

more able in mathematics (in one case as a major source, in the other as just one source out of many). In the third case, NRICH materials were used mainly to raise the profile of mathematics but this was in a school where most of the pupils were reasonably able in any case. In each school the NRICH materials had an impact beyond their usage with the most able as teachers discussed the problems and, when suitable, integrated the problems into their more general teaching.

Pupil usage of NRICH in the case study schools was much more varied. Only a few pupils in each school would be aware of NRICH and have accessed the site themselves. There was evidence of impact on some of the more able pupils, particularly in the two schools where special resources for such pupils were not in abundance. The impact was in terms of helping these particular pupils to gain a wider appreciation of mathematics and raising the profile of mathematics as a subject they could pursue either within school or outside school. None of the teachers were able to quantify the impact but all praised NRICH as a very valuable resource.

Overall, the evidence from the case studies suggests that to date, in schools where NRICH material is used, it has its biggest impact on teachers. It does this through regularly providing novel and interesting problems that often afford a new way of approaching a standard school mathematics topic.

7. Selected Case Profiles

7.1 *Introduction*

This fourth element of the evaluation was planned to be in the form of reasonably indepth accounts of the experiences of a small sample of pupils in accessing the NRICH website, particularly their experience in using the 'one-to-one' facility where they can talk over a mathematical problem with someone studying mathematics at university (one of the distinctive features of the NRICH website). As explained in section 3.3.4, in the event it proved quite difficult to make contact with such pupil users. Seventy pupils, who said on their questionnaire that they were happy to provide further information and gave an e-mail address, were contacted by e-mail. A total of five replies were received. Of these pupils, three were registered with NRICH and had used 'one-to-one' and perhaps some of the other NRICH bulletin board facilities. The other two replies were from pupils who were not registered and had never used any of the NRICH bulletin board facilities. Interview schedules for the e-mail conversations are given in Appendix E

With this small response rate it was impossible to carry out any random sampling of pupils. All that was possible was to enough data to present three very brief accounts (given below), one a home user of primary age, one a secondary school pupil who accessed NRICH from the school IT suite, and one a student at a 16-19 college who accessed NRICH at home. The accounts cannot be taken as representative of pupils and students who access NRICH.

7.2 *A Home User of Primary Age*

This pupil was 10 years old and attended a private preparatory school. The pupil accessed the NRICH site occasionally (mostly less than once a month) from home. The bulletin board facilities were also accessed less than once a month. The pupil found out about NRICH from a parent and was not recommended to try NRICH by a teacher. The pupil found NRICH much better than the mathematics at school where mathematics was not "fun" and there was no mathematics club for interested pupils. The pupil thought that accessing NRICH had made mathematics seem more interesting. The pupil was more likely to want to continue studying mathematics as a result of using NRICH.

The pupil had used 'one-to-one' several times and had very much enjoyed the exchanges with the University student who answered the queries. In each case, the replies were helpful and led on to further exchanges. The pupil greatly valued the opportunity of being able to partake in such exchanges. Few of the exchanges related to the mathematical problems provided on the NRICH site.

7.3 *A Secondary School Pupil*

This student was 16 years old and attended a secondary comprehensive school. The student accessed NRICH from the IT suite at school less than once a moth. The bulletin board facilities were also accessed less than once a month. The student had not been

recommended by a teacher to try NRICH but had found it while browsing the web. The student was unsure whether or not NRICH had made mathematics more interesting but it had raised the profile of mathematics as a subject worth continuing to study.

The student had used ‘one-to-one’ on a few occasions. The student’s queries were always related to the mathematics examination syllabus the student was following rather than anything to do with the problems appearing on the NRICH site. The replies invariably made the student want to ask more questions. The student was very appreciative of this NRICH facility.

7.4 *A Student at a 16-19 College*

This student was 17 years old and attended a tertiary college studying mathematics at advanced (University entrance) level. The student accessed NRICH at the college where online access was free for students. When the student had identified appealing mathematical problems, the NRICH site was accessed from home and print outs made of these problems (printing was cheaper from home than at the college). NRICH was used in this way by this student about once a month. The NRICH site was recommended to the student by a teacher but using NRICH had not made the student more interested in studying mathematics.

The student enjoyed tackling the more challenging problems but only rarely accessed any other part of the NRICH site. The student had made use of the ‘one-to-one’ facility on one occasion to ask a mathematical question not related to any of the NRICH problems. The student received a reply which was found to be very informative and said exactly what the student wanted to know. More often the student used the other bulletin boards (such as the ‘open discussions’ and the ‘Statue of Anonymous’) to pose questions or join in a discussion as the student was interested in replies from other students in the same position.

7.5 *Summary*

It was only possible to collect data on pupil usage of NRICH for three pupils. All three accessed NRICH no more than once a month. All three had found the ‘one-to-one’ facility helpful and informative, and often found themselves wanting to know more. All three valued the opportunity of being able to ask questions, although few of the exchanges they had through ‘one-to-one’ were related to the mathematical problems provided on the NRICH site.

8. Conclusions

8.1 *Introduction*

The objectives of the external evaluation were to assess how the use of the NRICH website facilities enhances the mathematical development of children who have the potential to go on to study mathematical subjects at university, how the features of the website are used by teachers to help meet the special educational needs of exceptionally able children in mathematics, and the particular contribution of Information Communications Technology (ICT) to the above. These objectives were derived from the aims of the NRICH project. In this section, evidence from the evaluation is used to draw conclusions on each of the objectives of the evaluation.

8.2 *The Impact of NRICH on Pupils*

Evidence from this evaluation suggests that pupils using the NRICH website facilities gained by having access to interesting mathematical problems. For some pupils, these mathematical problems were more stimulating than the mathematics they regularly did at school. Many pupils who accessed NRICH did so from home which is an indication that the NRICH materials are intriguing enough to attract pupils in their own time. Some pupils accessed NRICH quite frequently, another indication of the quality of the materials. Only a minority of pupils made use of the bulletin board facilities available through NRICH. Those that did so spoke highly of the service and how it stimulated further thought. These pupils particularly valued the opportunity of being able to ask mathematical questions and receive replies. Seeing their solutions published on the NRICH website was also popular with pupils.

Girls were under-represented as NRICH pupil users. Certain ethnic groups might also have been under-represented but the numbers of respondents was not sufficient to draw any firm conclusions. Data on the socio-economic class of pupils was not collected (for reasons outlined in section 3.3.1) but the large proportion of pupils who accessed NRICH at home is one indication of the socio-economic status of their families. Few pupils accessed NRICH through a public library or other public access location. The main impact of NRICH on the more able pupils was in terms of helping them to gain a wider appreciation of mathematics and raising the profile of mathematics as a subject that could be interesting enough to pursue either within or outside school or for further study. Quantifying this impact was beyond the scope of this evaluation.

8.3 *Teachers' use of NRICH*

Teachers mostly accessed NRICH to find problems to use in their teaching. Most worked in the state sector, began using NRICH relatively recently, accessed NRICH from their home, and were not registered (and thus did not have access to the NRICH bulletin boards). These teachers did recommend the site to their pupils and thought the site particularly good for those pupils who had a talent in mathematics. The teachers used a variety of approaches to meet the needs of their more able pupils. Some used the NRICH problems with groups of more able children withdrawn from their regular classrooms. Some teachers used NRICH problems as extension material once regular

classwork was complete. For some, NRICH was one resource amongst many. Only a few organised an extra-curricular mathematics club based solely around NRICH.

8.4 *The Contribution of ICT*

The contribution of ICT to both the enhancement of pupils' mathematical development and to how teachers made use of the NRICH facilities was associated with the functionality and accessibility of the NRICH site. The NRICH website was judged by the evaluation team to score highly in terms of aesthetic appeal, functionality, ease of navigation, and the quality of the content. NRICH compared very favourably with other sites that provided mathematical puzzles, games and problems, and/or an answering service. All categories of respondent to the questionnaires also complimented the NRICH project for the design and ease-of-use of the NRICH website. Teachers preferred NRICH as a web-based service rather than a printed resource. Being on the world wide web meant that NRICH was accessible (providing that internet access was available and the NRICH server was reliable) and, unlike paper, it does not get lost under other paperwork. The site can also give pupils the impression that they are using a piece of software, which, in some schools, was important.

Although most teachers did not use the bulletin boards nor send in pupil solutions, those that did valued these facilities very highly. The interaction that was possible through using information and communications technology was seen as a particular advantage of the NRICH project.

8.5 *Unexpected Outcomes*

One unexpected outcome of the evaluation was the limited number of completed questionnaires from registered NRICH users. The evidence from the evaluation indicates that there were some NRICH users who make frequent use of the NRICH website and some use of the NRICH bulletin boards. The majority of users, however, were relatively new to NRICH and were yet to make use of the wider NRICH facilities (such as the bulletin boards or sending in pupil solutions). It is unclear how many registered users were active users of NRICH.

The evaluation also suggests that NRICH may be having a wider impact than might be expected giving its mission. The evidence from teachers suggests that many used NRICH as a source of mathematical problems in their teaching rather than a resource solely or mainly for their most able pupils.

8.6 *Suggestions for the Future Development of the NRICH Project*

The evidence from the evaluation allows the evaluation team to highlight some issues that may be worthy of consideration by the NRICH project in order to inform its future development. The following suggestions are not in any order of importance or priority:

1. While the design of the NRICH site launched in July 1999 is a great improvement on the previous design, there remain differences between the 'NRICH primary site' and the 'main' site. For example, the primary 'site' has a 'staffroom' section and 'teachers notes' to accompany the mathematical problems, neither of which appear to be aspects of the 'main' site. There are also minor differences in terminology such as 'library' on the primary 'site' and 'archive on the 'main' site. Neither 'site' appears

to make any mention of parents. Some reconsideration of the intended audience for the various components of NRICH and the relationship between the components would aid the clarity of the NRICH website and should help new users to make best use of the material.

2. The NRICH registration process would benefit from some attention. While registering is relatively straightforward, there appears to be no clear way of how to change registration details (for example, when moving schools, or changing postal address or e-mail account), nor how to de-register. There is also no mention during the registration process of the (UK) Data Protection Act, how the data will be used (for example, that it will not used for unsolicited mailings, nor sold to a third party), or the security of registration process.
3. Pupils said that they liked seeing their solutions published on the NRICH site. Teachers asked for a simpler way of submitting solutions. The stance that NRICH takes to pupil solutions would benefit from a review. The current design of the site does not make it clear whether pupil solutions are welcomed nor how such solutions can be submitted. Some information is present but, at the time of writing, the details are not that easy to find.
4. Most pupil users of NRICH were boys. There was some evidence that particular ethnic groups might be under-represented as NRICH pupil users (although the numbers were too small to be at all certain about this). A large proportion of NRICH users accessed the site from home while access from public libraries was very low. The NRICH project might like to consider how it could reach those categories of users currently under-represented.
5. Usage of the NRICH site is likely to continue increasing. All categories of current user valued the NRICH website very highly. As internet access and levels of teacher competency grow, both word-of-mouth and links to NRICH from sites such as the UK Virtual Teacher Centre[14] are likely to increase the number of NRICH users. This means that it will become increasingly important to be able to predict the likely impact on various NRICH resources. These include technical issues such as the bandwidth and reliability of the NRICH server, but also human resources such as those required to answer queries, monitor the bulletin boards, review and select pupil solutions, as well as continue the NRICH publishing schedule.
6. Attention might be paid to the NRICH mission and to the aims, objectives, and method of the project now that it is entering a phase of further development. The aim of such a review would be to ensure a close match between the mission of the project, the facilities provided through the NRICH website, and the allocation of human and physical resources. Where possible, it would be helpful if objectives could be specified in a way that might make it possible to quantify outcomes.
7. The review of physical resources might include a consideration of recently developed, and relatively sophisticated, web server statistics software and web-based questionnaire software in order for the NRICH project to generate for itself quantifiable data to inform the ongoing development of the project.
8. A number of users made suggestions that the NRICH project might usefully consider. Amongst these suggestions were making the site more interactive so that some of the mathematical problems might be solvable on screen, providing a

[14] The UK Virtual Teacher Centre can be found at http://vtc.ngfl.gov.uk/

(compressed) version of each monthly edition so that these could be downloaded and viewed offline, and circulating registered members with a monthly e-mail giving the highlights for each edition.

8.7 *Closing Comments*

The NRICH site was highly valued by its users. One user commented that since internet resources are notorious for being present one day and gone the next, it was hoped that NRICH would be around long enough for users to make full use of the resource. It is likely that many current users, as well as potential future users, would agree with this sentiment.

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Appendix A: about the NRICH online mathematics project

The following notes are taken verbatim or near verbatim from the general description of the NRICH project provided on the NRICH site and the details of its aims, objectives and methods (see web pages http://nrich.maths.org.uk/mathsf/about.htm and http://nrich.maths.org.uk/mathsf/aims.htm).

NRICH is located at the University of Cambridge School of Education and is a partnership between the University of Cambridge Faculty of Education and the Royal Institution. It began as a research and development project and has become a component of the Millennium Mathematics Project (MMP) a new national initiative, based in Cambridge, UK. The URL for the NRICH website is http:\\nrich.maths.org.uk

The NRICH Mission Statement
The project aims to establish a permanent national centre for curriculum enrichment to provide mathematical learning support for very able children of all ages. The learning and enjoyment of mathematics will be promoted through an Internet Newsletter and the participation of university students as peer teachers providing an electronic answering service. The centre will offer support, advice and inservice training to teachers, and resources for mathematics clubs.

The aims of NRICH

1. To pave the way for the establishment of a permanent national UK Mathematics Enrichment Centre.
2. To raise the standards of achievement in school mathematics, to promote the mathematical development of children who have the potential to go on to study mathematical subjects at university, and to support the special educational needs of exceptionally able children.
3. To extend the provision of the Royal Institution Mathematics Masterclasses by providing continuous and sustained support for children so that they can participate wherever they live or go to school as individuals or as members of a school mathematics club.
4. To develop the use of Information Communication Technology to provide interactive links to the centre and to facilitate links between schools and also between individual children.
5. To extend peer assisted learning into a distance learning mode and so to contribute to the personal and cognitive development of both the pupils and the peer teachers.
6. To promote and support the setting up of locally organised user groups and mathematics clubs by providing resources on the Internet, and offering advice and inservice training for teachers.
7. To conduct research into the effect of communication technology and peer assistance on the quality of learning for very able pupils, on the quality of teaching offered by schools, on the cognitive gains for peer teachers and learners, and on the development of increased usage of IT in mathematics teaching.

Method

1. The project will advance the development of mathematical thinking and language, and emphasise the importance of proof, through Internet Newsletters providing a regular fresh supply of mathematical challenges and problems, together with solutions contributed by the children.
2. The NRICH Maths Centre will provide an electronic answering service whereby young people will be able to ask mathematical questions which will be answered personally by students from the University of Cambridge. Quality control will be exercised through rigorous selection and training of volunteers, and through checking samples of question and answer exchanges.
3. All services of the NRICH project are freely available to all schools throughout the UK[15].

[15] In fact, registration with NRICH is free to schools anywhere and to pupils and others at home or wherever.

Appendix B: website impact questionnaires

This appendix contains copies of the three questionnaires mounted on the NRICH website during May 1999 (from 1 May 1999 to 6 June 1999). Being web-based questionnaires, for many of the questions respondents could choose their responses from drop-down menus or 'click' a mouse button to make their choice. Questionnaire responses were stored electronically and the results converted to computer files suitable for analysis using a spreadsheet.

The three questionnaires are aimed at the following groups and appear in this appendix in that order:

- school or college teachers
- school pupils or students
- those who categorise themselves as neither a school or college teacher nor a school pupil or student

Evaluation of NRICH

NRICH has asked the University of Southampton to conduct an independent evaluation of the NRICH online mathematics project. The aim is to provide information to NRICH in order to further develop the project.

Your help is much appreciated in spending a few minutes completing this questionnaire.

All individual responses will be kept strictly confidential.

For most of the questions you choose from a drop-down menu.
To change an answer, click on another choice

Please choose one of the following:

- I am a school or college teacher
- I am a school pupil or student
- I am neither a school teacher nor a school pupil or student

Notes
1. On the web-based versions of these questionnaires the options above were hypertext buttons that led to the different versions of the questionnaire.
2. The web-based questionnaires that follow used drop-down menus for questions 1-9. The default choice was "choose" which was recorded as a nil-response.

Teacher questionnaire (school or sixth-form teachers only please)

For many of the questions you choose from a drop-down menu.
To change an answer, click on another choice

First some questions about your school or college

1. Country
   - England
   - Northern Ireland
   - Scotland
   - Wales
   - Another country - please specify

2. Type of School
   - primary (infant or junior)
   - middle
   - secondary comprehensive
   - secondary selective
   - 16-19 college
   - private (preparatory)
   - private (upper)
   - other - please specify

3. School status (*only for UK schools please*)
   - LEA
   - grant maintained
   - voluntary aided or controlled
   - further education
   - private
   - other - please specify

4. School location
   - inner-city
   - urban
   - suburban
   - rural

5. Number of pupils
   - less than 200
   - 200 - 499
   - 500 - 999
   - 1000 or more

6. Pupils or students
   - boys
   - girls
   - mixed (all years)
   - mixed (some yeargroups) - please specify

Now some questions about **your own use** of NRICH

7. How did you first learn about NRICH?
   - a colleague
   - a leaflet
   - an article in a journal
   - an INSET course
   - from browsing the web
   - by another means- please specify

8. How long have you been using NRICH?
   - a month
   - six months
   - a year
   - a year or two
   - more than two years

9. Where do **you** usually access the NRICH site from?
   - school library
   - school staffroom
   - departmental office/room
   - own classroom
   - IT suite
   - home
   - elsewhere - please specify

If you access NRICH from more than one place, please explain

10. How often do **you** use the following NRICH facilities

	most	most	once a	less	never

	days	weeks	month	than once a month	
Ask NRICH (answering your mathematical queries)	o	o	o	o	o
Emailing list or askNRICH (to follow mathematical discussions)	o	o	o	o	o
Primary Site: Bernard's Bag	o	o	o	o	o
Penta Problems	o	o	o	o	o
Let Me Try	o	o	o	o	o
Kids Mag	o	o	o	o	o
Staff Room	o	o	o	o	o
Main Site: News	o	o	o	o	o
Articles	o	o	o	o	o
Monthly Six Problems	o	o	o	o	o
More Challenging Problems	o	o	o	o	o
Play Games (Primary) or Games (Secondary)	o	o	o	o	o
Resource Bank/Library (stored problems etc. search, and links to other sites)	o	o	o	o	o
Send in your pupils' solutions	o	o	o	o	o

11. Please say how far you agree or disagree with each of the following statements

	Strongly agree	Agree	Disagree	Strongly disagree	don't know
The NRICH website is well-designed	o	o	o	o	o
It is difficult to find what you are looking for on the NRICH website	o	o	o	o	o
I don't have the time to use the *ask NRICH* bulletin board	o	o	o	o	o
One-to-One (ask a mathematician) is the best facility provided by NRICH	o	o	o	o	o
NRICH makes me feel I can share issues with other teachers	o	o	o	o	o
I always look forward to new NRICH monthly editions	o	o	o	o	o
I never read the articles on the main site	o	o	o	o	o
The problems are the best part	o	o	o	o	o
Sending in solutions is too time consuming	o	o	o	o	o
The Resource Bank/ Library is the only part of NRICH I regularly use	o	o	o	o	o

12. Please say how far you agree or disagree with each of these statements

	Strongly agree	Agree	Disagree	Strongly disagree	don't know
I mainly use NRICH as a source of problems to use in my teaching with my classes	o	o	o	o	o
I never suggest to any of my pupils that they access NRICH independently	o	o	o	o	o
My school has a maths club based around the NRICH facilities	o	o	o	o	o
I only recommend NRICH to the most able pupils in my classes	o	o	o	o	o
I mostly use NRICH for setting homework	o	o	o	o	o
My pupils will never have heard of NRICH	o	o	o	o	o
NRICH is particularly good for those pupils of mine that have a talent for mathematics	o	o	o	o	o
There is no advantage for NRICH to on the www. It would be better as a printed magazine.	o	o	o	o	o
NRICH is just an entertaining pastime, it is not an important way for me to develop my pupils' mathematics	o	o	o	o	o
Using NRICH with my pupils has made them more interested in mathematics	o	o	o	o	o

Is there anything else you wish to add which indicates how you use NRICH and what value you think it has?

And finally, please indicate if you are

- registered with NRICH. My NRICH ID, if known, is

(this information will only be used to count responses from NRICH members)

- happy to be contacted by e-mail to provide further information

My e-mail address is

Before clicking on Questionnaire complete, please check that you have not accidentally missed a question.

Thank you for your help.

A summary of the evaluation will be published on the NRICH website.

Questionnaire complete

Pupil or student questionnaire
For many of the questions you choose from a drop-down menu.
To change an answer, click on another choice

First some questions about where you go to school or college

1. I live in
   - England
   - Northern Ireland
   - Scotland
   - Wales
   - Another country - please specify

2. My school is
   - primary (infant or junior)
   - middle
   - comprehensive
   - grammar
   - 16-19 college
   - private (preparatory)
   - private (upper)
   - other - please describe

3. My school or college is
   - in a large city
   - in a small town
   - in the countryside

4. The pupils or students in my school or college are
   - boys/male
   - girls/female
   - both male and female

Now some questions about your use of NRICH

5. I usually use NRICH when I am
   - in the school library
   - in my mathematics classroom
   - in another classroom (not mathematics)
   - in the IT room
   - at home
   - in the public library
   - elsewhere - please say where

   If you access NRICH from more than one place, please explain

6. How often do you use the following parts of NRICH?

	most days	most weeks	once a month	less than once a month	never
Ask NRICH (answering your mathematical queries)	o	o	o	o	o
Emailing list or askNRICH (to follow mathematical discussions)	o	o	o	o	o
Primary Site: Bernard's Bag	o	o	o	o	o
Penta Problems	o	o	o	o	o
Let Me Try	o	o	o	o	o
Kids Mag	o	o	o	o	o
Staff Room	o	o	o	o	o
Main Site: News	o	o	o	o	o
Articles	o	o	o	o	o
Monthly Six Problems	o	o	o	o	o
More Challenging Problems	o	o	o	o	o
Play Games (Primary) or Games (Secondary)	o	o	o	o	o
Resource Bank/Library (stored problems etc. search, and links to other sites)	o	o	o	o	o
Send in my own solutions with the help of a teacher	o	o	o	o	o
Send in my solutions on my own	o	o	o	o	o

7. Please say how far you agree or disagree with each of the following statements

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	don't know
The NRICH website is well-designed	o	o	o	o	o	o
It is difficult to find what you are looking for on the NRICH website	o	o	o	o	o	o
The *ask NRICH* bulletin board is difficult to use	o	o	o	o	o	o
One-to-One (ask a mathematician) is the best facility provided by NRICH	o	o	o	o	o	o
NRICH makes me feel part of a mathematics club	o	o	o	o	o	o
I always look forward to new NRICH monthly editions	o	o	o	o	o	o
I never read the articles	o	o	o	o	o	o
The problems are the best part	o	o	o	o	o	o
I don't understand why games are included. Games are not mathematics.	o	o	o	o	o	o
I like seeing my solutions published on the world wide web	o	o	o	o	o	o

8. Please say how far you agree or disagree with each of these statements

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	don't know
My teacher suggested that I try NRICH	o	o	o	o	o	o
NRICH is better than the mathematics I do at school	o	o	o	o	o	o
My school has a maths club where we always use NRICH	o	o	o	o	o	o
I usually find mathematics easy	o	o	o	o	o	o
I never use NRICH in school	o	o	o	o	o	o
I always work with a friend on NRICH problems	o	o	o	o	o	o
I find all the NRICH problems too hard	o	o	o	o	o	o
Using NRICH has made me more interested in mathematics	o	o	o	o	o	o
My friends think I am mad to like NRICH	o	o	o	o	o	o
Using NRICH has made me think that I would like to continue studying mathematics	o	o	o	o	o	o
I would prefer NRICH to be a printed magazine	o	o	o	o	o	o

Is there anything else you wish to add which tells us how you use NRICH and what you think of it?

Now some questions about you.

9. My age is:

10 I am a
- boy/male
- girl/female

11. I am
- White
- Black - Caribbean

- Black - African
- Black - Other
- Indian
- Pakistani
- Bangladesh
- Chinese
- Other Asian groups
- Other groups

And finally, please indicate if you are

♦ registered with NRICH. My NRICH ID, if known, is

(this information will only be used to count responses from NRICH members)

♦ happy to be contacted by e-mail to provide further information

My e-mail address is

Before clicking on Questionnaire complete, please check that you have not accidentally missed a question.

Thank you for your help.

A summary of the evaluation will be published on the NRICH website.

Questionnaire complete

Questionnaire for friends of NRICH

For many of the questions you choose from a drop-down menu.
To change an answer, click on another choice

First some questions about you

1. I am
   - a parent
   - a lecturer in higher education
   - a local education authority advisor
   - an inspector
   - a school governor
   - an adult studying mathematics
   - an adult interested in mathematics
   - a student teacher

2. I live or work in
   - England
   - Northern Ireland
   - Scotland
   - Wales
   - Another country - please specify

3. I heard about NRICH from:
   - a colleague
   - another family member
   - a leaflet
   - an article in a journal
   - an INSET course
   - from browsing the web
   - by another means- please specify

4. I have been accessing NRICH for
   - a month
   - six months
   - a year
   - a year or two
   - more than two years

5. I usually access NRICH from
   - work
   - home

- elsewhere - please specify

Please indicate how you use NRICH

Please tell us what you like about NRICH

Please tell us what could be improved

And finally, please indicate if you are

♦ registered with NRICH. My NRICH ID, if known, is

(this information will only be used to count responses from NRICH members)

♦ happy to be contacted by e-mail to provide further information

My e-mail address is

Before clicking on Questionnaire complete,
please check that you have not accidentally missed a question.

Thank you for your help.

A summary of the evaluation will be published on the NRICH website.

Questionnaire complete

Appendix C: website evaluation criteria

The website evaluation criteria below were adapted from those described by Branch *et al* (1999), Coe and Land (1998), Shneiderman (1997), and by Testa (1998) and cover the following:

- Authority
- Accuracy
- Currency
- Navigation and Design
- Applicability and Content
- Scope
- Audience Level
- Quality

The categories are not entirely discrete; there is inevitably some overlap.

1. AUTHORITY

- Is the information credible and of high quality?
- Is the information objective?
- Is the author clearly identified?
- What are the author's professional affiliations?
- Can the author be contacted?
- Is this the official site of an organization or association?

2. ACCURACY

- Is the information correct?
- Does any advertising create a possible conflict of interest?

3. CURRENCY

- How frequently is the site updated with new information?
- Are different parts of web sites updated at different times?
- Is the date of updating clearly visible?

4. NAVIGATION AND DESIGN

- Does the site function well and allow the user to progress logically through the information?
- Does the arrangement of elements when viewed in a browser window serve to make the purpose of the site clear?
- Are there enough internal links?
- Are the links to other resources kept up to date?
- Are all the links relevant to the nature of the site?
- Is the content presented in an orderly manner?
- Does the design promote understanding of the content?
- Is a text-only version available?
- Is the overall design ‘user friendly’?
- Is the overall design of the site aesthetically pleasing?

- Is there a search facility?

5. APPLICABILITY AND CONTENT

- Is the content relevant?
- Is the content coverage sufficient?
- Is the purpose of the content clear?
- Is there variation in how the content is presented?

6. SCOPE

- What is included?
- What is the purpose of what is included?
- Does the site match its own mission or scope statement?

7. AUDIENCE LEVEL

- Is the intended audience clear?
- Is all the material presented consistent with the intended audience?
- Is the site slow to load?
- Are all parts of the site easily accessible?

8. QUALITY OF WRITING

- Does all the text follow the essential conventions of spelling and grammar?
- Is the use of unnecessary jargon kept to a minimal?
- Are complex ideas introduced and discussed with clarity?
- Is humour used effectively?

9. REVIEWS

- Has the site won any awards?

Appendix D: case study interview foci

During the preparation of the case studies, the following foci were used to inform the interviews and classroom observations, and the e-mail conversations:

1. General information on the school and its pupils.
2. The approach to mathematics teaching.
3. The use of ICT in mathematics teaching
4. Details of examination entries and number of students going on to study mathematical subjects at university (if appropriate).
5. Details of any provision for exceptionally able students in mathematics
6. Use of NRICH
7. Evidence of possible impact of NRICH on mathematics teaching and learning

As far as was possible, school visits included the following:

1. Time to talk with the teacher contact (the teacher who completed the NRICH teacher questionnaire).
2. Time to observe some mathematics lessons to gain insight into the approach to the teaching of mathematics used in the school.
3. Time to see the ICT resources.
4. If appropriate, time to interview some pupils (with the contact teacher, or another teacher, present) who have accessed NRICH themselves or made use of any NRICH facilities.

Appendix E: case profile interview schedule

Interviews with the case profile pupils were planned as conversations to be conducted by e-mail. The schedule for the interviews were planned to be conducted along the following lines:

1. Use of the ‘One-to-One’ facility on the NRICH site where help with a mathematical problem can be obtained:

    has the pupil used ‘One-to-One’?

    if yes, when was last time?

    what was the nature of your problem?

    what sort of reply was received and how long did it take to get a reply?

    was the reply helpful?

    has ‘One-to-One’ been used more than once?

    if so, how often?

2. Use of any other NRICH bulletin Board facility?

    what other NRICH facilities have been used?

    for what purpose?

    how are the other facilities different to ‘One-to-One’?

University of Southampton Centre for Research in Mathematics Education

The Centre for Research in Mathematics Education (CRME) is a research centre of the University of Southampton, UK. Active members of the centre come from the Research and Graduate School of Education and the Faculty of Mathematical Studies.

Work in mathematics education at the University of Southampton has had a national and international reputation for almost forty years. Activities of the centre include research and curriculum development in mathematics education and professional development opportunities for teachers and other education professionals. The Centre has close links with the School Mathematics Project, which began as a University research project in 1963.

For more information on the work of the centre, please contact The Director, Centre for Research in Mathematics Education, School of Education, University of Southampton, Highfield, Southampton SO17 1BJ, United Kingdom. or visit the canter's website: http://www.crme.soton.ac.uk

Selected Recent Publications

Davis, G., Pearn, C., Price, G. and Smith, K. (1997), Connections between Counting and Reading. Paper presented at *SEMT 97, International Symposium on Elementary Mathematics Teaching. The Evaluation of Elementary School Mathematics*. August 24-29, 1997 Prague, The Czech Republic.

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Online Mathematics Enrichment: an evaluation of the NRICH project 1998-99

Keith Jones
Helen Simons

This is the full report of the independent external evaluation of the third year of the development phase of the NRICH online mathematics project, conducted by an evaluation team from the University of Southampton, under contract to the University of Cambridge, UK, as represented by the Millennium Mathematics Project.

Each month (except August) the NRICH project publishes new web-based 'magazines' aimed at school students of all ages who are interested in mathematics, but especially the more able. The emphasis is on mathematical activity through mathematical problems, puzzles and games. Children's solutions to mathematical challenges are also included. NRICH also provides an e-mail answering service where children can get help and a number of special-interest e-mail discussion groups, both for children and for teachers. The evaluation focused on how the use of the NRICH website facilities enhances the mathematical development of children and how the features of the website are used by teachers to help meet the needs of exceptionally able children in mathematics. The report presents an analysis of questionnaires completed by pupils, teachers, and other interested parties (such as parents) who access the NRICH website, a critical review of the NRICH website, and selected case studies of school, classroom and pupil use of the NRICH project facilities.

ISBN: 085432 701 0

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