

BRLSI Researchers: Enthusiastic enquirers into science, learning and life

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Abstract

This multimedia publication recounts the learning journeys of a group of teenagers and the postgraduate research students and project leaders they worked with as participants in the first Bath Royal Literary and Scientific Institution (BRLSI) Researchers Programme.

The Young BRLSI programme aims to raise aspirations and knowledge of Science, Technology, Engineering and Mathematics (STEM) research and engender an interest and confidence in young people to undertake self-directed, passion-led, co-creative and hands-on learning. In addition it offers an opportunity for students and members of the community to practice and improve their communication skills, particularly with reference to STEM.

The BRLSI Researchers project forms part of the Young BRLSI programme, and brings self-selected young people and post-graduate young people researchers together to enjoy challenging workshops that provide fun learning opportunities. The BRLSI Researchers programme came from an approach by two young people who had been to many of the Young BRLSI workshops and wanted a greater challenge to support their progress as researchers. At the same time, the University of Bath (UoB) Public Engagement Unit was seeking to facilitate high quality public engagement, embedded across links between their research and the public.

The BRLSI Researchers programme provided a context in which everyone was equally valued in their ability to provide help and support for other people to learn, as well as for taking control of their own learning. In addition to sharing and developing STEM knowledge and research skills, the intention was to encourage all participants to develop their ability to work in a team, gain confidence to organise and present their learning, recognise themselves and act as an expert knowledge-creating researcher, learn more about themselves and contribute useful knowledge to the community. In addition, the postgraduate students developed their skills as research supervisors and mentors.

All the postgraduate students were recruited from the UoB's Department of Architecture and Civil Engineering. Therefore the young researchers were encouraged to focus their enquiries on the built environment. Their research covered a variety of themes relevant to local communities, such as: the causes of the 'black crust' which disfigures the surface of the city's iconic building material (Bath stone); how to encourage local people and visitors to take a greater interest in the urban environment and its history; the development of alternative building materials and an effective way of nudging householders into reducing energy consumption.

The journey has only just begun. But for all of the participants it has already been a life changing experience.

Preamble.

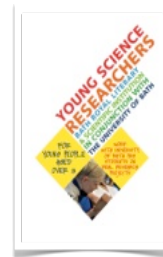


'BRLSI Researchers: Supporting enthusiastic enquiries into science, learning and life'

This project has involved developing educational practice, which puts the young person and their interests at the centre of learning.



BRLSI Youth, in collaboration with the University of Bath's Public Engagement Unit and Department of Architecture and Civil Engineering, secured a small EPSRC grant to pilot an innovative educational opportunity for young people (13yrs+) researching the Built Environment and developing their reflective research journals supported by PhD/Post-Doctoral students.



Participants met monthly for 7 months to develop their research, devise experiments to test their hypotheses, implement experiments and analyse results, as they would in a university context.

The PhD/Post-Doctoral students acted as research supervisors and the young people as researchers.

The sessions included time for reflection, 'supervision', participation in a research group, introducing skills researchers need to be effective, and opportunities to present to an audience.

All participants in the project learned from, and with, others.

The young researchers developed their knowledge of themselves, what it is to be a researcher, deepened their understanding of their own learning processes, and developed their confidence and ability to generate and research questions of interest to them. The PhD/Post-Doctoral students refined and deepened their educational practice and understanding of supervising knowledge creating research, communicating and sharing knowledge, and supporting learning. The project leaders researched their educational influence in learning and this innovative educational opportunity to improve it.

In autumn 2014, Paul Thomas, the originator and convener of Young BRLSI, in collaboration with Paul Shepherd of the Department of Architecture and Civil Engineering of the UoB, and with support from the UoB Public Engagement Unit, secured a small grant from the EPSRC research council. The purpose was to enable young people and postgraduate students to work together, to develop their expertise and knowledge as expert science researchers and life-long learners, by researching questions of personal interest. It was also an opportunity to research the educational implications of a practical expression of the Young BRLSI philosophy.

The plan was for a project to offer 6 monthly workshops and to culminate in a mini conference where the research could be presented. As with all good plans, the project evolved, and continues to do so, fuelled by the knowledge and understandings created. The story of the project is told through the accounts of some of the research and the learning of the participants.

As researchers we have a responsibility to contribute to the edification of others and ourselves by making our knowledge publically accessible. This publication is one of many forms we are using to communicate to a wide and diverse audience. This publication has been created for an audience of those with an enthusiasm for developing learning opportunities for young people and postgraduate students as life-long learners contributing to and benefitting from their own learning and that of others.

We hope that this publication will:

- Commemorate what we did, how we did it and what we learned
- Disseminate our work, not only our findings, but also our journeys as researchers
- Allow people to learn from what we have done to improve what they are doing
- Influence educators' and academics' educational practice.

We begin by setting the scene in Part 1 by introducing the principle participants, the context, history and aims of the project. In Part 2 we describe briefly what happened session by session. So the flow of our narrative is not interrupted we provide extra documentation in the Appendix. In Part 3 we each present some of what we have learned. We conclude in Part 4 with the rationale underpinning the project, our evaluation, key points of learning that have emerged through the project and implications for possible future developments.

The success of our efforts to make our knowledge publically accessible can only be known over time. It will be evidenced by whether or not our account stimulates your imagination and contributes anything to your efforts to improve educational experiences and learning as you develop your own science and educational research projects. How could we improve our account? What are you doing that we could learn from? We would really love to hear from you – coolbookings@brlsi.org

Part 1 Setting the Scene

We begin by introducing participants and then telling you something of the history and mission of the Bath Royal Literary and Scientific Institution, Young BRLSI and the BRLSI Researchers project.

1.1 Main Participants

Project team

Paul Thomas, BRLSI Researchers Project Leader and 'Young BRLSI' Convenor: Graduate of Oxford, Bristol and Exeter Universities. Retired writer, artist and academic, Paul T has lived locally since 1968. He is passionate about research and encouraging young people to be involved in STEM. He initiated and has been responsible for the 'Young BRLSI' programme since 2012.

Paul Shepherd, BRLSI Researchers Project Leader: After completing a Degree in Maths (Cambridge) and a PhD in Fire Engineering (Sheffield), Paul S joined international consulting engineers Buro Happold where he developed specialist software and used it to design large complex buildings such as the Emirates and Lansdowne Road Stadiums, working with some of the world's most influential architects. Now an academic in the Department of Architecture and Civil Engineering at the University of Bath, he uses the skills and experience he gained in industry to inspire the next generation of built environment professionals, and to research new ways of using computers to improve the building design process. He is also a passionate Public Engagement advocate, and regularly presents to audiences of 1000 school pupils about the use of maths in real world applications through his work with MathsInspiration.com.

Marie Huxtable, BRLSI Researchers Project Leader: Developed a lifelong interest in psychology during a degree course at Hull University and subsequently a commitment to contribute to improving the educational experiences and learning of children and young people by qualifying and practicing as an educational psychologist. She developed her passion and commitment to researching educational practice to improve it during her doctoral research at University of Bath. She has continued her research as a visiting research fellow with University of Cumbria, an editor of the Educational Journal of Living Theories, and working with learners of all ages engaged in researching their passions for learning and making a difference that contributes to the flourishing of humanity.

Supervisors with their research teams

Muzzamil Shakil, BRLSI Young Researchers Supervisor: Previously studied Civil Engineering and currently a PhD researcher in Low-carbon cementitious materials (both at the University of Bath). Interested in engaging and inspiring the younger generation through research: passionate about yoga and running on trails.



Figure 1 Joe, Oliver and Barnabas

Joe Williams, BRLSI Young Researchers Supervisor: PhD candidate at the University of Bath and former graduate with an MEng in Civil and Architectural Engineering. STEM ambassador and keen participant of several university public engagement programs. Particularly interested in promoting engineering and sustainability to future generations.

Barnabas, BRLSI Young Researcher: Studying for GCSEs at Kingswood School in Bath. Favourite subjects are Chemistry and History.

Oliver Sani, BRLSI Young Researcher: A Ralph Allen student, who enjoys skiing and science! Has appreciated the opportunities provided by BRLSI since the age of about 10.



Figure 2 Giovanni and James

Giovanni L. Pesce, BRLSI Young Researchers Supervisor: Post-doctoral research associate at the Department of Architecture and Civil Engineering. Graduate of Genoa (Italy) and Bath (UK) Universities. Lives in Bristol with his partner. Inquisitive person, he is passionate about research and loves Richard Feynman's books (e.g. "The pleasure of finding things out").

James, BRLSI Young Researcher: Enjoys maths and science, especially Elements and the Periodic Table. Also a junior croquet player and a keen horse-rider. Attended the younger children's science workshops in 2013 and joined the Young Researchers group in October 2014. Has enjoyed working with the PhD students and getting involved in the research project.

Ammar, BRLSI Young Researchers Supervisor: Graduate of Salford University with a Masters in Project Management in Construction, he is currently doing his PhD in Architecture at the University of Bath. Before his Masters, Ammar graduated as the top student at Al-Baath University, Homs, Syria in 'Architectural Engineering' Bachelors degree. Interested in combining art with architecture and engineering, he has exhibited his artwork in Germany, the UK and Syria and recently was the curator of the 'Poetry of Line' Exhibition at the University of Bath.



Figure 3 Ammar, Mari and Molly

Mari, BRLSI Young Researcher:

Molly, BRLSI Young Researcher:



Figure 3 Teresa with Nicola and Kitty

Teresa Chiang, BRLSI Young Researchers Supervisor: Teresa obtained her PhD in Architecture from the University of Bath whilst working on the Young Researchers Project. She joined the project to develop her learning about working with young people interested in STEM and to gain experience in public engagement.

Nicola, BRLSI Young Researcher: Has lived in Somerset since birth. She loves research, likes to try new things, is very inquisitive about new opportunities and takes them with enthusiasm. She hopes to become a science journalist in the future.

Kitty, BRLSI Young Researcher: Attends Hayesfield School

Georgia, BRLSI Young Researcher: Attends Hayesfield School

1.2 The Bath Royal Literary and Science Institution

Bath Royal Literary and Scientific Institution is a registered charity. It exists to promote an interest in the arts, literature and sciences in Bath [UK] and the surrounding area and provide resources for education, research and enjoyment. It acts as a cultural centre for its members and the public and provides a wide-ranging programme of lectures, discussions, science demonstrations and exhibitions. Anyone can become a member and anyone can attend its activities. (Thomas, 2014, p. 111)

BRLSI was founded in 1824 as the direct descendant of Bath societies going back to the 1770s and re launched and registered as an Education Charity. 15 years ago BRLSI members initiated the annual 'Bath Taps into Science' event, which has gained in popularity and is now organised by the University of Bath. It offers local schools and members of the public two days of fun 'hands on' STEM activities. Since 2010 BRLSI has invited research students from the University of Bath to deliver short lectures on their research and offers supportive feedback.

1.3 Young BRLSI

Young BRLSI began in September 2012. Its premise is to bring (self-selected) school age children and young people from across the area together and provide them with challenging and fun learning opportunities, which are not directly related to the existing school curriculum. These workshops take place in the context of 'hands on' and 'discovery' learning activities and enquiry led learning, and concentrate on Science, Technology, Engineering and Maths (STEM). In this way it is hoped that the aspirations of children will lead them to consider STEM

subjects as a career choice and inspire local communities to consider STEM as something relevant to their own local areas.

To deliver the workshops, a team of volunteers was recruited from the BRLSI membership, graduates and undergraduates from the University of Bath, Bath Spa University, Norland Childcare Training College and STEM Ambassadors from Industry. Volunteers are encouraged not to tell the participants anything, but to ask open-ended questions. The aim is that through participation in the BRLSI Youth Activities workshops, children work with others, retain a sense of curiosity, a passion for enquiry, the confidence to develop and test the validity of their own explanations, share the knowledge they create, and present what they have learned.

Volunteers also learn. The core skills are about effective communication, sensitivity to the process of individual learning, the ability to reflect on participants learning and their own learning, and knowledge of how to support educational enquiry. In the case of volunteers without a STEM background they also learn, side by side with the children, about the scientific content of the STEM activities.

Volunteers contributed in February 2013 to the following clarification of the purposes of the programme, which provides the basis for development, implementation and evaluation:

- To enable children and young people to experience passionate learning and serious fun in a relaxing academic environment
- To foster a love of science in young people
- To foster a love of enquiry
- To provide STEM opportunities for children beyond those restricted by school curricula.
- To increase the knowledge and experience of children, young people and adults as researchers.
- To bring young people and adults (family members such as parents and grandparents) into BRLSI
- To enhance the contribution BRLSI makes to the academic quality of knowledge for local people
- To help BRLSI realise its mission as an educational charity concerned with the promotion and advancement of science, literature and art

All the activities involve collaborative, active learning, problem solving and use the analytic, creative thinking and planning skills that the 'expert' uses. Most activities involve a 'product' of which participants can feel proud, and include suggestions which aim to encourage participants to extend their thinking and learning and explore additional possibilities.

The workshops provide an opportunity for children over 8 years of age to learn with student volunteers over 17 years of age, postgraduate researchers, BRLSI members and STEM Ambassadors. But it was felt that the workshop format is

not so well suited for young people over 12, and as BRLSI wished to retain their interest, an alternative had to be found.

Early in the autumn of 2014, Paul T was invited to a seminar by the Public Engagement Unit of the University of Bath. One of the exercises was to put in a bid for research council funding ring-fenced by the University for a Public Engagement project. Paul S, and Paul T were in one of the groups. Their proposal was that Paul S would invite PhD and postdoctoral researchers from his department to join the proposed programme where the students would act as mentors and share their research. This would provide teenagers with an insight into what it was to be a researcher, give them experience of working with 'real researchers', and provide the university researchers with an opportunity to experience and reflect upon what it is like to supervise research. Paul S and Paul T developed these ideas into a formal bid, which the University of Bath accepted and offered funding, and so the programme was born.

Part 2 BRLSI Researchers Project in Action

We'll now tell you how the idea translated into action with brief details of how the other participants became involved, the approach taken to planning the sessions, and what happened in them and at the Bath Taps into Science event and the mini conference. There will be a future publication detailing what happened subsequently.

2.1 Inviting Participants

Paul S recruited the PhD students and agreed to lead the project from the point of view of the University. Paul T invited BRLSI member and volunteer, Marie Huxtable, who had previously developed APEX¹ and had been part of the Young BRLSI Programmes since the beginning, to join the project team. Paul T and Marie worked up a short paper dealing with the terms of reference and associated tools such as evaluation, feedback procedures, planning, investigation and recording formats.

Paul T contacted parents of teenage members of the Young BRLSI programme to tell them about the project and invite them to apply. The details circulated to potential participants are shown below:

¹ APEX (All are Able Pupils Extending Opportunities) was an inclusive educational 'gifted and talented' project that was run by Bath and North East Somerset Council until 2012. Details in APEX Living Legacies: Stories creating futures (Henon, A. (Ed) 2012, freely accessible from <http://www.actionresearch.net/writings/apex/livinglegacies2012.pdf>

BRLSI Young Researchers Project 2014 -2015

The project is linked to the University of Bath's Department of Architecture and Civil Engineering research programme. It will deal with aspects of the built environment in the centre of the city of Bath.

The 6 month project aims to: enable 13+ [years of age] young people to learn from and with doctoral students what it is like to be a researcher by completing a meaningful research project which might contribute to a post graduate research thesis.

The project will provide the young researcher with opportunities to:

- Create and research a question
- Develop an ability to enquire in a disciplined and creative scientific manner and have the opportunity to learn to work within a time frame
- Acquire and improve skills in the formation and identification of hypotheses
- Acquire and improve skills in observation
- Accept responsibility for practical research tasks
- Learn to record results and also record progress in learning
- Improve skills in presentation
- Reflect on their own learning, the research process and what they have learned for themselves
- Make a valuable contribution to the learning of other people by sharing the research by, for instance creating a public artefact such as a 'Bath Geology Trail,' (paper or web version), an article for a magazine, a poster, an oral presentation to BRLSI children's workshops, BRLSI members
- Make an action plan of what they wish to research next

The project also aims to enable postgraduate students to:

- Further develop an awareness of the processes of research and learning
- Further develop skills in the communication and presentation of research information by communicating effectively the contents or part of the contents of their own research projects
- Reflect on their own learning and research skills
- Acquire academic supervision skills by working with 13+ in meaningful and realistic research

Several young people indicated an interest and they recruited some friends. A room was booked on the BRLSI premises and participants enrolled and paid a small fee. All the sessions ran on the second Saturday of the month alongside the Young BRLSI workshops.

The rooms used were large enough to accommodate the whole group and had tables and chairs that were easy to rearrange during the session for small group supervisions and whole group discussions. Rooms also had good Wi-Fi connection, a laptop, projector and screen, flipchart and A4 paper, pencils and pens. Research Portfolios were printed ready for each Young Researcher and Supervisor.

2.2 Approach to Planning

Paul T, Paul S and Marie met prior to each session to prepare. They reflected back on the previous sessions and reviewed the feedback sheets to see if there was anything they could learn from what had happened. The conversation focused around what might be done in the next session to enable the young people to experience what it was like to be 'real' researching scientists in a research group, as well as assessing where they were in developing their research, what would help them progress, and what skills might be useful to them. The conversation didn't follow a set agenda but rather flowed between the three project team members so they were able to draw on their different perspectives and experiences to develop a programme for the afternoon that provided a balance of active 'hands-on' fun, time for conversation between young researchers and their supervisor and team, reflection, planning, and engagement with the whole group.

From the discussion, Paul S developed an outline schedule (Appendix 3) to provide a reference point for Paul S and Marie during the session. Rather than serving as a constraining script, it was used creatively and changed depending on the educational needs of young people during the session. Paul T developed and provided feedback sheets, and additional planning and reflection sheets for the young people to complete and add to their Research Portfolio.

Data was collected in the form of video and photographs. Permission was secured from all involved (and the parents of the Young Researchers) for video and images to be used as part of the project research.

2.3 What Happened

Session 1 - 8th Nov 2014

The focus of the 1st session was to introduce all participants to each other and the opportunity the project offered for them to enjoy learning, and creating and contributing knowledge by researching something that was of energising interest to them. We were aware that learners, irrespective of age or experience, could feel nervous when they go somewhere new physically, socially, intellectually, and/or personally. This was an important consideration throughout the project, and particularly in this introductory session. We were also aware that the form of learning and research that we wanted to engender through the project might be unfamiliar to both the Young Researchers and the Supervisors. From experience we anticipated that some might find the expectation that all participants accept responsibility for contributing to and benefiting from their own learning and that of others challenging. We were also aware that the notion of research we were introducing, that of creating and contributing to knowledge rather than simply finding out what is already known, might be novel and therefore also challenging. Finally we kept in mind our intention to provide an opportunity and support for young people to develop

their knowledge as expert researchers and learners in the process of investigating a question of personal interest, within a time frame and with a valued outcome.

We began with an introductory exercise to enable participants to begin to get to know one another and feel at ease moving, talking and listening in an unfamiliar space in the room. We also wanted them to begin developing cooperative educational relationships with other researchers (including their supervisor/supervisee relationships), rather than the hierarchical relationship they were probably more familiar with, which can stifle or suppress creative, productive research as this story illustrates:

“The recent Nobel prize in chemistry was won by an Israeli - Dan Schechtman for his discovery of quasi-periodic crystals. When he "noticed" this first - about 30 years ago - he couldn't believe it, and when he announced his work, Linus Pauling - who had by then won TWO Nobel prizes, in different fields - essentially called him a fool and a charlatan. And he was then asked to leave the research group in which he had been working. But he was convinced he was right, and persevered - and the rest is history. (Personal email from Michael Neugarten, 4th January 2012)

All participants were asked to form two concentric circles with Young Researchers, their prospective Supervisors and the project team mixed together. Those in the inner circle faced outwards and those on the outer circle faced inwards. The instructions were for each person to introduce himself or herself to the person opposite and find one thing they had in common. Each pair had just one minute to speak before the people in the outer circle moved around one place and the exercise was repeated until all introductions were complete.

The activity proved to be a good, energising ‘icebreaker’, with the use of humour around some of the more obscure things in common helping to bond the group as a whole. After a break we moved onto a small group activity so the young people could learn more about the research the students were engaged in and find with whom they shared an interest. This gave the Supervisors an opportunity to communicate their research; the Young Researchers a taste of what ‘real’ research is like, to begin to talk with the university researchers as potential supervisors and the other young people as potential fellow researchers.

The students each moved to a table and the young people were asked to join one table, avoiding friendship groupings. The Supervisors had 5 minutes to introduce their research topic to a small group of Young Researchers before the Young Researchers were asked to move to another table to listen to and talk with the next Supervisor.



Figure 5 Session 1 - Getting to know each other and research interests

When the Young Researchers had spoken with each of the Supervisors they were then asked to move to a table with the Supervisor whose work they would most like to work with. They were also asked to have a second choice in case the numbers needed to be more evenly balanced, but in the end the students serendipitously distributed themselves equally amongst the Supervisors.

The practicalities of the project were then explained, including the time-line, the schedule of meetings, possible outputs, and the mechanics of contacting the supervisors and project team via email or web forum. The research journal/portfolio were given out, together with BRLSI planning and observation sheets, to introduce participants to issues concerning recording as a researcher. The young people worked in their small research group with their research Supervisor to learn more about recording as a research scientist before feeding back to the whole group.

Attention was drawn to the TASC (Thinking Actively in a Social Context) wheel (Wallace, 2000) that was in the back of each Research Portfolio (see Figure 6), and which is also used by children who attend the BRLSI Youth Activities workshops. The TASC wheel was used as it presents a simple and elegant summary of the research processes in many disciplines, including science, technology, engineering and maths. It has been used successfully in schools with children and young people over many years. Joy Mounter demonstrates in her Masters unit (Mounter, 2008), *'Can children carry out action research about learning, creating their own learning theory?'*, how even very young children can understand and critique TASC to produce their own learning theories. Sally Cartwright (2007) in her Master unit, *'How can I help my students understand and develop the skills of independent learning?'*, demonstrates the use of TASC with secondary age learners. Marie (Huxtable, 2012) demonstrated that TASC can also be used by doctoral researchers.



Figure 6 TASC (Thinking Actively in a Social Context) Wheel by Belle Wallace.

The Young Researchers were encouraged to use a variety of methods, such as videoing, sketching and keeping a journal and/or diary, to record their research

and learning journeys during the project. They spent time working in their small groups with their supervisors to begin asking and answering questions such as: What is your possible topic? What do you already know about your topic? What do you want to find out? What do you hope to do next? Recording their thoughts in their Research Portfolios.



Figure 7 Young researchers learning to record their thinking

As the rest were working in their groups, each participant was asked individually to speak to camera for just one minute to record why they had come and what they hoped for by participating in the project. You can hear what they had to say at:

https://youtu.be/lyN4a7bjgXs?list=PLUAuUrjrSdqbpXH38LPxS_7Uec786iyEA

The <http://www.brlyouthgallery.org> website was demonstrated as a source of resources and communication between meetings and how to email questions. Child protection issues meant that Young Researchers and Supervisors were not allowed to email each other directly, so they were shown how to email a generic email address - coolbookings@brly.org - with 'BRLSI Young Science Researcher' in the subject line so it could be easily identified. After anonymising the email it would be passed to the person who might best answer it and/or it would be posted on the website so anyone (Young Researchers included) might be able to help. Ideas about the feasibility and appropriateness of other sources of support and knowledge, such as family, were shared.

The session concluded with 'planning ahead' with participants completing as best they could the planning sheets, agreeing the format for each future session;

1. Review what has been done.
2. What needs to be done?
3. What skills need to be learned/practiced?
4. What support/equipment is needed over the next month?
5. Any suggestions for next time and completing feedback sheets.

And finally they all completed feedback sheets (Appendix 2di and 2dii).

In planning the second session we took what we had learned from Session 1, continuing to give attention to enabling the young people to gain confidence to talk about their research and contribute and benefit from conversations in small groups. We also wanted to revisit what they had done before, referring to their research files, to introduce a research skill in a fun and active way and enable them to work with their research group to progress their research. We decided that the research skills of most relevance at this early stage were those they possibly thought they already knew about and took for granted – the skills of observation and recording. We wanted to keep a connection between the fun activity introducing research skills and real research, so Paul S suggested using bricks, since the common theme was the built environment, and he could provide bricks used in a real research project on the thermal performance of historic masonry.

An observation sheet (Appendix 2a) was developed for use with the hands on activity, as was a review sheet (Appendix 2b) for encouraging reflections on learning, a planning sheet (Appendix 2c) for the period of Christmas and New Year to capture ideas on the way in which the participants will present what they have done at the beginning of the third session. Feedback sheets (Appendix 2di and 2dii) for the Supervisors and the Young Researchers were used again.

After a brief introduction to the second session we help a catch-up ‘icebreaker’ in supervision groups as would happen in a real research group, with each participant invited to talk briefly about anything interesting they had found out during the preceding month, what they had done on their research, and what their expectations were for the session and the project.



Figure 8 Learning to work with other members of supervisory groups

The Supervisors were also expected to take their turn and to facilitate the group so everyone had a chance to speak, to be listened to and to listen to others. There were a number of purposes for this activity: to give an opportunity for the Young Researchers to develop their confidence in speaking (albeit in a small group); to hear their own voice and realize that they are active contributors to their own learning and the learning of others. Time was spent in the supervision groups discussing in detail the individual projects and helping each Young Researchers, drawing on their notes in their research file, to begin to form a solid idea of what they might like to research and what that might practically involve. The

Supervisors facilitated the discussions and contributed, drawing on their knowledge of scoping a research programme and the design of experiments.

We wanted each participant to feel part of the whole project, as well as their supervisory group, so we rearranged the room to sit everyone around a single table where each researcher and supervisor was encouraged to talk for just a minute to the entire group about their project and expectations. After having practiced speaking in their small group, speaking to the whole group did not seem so daunting and everyone was able to contribute.

After a short break we changed the form of activity to demonstrate the importance of observation and recording as research skills and practice them.



Figure 9 Young researcher learning to notice and record

Each Young Researchers and Supervisor was given a small brick from a real research project, an observation sheet (Appendix 2a) and 10 minutes to record what they noticed about their brick and the context within which their observations were made.



Figure 10 Supervisor as co-learner

Supervisors took part in the activity as co-learners, modelling learning as experienced researchers by revisiting research skills they were familiar with.

All the bricks were then gathered together and mixed up and observation sheets swapped around so that nobody retained their own sheet. Each person had to find the brick described on the sheet they had been given, and add new observations to the sheet that may have been missed. Most people easily identified the brick fitting the description they had, but two people were convinced that one brick was their brick. This helped to illustrate how important, and at times difficult, it is to observe and record in sufficient detail.



Figure 4 Learning to work together

The whole group discussed the similarities and differences in what was recorded and what helped them to find the 'right' brick. We discussed subjectivity, the difficulty and need to observe carefully and record precisely, and we learned not just to 'see' but to 'notice'. We shared ideas about different ways of recording and the importance of clarity in written and general communication.



Figure 5 Learning to reflect and record

Each researcher completed the 'what I have learned' sheet as a reflective device and to serve later as an aide memoire.

The supervisory groups were reconstituted for the Young Researchers to revisit and revise their plans and to decide how to spend the coming month developing their research. Supervisors facilitated the groups and provided guidance, advice and suggestions.

Since the on-line forum had been inactive during the month, the last few minutes were spent re-introducing it for asking questions, and we also shared individual hopes for next time and completed feedback sheets.

Session 3 - 10th Jan 2015

When we planned the third session we were told that a couple of young researchers (brothers) had dropped out of the project. We decided to bring this situation to the fore in the upcoming session, as it is a real issue for many research groups in universities and business, but a research or project group is more than just a collection of self-serving individuals. Each person's presence contributes something unique and the whole, the group, is truly more than simply a sum of its parts. Individuals have a responsibility to contribute to, as well as benefitting from, other people's learning as well as their own. We wanted to show that by foregrounding problems in a non-judgmental way, productive and mutually satisfying ways forward can emerge. We decided on a post-it activity, as this would enable everyone to 'have their say' and learn what other people were thinking without identifying themselves. It was hoped this might make them feel more confident to be 'honest' rather than saying what they think other people might want to hear.

We also wanted to build on the observation and recording skills introduced in Session 2 by highlighting the importance of developing communication skills as a researcher. As the first part of the session might be quite intense, we wanted to do this in a light-hearted but still productive way. We developed an activity used to develop language skills, and instead of writing they would be asked to draw a picture that only their partner could see. Again the subject matter was chosen to have some relationship with the build environment to encourage the connection between an abstract activity and some 'real' research.

Finally we wanted to make sure we allowed time for the Young Researchers to work with their Supervisors and research group to progress their research.

When we began Session 3 our decision to address the issue of missing members proved to be even more appropriate, since our turnout was smaller than anticipated.

After the initial welcome we told the group that two of the Young Researchers had withdrawn and that we wanted to identify any issues there were for the remaining members of the project and find joint solutions. We asked each person to write on post-it notes why they were involved in the project and/or what they hoped to get out of it. They were to write one thought per note and stick them up on the wall. The notes were to be anonymous and they could write as many or as few as they wanted. When everyone had finished we asked that they look at all the post-its and discuss, negotiate and come to an agreement with others about how to group them. As a whole group we looked at the groupings, the overlaps and differences, and discussed how we might try to make each goal happen. We made the point that in real research groups, students and supervisors have different payoffs, such as PhD students wanting a thesis and their supervisors wanting journal papers. We also discussed individual and group social responsibilities to the project and the members.

After a break we used a light-hearted activity to extend the communication skills we had introduced in session 2 and relate that to the shared responsibility of listener and speaker to improve the clarity of understanding and description. Everyone, Supervisors and Young Researchers, participated as equals. They found someone to work with and sat in pairs back to back. One person in each pair was given a picture (Build Environment Research themed), which they had to keep hidden, and had 10mins to describe to their partner verbally what it looked like so the other could draw it accurately. They were told the 'drawer' could ask questions and once, half-way through, could show their sketch to the 'describer' so they can see where the 'drawer' was going wrong and try help them correct it. It was made clear that success would come from the shared responsibility of describer and drawer for clarifying the communication and it was the pair's performance that would be judged. Roles were then swapped and the exercise was repeated using a different picture so everyone had chance to draw and have a sketch to put in their portfolios.

The whole group was then brought together to discuss how they got on, how they felt, what helped and what didn't. In the discussion it was acknowledged that listening is an active process requiring concentration, that the use of questions is crucial and that we can learn from another's questions, even when they have limited knowledge of the subject. Each researcher was encouraged to fill in a 'what I have learned' sheet as an opportunity to reflect on what they had discovered about listening and communication, to further consolidate and extend what they had learned.

The supervision groups were then formed for the Young Researchers to update their group on their progress during the previous month, identify any problems/needs and help each other to move forward. We wanted to extend their confidence and ability to work in a larger research group, so we drew the group together afterwards and each person was given the opportunity to report to the whole group what they were working on. To make that step easier, they were first asked to talk with the person next to them, who was not in the supervisor group, and if they didn't feel confident enough to address the whole group their partner or supervisor could help or talk for them. This afforded the Supervisors and opportunity to build on their experience of 'how to explain to a lay person' from previous sessions.

The last half hour was spent in supervisory groups with Young Researchers working on their planning sheets to organise their time over the coming month. They developed their research in response to the questioning from the rest of the group, and with the supervisors guidance, advice and suggestions. We also explained how the Young Researchers could apply for resources and equipment, in exactly the same way as their supervisors would have to in the course of their university research. They would need to supply two quotes (links to online suppliers) and a paragraph of explanation of why the equipment was needed.

Following the session we discovered why attendance was low - some Young Researchers had thought we were not restarting after the Christmas break until the following month! As a consequence a reminder email was sent out the week

prior to each subsequent session. In the interim one of the Young Researchers applied for funding and was granted the purchase of a paper briquette maker.

Session 4 - 14th Feb 2015

In planning this session we were aware that the end of the project was approaching and we needed to clarify the form of communication that would be suitable for the Young Researchers to make public the knowledge they had created in the course of their research. We originally thought of the Young Researchers writing research papers, to make the experience as realistic as possible, but this was thought to be too challenging and perhaps not entertaining enough (or too like school) to capture their enthusiasm. An academic poster seemed to present a more appropriate vehicle to enable the Young Researchers to continue develop the skills of 'real' researchers, and would also be a suitable mechanism for the Supervisors to communicate their educational learning journey. We wanted to build on the research skills introduced previously, and learning to create an academic poster presented a different and fun activity that would help the Young Researchers to progress their critical and creative thinking and research.

This session saw a major change. As the young people began arriving they were encouraged to find their Supervisor and begin a catch-up with them. One Young Researcher loaded up photos he had taken around Bath as part of his research onto the laptop to share them with his Supervisor. As there was a digital projector available he was asked if he would be willing to share them with the whole group and he agreed. This seemed an opportunity for the Young Researchers to step out of the comfort of their supervision groups and to begin to share their research with a larger group. Since one Young Researchers had agreed to present his work, when the others were asked individually whether they too would share what they had been doing with the whole group, they all agreed. So once everyone had arrived, the room was rearranged and each Young Researcher and Supervisor shared what they had been working on and everyone was encouraged to ask questions as they would in a 'real' research group meeting. You can see how this session started by watching the videos on https://youtu.be/nGL4B_rtaSk?list=PLUAuUrjrSdqY-1mD8Mx92yAzxF4UB24NQ

The presentations served to extend and value the voice of the Young Researchers and provided an opportunity for them to learn from each other and integrate others' ideas into their own research plans. We freed up time in the afternoon by not only adjusting the timing but also deleting a planned activity. We went into supervisor groups for the young people to talk in more detail about their research, the problems encountered and to begin to formulate possible solutions. Supervisors facilitated this, reminding them to practice the listening and communication skills developed during previous sessions.

After a short break Paul S presented, 'How to make a poster', focusing on how to communicate research, capture attention but keep the science. The PowerPoint presentation he gave was based on one created by his colleague Dr Darby who

uses it to explain research posters to undergraduate research project students, and it was uploaded to the website later for reference. Everyone was given a rubric (Appendix 4) and one minute to evaluate each of the real academic posters arranged round the room, which had been collected from some of Paul S's PhD students and some of the BRLSI Supervisors. Notes and scores were then compared in supervision groups and the consensus reported back to the whole group. Key learning points were taken into the next activity, which was to get each researcher to begin to sketch out their poster.

Everyone was given a blank A0 sheet to sketch out their own research poster. They were reminded to think of the layout, the key message and how they might present their results. The main aim was to get the young people to make their first mark on a big sheet of paper, to feel confident enough to take the sheets home to finish (in draft) over the month.

They then returned to their supervision groups to fill in planning sheets for how to spend the coming month developing their individual research with the supervisor's guidance, advice and suggestions. Feedback sheets were completed and everyone departed clutching A0 pieces of paper having committed to drafting their posters over the coming month.

Session 5 - 14th March 2015

Developing the confidence to talk about research and consider the implications of new thinking that can arise from questioning is an important ability for researchers to develop. So in planning the fifth session we wanted to give plenty of time for the Young Researchers to build on what they had done spontaneously in the previous session, i.e. addressing the whole group. With the mini conference rapidly approaching we also had to allow plenty of time for Young Researchers to work with their research group and supervisors on their research. They needed to ensure they were able to present what they had learned and identify what they would need to do to prepare their posters in an electronic form that could be printed. There was also an opportunity for the Young Researchers to talk about their research and the BRLSI Researchers project to members of the public at the upcoming Bath Taps into Science event, so this also needed to be given discussion time.

Repeating the successful start of the last session, as the young people arrived they sat in their supervision groups for an informal catch-up. Once everyone had arrived we reorganized the room for a whole group update. All the Young Researchers and the Supervisors shared the progress they had made during the last month, including showing the current state of their draft poster. They were much more confident, both to talk about their research progress to the whole group, and to ask one another questions to help. Afterwards, the Supervision Groups were re-formed for a more detailed catch-up and to resolve any outstanding issues.

After the break the whole group came together to focus on the Bath Taps into Science event. We discussed what they wanted to get out of Bath Taps individually and as members of the project and the opportunities it offered:

- To show off the BRLSI Project itself;
- For individuals to show off their own research;
- To do some actual research (questionnaires, live testing).

We showed them the table and display boards that would be available in the marquee and discussed how to use the space. Moving on to the practicalities of who could attend, when, and made a rough plan for the day.

After a short break the focus was on planning for April, explaining the logistics of preparing an electronic version of an academic poster for printing. Work on the posters went on in the supervision groups, resolving research problems and completing the planning sheets.

In a final whole group activity, participants reaffirmed their commitment to the Bath Taps event by outlining what they were intending to do and finalising when they would be at the event. They also explained what they needed to do in preparation for the April session and completed the feedback sheets.

Subsequently one of the young researchers set up a twitter account, #BathBlackCrust, and used the online forum to talk with this supervisor and created a PowerPoint for displaying at the Bath Taps event. Others prepared paper questionnaires to use with the Bath Taps public.

Bath Taps into Science - 21st March 2015

'Bath Taps' began in the early 2000s as a BRLSI initiative organised by BRLSI members who were also members of staff at the University of Bath and in conjunction with the Bristol branch of the (then) British Association for the Advancement of Science. In the early days it was hosted by BRLSI. As time went on the Bristol branch of the British Association felt it was more appropriate for Bathonians to be responsible for its own festival of science, and so staff at the University of Bath, in particular members of the Maths and Physics departments, took on greater responsibility. For the last few years it has been seen as a University of Bath event, sponsored, organised and hosted by the University. BRLSI has one or two stands and BRLSI members help as volunteers, side by side with University staff, students, STEM Ambassadors and the University Public Engagement Unit.

Six Young Researchers, together with two Supervisors, attended the event in the Victoria Park in Bath. It was a really useful experience, providing an opportunity to survey interested members of the public, capturing more information using two sets of questionnaires. In addition the Young Researchers were responsible for devising and designing a tabletop display, with examples and photographs of their work and the working sessions. Using the material available in the stall they were able to engage with members of the public to discuss the programme

and to encourage other teenagers to consider joining the programme in 2015 – 2016. Nearly 2,000 members of the public attended the day and many visited the stall. The Young Researchers fielded questions and demonstrated their work using their display while staffing the stall. This was a truly confidence boosting exercise and helped the teenagers both to practise and successfully demonstrate their presentation skills. Two of the research groups used the opportunity to roam the marquee soliciting raw data for their research through their questionnaires. Helen Featherstone and Ed Stevens of the Public Engagement Unit of the University of Bath visited the stall and talked to some of the Young Researchers and their mentors about the operation of the programme.

Session 6 - 11th April 2015

The April session fell during the Easter holiday, but it was decided not to change the date as it was inevitable that no date would suit everyone. The problem of clashes with Young Researcher's family holidays and other activities, such as Ten Tors, was a continual problem. We tried hard to show the young people that they could continue with their research and be part of the programme even if they had to miss some sessions, but there doesn't seem to be a perfect solution and some young people didn't return if they had missed two sessions in a row. As it was on this occasion, not only were some young people unable to attend, but two of the Supervisors and one of the project leaders were also unable to attend for very pressing family reasons, which could not have been anticipated. This offered an opportunity for each person to overtly recognise that they contribute not only to their own learning but also to the learning of others.

The session was devoted to ensuring the Young Researchers were properly prepared to present their research at the mini-conference in May. The email sent round prior to the session asked them to bring a laptop if they had one, or their poster file on a memory stick if not. A spare laptop was available in the room.

The session started by telling the group how we were going to help one another to prepare for the mini-conference, where they would be presenting their research to an audience of family and friends. They were told about the deadline for electronic copies of the posters so they could be printed, and most of the afternoon was given over to the young people working on their posters with help from Supervisors. A couple of groups were combined where a supervisor was absent, and where a member of a research team was absent the poster was developed so that should the absent member provide a poster it could be added but if not the poster produced could stand as it was.

There was a debrief of how Bath Taps went and what they had learned. The young people felt they had got a lot from the experience, learning to talk about their research, getting ideas on how to improve their research, and gathering data – over a hundred questionnaires!

The young people then worked on their posters and presentations with Supervisors and each laptops was projected in turn to see what each had done

and share ideas on how to improve them. That way they could learn not just from what they were doing, but also from what others were doing too, and coming up with thoughts of what might improve someone else's poster.

Many of the Young Researchers had not begun their poster, so most of the afternoon was given over to helping them get as far as possible so that they knew how to continue at home over the coming month. We talked about the mini-conference, agreed the order of presentation, (the Young Researchers decided they preferred the Supervisors to go first) and shared thoughts about what might be helpful to keep in mind when presenting. The deadline for getting posters sent in electronically was repeated and they were told if they were stuck not to worry but to tell us and we would help. They completed the feedback forms and away they went.

Mini conference 9th May 2015

Prior to the mini-conference an invitation was sent to the families of the Young Researchers. The intention was to make the event as like a real academic conference as possible, so timings were strictly held to.

The programme for the afternoon:

- 1pm Briefing and preparations
- 1:25pm Visitors arrive
- 1:30pm Opening keynotes: Paul T, Paul S, Marie.
- 1:45pm Supervisor presentations
- 2:30pm Comfort break
- 2:45pm Young Researcher presentations
- 3:30pm Plenary with audience, closing ceremony and photographs

Researchers had three minutes each to present their poster with five minutes afterwards for questions. Paul S kept us all very strictly to time.



Figure 63 Paul T, Paul S and Marie opened the conference <https://youtu.be/i0M35Cm14fo>

The Supervisors then presented what they had learned through the project.



Figure 14 Ammar presents <https://youtu.be/rciB065zRck>



Figure 75 Joe presents <https://youtu.be/gh4TPcEewsl>



Figure 86 Giovanni presents <https://youtu.be/RymzYmHA80g>



Figure 97 Teresa presents <https://youtu.be/25nSk3nTQZo>



Figure 18 Muzzamil presents <https://youtu.be/r1cTerLVT4c>

Then the break, during which the Young Researchers talked with their supervisors and the audience about their posters



Figure 19 Enjoying the moment

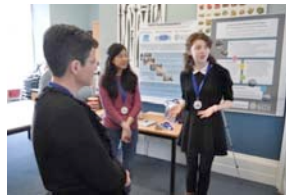


Figure 20 Talking about their poster



Figure 21 Sharing a thought

Then the Young Researchers presented their research

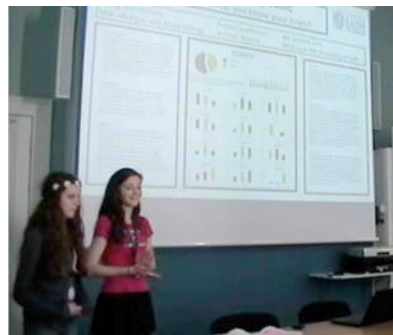


Figure 22 Molly and Mari present https://youtu.be/t_JfruwBdjic



Figure 23 Barnabas presents <https://youtu.be/fNGfTWej6TU>



Figure 24 Kitty and Nichola (with Georgia in absentia) presents <https://youtu.be/-nCUpNVIMOU>



Figure 25 James' research presented by his supervisor <https://youtu.be/btUofXTgjuc>

James' research was presented on his behalf by his supervisor, Giovanni, as James was on the Ten Tors.

The conference concluded with a conversation with the audience, comprising family and friends of the researchers and a group photograph. The key point that emerged was the importance of parents, family and other adults support for young researchers and the need to brief them on the programme as it is very unlike school.



Figure 26 The mini conference photo!

After the conference we gathered quickly for debriefing and to share preliminary thoughts about publication, holding a more public conference at the University and next cycle of the project.

Part 3. What We Have Each Learned

The Young Researchers' accounts come first. These show they developed their knowledge of science, what it is to be a researcher, and a deeper understanding of themselves and their own learning processes. Through the project they grew in self-confidence, increased their ability and willingness to contribute to and benefit from their own learning and that of others, and took responsibility for their own research.

Then come the Supervisors' accounts. These show how they refined and deepened their understanding of their own learning and of their research in the course of learning to mentor young people. They also show that the project afforded them an opportunity to make a valuable contribution to the community, improve their ability to communicate science and develop their practice as research supervisors

Finally, the Project Leaders show what each has done to create an educational context where young people might develop their ability to act as an expert knowledge-creating researcher, learn more about themselves and contribute useful STEM knowledge to the community. We researched our practice in leading the project and assessed the effectiveness of the educational techniques used. We learned more about how to create collaborative educational experiences for young people and postgraduate students that contribute to their progress as scientists and life-long learners.

3.1 Young Researchers' Research and Reflections

The young people presented their science research in the form of an academic poster at a mini conference and sent a summary of their learning journey in response to prompt questions.

Molly and Mari's Conference Poster

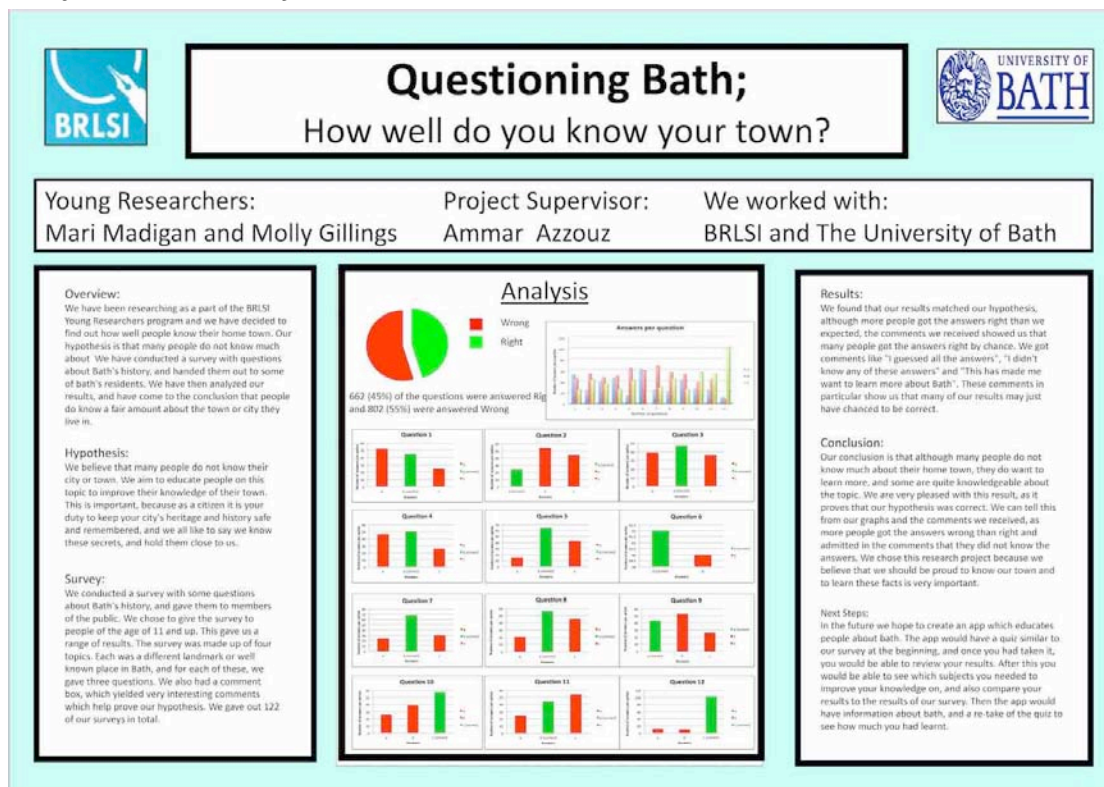


Figure 27 Molly and Mari's conference poster

Molly's Reflections

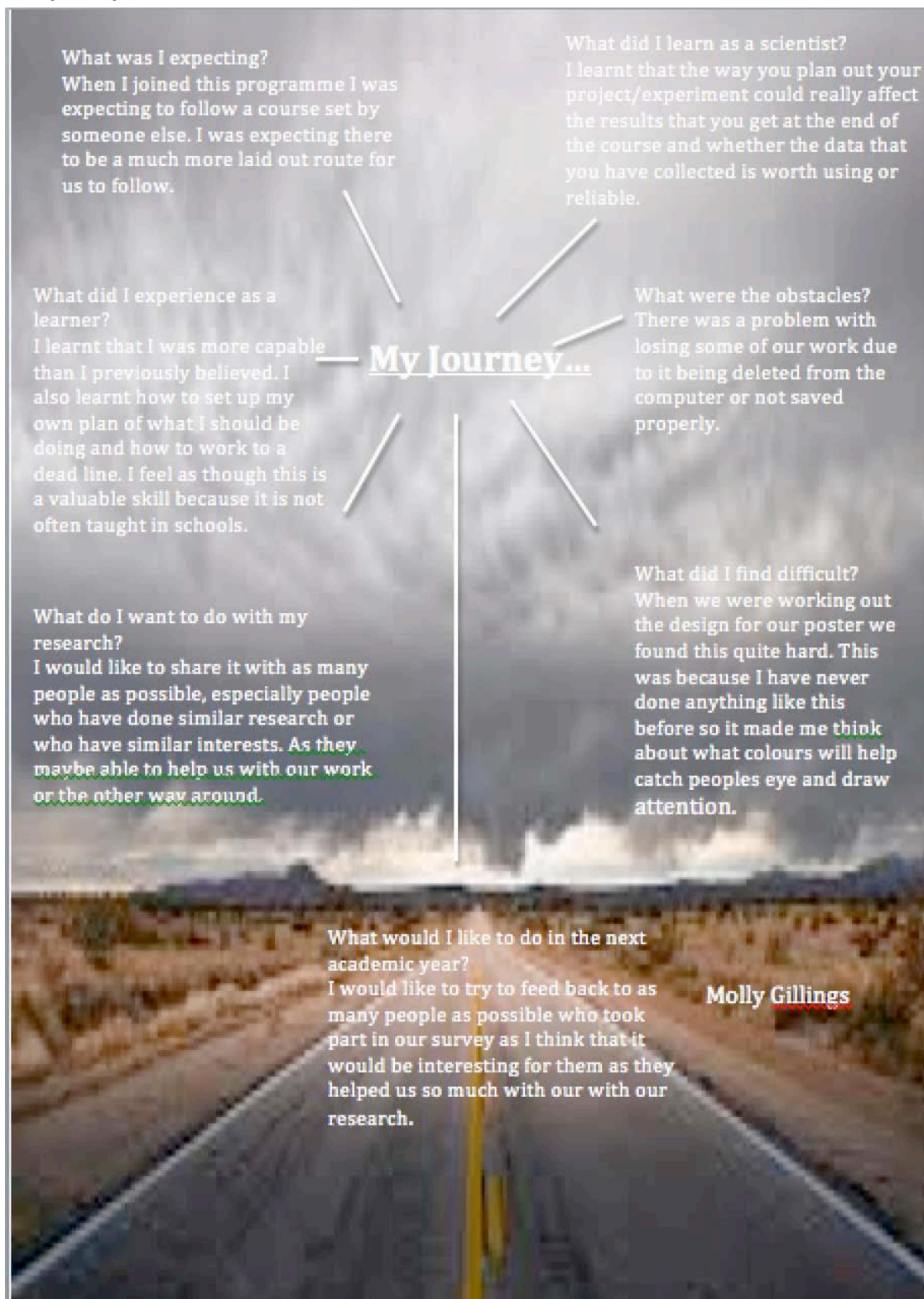


Figure 28 Molly's reflections

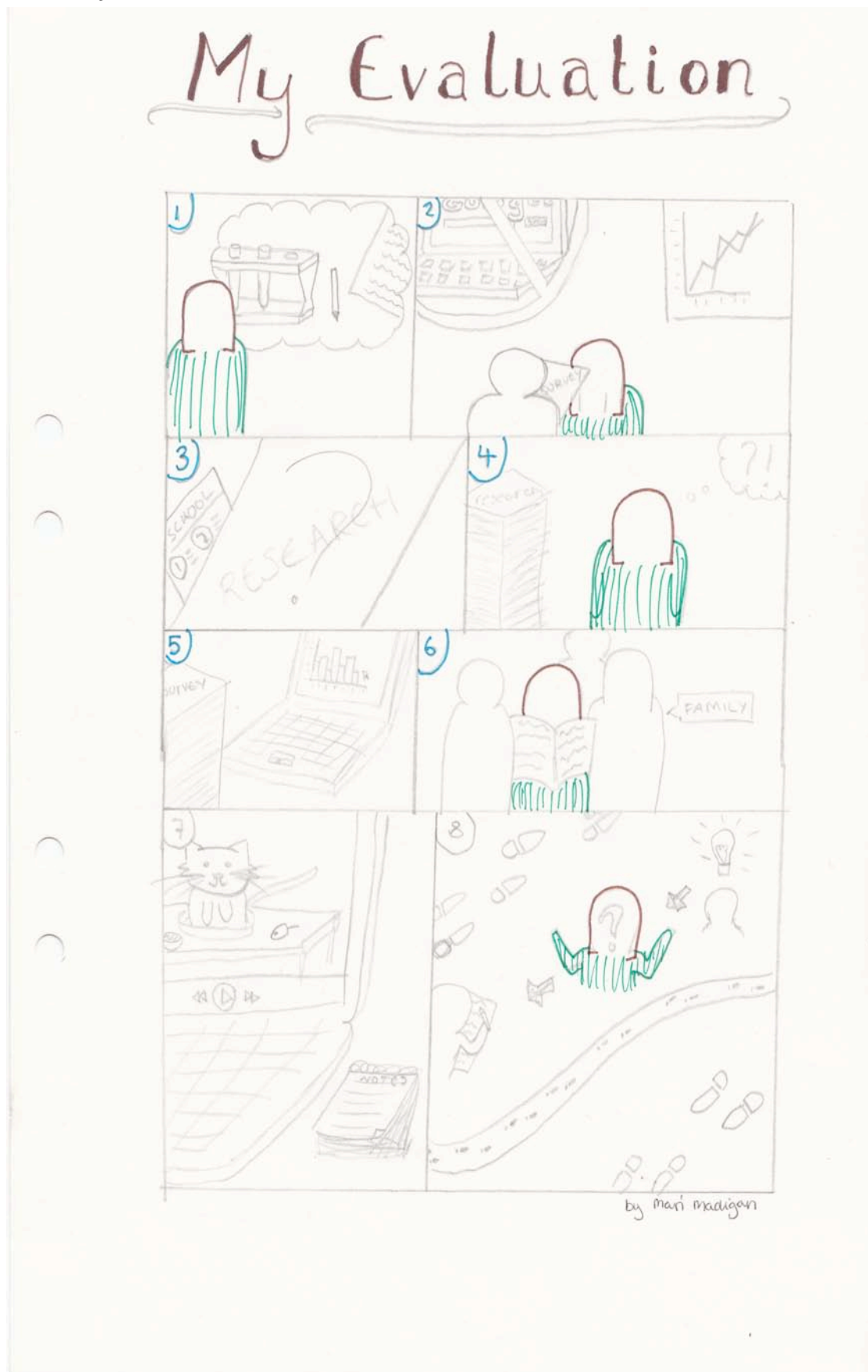


Figure 29 Mari's reflections

1. What did I expect from this programme?

I expected experiments with ready-trying and tested answers and results.

2. What did I learn as a scientist?

I discovered that there aren't always answers and that sometimes you have to find the answer yourself.

3. What did I experience as a learner?

I learnt that sometimes learning is not always prepared for you, and you have to take it into your own hands.

4. What were the obstacles to my learning and research?

Analysing the surveys was hard, but in the end we finished.

5. What did you find challenging?

Creating the graphs was also difficult.

6. What do I want to do with my research?

I would like to show my family and friends what I have achieved.


7. What would I like to do in the future?

I would love to research animals and their psychology because that is what I am interested in.

8. Conclusion...

I have learned that researching is a journey.



Barnabas's Conference Poster





Paper Bricks: a useful alternative to concrete?

Author: Barnabas Fletcher Supervisor: Joe Williams

Every year in America 4.5 million tonnes of paper is thrown. What if this waste paper could be used to make homes in impoverished countries? I set out to find out whether or not this would, theoretically, possible. I created 6 test samples and tested them for strength and the results were surprising.

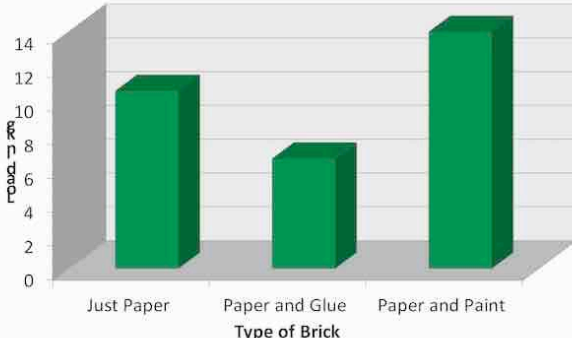



Method

- To begin my research I filled a bucket ripped-up newspaper and water. This formed a pulp, which would be used to make my test samples.
- A week later, I put the pulp into the maker. To try and ensure the same amount of paper in each brick I marked point that the first brick had reached and worked from there.
- I produced 6 samples in the same way, these samples were approximately 23cm x 9cm x 5cm. These were left to dry for 2 months by a de-humidifier indoors.
- On the day of the test I took 4 of the bricks and painted them, 2 with white emulsion paint and 2 with PVA glue.
- For my experiments I used 2 chairs, to act as supports, a cloth bag, to hold my weights, and of course a brick. The chairs were set up 20 cm apart.
- To conduct my experiment I placed my weights into the bag at 250g intervals. When the brick broke, I recorded the total weight in the bag. I repeated this twice for each sample type, Paper, Paper and Glue and Paper and Paint

Results

Average Load at Breaking Point



Type of Brick	Average Load
Just Paper	13
Paper and Glue	17
Paper and Paint	8

Type of Brick	load at breaking point	Comments	Average Load
Just Paper	13kg	At 9kg 250g a small piece broke off At 13kg the layers of paper broke apart	
Just Paper 2	8kg	Split in half along the layers of paper	10.5
Paper and Glue	17kg	It didn't break, but I ran out of weights	
Paper and Glue 2	11kg	Broken in half	6.5
Paper and Paint	8kg	***	
Paper and Paint 2	5kg	The brick was still wet inside, so its an anomalous result	14

Conclusion

Despite initial promising (not to mention surprising results) I discovered that, without further work, paper bricks would not be a viable alternate to concrete in most cases. However the paper and glue bricks were promising, so if I were to continue I would explore that avenue of research. Conversely I believe that the strength of each individual brick not only depends on the additional substances added to it, but also the internal structure of the brick itself. The majority of damage done the bricks was not down the middle, but horizontally as the layers of the brick broke apart. My conclusion from this is that to truly strengthen paper bricks the internal structure needs to be analysed and a method of regulating the internal structure needs to be used and until this is achieved I believe that paper bricks can not be used , effectively, to construct buildings in impoverished areas.

Figure 30 Barnabas's conference poster

For my research I decided to try and find out if paper bricks would be of any use in the construction of houses and other buildings. This choice was inspired by two things: firstly it was related to what my supervisor was doing (always convenient!), and secondly I wanted to see if they would be of any use.

To find out if they would be any good I decided to make some bricks myself. To do this I asked BRLSI to buy a paper brick maker and then used that to make my bricks. To make the bricks I mixed paper and water to create a pulp, and then I put this into the brick maker. I produced 6 bricks in total. Despite the instruction sheet saying it would take 1 week to dry, it took 3 months and even then one of the bricks wasn't totally dry inside.

For my experiments I used 2 chairs (to act as supports), a cloth bag (to hold my weights), and of course a brick. The chairs were set up at 20 cm apart. To conduct my experiment I placed my weights into the bag at 250g intervals. When the brick broke, I recorded the total weight in the bag. I repeated this twice for each sample type: Paper, Paper and Glue, and Paper and Paint.

I discovered that despite the initially promising (not to mention surprising) results, paper bricks would require more work and research to be able to be used as a strong and safe building material.

Barnabas's Reflections

What did I expect from the programme?

I expected to learn more about 'real' researching and to learn how to become a better scientist.

What did I learn as a scientist?

That research isn't as easy as it sounds and that sometimes you have to be very, very patient.

What did I experience as a learner?

I experienced both interest and sometimes some more boring moments. For example when I was waiting for my bricks to dry it was very boring (they took 2 months to dry) as I had nothing to do for my research.

What were the obstacles to my learning and research?

The biggest obstacle was the two month period in which my bricks were drying. As during this time I lost interest in my research due to the wait.

What did I find difficult?

Again the wait for my bricks to dry was tough, but also the presentation at the end was hard too.

What excited me and 'fired me up'?

The most exciting part of my research was the experiments. Also, once I had got going with my presentation I enjoyed that as well.

What do I want to do with my research?

I might try and build on it. E.g. do the experiments I ran out of time to do: The waterproof test and the wall strength test. Both of which I devised but didn't put into action.

What would I like to do in the next academic year?

Nothing in particular really, perhaps it might be good for the current young researchers to help next year's group or maybe do something in the first session.

 **ELECTRICITY MONITOR MODEL**  UNIVERSITY OF BATH

NICOLA BARKER KITTY GILLINGS GEORGIA BAPTIST TERESA CHIANG

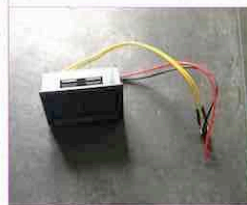
Over the past few months, our team have been looking at the electricity usage of different households. We created a survey and also an electricity monitor model. See below. The surveys were a real success and if you look at my colleagues poster, it will explain about the survey aspect of our investigations.

The making of our model:

1. First i made a wooden box to hold all the electrical wiring:
2. i then made battery holders and soldered the clock wires onto the battery holders. Then i put the batteries in and the clock lit up!
3. On my empty box, i had a piece of Perspex which is a type of plastic. I then needed to cut a hole in the Perspex to fit the clock... So i did!
4. I then fitted my clock into the hole in the Perspex and glue gunned it in to keep it secure and in place. I also glued the thermometer onto the Perspex and i glued the switch on to the outside. I still haven't finished my model. But this is how far i have got:



Wooden box



clock



Figure 31 Nicola, Kitty and Georgia's poster - a

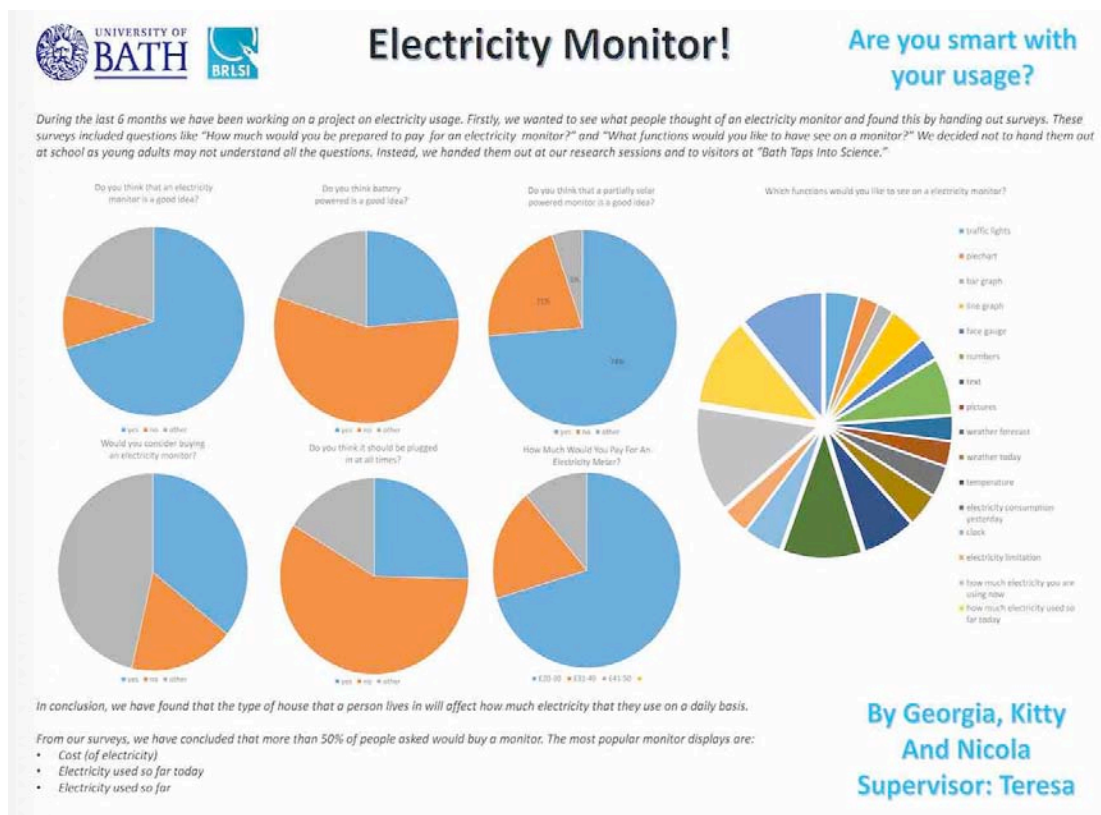


Figure 32 Nicola, Kitty and Georgia's poster - b

Nicola's Reflections

In the beginning I was excited and rather daunted! I walked into the room and there were lots of people and I didn't know any of them. After a while I made friends with Kitty and Georgia and we decided to form a group together. We knew exactly which group we wanted and we made sure we were going to get it! And we did! Yay!

I am not sure what I expected from this but I have had great fun and learned a lot! I came in all shy and quietish... I found it hard with public speaking. But now I am loud and more confident to speak out in front of other people. Bath Taps into Science was a great experience as we talked to complete strangers as if they were our friends. They were interested in the same stuff as us so it was easy to explain everything.

I have been trying to encourage some of my friends to join our group next year but they don't seem very interested, I think this is because they don't want to be interested. I think that if they came along to a session they would be like "I want more!"

Some of my neighbours have encouraged me to become a scientist. I used to find science boring but since they told me about BRLSI I find science fun and now I

think it might be my future dream career. The fact that my future is in this project it keeps motivating me to keep on with it.

I learned not to be so shy in myself and to be more confident and outward going. I think this experience will really help me interact with people in my hopeful future career as I want to be a science journalist. I would like to interview scientists on what they have discovered and write an article on it. I will need the people skills that I have learned at BRLSI to do this.

I hope that they do another session of these next year and if they do I am DEFINITELY coming to it ☺ I am now excited and not daunted! I have made friends and had fun as well as learning! Its an ideal environment to come out of your shell and find who you really are. Thank you BRLSI!

By Nicola Aged 14

Kitty's Reflections

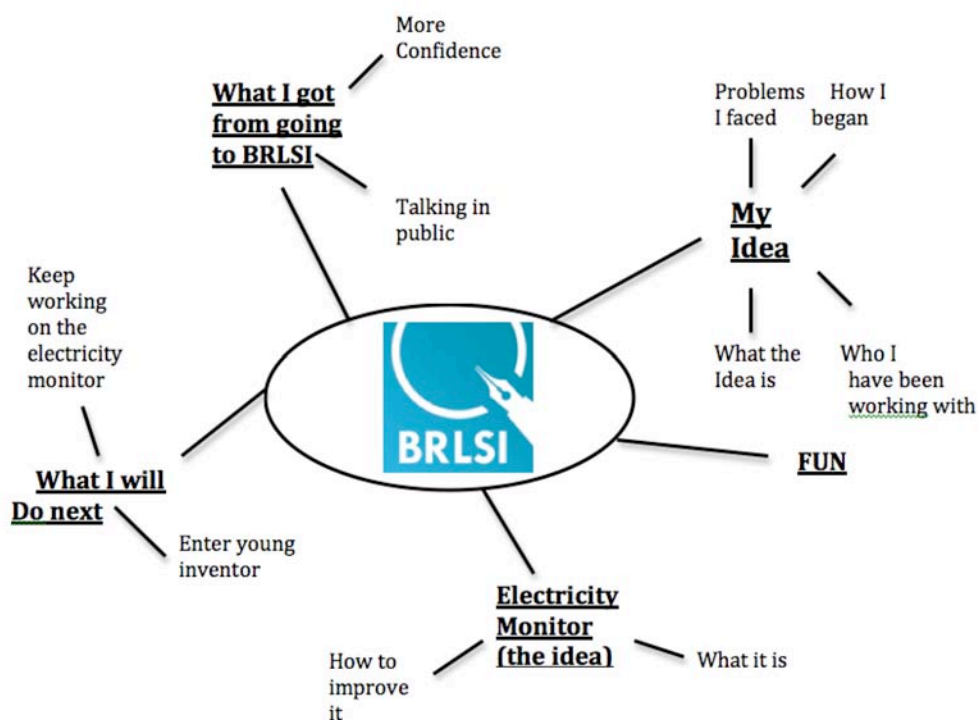


Figure 33 Kitty's reflections

I really enjoyed going to BRLSI when I started I didn't really know what to expect from it but I loved the first session so I kept coming! There are loads of things that I have learnt through doing this. Firstly I learned that things don't always go to plan and so you have to look at what went wrong and then change it. You also have to be organized and be able to meet deadlines. At BRLSI they help challenge you and one thing that I found really hard was talking in front of all the parents at the conference. I was nervous speaking but after I was really happy! I think next year I would like to carry on with my project!



Black Crust



James R. Galpin - Gianluca Pesce

What I Researched

I researched what Black Crust is, how it forms, where it forms and what causes it.

I focused my research in Bath but Black Crust forms everywhere where there is pollution and where there is the right material for it to form on (e.g. limestone).

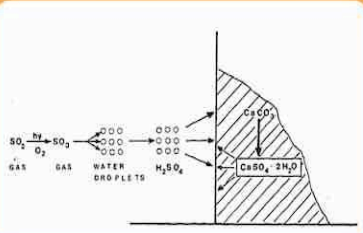


What is it and How it forms

"Black crust is a kind of crust developing generally on areas protected against direct rainfall or water runoff in urban environment. Black Crusts usually adhere firmly to the substrate. They are composed of particles from the atmosphere, trapped in a gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) matrix." (ICOMOS-ISCS)

Illustrated glossary on stone deterioration patterns, September 2008, Page 42.

http://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf



(Gazzoni) - The Determination and Conservation of Stone, Richard Poppel Editors, Page 128, <http://www.doc.ic.ac.uk/~img/0000200012/0015716a.pdf>

Black Crust Forms on the surface of stones containing calcium carbonate (CaCO_3). Here the acid rain containing sulfuric acid (H_2SO_4) that wets the surface of the stones, dissolves the CaCO_3 and turns it into $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

Acid rain forms in pollutant environments where the exhaust of the cars or the chimneys of buildings introduces sulfuric dioxide (SO_2) in the atmosphere. Here the SO_2 chemically reacts with the water droplets (humidity) to form H_2SO_4 .

Where it Forms in Bath

Where it forms



I walked around Bath and took pictures of buildings that had Black Crust. Some of the buildings I took pictures of were very interesting. For example building in the picture labelled 1, on the left side it has been cleaned but on the right side it clearly not been cleaned. You can clearly see on the right side, Black Crust forming underneath the ledge. This picture was taken at The Royal Crescent. The Building in the picture labelled 2 has a lot of Black Crust. You can see where a sign has been, but the sign has been removed leaving behind a clean area of stone. The pictures labelled 3 and 4 are of the same building. The building in the picture labelled 3 is in a reasonably open place and is not near a road, where as the building labelled 4 is in an ally way and is near a road. I do however think that the building in the picture labelled 3 has been cleaned but there is no easy way to find out. Another interesting thing I found is that on the building in the picture labelled 5 the pattern on the stone has affected where water runs down and this has affected where the black crust has formed.

Conclusion



I found out what Black Crust is, how it forms, where it forms and that cars and other motor vehicles are mostly what causes Black Crust to form. If you would like to find out more about black crust then ask a question on twitter with the hashtag #BathBlackCrust



Figure 34 James's conference poster

James's Reflections

What did I expect from the programme?

I expected to research something and learn about science things I did not know about?

What did I learn as a scientist?

I learnt about black crust and things related like limestone, the weather and pollution.

What did I experience as a learner?

As a learner I experienced meeting new people and listening to their knowledge. I also learnt lots of new science things.

What were the obstacles to my learning and research?

Some obstacles I encountered were:

- Meeting and talking to new people;
- Explaining information so that other people would understand.

What did I find difficult?

At "Bath Taps into Science" I found it difficult talking to strangers about black crust.

What excited me and 'fired me up'?

At the start it was knowing that I would meet new people with lots of good knowledge to share. Also when I finished my poster it looked really good and professional and this excited me.

What do I want to do with my research?

I want my research to be available to anybody who is doing a similar research project and who would benefit from it.

What would I like to do next?

Before I went to the BRLSI young researchers I didn't understand how people got PhDs, but now I know so that is something I would like to do when I am older.

3.2 Doctoral Students' Research and Reflections

This section includes accounts of the educational influence in their own learning and that of the Young Researchers

Ammar's Conference Poster

Background

Public engagement is emerging increasingly in the academia where researchers share their knowledge and skills with public.

As a PhD researcher at the University of Bath, I wanted to share my experience in research with 'Young researchers' in the local community.

This led me to take part in a project created by Dr. Paul Shepherd, a lecturer at the university of Bath, where five PhD students meet once a month (for six months) to mentor local school 'young researchers', aged +13, in how to design and carry out a research based project. I was a supervisor for two young researchers as seen in the photos.



Tomorrow's budding researchers

Reflections on my personal journey

Ammar Azzouz
aa2308@bath.ac.uk

PhD researcher
University of Bath
Department of Architecture and Civil Engineering



Image: In Bath Taps into Science Victoria Park March 21st 2015, the two young researchers I supervise, as in the picture, and myself, talked to families, kids and university students, about our project.

Drivers

There are three main drivers for engaging non-researchers in research, which build the 'Public Engagement Triangle'. These three drivers are: 1) transmit, 2) Collaborate, and 3) receive. However, there are many other reasons behind my participation in this experience, including: influencing young researchers in the local community, develop my communication skills and also getting out of my research's bubble, as highlighted below.


Influencing


Collaborate


Transmit
Raise Awareness


Receive
Open access opens doors


Share ideas
Research does not happen just at the library

What did I learn?



I learnt how to change my hat, namely, at the University I am a student getting the support from my supervisors (picture above with my supervisor Dr. Paul Shepherd). In contrast, at BRLSI, I was the supervisor helping the two young researchers. This made me understand that knowledge is transferable, you take and then you give, and vice versa.

It is all about the beauty of sharing

The journey

On the second Saturday of each month, we met in BRLSI for three hours and a half. Here is my journey:



Impact of this journey:

- Develop a dialogue with different groups from different ages
- Develop my communication skills
- Learn how to listen and how to explain my research ideas to non-researchers
- Enjoy working in a team.
- Enjoy volunteering

Acknowledgement



Stem Ambassadors
Inspiring the Next Generation
National coordinated by STEMNET



BRLSI



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Figure 35 Ammar's conference poster

Ammar's Reflections

What is motivating you? What did I expect from the programme?

Steve Jobs once said: 'You can't connect the dots looking forward, you can only connect them looking backwards'.

When I participated in this extraordinary programme, I did not have any pre-concept as it was the first of its kind. I had, however, a faith in it and I thought this would be great dot to be connected in my research journey. I did not get involved only because it was a new idea to inspire tomorrow's researchers find out more about research, but also because I believed that in the future I will look backwards at this journey and say 'now I can connect the dots'. I believe that this incredible experience will take me somewhere else.

What did I learn as a scientist? What did I experience as a learner?

As a researcher I learnt that science is not only about the knowledge we conduct. But rather it is about the ability to explain and transfer complex ideas to other disciplines and to non-researchers in a simple form. All of us have creative ideas, but the most significant challenge is to take these ideas out of one's mind and share them simply with others. This is, I think, one of the key secrets of successful scientists and researchers. It is not about the science itself, it is about presence, passion, enthusiasm, human interaction, sincerity and creativity.

What excited me and 'fired me up'?

I think what truly excited me the most was the internal fulfilment I gained. There is often a cliché that volunteers help others because they want to firstly help themselves as well. I believe that helping others is a moral and ethical obligation, which improves our satisfaction in life. There is a beauty about giving, and what is nicer than giving knowledge. Education and knowledge are the major forces that should direct societies. Without them societies will struggle to thrive.

Young researchers changed a lot during this journey. This deeply touched me and made me feel pleasure, joy and pride to be part of influencing this change. The young researchers gained tremendous amount of confidence, energy and communication skills; and so we did. I hope we can spread this energy that gives students the freedom to express their ideas in schools, especially in societies where youngsters are facing tragic challenges, such as bullying.

What did I find difficult?

I did not have difficulties but rather a fear. I was afraid, because it is a new project, that the young researchers will not be able to collect their data and analyse it with the proposed timeframe. Looking backwards now, I see my fears very natural. Research is a learning curve, and real researchers face unexpected challenges. But with sincere commitment and intellectual effort they can achieve their goals. This was the case in this programme, and young researchers were able to finish their research on-time.

What would I like to do next? What do I want to do next?

I am very delighted to be part in this project. Many colleagues, friends, academics and PhD candidates will ask 'why'. Why shall we bother and spend time out of our research? The answer is this not time out of your research, it is just time out of your office and lab. It is crucial indeed to know that 'engagement, influence and impact' is one of the four core domains that construct the 'Researcher Development Framework' according to Vitae. Research is made to be shared, not to be only to be in paper or a thesis on the shelf. Therefore, I would like to be more involved to contribute to and raise awareness of public engagement in the academic environment.

My second aim is to break the stereotypes about research and researchers. We are often misunderstood in media and social networks with several misleading stereotypes. I have an idea in which I would like to interview PhD students to explain their research experience in one word. Then collecting these interviews in a short video. This video should be then presented in schools and the undergraduate programmes. It is hoped that this will help break some of the stereotypes to non-researchers.

I learnt a lot from this experience. I learned that ideas will always be unseen unless you communicate them. I, therefore, tried to apply this concept myself. I had an idea about curating an art exhibition in my department at the University of Bath. I sent an email to all academics, staff, and students to submit their artwork to me. After a couple of months, the idea is a project, the project is an exhibition titled 'The Poetry of Line', and the exhibition is open to public and staff and displayed on http://www.bath.ac.uk/ace/news/news-items/news_0152.html. I connected the dots and created a line.

And I am looking forward to the next dots to be created and then connected.

The Path To STEM Enlightenment

Joe Williams

Department of Architecture and Civil Engineering, University of Bath



Introduction

Science, Technology, Engineering and Maths are some of the most important skills required in society yet it is difficult to encourage a young up-take. Outreach is a concept of growing importance in academia given the competition for finances in the modern world. The STEM outreach program with BRLSI and the University of Bath provides an opportunity for people new to the academic world to get involved with outreach, promoting these core values in a way that provides a personal benefit.



First Session:

Meet the young researchers and "pitch" our interests and topics to them.

My Experience

As a PhD student in this scheme, I have spent a few hours every month monitoring a group of young researchers from local schools as they complete independent research projects in the STEM fields.

Initially I did not know what to expect from the scheme in terms of benefit for me or benefit for the young students however believed it would be a positive experience either way. In addition I was eager to become involved in some community driven voluntary work and as an engineering graduate, feel strongly that STEM outreach is a great way of doing this that is both relevant to me and important to society.

At the start of the project we were given the opportunity to "pitch" our interest and topics to the students who were then able to choose what they wanted to research and who with. This was a hugely beneficial part for me as it helped me to distill exactly what it is that I do in a professional sense and communicate it efficiently. It was also rewarding in so much that I was able to generate interest in a subject that I believe is important and interesting.

Throughout the project we participated in a number of arranged activities as well as supervision sessions. I found these activities useful for my own development as well as observing the positive effect on the students. The supervisor sessions and independent study element were new concepts for the young researchers and I believe were appreciated but only once the required interest was generated. Maintaining interest and inspiration was one of the hardest parts of being a supervisor in this situation.

Overall the experience has certainly benefited me personally. My communication skills have been greatly enhanced by the experience and in particular it has showed me how to communicate my own work in a clear and understandable way that I'm sure will be greatly beneficial in the future. In addition it has been both beneficial and interesting to take on the role of supervisor as it has allowed me to better understand the position of those supervising me.

Outside of the skills development the experience has also provided an immense personal satisfaction. Seeing the development of those I am supervising and the quality of their thought and ideas has been a rewarding privilege. As engineering in my personal consideration is of such importance but is not directly covered in schools, this activity has produced a great deal of satisfaction for me.

In what I have seen I also believe that the young researchers have gained from the experience. Not only have I been impressed with the development in skills of those working with me but also the insight they have shown into scientific principles and techniques. I hope now that the experience will stay with them and maybe inspire them to pursue

Second Session:

Develop their own idea into a question, consider how it might be answered.

Third Session:

Develop skills that might be required, produce a method to answer the questions.



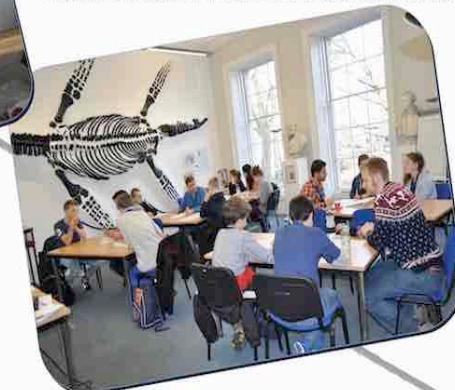
Fourth Session:

Assess where you have got, change your aims and plans appropriately, the experiments are now underway.



Fifth Session:

How will you present your work? Start the poster design and bring together the results.



FINISH !

Present the findings to an eager and interested audience. Reflect on what can be done in a handful of weekends.

Conclusion

I have found the BRLSI / University of Bath STEM outreach experience to be both personally beneficial and incredibly rewarding. It has been well worth the small commitment required. I would encourage any PhD student to become involved with similar projects in the future and will myself continue to pursue STEM outreach projects. The confidence and experience the project has given me has already empowered me to attend additional STEM training with the hope of starting school workshops and inspiring the next generation of engineers we need.

Acknowledgments: I would like to thank all the staff and volunteers associated with this project. I would especially like to thank Paul Shepard for presenting me with the opportunity to become involved in the scheme.

Figure 36 Joe's conference poster

Joe's Reflections

What did I expect from the programme?

For me one of the nice things about this experience was that I literally had no idea what to expect! This was part of the appeal as I wanted to do something outside my usual norms taking the attitude that if you don't try something you will never know what you missed. The results were all the more amazing for this initial ignorance.

What did I learn as a scientist?

As a scientist I learned new things from all of the individual young researcher projects that were undertaken. I learned that paper bricks are amazingly flexible prior to breaking, how little people living somewhere tend to know about it and what black crust actually is. My eyes were also opened to the other fields that I would have had previously no experience of, the specific challenges and requirements of energy monitoring being one.

What did I experience as a learner?

As a learner I learned the true importance of an alternative perspective. In communicating ideas from the world of my research to the young researchers I was required to alter my perspective of it and distil in understandable and reasonable terms what it is I am doing and why. This sharpened my own ideas and has benefited my work. Embracing alternative perspectives was something I also found very important in the supervisor role where I found that an equal footing and mutual respect for all ideas is essential for effective supervision and the best results.

What were the obstacles to my learning and research?

I feel that one of the main obstacles was the time constraints and the lack of effective communication between the sessions. Better planning at the start by myself and my researchers may have more evenly distributed the work load and allowed for development of the ideas later on.

What did I find difficult?

Finding time for lunch! It was also hard to encourage and motivate some of the young researchers through some of the more introspective moments. Too much time was spent in my opinion looking at the "why you are here", "what are your learning goals" etc. The workshops for younger years have a lot of hands on elements and the amount of time spent on this seemed too watered down.

What excited me and 'fired me up'?

When the young researchers made a progressive thought relating to their work that outstripped my own ideas.

What do I want to do with my research?

Not sure if this applies to the supervisors but on a similar path I would like to take what I have done this year and come back next year as a better supervisor.

What would I like to do in the next academic year?

Do this again! Start wider tutoring. I think it would also be nice next year if within the projects a can give the young researchers the chance to come to the university and carry out a simple test in a real lab environment i.e. a proper compression test. Do some of my own research.... Maybe.

Subsequently Joe reports the fact that using the confidence gained and skills learned as a mentor on the project he has signed up to offer his services as a GCSE and A level tutor.

Giovanni's Reflections

I joined the BRLSI Young Researchers programme for a number of reasons. First of all I wanted to be involved in an activity in which the skills and knowledge I acquired working at the University as a researcher could have an immediate impact on the society in which I live. Very often, in fact, the research projects in which I am involved at the University only have a long-term impact on the non-academic society and this makes me feel disconnected from it. Furthermore, as a foreign researcher, I saw this project as a way to get more integrate in the community in which I live. The fact that I would have helped students from local schools was, for me, a way to provide my contribution to the local community and in particular to the youngest. The project was also as a way to test my ability to communicate with young people and a useful experience to develop my communication skills.

Despite the fact that I was strongly motivated, because of my lack of experience with 13 years' old students, the project was a real challenge. I was worried about the differences in cultural background (e.g. common experiences, language) that could have been an obstacle to our communication. From the point of view of the projects, I was worried to not turn the students' experience (that had to be pleasant and exciting) in something boring or too difficult.

The most difficult time was at the beginning, when the ice yet had to be broken. Because of the natural lack in familiarity between students and supervisors at the beginning of the project, students were quite shy and provided little feedback to the supervisors so that it was difficult for us to understand how our guide and suggestions were received.

After the first 2-3 meetings, however, the research projects started to more and more captivate the students and, as a consequence, they begun to feel more and more confident and the whole supervision process began to run smoothly. After having worked with the young researchers for several weeks and after having seen them presenting their results in a public meeting, I can state that what the students have achieved through this project went far beyond my initial expectations. In seven months I have seen shy and apparently insecure teenagers becoming confident researchers able to speak to a wide audience. The quality of their speeches, of the slides they have shown and results obtained was something I did not expected at all.

As a scientist I have learned a lot. I have now a better idea of the general knowledge of 13 years' old students (which is similar to the knowledge of the average population thought to be typical of a 16 years' old teenager) and a better idea of how to deal with them. The meetings with the students I supervised forced me to avoid jargon and use a language understandable for the most part by most people and this is definitely useful in every circumstance outside of academia. Furthermore, during the time of this project I had the chance to think about a number of issues related to my job. First of all the importance of keeping in mind the "big picture" when communicating my research. Very often, in fact, during my daily life as a researcher I get excited by very tiny details of my research projects. These details are not completely understandable to non-

expert because they are only tiny fragments of a bigger problem. As a consequence, despite the fact that I know the final goal (the “big picture”) of my research, very often when I talk to non-experts I tend to forget it and to concentrate on tiny details. Furthermore, I have learnt that in explaining my research to non-experts, I should provide a simple explanation of all concepts I introduce, even if I consider these concepts a basic knowledge that everyone should have. What was shocking for me was to learn that even the meaning of the word “research” (something in which I have been involved for more than ten years now) is unclear to non-expert. What is research, what a researcher does, what is the typical work of a researcher is something which is obscure to non-academics.

Overall I consider this experience far more educational than I expected at the beginning from both, a personal and a professional point of view. I achieved my goals because now I feel that my skills and knowledge are useful to the society in which I live, because I made a step forward in my integration within the local community and because I have learnt something about how to communicate my research. Apart from this, however, my experience was even more rewarding. I was really impressed and satisfied by what the young researchers have achieved under our guidance and now I have a better idea on how my work at the University fits within society.

I think that the time that each of us invests in activities that can be helpful to others is always well invested. Besides, if James (the researcher whose research I supervised) got benefit from this experience (it does not matter how), we all reached our goal. This is because the young researchers are the most important people in all this activity. They must be those who have to benefit from this experience and, honestly, I was speechless on Saturday when I saw how well all the students have done!

I will be happy to join you next year, although I must say I am looking for a permanent position in academia and for this reason it might be that I will no longer be in Bath/Bristol next year. Nevertheless, if I will be in Bath/Bristol, I will be happy to join you again. Otherwise, I will take with me, in my heart and in my mind, the experience with the young researchers that Paul T, Paul S, Marie and the BRLSI gave me the opportunity to do.

Young Science Researchers Project

From a supervising Ph.D. student's perspective

Teresa Chiang (University of Bath)
Project leaders: Paul Shepherd (University of Bath) & Marie Huxtable (BRLSI)

This was a six-month project for young people aged over 13 to learn from and work with Ph.D. students on real research projects.

Why did I Join the Project?

1. To engage with young people and help them develop an understanding of what doing research is like.
2. To generate interest in STEM subjects.
3. To improve my communication skills by working with people who have no previous background knowledge of my research topic.
4. To try something different and have fun.

Tip 1
Be mindful of using the most appropriate language when talking to non-technical audiences.

What did I Enjoy the Most?

1. Assisting the young researchers to devise their own research projects.
2. Witnessing their developing sense of responsibility, taking initiatives for practical tasks, and how their interactions with one another and with their supervisors grew over the months.
3. Sharing their work progress and being a part of it!

Tip 2
Young people are as capable of independent thinking as adults.

Tip 3
Encourage group members to speak, ask questions, and listen to others.

What were the Challenges?

1. The uncertainty of what the young researchers did and did not know about aspects of the research subject (the built environment).
2. Assigning enough time to each researcher in supervisory groups to discuss their progress.

Tip 4
Activities designed to develop research skills that are interactive and enjoyable are more memorable than a talk.

What did I Gain from Joining the Project?

1. Acquired supervision skills.
2. Developed an interest in promoting STEM education in informal environments.
3. Increased confidence in sharing my research and re-considered its value.

BRLSI Bath Royal Literary and Scientific Institution
The promotion and advancement of science, literature and art

UNIVERSITY OF BATH

Figure 38 Teresa's conference poster

Teresa's Reflections

Thoughts about learning, teaching, public engagement experiences

Research project: how to be a supervisor, how to engage with young people

What did I expect from the Young Science Researchers programme?

- To spend Saturday afternoons on interacting with young people, working on a research project together.
- To develop my learning about a specific population, and to learn to work with young people who have little previous background knowledge of my research subject.
- To learn what it is like to supervise a research project.
- To do something different, fun and not related to my research work at the University.
- To be given an opportunity to share my research, to reflect on it and re-assess its value to develop my expertise.

What did I learn as a scientist?

- Young people are as capable of independent thinking as adults, and they could come up with fresh and interesting ideas that I might not think of.
- Interactive activities designed to develop research skills are more memorable than a talk.

What did I experience as a learner [of being a supervisor and engaging with young people]?

I realised the delicate relationship between a supervisor and their students, like the one I had with mine. While the supervisor has more knowledge of the research area than their students, they could get as excited about the project as their students. The supervisor is in a position to give support and advice to students on how to improve or progress with their projects, and let the students decide what method they want use to conduct their research, and how they will proceed with the practical tasks and the final production and presentation of the research.

What were the obstacles to my learning and research (supervising and engaging)?

- Not getting feedback on what the young researchers enjoyed doing and what difficulties they had encountered while working on the project at home.
- Not knowing what and how much the young researchers knew about aspects of the built environment.

What did I find difficult [as a supervisor and engaging with young people]?

Leadership skills: I still need to learn to run the group discussion, by allowing enough time for each young researcher in the group to talk about their progress and plans, and asking questions for the group to discuss together, and to establish research plan and expectations.

What excited me?

- Passing knowledge on to young people.
- Helping young people develop an understanding of what doing research is like.
- Convincing them what I do is useful and interesting.
- Assisting the young researchers to devise their own research projects.
- Witnessing their developing sense of responsibility and taking initiatives for practical tasks.
- Being a part of the process of personal development and transformation.
- As a result, my experience as a research student was enriched, and self-confidence increased.

What do I want to do with my research (mentoring and experience in engaging with the public)?

- Use my experience to share with people with an interest in public engagement and in working with or mentoring young people.
- Promote STEM education in informal environments.

What would I like to do next?

Take part in other similar activities engaging with young people, to interest them in the prospects of studying and choosing STEM-related careers.

Teresa subsequently says she gained confidence and learned skills as a member of the programme and she wants to further and extend her involvement in Public Engagement programmes associated with STEM.

BRSLI Young Researchers Project



Muzzamil Shakil - Department of Architecture & Civil Engineering

Centre for Doctoral Training in Decarbonisation of the Built Environment

University of Bath

Introduction

The project was launched in efforts for academics and doctoral students to undertake **public engagement** with research. Over the course of six months 13+ young students conducted their own research whilst being mentored by their relevant supervisors.

Research Background

Cement and concrete science: My PhD aims to use Sol-Gel technology or in simpler terms nanotechnology to modify and enhance the hydrated cement particles at the molecular scale. The driving force behind my research is to promote a Low-carbon cementitious building material.

Motivation

Research has become compelling and sustaining for me, an area where I have found and experienced the purest form of love. But I didn't get here on my own. My teachers and supervisors through school, college and university, did more than just inspire me. **If I could only 'give' to others what was 'given' to me** - this is by far my overriding motivating factor.

Expectations

I had no prior involvement with a similar situation or a 'role' like this. Thus, I expected it to be challenging yet an invaluable learning experience to say the least.

The 'Journey'



Introductory Meeting: Explaining PhD topic and general research interests



Planning and discussion sessions with the supervisors



Progress review and mock presentations

Learning Outcome & Conclusions

Students drop out. Almost every supervisor experiences it at some point. Instead of being disheartened, reflect and improve yourself. Despite having no students of my own the sessions were beneficial. I'm one 'step' better at communicating and engaging, in particular with younger students. I feel better equipped for a similar role in the future.

Acknowledgements: Paul Shepherd, Marie Huxtable, Paul Thomas, and more importantly the entire group of Young Researchers.



Figure 39 Muzzamil's conference poster

Muzzami's Reflections

As I expressed during the 'conference' it was difficult to have a predetermined notion or expectations prior to starting the BRSLI project. This was primarily due to the fact I have never been involved in STEM projects or similar settings before hand. The concept of public research as a whole was rather new to me. That said, if I had to point out what my expectations were, generally speaking, I expected the programme to be a series of dialogues between the students and mentors followed up with some form of research, experimental or otherwise. In some ways I thought it would be an ideal platform to inform as well as get the younger generation excited about the research we or I do at a higher level. Something along the lines of engaging them with my particular domain or research interests.

It is very easy to get caught up in the research we do at an institutional level, with all the technology, sophisticated tests and equipment, software etc, to even realise sometimes there are simpler ways of asking questions or the fact that there are real research questions, which may be relatively basic existing within or outside of our domain/field/interests. What is more is that there maybe even simpler methods to investigate such questions. In many ways we forget that great research, both ideas and discoveries, have stemmed from the most simple of questions, the most basic curiosity. For example, asking, 'why does the apple fall down?' or the discovery of penicillin by accident (messy lab condition, mistakes and curiosity). It was stimulating to see the young researchers come up with their research 'questions'. I learned that the younger generation is far more curious than I was at that age.

Perhaps for me the most difficult part was introducing ourselves in that 'ring go around' thing on the first day - believe it or not, I am shy and terrified to my bones when it comes to younger people, and the complete opposite towards elders. I also found explaining my research whilst going table to table or 'sell myself' rather demanding and an almost impossible task. Sometimes you need to get out of the technicalities and simplify things down far more basic than you are 'willing' to, that is if you want the other person to really understand and be/get excited about what you are doing/researching. In general I found communication with young ones took me slightly out of my comfort zone, and my difficulty could be partly explained by my personality but could also be due to lack of prior experience.

In truth, in many ways the excitement was rather 'low' when my students stopped coming. What fired me up still and the reason I kept coming was simple. A) I had committed and the slight to near impossible chance they may show up again. But more so B) every Saturday that I spent at BRSLI I was taking a step, even if baby steps towards overcoming a barrier, and improving my communication skills with the younger ones; even if it meant saying a simple hello. Seeing other supervisors and students interact with each other and amongst themselves is a form of learning I am not sure how to really articulate in words. Adding to that, just generally learning and observing the younger ones presenting their work, their commitment, and courage (surely it takes a lot of courage to speak in a room full of academics). What I can say is, all of it,

collectively, it was a learning experience I am very grateful for, and perhaps its true value I can only appreciate in hindsight.

Like any form of research: take what I have learned so far; experiment with it and build upon it, in a manner of speaking. Ideally, if workload and commitments permit, I would want to try this out again, and/or something similar, apply what I learned and see how I get on. Wasting this experience by not getting involved again would be a shame in my opinion. Expanding and adapting along the way and adding to the experience is the only way forward I believe. Who knows it might lead to an outcome I could have not imagined; true value of hindsight.

3.3 Project Team's Research and Reflections

In order to understand properly what transpired, the accounts of the project team are needed to help put things in context, starting with their joint poster:

BRLSI workshops

UNIVERSITY OF BATH

BRLSI

'BRLSI Researchers: Supporting enthusiastic enquiries into science, learning and life'

This project has involved developing educational practice, which puts the young person and their interests at the centre of learning.

BRLSI Youth, in collaboration with the University of Bath's Public Engagement Unit and Department of Architecture and Civil Engineering, secured a small EPSRC grant to pilot an innovative educational opportunity for young people (13yrs+) researching the Built Environment and developing their reflective research journals supported by PhD/Post-Doctoral students.

Participants met monthly for 7 months to develop their research, devise experiments to test their hypotheses, implement experiments and analyse results, as they would in a university context.

The PhD/Post-Doctoral students acted as research supervisors and the young people as researchers.

The sessions included time for reflection, 'supervision', participation in a research group, introducing skills researchers need to be effective, and opportunities to present to an audience.

All participants in the project learned from, and with, others.

The young researchers developed their knowledge of themselves, what it is to be a researcher, deepened their understanding of their own learning processes, and developed their confidence and ability to generate and research questions of interest to them. The PhD/Post-Doctoral students refined and deepened their educational practice and understanding of supervising knowledge creating research, communicating and sharing knowledge, and supporting learning. The project leaders researched their educational influence in learning and this innovative educational opportunity to improve it.

Figure 40 Project team's conference poster

Paul T's Reflections

The BRLSI Researchers is something I feel I have ownership of. It is part of the overall Young BRLSI strategy I have been developing over three years and is the first of what I hope will be an ongoing programme. I had been working towards the realisation of the project for over a year when I met Paul S and 'sold' him the idea and then invited Marie to get involved. The idea of a publication was implicit in the long term plan, as publication is part of the research process and I wanted to make the whole procedure as realistic as possible and could show the educational implications of a practical expression of the Youth Activities philosophy. The Young BRLSI philosophy is one of providing 'hands on' challenging opportunities for enthusiastic learners, from which discoveries the learners can be supported to share with others. I wanted a publication that was not overly educationally academic, was down to earth, replicable and ideally something that would actively engage and encourage other community groups to copy. Clearly we should take account of the needs of the university STEM community too, but I would suggest that this should be from a scientific/layman's, not an educationalist/academic, point of view.

I have been at arm's length to the project because the BRLSI Researcher sessions take place on the same day at the Young BRLSI activities, which I supervise. I join the planning of the sessions and 'visit' each session to take photographs and offer a certain amount of objective observation, collate the feedback sheets and provide a link between the project and the young researchers.

What did I expect from the programme?

- For all participants to have fun and to enjoy the learning process.
- To nudge the BRLSI back to part of its founding purpose, locally generated original and innovative research.
- To establish a regular programme for 13 to 15 year olds and PhD students in a project that assumed equality, provided meaningfully learning as appropriate to each individual and an 'educationally safe' environment in which to develop skills.
- A way of producing a Geology Trail
- A way in which to produce a critical 'research paper' to evaluate the project and to disseminate the processes, procedures, research findings and learning.

What did I learn as a scientist?

Sadly because I was dropping in and out of sessions I did not attend the feedback from mentors so I did not share in their findings. I learned new things from Paul Shepherd especially the 'hands on activities' regarding observation skills. I have already been able to put one of these into use. From Young Researcher projects that were undertaken I was impressed with James' project on black crust, which was very relevant to the Geology Trail and has been incorporated into it. Molly and Mari's project reinforced my feeling that local people and visitors are often unaware of the built environment, its nature and its history, so the idea of BRLSI Trails is a good

one. Specifically I learned from Barnabas that it might be possible to use recycled paper to create bricks that are amazingly flexible but take a long time to dry out and how the BRLSI Researcher's programme can impact on the whole family. From Kitty, Nicola and Georgia's project I realised that we could develop research projects in partnership with local communities, which are relevant to local people. This is something that I hope to progress over the coming academic year. My own research centred around the Geology Trail and adding a little to my knowledge of geology and the location of specimens in the centre of Bath.

What did I experience as a learner?

An obvious fact that it is not satisfactory to be an 'ad hoc' member of a learning group. I was thus able to empathise with a couple of the Young Researchers who missed sessions and then decided to drop out. It also set me thinking about school children who have irregular attendance (for whatever reason) particularly young carers. However, I also experienced the support of the group in wanting to encourage and include me in the group.

Regarding my role as a joint provider of the learning opportunities I learned from my observations and the regular evaluations that once a month sessions require very careful planning and that the learning group needs generous advance warning of the timetable, deadlines, events etc. and that forward planning for everyone is very important. The planning needs to be effectively negotiated and communicated. Also that because the time available at each session is limited, they need to have impact, be tightly focused throughout, give the mentors and young researchers time to report back, reflect and assimilate information acquired and learning achieved. In addition the acquisition of skills through 'hand on' activities can be very effective and possibly more effective than talking about them.

I also learned a great deal from the alternative perspectives provided i.e. Marie and Paul S, the mentors and the young researchers. Thus I was able to develop and improve the whole of the Young BRLSI programme to take more account of the learning of everyone involved, volunteers, mentors, young researchers, younger participants and families. To ensure that I do this I need to set aside more time to evaluate and reflect on the effectiveness of the provision and the learning opportunities provided. Fundamental to all developments is a need to develop mutual respect for all ideas, which lead to the effective provision and the supervision of the learning process.

What were the obstacles to my learning and research?

The time constraints and having to flit in and out of sessions, the lack of effective communication between the sessions. Better planning at the start, particular signposting the development of the programme, more accurate and detailed recording of my learning and achievement. The need for a more accurate and detailed recording of the learning processes at all stages in the programme and the lack of a formalised system for support for participants

and in the case of the Young Researchers their families during the period between the sessions.

What did I find difficult?

Ensuring that we retained all the young researchers. Communicating with all the families effectively regarding BRLSI's assumption that the Young Researchers and their families were going to be committed to the programme. Identifying accurate nomenclature for the participants. Providing a wider range of research options. Ensuring that each session had a greater proportion of the time dedicated to 'hands on' activities and appropriate equipment (e.g. lap tops). Providing the same room for all the sessions and avoiding a clash with other users (e.g. at the beginning of sessions and during the comfort break).

Too much time was spent in my opinion looking at the "why you are here", "what are you learning". I need to reflect on the appropriateness and effectiveness of this approach.

What excited me and 'fired me up'?

The enthusiasm of my colleagues and the keenness of the mentors and the way in which the young researchers made very noticeable progress and gained significantly in confidence and were able to identify their achievements and explain them.

What do I want to do with my research?

My research was more in the area of participant observation and I want to use the experience to improve the programme for next year.

What would I like to do in the next academic year?

Repeat the programme but in an improved format and adapted processes and procedures. Investigate the possibility of developing a similar, but different programme for older teenagers (6th formers).

Paul S's Reflections

Why did you want to get involved in the young researchers project?

When I attended the "Sandpit" I was looking for opportunities to get me Department's postgraduate researchers (and staff) involved in what universities call Public Engagement (PE), that is, explaining what they do as researchers to a non-specialist audience. I firmly believe this is an important part of what being an academic is all about – not just carrying out leading research, but sharing that research with as wide an audience as possible – the tax-payers who fund the research as well as other academics who can benefit more directly from the findings. And whilst I had been involved in a large number of PE projects over the years, I felt that there were far more

opportunities for PE presented to me than I had time available. And through the Sandpit I was therefore looking for a way to support others in beginning to experience PE, such that they would gain the confidence and motivation to continue to engage with the public in their own right, and by doing so perhaps encourage others to follow.

The Young Researchers project was a truly symbiotic opportunity, whereby my above desires could be met, whilst at the same time helping BRLSI to deliver a much-needed programme of research for enthusiastic teenagers. I am particularly passionate about engaging with a young audience and have personally presented to over 20,000 young people over the past 10 years as part of my PE activities. Raising awareness of Engineering as an academic discipline is important to me. Since there is no “A-Level” in Engineering I myself never considered engineering as a degree subject, instead studying Mathematics in order to “keep my options open”. And whilst this provided me with a sound basis for further study, research and practice, I am mindful that perhaps if someone had come along when I was a teenager and raised my awareness of what Engineering is as a subject of study and as a profession, I might have made other choices. I am also acutely aware that I travel the country to share my experiences as an engineering researcher, but only occasionally do I collaborate with organisations locally. So working with BRLSI to develop the Young Researchers project locally appealed to me on many levels.

What was it that excited you about working with Paul T when you first met him?

Apart from the obvious synergies between what we were both looking for from the Sandpit, Paul T’s friendly and hugely enthusiastic approach to devising such an innovative project struck me immediately, suggesting that here was someone who would be fun to work with, even if things went pear-shaped. He seemed to have a very wide network of contacts who he was sure would be willing to help support the project in different ways. And he also seemed to know exactly what he wanted to achieve and immediately made an approach, having identified in me as someone who could deliver what he wanted. I admit that on more than one occasion I thought to myself – “hang on, what have I just let myself in for?”, wondering if I’d somehow been hoodwinked into biting off more than I could chew. But Paul T’s infectious enthusiasm and optimism meant that I always dismissed these thoughts with a “what the hell, let’s see what happens” justification.

How would you know the project has been successful?

Against our original aims, I’d say we have achieved two out of three objectives. We have developed a framework in which teenagers can develop independence as researchers, and an understanding of how research is conducted for real. We have also provided a platform for postgraduate researchers to learn how to communicate complex research to a lay-audience and for them to experience what it is like to supervise research, rather than simply receive supervision themselves. Our original dissemination objective,

that of creating a smartphone app to map the youngsters' research findings across the city and share their findings with a global audience, has unfortunately not been achieved, although the concept remains and it could certainly be realised in future years. The question of dissemination has instead been addressed through the organisation of an "academic style" conference and indeed this publication. Although reaching a smaller audience, this is nevertheless a dissemination route more typical of those seen in academia, and as such, more directly addresses the first two objectives and is perhaps a more appropriate outcome.

I am also conscious that new objectives were developed along the way, which were not foreseen (at least not by me) at the beginning. Specifically our pedagogic study of how a group of youngsters can begin to direct their own learning and can gain an understanding of what "research" really is. In addition, whilst constantly grounding our approach with the mantra "what would happen in a real research group", we have been mindful to develop a framework which is (we believe) repeatable in many other contexts by many other education / community groups. This publication is our way of sharing what we have done and what we have learned, such that others might build on our successes and allow more youngsters (and university researchers) to engage in similar projects and reap the benefits. In that respect, I would judge the project a success if others believed in it sufficiently to replicate a version of our programme elsewhere.

Marie's Reflections

What did I expect from the programme?

What I expected from the programme was to learn how to give young people and doctoral students an opportunity to:

- Learn and research together as expert researchers, scientists and learners
- Develop their expertise and knowledge about the world and themselves
- Enquire into a question of personal interest them and create and offer valued knowledge that enhanced their own learning and lives and the learning and lives of others.
- Learn cooperatively, recognising, valuing and working with the knowledge, expertise and talents that each person brought to the project and created during it
- Go somewhere new cognitively, personally, emotionally, physically and intellectually

What did I learn as a scientist?

What I have learned through this project is that my learning, as a scientist, often appears serendipitous and 'messy' rather than predictable and formulaic. For instance, while I was involved in this project I was also working with others to bring practitioner-researchers from around the world into a seminar (Action Research Network of the Americas 2015 conference, Town Hall meeting) and develop different forms of communication. Marie's approach to telling her story

of her learning, in the form of a 'graphic story' has taken me to ask around the other research groups I am involved in and I now have many (new to me) work and ideas to explore. Paul S's presentation on the academic poster and the posters young researchers and supervisors stimulated my imagination. Somewhere between these emerged the idea of 'living posters' as an approach for practitioner-researchers to extend the educational influence of the knowledge they were creating and create and enhance educational relationships that are crucial to the generation of knowledge (see <http://www.actionresearch.net/writings/arna/arnaposters270415.pdf>). This was at a time I was also working with Jack Whitehead to communicate and evolve Living Theory research methods (Whitehead, 1989) at a seminar and workshop at the Annual Conference of the University of Cumbria's Research Institute for Professional Learning in Education Annual (see <http://www.actionresearch.net/writings/jack/jwmhcumbria310515.pdf> for an example) which led to me recognizing that creating living posters was not only a form of communicating research but was also a research method.

What did I experience as a learner?

- The delight of learning to develop educational learning opportunities with very creative people who share my passion
- Intellectual and emotional challenge to go beyond previous practice
- The excitement of contributing to the creation of new knowledge that might make a difference that is of value

What were the obstacles to my learning and research?

The obstacles as always came from me. For instance, not keeping a research journal as I encourage others to do, not keeping up with updating the website, talking too much and listening too little.

What did I find difficult?

- Expressing myself clearly and concisely – as you might have noticed
- Recognising, appreciating and working with the knowledge that was being created by each participant

What excited me and 'fired me up'?

Seeing each person growing in confidence and learning and particularly moments when I saw someone recognize and value them self and the progress they were making.

Moments when I saw someone:

- Enjoy being part of the project
- Taking responsibility for their own learning and contributing to the learning of others
- Growing in confidence to 'boldly go' beyond the familiar cognitively, intellectually, socially, physically, emotionally and personally

- Learning something about themselves, the person they are and want to be making a difference that matters to them

What would I like to do in the next academic year?

- Learn to focus better on what individuals say they want to do to improve their practice and knowledge of science, research and make a helpful response to taking their enquiries forward as I research the process of enhancing my educational influence.
- Learn from what has happened to extend and develop online and community support to keep connection and momentum between meetings
- Learn how to introduce more research skills, such as how to use different forms of recording and TASC creatively, which can help researchers to improve what they are doing
- Learn how to involve more young people and students and maintain their commitment and enquiries
- And so much more!

Part 4. Why, What and Where to Next

We have told you about what we have done and some of what participants have learned through engaging in the project. You may have begun to understand something of why we did what we did. We now want to tell you more about the rationale that underpins the project, our explanatory principles and standards of judgment that inform the evaluation of the project, something of our growing understandings of creating contexts that enable educational development as well as development of expertise in STEM subjects, and what we currently see as possible future developments. We do so with the hope this will help you to draw critically and creatively on the knowledge and learning created through this project to improve what you are doing to develop opportunities for young people of school age and students in HE to: learn cooperatively to contribute to and benefit from their own learning and the learning of others; extend their enthusiasm, knowledge and practice as researching scientists; develop their knowledge of themselves, their passions for learning, what gives their lives meaning and purpose and how they might contribute to making this a world where humanity flourishes.

4.1 Rationale

The project rests on a number of beliefs (that which we believe to be true) and values (that which give our lives meaning and purpose). These are some of the assumptions of the project: that people (of all ages):

- Are capable of researching as experts to create knowledge of science, learning and themselves, which they value and in the process develop their expertise.
- Are capable of contributing to and benefiting from their own learning and the learning of others
- Can work and learn creatively and productively together and in the process learn to recognize, value and improve the individual and collective knowledge, expertise, experience and wisdom
- Learn best:
 - In convivial situations where what they feel they and what they create and offer are valued;
 - When they are engaged in learning to enquire into something of interest to them;
 - When there is time for thinking and dialogue
 - When there are a variety of opportunities for them to learn by having 'serious fun' which comprise 'hands on and brain engaging' activities which develop their expertise as a scientist, and generic skills and knowledge.

One definition of science is: the state of knowing: knowledge as distinguished from ignorance or misunderstanding – with ignorance defined as: a lack of

knowledge, understanding, or education (Merriam-Webster dictionary). We are distinguishing education from schooling and training as a values laden life-long process whereby a person learns to live a good life well to his or her own benefit, the benefit of others and contributing to the flourishing of humanity. How we help young people learn to live a good life for them selves is important and we are developing a pedagogy that might be seen as a response to, 'The Student's Prayer', that Chilean biologist, Umberto Maturana wrote:

*Don't impose on me what you know,
I want to explore the unknown
And be the source of my own discoveries.
Let the known be my liberation, not my slavery.*

*The world of your truth can be my limitation;
Your wisdom my negation.
Don't instruct me; let's walk together.
Let my riches begin where yours ends.*

*Show me so that I can stand
On your shoulders.
Reveal yourself so that I can be
Something different.*

*You believe that every human being
Can love and create.
I understand, then, your fear
When I ask you to live according to your wisdom.*

*You will not know who I am
By listening to yourself.
Don't instruct me; let me be.
Your failure is that I be identical to you.*

We are also mindful that education is a process by which a person learns to live a life that contributes to the wellbeing of others and society as well as their own. These values are what Crompton, in his report *Common Cause: The Case for Working with our Cultural Values*, drawing on Schwarz, refers to as intrinsic or self-transcendent values. These:

'... include the value placed on a sense of community, affiliation to friends and family, and self-development...

Intrinsic values are associated with concern about bigger-than-self problems, and with corresponding behaviours to help address these problems.' [redacted] (Crompton (2010), p.10)

Ginott (1972), an Israeli schoolteacher, child psychologist and psychotherapist, illustrates the importance of developing shared meanings of education that does not simply reflect an individual's concern for their own betterment:

'On the first day of the new school year, all the teachers in one private school received the following note from their principal:

Dear Teacher,

I am a survivor of a concentration camp. My eyes saw what no man should witness:

- Gas chambers built by *learned* engineers.
- Children poisoned by *educated* physicians.
- Infants killed by *trained* nurses.
- Women and babies shot and burned by *high school* and *college* graduates.

So, I am suspicious of education. My request is: help your students become human. Your efforts must never produce learned monsters, skilled psychopaths, educated Eichmanns. Reading, writing and arithmetic are important only if they serve to make our children more human.' (p.317)

This may seem serious and negative in contrast with the positive and upbeat feeling engendered through the project. It is included here to keep in clear focus the purpose of the project, which was educational and not simply to train budding scientists, technologists, engineers or mathematicians or introduce them to exciting career possibilities.

Understandings and methods of research take many forms. Peter Medawar, a Nobel Prize winning scientist, wrote, 'If the purpose of scientific methodology is to prescribe or expound a system of enquiry or even a code of practice for scientific behaviour, then scientists seem to be able to get on very well without it.' (Medawar, 1969, p.8). The form of research we are concerned with is a process of creating knowledge rather than just one of acquiring knowledge that has already been created. Elliot Eisner, well known for his work in arts education, curriculum studies, and educational evaluation, said, 'We do research to understand. We try to understand in order to make our schools better places for both the children and the adults who share their lives there' (Eisner, 1993, p.10). We go further than Eisner and say that we do research to try to understand in order to make this world, and not just our schools, a better place to be for all.

One of the research methods we introduced was TASC (Thinking Actively in a Social Context) (Wallace, 2008). We introduced TASC (Figure 41) as it can be understood and used creatively by young children as well as adults, to research their learning and questions of interest, in various fields as apparently diverse as, for example, science and art.



Figure 410 TASC (Thinking Actively in a Social Context) (Wallace, 2008)

4.2 Learning and Knowledge That Has Emerged

A great deal has and continues to emerge. For instance:

- The young people learned how to work with others as co-learners and knowledge-creating researchers. They persisted over 6 months to develop their enquiries, creating and evolving their own questions, and dealing with the trials and tribulations that real researchers face. They learned and valued something about themselves and grew in confidence to share their knowledge, learn from critique and contribute to the learning of others.
- The postgraduate students learned a lot about communicating with a lay audience. They learned about themselves and developed skill and insights as Supervisor and student as they worked with the young people. They became role models as well as sources of knowledge and made a substantial contribution to the community.

- We, the Project Leaders, learned how important the interest, support and encouragement of parents, family, adult and peer friends is for young people to maintain their commitment and enthusiasm to research over time. We also learned how busy young people are and the compromises they have to make to meet the various demands made of them in and out of school.
- We extended our practice, creating cooperative educational learning opportunities that integrated fun and experimentation. We learned to integrate different types of learning opportunities (Figure 42) into the sessions and throughout the programme; broadening the cognitive, social, and personal palette from which learners can draw and extend through playful experimentation (type 1); extending skills, expertise and knowledge of science and other disciplines and fields as a researcher (type 2); and supporting young people as experts researching a question of personal interest, in a disciplined manner, within a time frame and with a valued outcome (type 3).

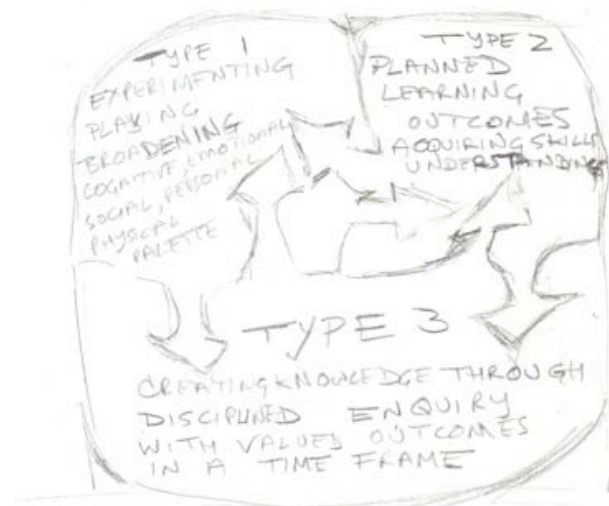


Figure 42 Renzulli's three types of learning opportunities

- We all learned how to value and pool our diverse experiences, knowledge and expertise to produce a creative and very productive tension. Together and with the young people and postgraduate students we produced more than each of us could have managed individually.

4.3 Explanatory Principles, Standards of Judgment and Evaluation

As this is educational research, the evaluation of the project is concerned with more than just standards reflecting instructional purposes. It is also concerned with the educational influence that participants have had in their own learning, the learning of others and the learning of the social formations, which are the context of the project – that is the community, BRLSI, and the University of Bath.

As can be seen in the preceding sections of this publication the Young Researchers developed and valued their knowledge of themselves, of what it is to be a researcher, deepened their understanding of their own learning processes, and developed their confidence and ability to generate and research questions of interest to them. The Supervisors refined and deepened their educational practice and understanding of supervising knowledge-creating research, of communicating and sharing knowledge, and of supporting learning. The Project Leaders developed their understanding and practice creating an innovative educational opportunity for those with an enthusiasm for developing their abilities to research as scientists, technologists, engineers or mathematicians.

Creating an account, such as this publication, is part of our research process. It is important that the publication communicates to a diverse audience, comprising laypersons in the community and educational-practitioners working in schools, Further and Higher Education and Business. It is also important that the research is of high academic and scholarly quality, that is, the arguments are reasonable and well reasoned, and there is evidence of creative and critical engagement with existing knowledge – we see further when we stand on the shoulders of what has been already created.

As this is educational and practitioner-research we have used a Living Theory research methodology (Whitehead, 2008). With this methodology the questions we ask include:

- Is what we have written comprehensible?
- Is there sufficient evidence to justify the claims that are made?
- Do the writings show sufficient understanding of the sociocultural and socio-historical influences in the context of the practice?
- Do the writings show that individuals are authentic in the sense of living as fully as possible the values they claim to hold, over time and interaction?

We ask for responses that are not only judgmental in the sense of being critical, but also creative and educational in the sense of helping us to improve our practice and knowledge-creating research.

So far we have asked a few academics and educational professionals to respond to drafts of this publication. This is an example of a response from an academic who is an educational professional:

‘Here are the 5 values I discern through the writings for the BRLSI book:

I can feel your democratic value of enabling the voices of all participants to be heard.

I can see evidence of your commitment to enabling young people to focus on something that matters to them and to engage in enquiry learning researching their own interests.

I can see evidence of your commitment to enabling your people to become researchers in the sense of engaging in a disciplined way with their own enquiry/topic and (very important) sharing an account (making public) of their enquiry.

In the collection of the posters, text and context I can see evidence of the expression of your passion to focus on learning that is worthwhile to the learner.

Through the text as a whole I can see evidence of your desire that individuals come to understand better themselves and others within democratic and co-operative relationships.' (Personal email 11th July 2015)

We would welcome responses from readers of this publication to help us improve it and to improve our research.

4.4 Possible Future Developments

We, individually and together, intend to develop enquiries researching problems such as:

- How do we each use our experience to improve the programme for next year?
- How do we repeat the programme but in an improved format and adapt processes and procedures?
- How do we develop a similar, but different programme for older teenagers (6th formers)?

The influence of this BRLSI project can be seen above to include the commitment of individuals to work together to live as fully as possible the social and educational values and purposes of BRLSI. We use the TASC wheel (Wallace, 2008) as a systematic and disciplined form of enquiry that supports individuals in making public their accounts of their research and their explanations of their educational influence in their own learning and in the learning of others. These accounts of these explanations comprise an individual's living-educational-theories (Whitehead, 1989). We are hoping to extend our narratives with multi-media data that can show in more details the meanings of our values as we work to fulfil the purposes of BRLSI.

A few preliminary thoughts for the next programme 2015-2016 include:

- Providing a support session for PhD students before the programme begins, using two or three, three-minute excerpts from early session videos to illustrate:
 - PhD students 'fears', diffidence, forebodings and aspirations
 - Research strategies/processes and expectations and how to explain them to teenagers

- Monitoring the interest of teenagers through body language and 'sub texts' to conversations
- Building into the new programme a way of using the videos, especially in the early sessions, to monitor the responses of the participants with a view to remedying and supporting
- Building into each session 'hands on' fun sessions to develop skills and 'homework' to encourage the use of the skills thus acquired. e.g. description, observation, recording, analysing
- Developing the research portfolio and making more use of planning and reflection sheets
- Building into the sessions various ways of recording including the use of 'iPads/tablets for recording and developing presentation of posters for mini-conference and inclusion on the website.
- Exploring ways in which the website can be developed to provide support and communication between participants and links with families.

The educational influence we have each had in our own learning, the learning of others and the learning of the social formations we are variously part of will only be known over time. The success of our efforts to make our knowledge publically accessible will be evidenced by whether or not our account stimulates your imagination and contributes anything to your efforts to improve educational experiences and learning as you develop your own science and educational research projects. How could we improve our account? What are you doing that we could learn from? We would really love to hear from you – coolbookings@brlsi.org

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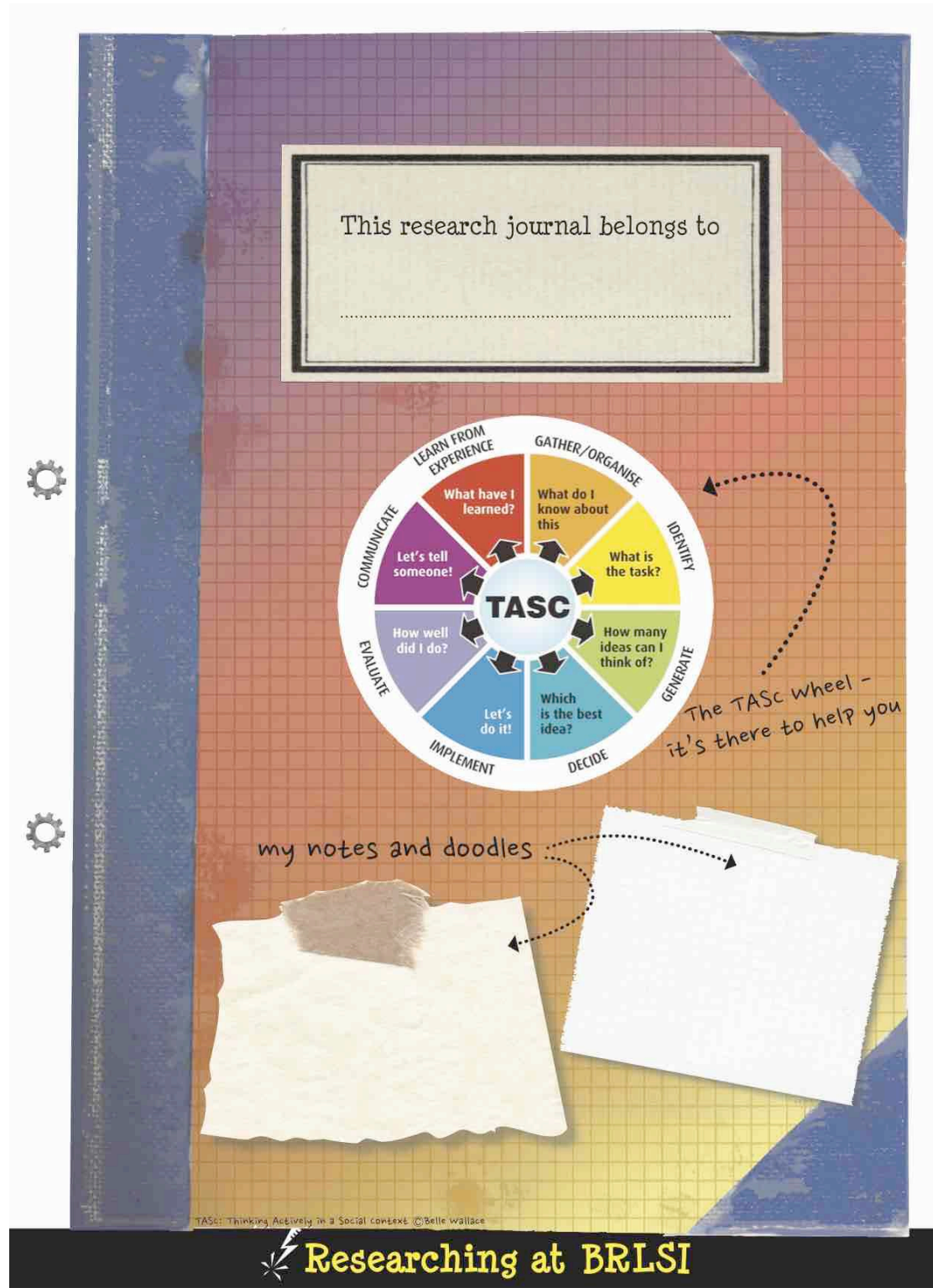
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Appendices

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2c A planning sheet	87-88
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1. Research Portfolio: cover and some sheets



As a scientist you are often trying to understand **WHY** something happens and **HOW**. You test your ideas and share what you have learned with other people.

Scientists are like artists, engineers and other creative learners with all sorts of interests.

They record their observations, questions, ideas, learning and creative thoughts.

Sometimes they write carefully, record measurements and make very carefully drawings.

How to be a scientist

Scientists use their recording to help them remember things and notice something they may have missed before.

What to record and where to start?

Here are pages with a few ideas to get you going. Keep them in a ringbinder so it is easy to add pages and change them around.

You can begin on any page you fancy, go backwards forwards, revisit pages, add pages in and cut pages out.

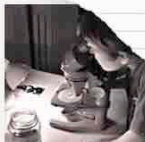
Put the date and anything that will help you remember what you were thinking, observing, learning... for when you look at it later.



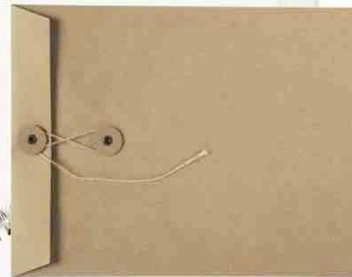
At the top of the next few pages there is an arrow to a place on the TASC wheel. You can use this when you want to organise your thoughts, observations and investigations.

The TASC wheel will help you use a 'scientific method' to investigate what you are interested in and improve your enquiry.

They also make rough notes, odd sketches and all sorts to help them remember things.



In your research journal you can include doodles, sketches, photos, odd words, a bit of writing, a lot of writing, poems, videos, stories... whatever you want. You can stick things in, make pockets on special pages... use your imagination!



Be a scientist and start your research journal today

Make it fun, fantastic and a treasure chest of your knowledge, ideas, thoughts and experiments that helps feed your 'creative imagination'!



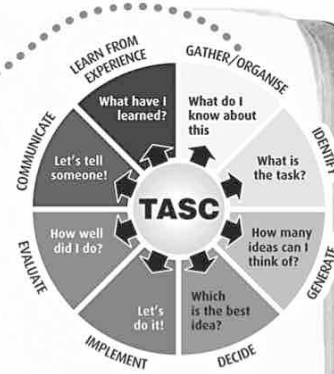
Most important - make it yours.

Researching at BRLSI

2

Scientists think about what they know and check they are right. They increase their knowledge by finding out what other people know. They don't just accept what they are told, they check it out!

Hmmmm... interesting! This is what I observed and learned today



I thought

I noticed

I felt

I know

I found out

I wondered

I imagined

✦ Researching at BRLSI

Scientists investigate questions to try to work out HOW and WHY things happen.

Think Actively in A Social Context -

Scientists think about what they want to investigate...

LEARN FROM EXPERIENCE

Scientists reflect on what they have learned, for instance, about science, about being a scientist, about themselves as a learner and person, what interested them, what was important to them, what puzzled them, what they might like to explore next...

GATHER AND ORGANISE

Scientists think about what they know and check they are right. They increase their knowledge by finding out what other people know. They don't just accept that they know or what they are told, they check it out!

IDENTIFY

Scientists are curious noticing and identify questions to investigate such as: "Why does that happen?" "I wonder..."

GENERATE

Scientists use their imagination to devise ways of investigating their question

DECIDE

Scientists chose one of their ideas and make it even better

IMPLEMENT

Scientists prepare their investigation by gathering equipment, deciding how to record their observations and then carefully putting their idea into practice

EVALUATE

Scientists use the results of their investigation to work out the best answer they can to their question, check out how reliable their answer is and what they might do another time and write a report to share

COMMUNICATE

Scientists talk with other people about their enquiry and they listen to what other people think about what they say. They discuss the ups the downs, the surprises and and what they have learned together.



TASC (Thinking Actively in A Social Context) has been developed by Belle Wallace.
For more information visit <http://www.tascwheel.com/>



Researching at BRLSI

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2a An observation sheet

**BRLSI YOUNG SCIENCE RESEARCHERS 2014 – 2015
OBSERVATION SHEET**

Please remember that ALL research findings need to be recorded carefully and in detail . It is important that all documents are dated.

Name Time..... Date.....

This is what I am investigating

.....
.....
.....

Where my research took place (Name and description of location, e.g. Indoors, outdoors, laboratory, other.....

.....
.....

The conditions were: estimated temperature... Tick appropriate description, wet, damp, dry, dusty, light, dark, clean, dirty, contaminated (add other relevant descriptions.....

.....
.....

I used this equipment

.....
.....

I used these materials.....

.....
.....

List of anything else I needed.....

.....
.....

This is what I expected to happen (The purpose of the experiment and the expected outcome).....

.....
.....

This is what happened.....

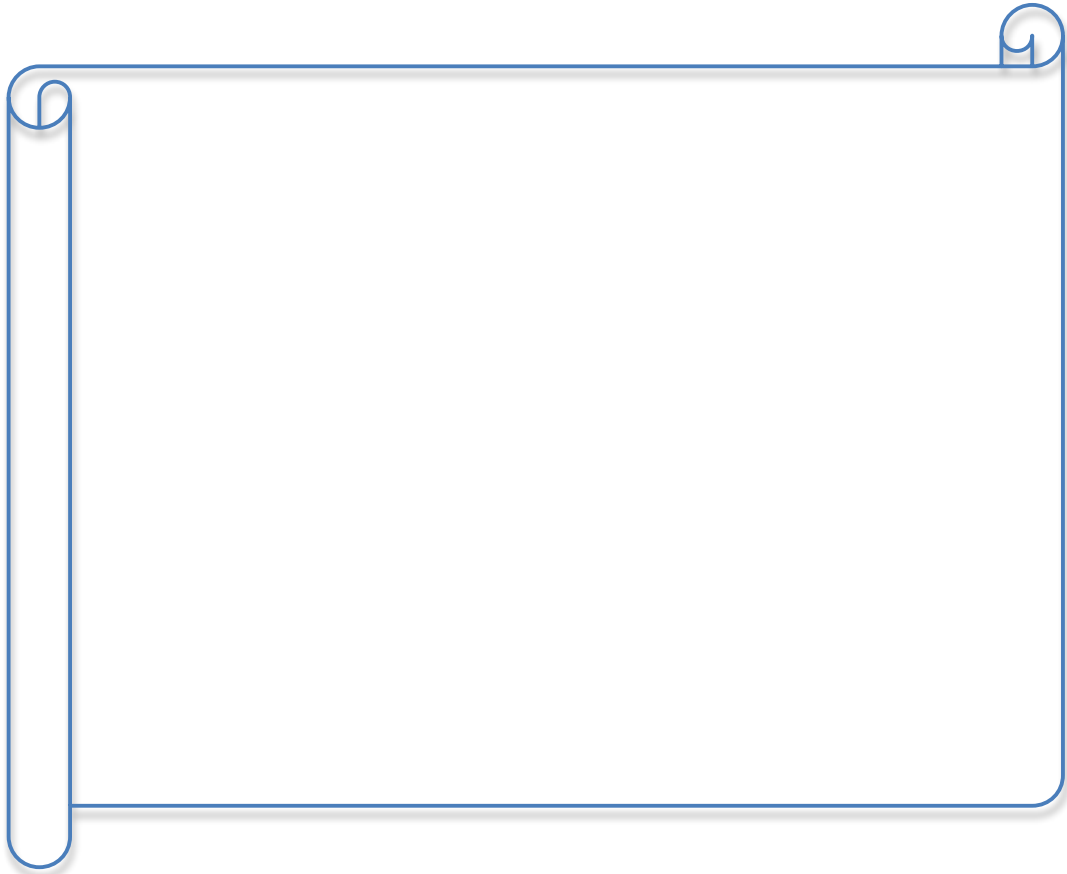
.....
.....
.....
.....
.....
.....

This is what I noticed.....

.....
.....
.....
.....

Other things I observed.....

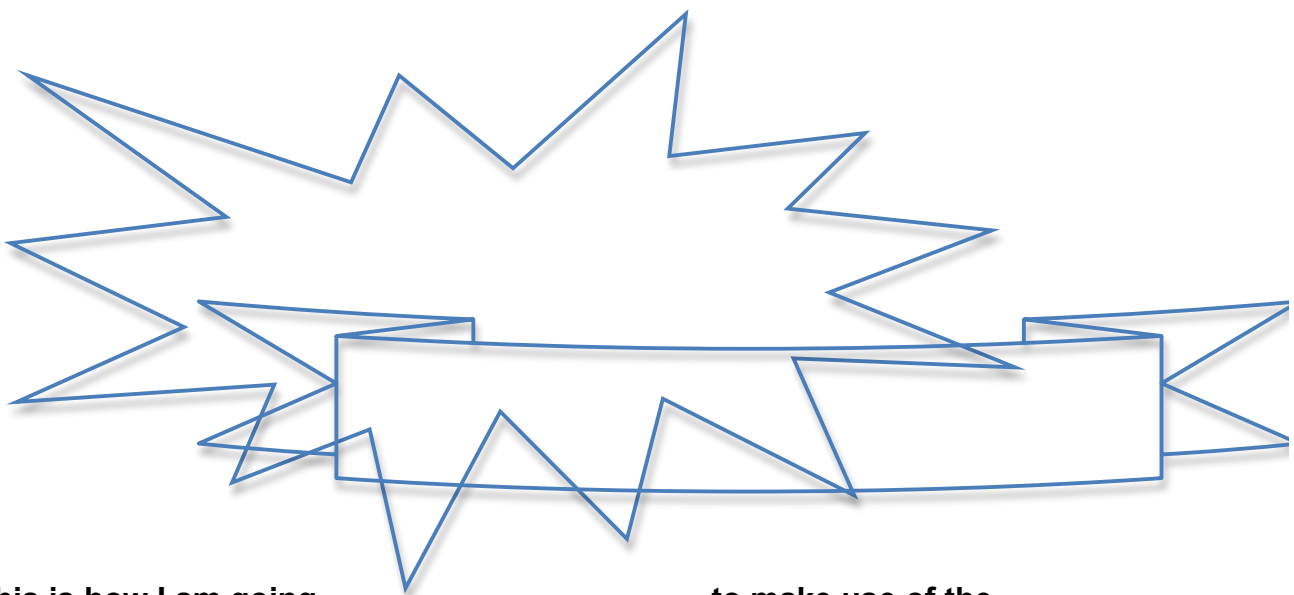
.....



**I think it happened
because.....**

.....
.....
.....

Other interesting things I have discovered or thought about.....



**This is how I am going
to make use of the
information.....**

.....

.....
.....
.....
.....
.....

2b A review sheet

**BRLSI YOUNG SCIENCE RESEARCHERS 2014 - 2015
REVIEW SHEET**

Please remember that all research activities must be reviewed so that as the research progresses, processes and procedures can be improved and the research itself be refined. It is important that all review documents are dated.

Name Date.....

This is what I am investigating

.....
.....

I wondered

BEFORE.....

.....

DURING.....

.....

AFTER.....

.....

.....

I felt

BEFORE.....

.....

DURING.....

.....

AFTER.....

.....

.....

This is what I knew

BEFORE.....

.....

This is what I know

NOW.....

.....

.....

I am sure that I know this because

.....

I might be wrong because

.....

.....

These are the things I need to check.....

.....

I will check by

.....

.....
.....
This is what I have learned about myself

.....
.....
This is what I have learned about researching.....

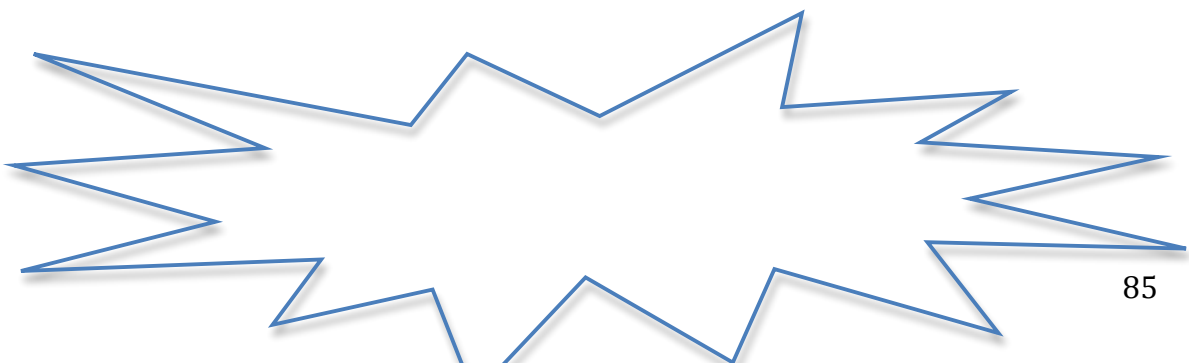
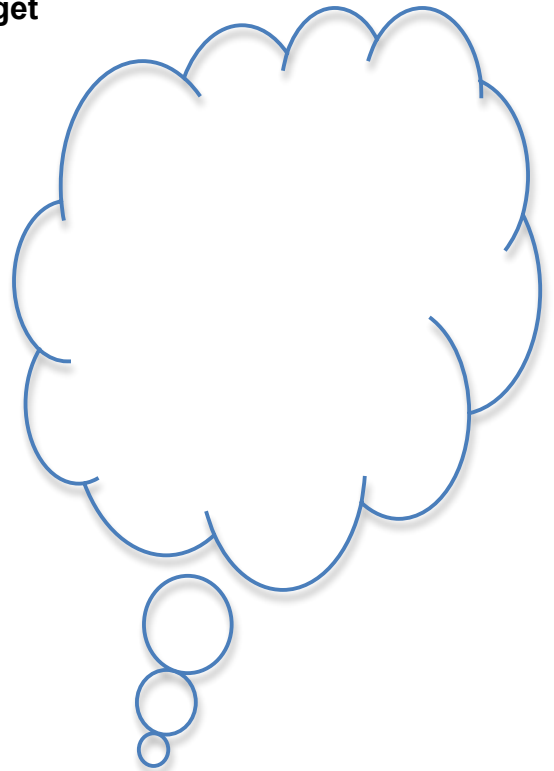
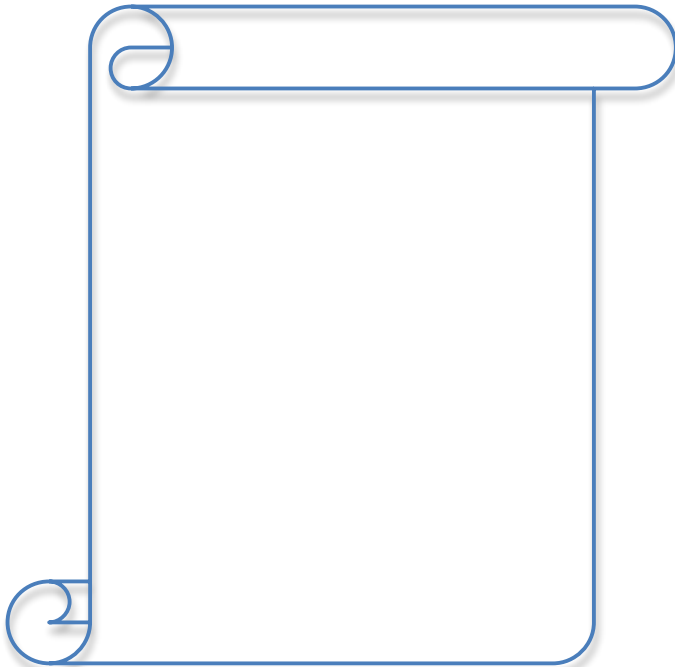
.....
.....
These are things I would like to improve.....

I think I will do this by

.....
.....
These are things that I need help with

.....
.....
These are the ideas of how and from whom I will get help.....

.....
.....
These are other thoughts I don't want to forget



2c A planning sheet

**BRLSI YOUNG SCIENCE RESEARCHERS 2014 – 2015
PLANNING SHEET**

**Please remember that all plans are flexible and are likely to be changed
as the research progresses.**

It is important that all documents are dated. Date.....

This is what I am going to investigate during the next month

.....

What I think I will find out is

.....

I think I will find that because

.....

This is what I need to get together:

Equipment.....

.....

Support (who I am going to ask to help me and how I hope they will help e.g. supervisor, member/s of my research group, family, friends, teachers etc)

.....

.....

**Get email support by going to coolbookings@brlsi.org and head email
BRLSI Young Science Researcher**

These are all the different ways I think I could investigate:

.....

.....

.....

.....

.....

This is how I am going to record my findings (tick):- Use an observation sheet. Make my own notes. Make my own drawings. Make a list of results. Take photographs. Other (explain what these are)

.....

.....

Places I need to visit:.....

.....

.....
Important dates e.g. next session, when to contact supervisor, completing
draft report, presentation etc.
.....
.....

As well as doing research I need to record HOW I did it.

(The TASC wheel will help.)

I am going to record my own learning by using (Tick) Diary, Video, or explain
other method(s)

.....
I am going to present my findings by e.g. Report/essay, App. PowerPoint,
Poster, Video, Magazine article.....
.....

2di Young researcher's feedback sheet

BRLSI Saturday Workshops

CHALLENGING OPPORTUNITIES FOR ENTHUSIASTIC LEARNERS

To Parents/Guardian. It is important that we know what you and your child think of the workshop and the project.

★ Complete it with your child and then give it to the workshop volunteer. Thank you.

BRLSI Researcher

Young researcher's name -----

School ----- Year Group -----

Parents/Guardian: Do you think a project session like this is a good idea? Have you any suggestions on how the project could be improved? (You may want to add some comments about this particular session when you talk to your child)




For young researcher to complete:

Would you recommend this project session? YES NO

How many points do you give the workshop? Circle a number.

Awful

Great

0 1 2 3 4 5 6 7 8 9 10
  

What did you like most?

What would you change?

Will you be coming to the next session? YES NO

2dii Supervisor's feedback sheet

BRLSI Saturday Workshops

CHALLENGING OPPORTUNITIES FOR ENTHUSIASTIC LEARNERS

To Supervisor It is important that we know what you think of the session and the project. We need to ensure that you are satisfied with all aspects as well as the young people you are mentoring.

★ Complete it and then give it to the BRLSI volunteer. Thank you.

BRLSI Researcher Project

Would you recommend this project to other students? YES NO

How many points do you give this specific session? Circle a number.

Awful											Great
0	1	2	3	4	5	6	7	8	9	10	
											

How would you rate the facilities?

Awful											Great
0	1	2	3	4	5	6	7	8	9	10	
											

What did you like most?

What would you change?

What suggestions do you have for improvement that would be helpful to the young researchers?

What suggestions do you have for improvement that would be helpful to you

2e planning, investigation and recording

**BRLSI YOUNG SCIENCE RESEARCHERS 2014 – 2015
PLANNING SHEET (second session)**

Please remember that all plans are flexible and are likely to be changed as the research progresses. It is important that all documents are dated.

Name..... Date.....

What I am going to investigate this month is

.....

.....

What I think I will find out is

.....

.....

.....

I think I will find this because

.....

.....

.....

What I need to get together is:
Equipment.....

.....

Support (who I am going to ask to help me, write name and how they will help)

.....

.....

I need to observe and record findings carefully to make sure my notes are objective, clear, simple to understand by other people and not ambiguous.
I will do this by.....

.....

These are all the different ways I will investigate during the coming month:

.....

.....

.....

This is how I am going to record my findings (circle all that apply):
Use an observation sheet; Make my own notes; Make my own drawings.
Make a list of results; Take photographs. Other (explain)

.....

.....

.....
Places I need to visit:

.....
.....
.....

Important date (e.g. I am going to present my findings on (write in date)

.....

Method of presentation (circle all that apply) Report/essay. PowerPoint, Poster, Video, Diagrams. Other (explain clearly how)

.....
.....
.....

As well as doing research I need to record HOW I did it.

(The TASC wheel will help.)

I am going to record my own learning by using (circle all that apply): Diary, Chart, Video, Other (explain methods)

.....
.....
.....

Please make sure that everything thing you do is recorded and INSERTED in your portfolio in a sensible order

3 Example of an outline schedule

Session outline for introductory session

12pm All volunteers arrive to meet and plan the afternoon. (The Duncan Room might have the 'tail' end of the BRLSI coffee morning)

1pm Children arrive and H&S/ introduction with the other BRLSI workshops in Elwin Room

1:05 Group meets in Duncan room. Paul S and Marie greet.

WHO? Introduction exercise. 2 circles facing each other, each person has one minute to introduce self then circle moves round and repeats approx 25 mins.

WHAT? Then PhD students move to one or other of 5 tables and children guided (to avoid friendship groupings) to go to a table, students introduce their subject area topic, after 5 minutes children change tables. approx 25 minutes.

FIND OUT MORE Children then move to a table, which they think they would like to find out more about. Maybe a practical session to introduce the idea/topic 25 minutes. Issue them with the proposed portfolio and the planning sheet.

COMFORT BREAK approx 2:15pm (very important to keep to this so that all workshops have break together)

Children return to their 'team/topic table with their PhD student

WHEN. Paul S (maybe power point) of the timetable calendar 5 minutes. Always the second Saturday of each month. Interim research findings to be provided to University of Bath Spa Team Jnary 2015 and then update each month. All the research MUST be completed by end of April. Presentation May 9th 2015. Possible further public presentation late May or June 13th) (Children record all dates on planning sheet).

HOW RECORD RESEARCH RESULTS? Students and children in their groups (maybe use the BRLSI observation sheet and/or University PhD methodology outline, maybe a practical example) discuss and suggest for 10 minutes then each group 1 minute feedback. 15 minutes in all

HOW RECORD LEARNING? Marie on the use of the BRLSI portfolio and TASC Wheel. What other methods of recording? Use portfolios to begin process of recording. 15 minutes. Plan a 1 minute interview on video to answer questions. (What is your possible topic? What do you already know about your topic? What do you want to find out? What do you hope to do next?)

VIDEO RECORDING of each participant (including PhD students and programme supervisors) 1 minute statement. 20 minutes

HOW SUPPORT Marie on the use of the website. Example of how to do it. 10 minutes.

During the time between monthly BRLSI session children can ask questions at

coolbookings@brlsi.org . Title the email BRLSI Young Science Researcher.

CAN FAMILIES HELP/SUPPORT? Groups discuss feasibility and appropriateness. 5 minutes

PLANNING AHEAD - Complete as best they can the planning sheet 10 minutes.

Agree the format for each future session (1. Review what has been done. 2. What needs to be done. 3. What skills need to be learned/practised. 4. What

support/equipment is needed over the next month. 5. Any suggestions for next time.

EVALUATION - HOW WAS IT FOR YOU? 10 minutes

4:00pm End.

4 Rubric for evaluating the real academic posters

Marker's Name	Author's Name						
Title	Boring	0					
	Key Hypothesis or Take-Home Message	1					
	Eye Catching	2					
Author / Supervisor Identification	None	0					
	Partial	1					
	Complete	2					
Overall Appearance	Cluttered / Sloppy	0					
	Pleasant	1					
	very pleasing	2					
White Space	Very Little	0					
	OK	1					
	Lots	2					
Colour	Very Little / None	0					
	OK	1					
	Harmonious	2					
Text/Graphics Balance	Too Much / Not Enough Text	0					
	Unbalanced	1					
	Balanced	2					
Text Size	Too Small	0					
	Easy to Read	1					
	Very Easy to Read	2					
Organisation and Flow	Cannot Figure Out	0					
	Implicit	1					
	Explicit	2					
Research Objectives	Can't find	0					
	Present	1					
	Explicit	2					
Main Results	Can't Find	0					
	Present	1					
	Clearly Represented and Explicit	2					
Summary	Absent	0					
	Present	1					
	Clear and Succinct	2					
Total							