National HE STEM Programme

Student Involvement in Science, Technology, Engineering and Mathematics (STEM) Activities:

Research Results

A summary of student experiences of being involved in delivering STEM communication activities.

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The National HE STEM Programme

The National HE STEM Programme (www.hestem.ac.uk) was an initiative that ran between 2009 and 2012 and that supported Higher Education Institutions (HEI) in the exploration of new approaches to recruiting students and delivering programmes of study within the Science, Technology, Engineering and Mathematics (STEM) disciplines. Funded by the Higher Education Funding Councils for England and Wales, the programme established over 500 projects nationally aimed at up-skilling HEI processes and activities with regards widening participation, curriculum development and workforce development. ***The 'Developing and Enhancing Student STEM Communicator Models'* project, an output of which is this research report, was one of 40 projects funded across the South West (SW) region of the National HE STEM Programme. All outputs from the project and from other SW-funded projects are available for free at:**

www.hestem-sw.org.uk

This activity was undertaken as a part of the National HE STEM Programme, via the South West Spoke. For more information on South West Spoke projects, please see www.hestem-sw.org.uk. For more information on the overall national programme, please see www.hestem.ac.uk.

Author Biographies

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Dr Karen Bultitude is a Lecturer in Science Communication at University College London, combining practitioner and academic perspectives in STEM communication. Karen is one of nine national Public Engagement mentors for the EPSRC and is passionate about embedding communication skills and training within STEM education and practice. Whilst working at the University of the West of England in Bristol, in 2006 Karen set up the Student Science Communicators programme that has continued ever since. In 2008 she was awarded the Joshua Phillips Memorial Prize for Innovation in Science Engagement and in 2010 was part of the Walking with Robots team, which was awarded the Rooke Medal for the Public Promotion of Engineering by the Royal Academy of Engineering

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Dr Alison Rivett has a dual role of Research & External Liaison Officer (Science Learning Centre South West) & Primary Science Outreach (Bristol ChemLabS), and previously spent five years as the Institute of Physics' Regional Officer in South West England. Alison has a wide variety of experience in developing, planning and delivering science outreach activities for primary audiences. She currently works part-time with Bristol ChemLabS to enhance primary provision, running hands-on workshops and giving exciting demonstration assemblies in primary schools across the South West and beyond. In her role at the SLCSW she is undertaking research into the impact of CPD courses and manages the Stimulating Physics Network project in the SW region.

We also gratefully acknowledge the strong support and helpful contributions from the rest of the project team in conducting this research: Professor Chris Budd (University of Bath), Helen Heath (University of Bristol) and Ed Stevens (SW Spoke, National HE STEM Programme).

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1. Introduction

This report summarises the main research findings relating to student experiences of being involved in delivering STEM communication activities. This research was conducted as part of a wider project which investigated different models for student involvement in such activities. Further practical information about running such activities is contained within the partner publication to this research, the Guide to Good Practice **http://www.hestem-sw.org.uk/project?id=12&pp=544.**

The research was conducted in March 2011 and focused on three different models of student involvement:

- Final year Maths students from the University of Bath (n=20) who were completing an accredited communication module. As part of their course the students were required to contribute to our different events including an exhibition at the Bath Taps into Science festival (delivered in groups), a Royal Institution Masterclass and various other events.

- Undergraduate students from the University of the West of England, Bristol (n=7) who were paid (at an hourly rate) for their involvement. These students underwent a competitive recruitment process involving both a written application and a verbal interview prior to selection. During the research period they were involved in the Bath Taps into Science festival as well as primary school workshops held on campus.

- Volunteer physics students (both undergraduate and postgraduate, n=34) who were recruited by the Institute of Physics to participate in the activities. These students came from a variety of institutions in the South West, including University of Bath, University of Bristol, and University of Exeter. They were each involved in one of the following events: the Bath Taps Into Science Festival; Changing Perspectives - a Science Week event for families & primary pupils; or hands-on workshops for primary schools at North Wyke Research Station.

The intention of this work is to compare the three different models of involvement to ascertain any similarities or differences in student motivations and development based on how they were recruited to become involved.

Research Focus

The following research questions provided a focus for the evaluation of this programme:

- What benefits and drawbacks are achieved through student and/or volunteer involvement in delivering STEM communication activities?
- How may students and/or volunteers be best supported in delivering STEM communication activities?
- What are the motivations for students and/or volunteers to get involved in STEM communication activities, and how can such involvement become sustainable within higher education institutions?

The current work builds on the Kirkpatrick (2006)[1] model of skills development, as well as the more recent Rugby Team Impact Framework, RTIF (2008)[2].

Methods

The results presented here are based on comparison of electronic questionnaires distributed to students both before and after being involved in the STEM communication activities. (n_1=40 and n_2=31 respectively – the subscript refers to the order of the questionnaire distribution). Copies of the electronic questionnaires are included in the Appendices.

[1]Kirkpatrick, D. L., and Kirkpatrick, J. D. (2006) 'Evaluating Training Programmes', Third Edition, Berrett-Koehler Publishers Inc ISBN-10: 1-57675-384-4; ISBN-13: 978-1-57675-384-4.

[2]The Rugby Team (2008) The rugby team impact framework, http://www.vitae.ac.uk/policy-practice/1418/Rugby-Team-activities.html.

Results and Discussion

Participant Details

60 students participated in the STEM communication activities across four higher education institutions in South West England (29M, 31F). These were broken down as follows:

- University of Bath: 32 people in total (15M, 17F), of whom 20 were UG final year maths students completing a dedicated maths module (6M, 14F), whilst 13 were volunteers recruited by the Institute of Physics to participate in specific events (9M, 4F). *Note that one of the female Physics volunteers was also completing the maths module simultaneously, therefore appears in both individual counts.*

- University of Bristol: 10 were volunteers from the University of Bristol, again recruited through the Institute of Physics (6M, 4F).

- UWE, Bristol: Seven 'student science communicators' (SSCs) had undergone a specialist recruitment process as described previously, and were paid as student ambassadors to contribute to the events. These students came from a wide range of degree programmes including psychology, environmental sciences and biomedical sciences (1M, 6F).

- University of Exeter: 11 volunteers for the Institute of Physics programme in the region (7M, 4F).

Questionnaire Participant Demographics
The majority of questionnaire respondents to both surveys were female (n_1=62.5%, n_2=59.3%). This represents a **slightly higher proportion of females who responded** to the questionnaire than males, given that the gender ratio of the overall participant numbers was approximately even.

There were 22 respondents who completed both surveys, whilst a further 20 completed only the first (pre-event) questionnaire, and 11 only the second (post-event) questionnaire. For the purposes of this analysis it is assumed that the respondents were in all cases a random selection of the overall cohort, and that therefore the averages of the pre- and post-event data sets are able to be directly compared. *It should be noted however that due to the self-selecting nature of the data collection process, the people who completed the questionnaires (especially the second one) may potentially have represented a somewhat biased sample who were more engaged in the STEM communication activities and therefore willing to participate in the data collection.*
The vast majority of participants were **below 25 years of age** (n_1=87.5%; n_2=92.6%) and were of **White English / Welsh / Scottish / Northern Irish / British origin** (n_1=92.3%, n_2=96.3%). One person in the pre-event survey described himself as 'White Irish' and another as 'White Polish', whilst one person completed both surveys who identified with the 'Caribbean' ethnic group. English was the native language for all respondents except one.

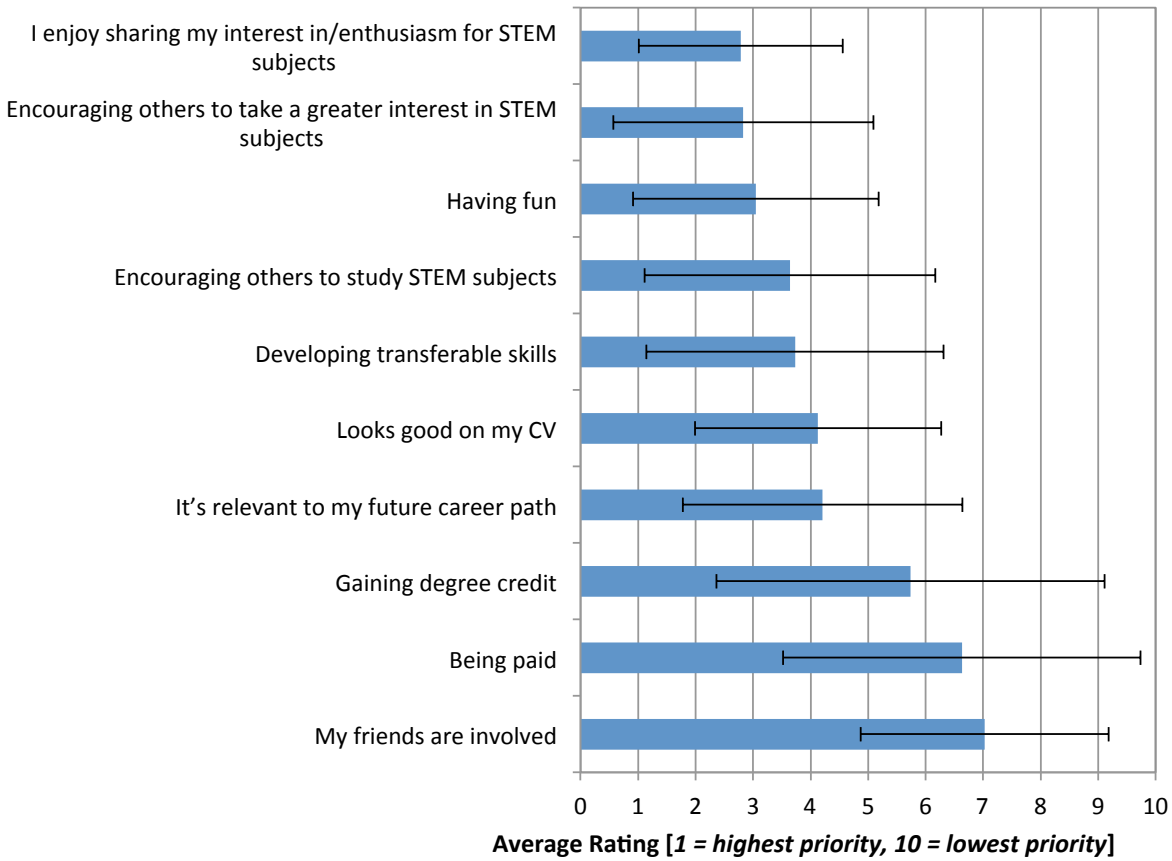
As might be expected from the current stage of their careers, the participants were generally **relatively inexperienced in delivering STEM communication activities.** For two-thirds of respondents this was the first such activity that they had been involved in. All but two of the remaining 15 respondents had been involved in 3 or less events prior to completing the first questionnaire.

Almost half of the respondents to the post-event survey (n_2=47.1%) had been involved in a single STEM Communication event in the interim, whilst a further 18 people had been involved in multiple events. Seven of these (n_2=20.6%) participated in two events, seven contributed to three events, two people to four events, and one person to six separate events.

Bath Taps into Science was the most popular event that participants had contributed to (n_2=60.6%). Respondents were additionally involved in four other events, including subject-specific Masterclasses with school pupils (n_2=24.2%), large scale national events (such as the Big Bang Fair in London, n_2=12.1%), or a university focused event entitled Changing Perspectives (n_2=18.2%).

Motivations

Figure 1 – Average ratings of potential motivations to be involved in the STEM communicator activities (data collected prior to involvement in any events, n1=40). Error bars indicate the standard deviation in the rankings across the cohort.



Within both questionnaires respondents were asked to individually rank a series of suggested motivations for getting involved in delivering STEM communication activities. For each of these motivations the average and standard deviation of all the ratings were calculated; these values are shown in Figure 1.

The calculated average motivations were broadly equivalent across all categories between the pre-event and post-event surveys, therefore only one figure is shown here. Participants were mainly inspired by altruistic motivations, such as wanting to reach out to others, either to encourage them directly to take a greater interest in STEM subjects or to share their own enthusiasm. 'Having fun' was also rated highly on average. Involvement appeared to be based on individual choice rather than linking to ties of friendship – the lowest average priority was allocated to 'My friends are involved'. Professional factors (such as CV or skills development) were moderately popular, but direct overt incentives ('being paid' or 'gaining degree credit') were relatively low in priority. From the perspective of people organising such events it is pleasing that students were so altruistically motivated, however it does suggest that there is a need for students to better recognise and focus on the transferable skills that they develop.

In order to explore respondents' underlying motivations, an additional open-response question was asked in the pre-event questionnaire which requested the respondents to explain what they hoped to achieve through their participation in the STEM communication activities. Respondents were free to include as many different elements as they wished within their response to this question. In total, **51 'internal' motivations** were mentioned, whereby the respondents identified personal factors relating to their own development. These included **skills development** (n_1=16), **experience** (n_1=9), **enjoyment** (n_1=7), **confidence** (n_1=5), **knowledge** (n_1=4) and **contacts** (n_1=3). Six respondents also mentioned **factors relating to their career**, for example *'To enrich my skills and give me a headstart in my teaching career' or 'Experience to put on my CV'.* In contrast, **23 'external' factors** were noted (i.e. those relating to the audiences involved in the activities), suggesting that in general the students' personal motivations outweighed those relating to the audiences they hoped to engage. Seven of the external factors **specifically related to children**, for example *'getting children involved in and interested in science'* or *'I hope to pass on to the children that maths can be fun and interesting'*, whilst the remainder referred to **public audiences more broadly**. There were additionally three comments which recognised the potential

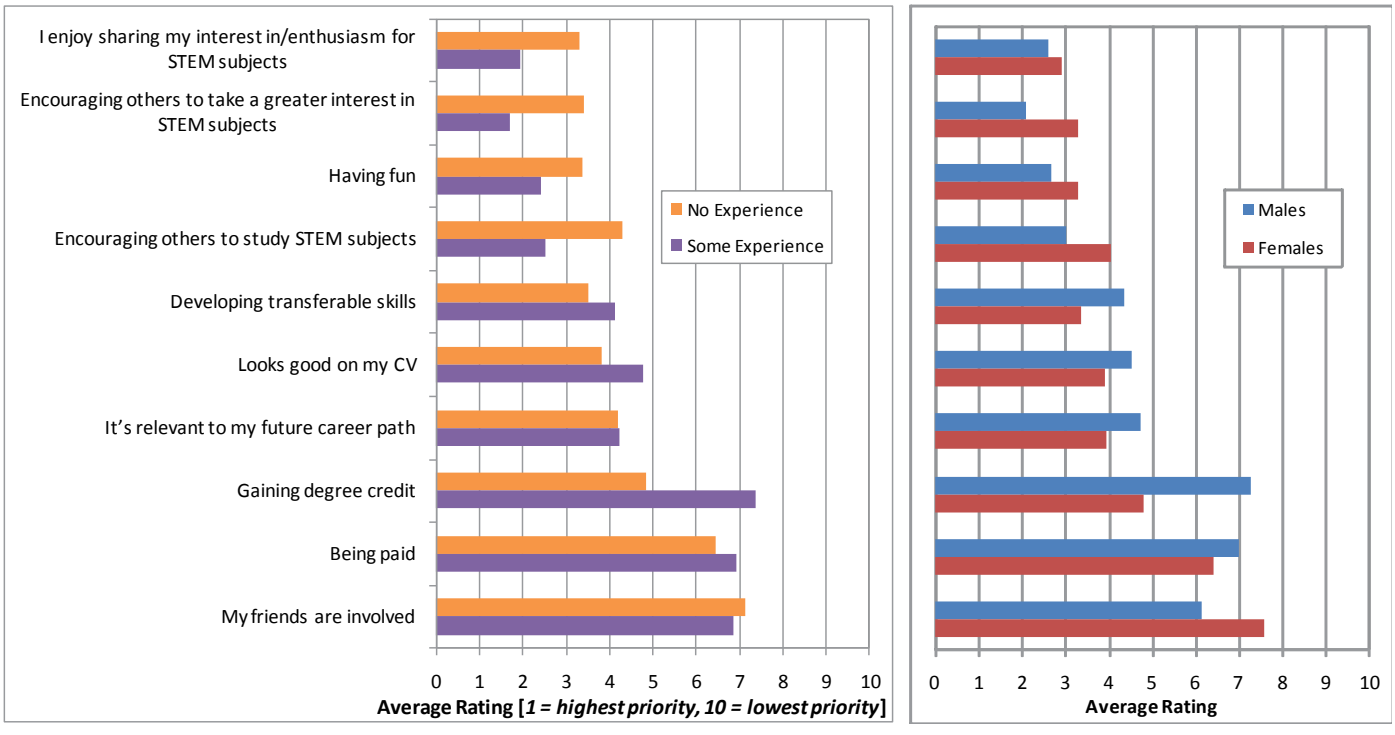
for a **bi-directional learning experience between the volunteer and the audience,** for example: *'A greater understanding of what the public know and are interested in'*, and two respondents explicitly stated that they hoped to 'do a good job' at the events.

This is not to say that the respondents were not overtly aware of possible impacts on the audiences they planned to engage. When asked 'What do you think is the main reason to engage with the non-specialist public?' responses generally related to **improving external perceptions**: n_1=60% indicated that the 'main reason' was 'To ensure the public is better informed...' whilst a further n_1=17.5% indicated 'To raise awareness of STEM generally'. This question was taken directly from the 1996 study by the Royal Society which investigated academic researchers' perceptions; within that study these two reasons were also the most commonly selected. A further open-response question in the pre-event questionnaire explored this idea further, asking the respondents to indicate what they thought the people they interact with at the events will get out of the experience. The majority of respondents (n_1=28) mentioned **increased interest, enthusiasm or inspiration** relating to STEM subjects. Both enjoyment (n_1=22) and **knowledge or learning** (n_1=19) were also strongly recognised, perhaps reflecting the informal but educational intentions of the activities under investigation in this research. The concept of **'novelty'** or **'new ideas'** was also popular, being mentioned by eleven respondents, as was 'curiosity' (n_1=6). Other intended impacts that were highlighted included **increased progression into science careers** (n_1=4), **reassurance** (especially relating to the perceived difficulty of STEM subjects, n_1=3), aspects relating to the scientific process (n_1=3) and the **involvement of positive role models** (n_1=2). The quantitative data regarding respondents' motivations can also be broken down by the various demographics of respondents. Figure 2 shows the variation in responses according to level of previous experience and gender.

The overall order of the average rankings is approximately consistent, with some specific exceptions. **Experienced students were even more likely to be motivated by altruistic motivations,** and ranked 'Gaining degree credit' as their lowest priority. **Males tended towards more external motivations** (impacting on other people rather than themselves) than females, and in particular females ranked 'gaining degree credit' much more highly than males, but were less inclined to be influenced by 'My friends are involved'.

As noted earlier, there were three different models of involvement of the participants: part of an accredited module; a paid position involving specialist recruitment; and a voluntary role associated with specific events. Figure 3 demonstrates the variation in the ranking of motivations according to the participant's model of involvement. As

Figure 2 –Average ratings of motivations broken down by a) level of previous experience and b) gender. Note that for clarity and in order to facilitate direct comparison these figures have been displayed side by side in the same order as Figure 1 without any error bars.



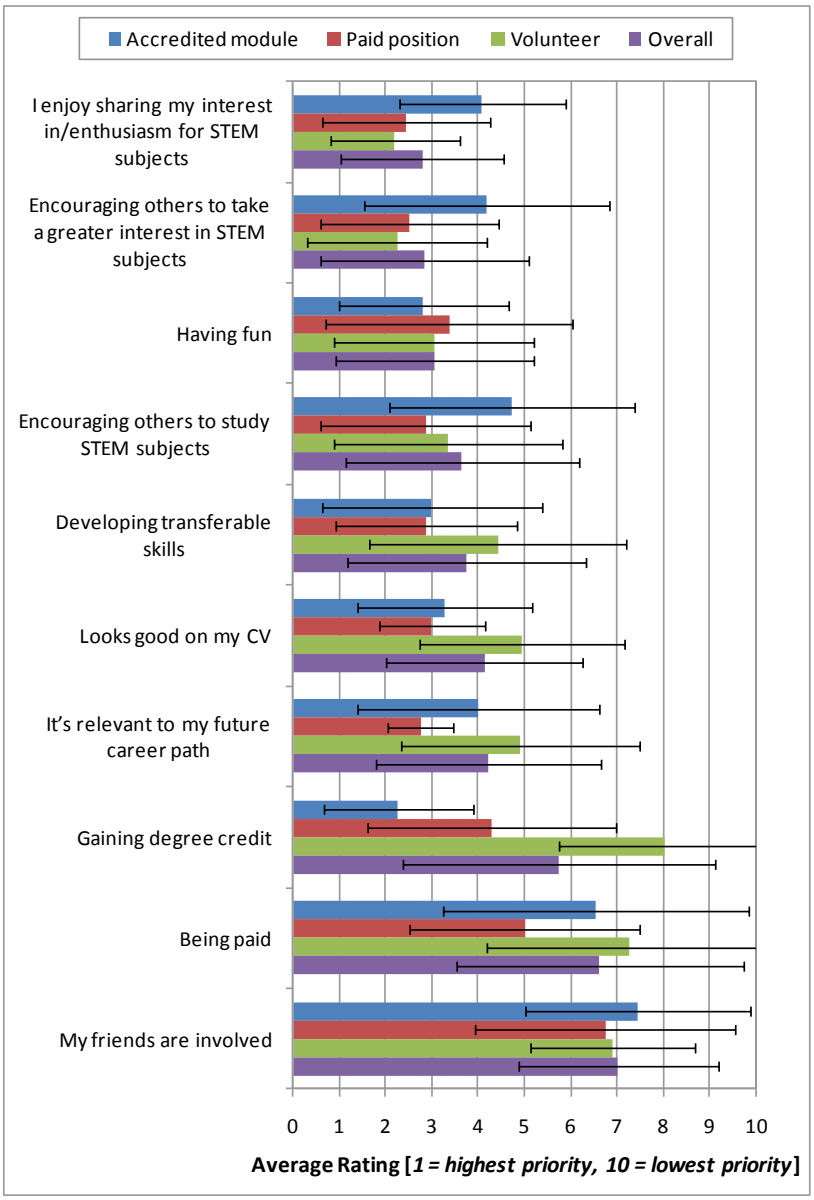


Figure 3 – Average ratings of potential motivations to be involved in the STEM communicator activities, broken down by the model of involvement of the participants. Error bars indicate the standard deviation in the rankings across the respective cohort.

might be expected, **there are some major differences in the students' motivations which are closely linked to the model under which they were recruited to participate** in the activities. The students taking the accredited module on average ranked 'gaining degree credit' as their top average priority, and ranked the more altruistic factors (such as 'encouraging others to study STEM subjects', 'I enjoy sharing my interest in / enthusiasm for STEM subjects' and 'encouraging others to take a greater interest in STEM subjects') much lower than the other two groups. In a similar vein, the students who were paid to participate ranked 'being paid' more highly than the other groups. It is however notable that in the case of these paid students the financial incentive was still their second lowest average priority. The volunteers ranked 'gaining degree credit' much lower than the other groups, possibly because some of the volunteers were postgraduate students (as opposed to the undergraduate cohorts in the other samples), and therefore degree credit now appeared less relevant to them. Other personal factors were also ranked lower on average by the volunteers, for example skills development, CV contributions or relevance to a career path. For all three models of involvement 'having fun' was a strong motivating factor, whilst having their friends involved proved to be a weak motivation for almost all participants.

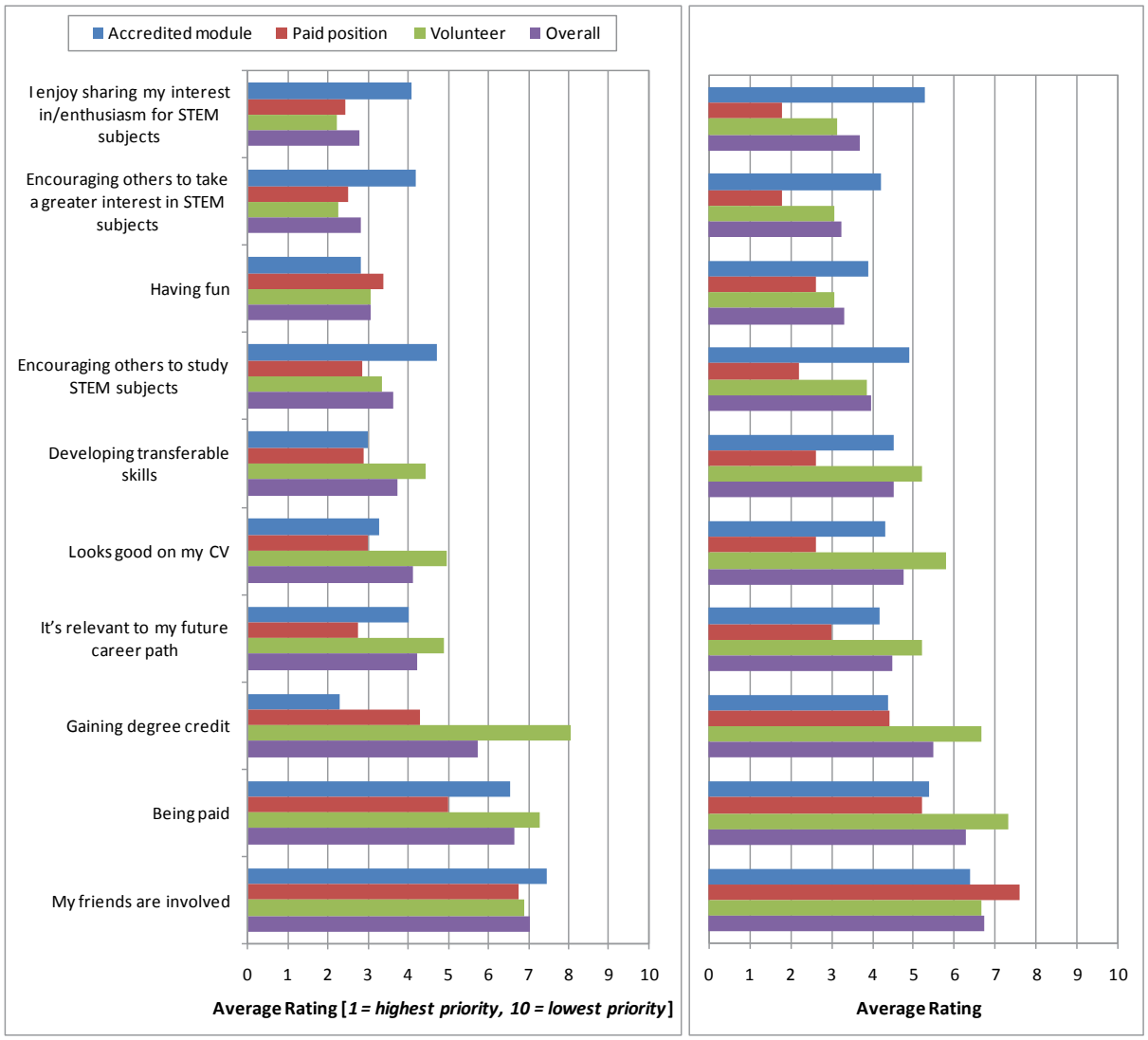


Figure 4 – Average ratings of potential motivations to be involved in the STEM communicator activities, broken down by the model of involvement of the participants. a) (left) Responses submitted prior to the events (n1=40) and b) (right) responses submitted after involvement in at least one STEM communication activity (n2=31). Note that for clarity and in order to facilitate direct comparison these figures have been displayed side by side in the same order as Figure 3 above without any error bars.

The same question was asked in the post-event questionnaire. Figure 4 provides a comparison of the average ratings before and after the participants were involved in the events. It is noticeable that the **students taking the accredited module reported being much less motivated by gaining degree credit once they had participated in a STEM communication activity.** They were also slightly more interested in being paid for such work, possibly due to a greater amount of confidence that they could deliver the task. However, their interest in developing transferable skills or gaining CV credit had decreased, possibly due to a reflection that they had already successfully delivered an activity and therefore had less incentive on that front. Whilst there were small adjustments in the average motivations of paid students or those who had volunteers, these were generally small scale and in line with the pre-event trends, therefore will not be discussed further here.

The gender distribution of motivations remained roughly consistent post-event, although males expressed a slightly stronger motivation related to the involvement of their friends, and in gaining degree credit.

Barriers

In the pre-event questionnaire respondents were asked via an open-response question what barriers they perceived to either their own or other students' involvement in STEM communication activities. By far the most common barrier identified was **time** (n1=27), with a further 16 respondents identifying **other commitments** as a key challenge. Two delegates even noted that they had to be careful that their involvement in STEM communication activities didn't detract from their other commitments:

> *Since I find the communication and creativity really interesting and enjoyable I really want to do well, not only for myself but for the general success of the Communicating Maths course. With this in mind, I do find it very difficult balancing it alongside my other modules comprising my degree. I do genuinely think this module is challenging and stimulating.*

> *Pressure of pretty much always feeling like I should be working on PhD stuff directly...*

Seven respondents noted a **lack of confidence** may possibly prevent some students from getting involved, whilst five made specific reference to **transport problems** and the **frequently distant locations** of such activities as being a challenge for them. There were some indications that pre-organised events where volunteers were reimbursed for their travel expenses would be appreciated: four respondents mentioned **financial factors** (e.g. travel costs), whilst three raised the issue of the **time required to plan such activities** if unsupported. Other areas noted were **lack of advertising of opportunities, student apathy,** reliance on others in a **teamwork** environment, or the **perception that the activities themselves are not worthwhile.**

The project management team identified an additional barrier related to the timing of the events on offer: due to the popularity of **National Science and Engineering Week** (NSEW) in mid-March, most events in the region are clustered around a two-week period. This means that inevitable clashes occur (e.g. large-scale events happening in both Bristol and Bath simultaneously), but also makes it difficult to provide a more coherent 'offer' of activities over a longer duration. In all three STEM communication models investigated here, the project management team reported that some students became very enthusiastic, and were keen to continue their involvement, however there were insufficient opportunities for them to do so locally. There can also be difficulties in recruiting sufficient STEM communicators within the NSEW 'crunch' period, due to the large number of commitments on offer in a short time.

The post-event questionnaire explored any barriers that delegates foresaw to their being involved in more STEM communication activities in future. The main results were similar to those identified in the pre-event questionnaire: again, the overwhelming barrier was time (n2=19), with eleven respondents mentioning other commitments such as university courses or jobs. Six respondents also referred to **transport issues** or the **likely locations of activities** as being problematic for them. However **many of the barriers perceived in the pre-event questionnaire were no longer mentioned**, for example lack of confidence or prior experience, student apathy, or financial factors were all greatly reduced or absent from the comments. Three delegates mentioned that they weren't sure whether such opportunities would arise once they had left university, although they were keen to continue their involvement if any such possibilities existed. This suggests that opportunities such as STEMNET Ambassadors might be worth flagging up to students towards the time that they complete their studies.

Preparation

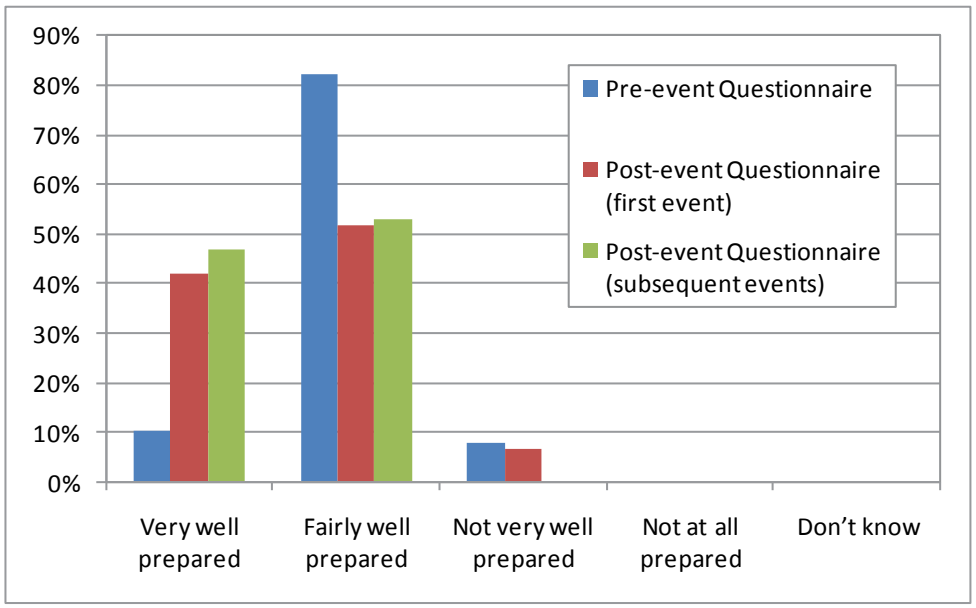


Figure 5 – Variations over time regarding how well prepared the students felt to engage with the non-specialist public.

The students were asked to indicate how 'prepared' they felt to engage with the non-specialist public, both before the events occurred and afterwards. Figure 5 shows the students' reported confidence in their level of preparation, expressed as a percentage of the number of respondents to each question.

The participants were generally relatively confident regarding how prepared they felt: in all three cases at least 80% of respondents felt at least 'fairly well prepared'. It is noticeable that **with hindsight, respondents considered themselves much better prepared for their first event than they had reported prior to the events.** In advance of the events 82.1% reported that they felt 'fairly well prepared', with a further 10.0% claiming the maximum category of 'very well prepared'. When asked after the event to judge how prepared they felt, 41.9% (n=13) respondents claimed to be 'very well prepared' whilst 51.6% (n=16) felt 'fairly well prepared'. This could be due to differences in timing of the questions (for example if they filled in the first survey a week before the event, but considered the question from the second survey in relation to how prepared they were immediately before the event, after they had spent a week or so in preparation). This observed increase in preparation could however also represent a higher level of confidence in hindsight, once the event was over. As might be expected, the **students who participated in multiple events expressed the highest levels of confidence**, with a unanimous indication of feeling at least 'fairly well prepared'. When asked to explain any differences in their responses for their first event compared to any subsequent events most respondents reported that this increase in self-perceived level of preparation was primarily related to confidence:

As I became more confident with the demonstrations and what was required of me I felt more prepared and less apprehensive

I felt better prepared after I had done the first event as I knew what to expect.

In both cases I had the chance to practice the experiments first, but just in terms of experience interacting with the kids, having done an event before was a big help.

Within the pre-event questionnaire the respondents were asked to outline in more detail what preparation they had undertaken. Internet research and reading were the most popular preparation tasks, with 13 comments relating to reading materials that were directly provided (e.g. activity guidelines or set coursework materials), and a further 13 respondents mentioning various types of supplementary reading or research that they conducted independently. In some cases this research was designed to focus on knowledge development, whilst other respondents were more focused on determining the appropriate 'level' to pitch their activities at:

Revision of the subjects covered, making sure I am prepared for likely questions that will come up and to make sure I can communicate the underlying physics the activities want to get across.

Reading up on the school syllabus to understand the level to pitch things at better.

Reading newspaper articles etc which pitch science at a reasonable level.

Training sessions were mentioned by 17 respondents, with a further 12 indicating that they made some effort to review and/or practice in advance the activities that they were planning to deliver. Planning more generally was a key area of focus (especially for the maths students who were developing their own activities to deliver). Logistical planning (n_1=7) and preparing the activities themselves (n_1=7) were the main areas focused on in this regard. Similarly, 12 respondents mentioned group discussions or getting together with their team in advance. Whilst most of these respondents were from the maths class (who were required to plan their activities in allocated groups) it is perhaps worth highlighting that students from other modes of involvement also raised the teamwork element as crucial to their feeling prepared for the upcoming events:

> *Group planning session to ensure that everyone knows who is doing what*

> *We have completed a 2 hour training session whereby the group were able to meet each and get to know each other and were given a useful prebrief on the activities we would be involved as well as an introduction to the equipment we will be using.*

Finally, five respondents emphasised that they specifically practiced the 'verbal' elements of the activities (for example practicing answering potential questions, or explaining a scientific concept), whilst one respondent had actively sought advice from a tutor with regards to a query they'd had.

As outlined in Figure 5, the respondents generally felt fairly well prepared for their involvement in the STEM communication activities. This perception was upheld within the open-question responses to both questionnaires, where they were asked to outline **what additional training / planning / preparation / support would have helped** them to get ready for the role. By far the largest response to this question (n_1=13, n_2=15) was 'none', indicating a high level of satisfaction with the current support. Some respondents (n_1=5, n2=3) would have liked additional advice or training sessions, with others mentioning further opportunity to practice (n_1=5, n_2=3). More detailed briefing or information provided about the upcoming events would also have been appreciated by respondents (n_1=5, n_2=5), for example:

> *I think theoretically the descriptions of the events have been adequate to good. The biggest problem in my opinion is that the logistics are seemed to be assumed, most likely because the organisers/people involved have done it before. I'd like to know, how much space we have, how much of a budget do we have, what size/ how much content should displays hold etc. More quantitative, logistical facts would be appreciated.*

The project management team found the comparison of their different preparation activities very enlightening, and plan to incorporate some adaptations based on ideas from the other alternative models of involving the students in STEM communication. For example, although a half-day training session is standard practice at the time of their recruitment, this was the first year that the UWE students had been involved in a 'dry run' activity (practice event with a small, friendly audience prior to a public display). The 'dry run' proved very popular, not only in preparing the students but also in engendering a team spirit within the group. Conversely, the Bath maths students have been conducting a 'dry run' for many years, however have little formal training immediately beforehand, and the management team now plan to incorporate further advice/training sessions for the Bath maths students, in line with the students' preferences indicated above. The benefits of getting the different institutions together for the 'dry run' were also noted by the project management team. In particular, the range of subject backgrounds of the students involved ensured that they had a chance to practice explaining their activities to non-experts. The event was also identified as a great opportunity for peer feedback and learning from others in a non-threatening environment.

As noted in the section on 'barriers', time was a major challenge for many respondents, with six people specifically mentioning within the pre-event questionnaire that 'more time' would have been helpful during their preparation for the events.

Respondents were also asked in the post-event questionnaire to reflect on **what they could have done differently themselves to prepare** for the activities. Sixteen respondents indicated that they were happy with the preparation that they undertook. Other suggestions included:

> *As a wider group we should have grilled each other about exactly how our Masterclass session would work, including details like having scissors!*

> *Attending the briefing session would have been a plus*
> *Maybe we could have practised explaining the tricks to each other on a child's level beforehand.*
> *I should have spent some time reading through some chapters relevant to the activity.*

> *I was very stressed prior to the Big Bang because I was struggling to find resources to adequately explain some of the concepts of the stand. Perhaps I should have asked Chris again, but was under the impression we were supposed to be working it out by ourselves. For Bath Taps, getting someone in the group to take the lead with regards to organisation would have helped, and meant we were better prepared in time for the dry run.*

Emotions

Pre-event emotions:

Post-event emotions:

Figure 6 – Word clouds representing the respondents' emotions both before and after being involved in the STEM communication activities. The larger the word the more respondents selected that option. Note that the word colours and orientations do not have any particular meaning in these figures.

Respondents were asked to **select from a list of 36 emotions** which ones they felt best described how they were feeling about the events. There were no limitations on the number of descriptors chosen, and the same question was asked both pre- and post-event in order to gauge any change in attitudes towards their involvement. Word clouds representing the respondents' reported emotions both pre and post-event are shown in Figure 6. Six emotions were not selected by respondents in either questionnaire: 'frustrated', 'inadequate', 'passive', 'afraid', 'bored', and 'confused'. It is noticeable that these are all negative emotions, thereby indicating an overwhelmingly positive response to the experience by most respondents. The three most strongly reported emotions prior to the event were **'excited'** (n_1=80.0%), **'responsible'** (n_1=60.0%) and **'creative'** (n_1=47.5%). 25.0% of respondents reported feeling **'anxious'** in advance (and a further two indicated they were **'nervous'** in the open-response part of this question), 15.0% **'rushed'**, and small numbers reported other negative emotions such as 'stressed' (n_1=10.0%), **'tense'** (n_1=7.5%), 'overwhelmed' (n_1=5.0%) or **'uncomfortable'** (n_1=2.5%).

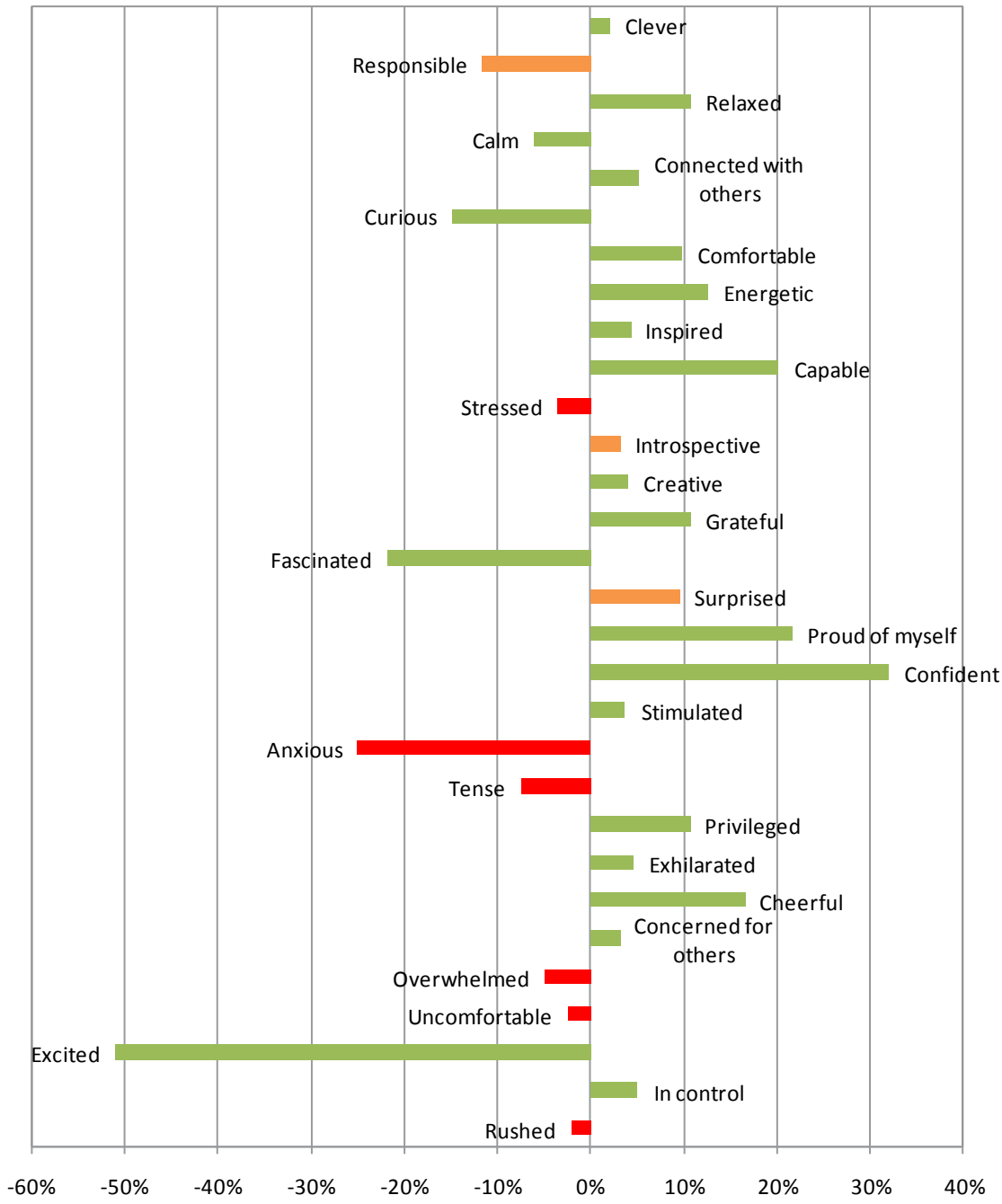


Figure 7 – Variation in participant emotions before and after the events. The values shown were calculated by subtracting the proportion of the cohort who expressed a particular emotion before the event from the corresponding proportion after the event. Negative values therefore represent a reduction in the proportion of the cohort who experienced that emotion, whilst positive values represent an increase.

An indication of the proportional variation in reported emotions between the two questionnaires is shown in Figure 7. It is noticeable that **all of the reported emotions identified as 'negative'** were reported to reduce between the two surveys. The most positive changes related to self-value, for example being **'confident', 'proud of myself'** and 'capable', as well as a variety of other smaller changes. There were also some positive increases in aspects relating to acknowledgement of wider effort and support, for example **'grateful'** and **'privileged'**. Some 'positive' emotions did however decrease between the two surveys (in particular 'excited', 'curious' and 'fascinated') however these are to be expected as they are associated with anticipation and are therefore less likely to be perceived after the event. It is perhaps interesting that fewer respondents reported feeling 'calm' after the event, however this could have been due to the timing of the survey, which coincided with a busy assessment period for most students.

Conclusions

Future Involvement

In the post-event survey respondents were asked to indicate whether they thought they will take part in more STEM communication activities in the future. The response to this question was overwhelmingly positive, with n2=61.3% indicating 'yes, definitely' and a further n2=32.3% selecting 'maybe'. Less than 10% (n2=6.5%) were 'not sure' and no respondents indicated a negative inclination. When asked to explain their reasons as to why they would (or would not) choose to continue with such activities, 'enjoyment' was noted as the most common factor (n2=13). Five respondents also reported that they specifically found the experience 'rewarding', whilst for six people the career links and/or CV development were important motivating factors. Four respondents made qualifying statements, for example indicating that they would like to continue if certain aforementioned barriers were overcome (e.g. time or travel issues), whilst two people felt it would depend on the specific activity and/or occasion involved. A further two respondents were motivated by external factors, for example:

> *It is rewarding when you can impress, stimulate and inspire younger children and make them realise that STEM subjects are accessible.*

It is interesting that many of the factors highlighted as being important motivators in the pre-event questionnaire (e.g. 'skills development', 'experience', 'confidence', 'knowledge' and 'contacts') were much less important to respondents once they had participated in the STEM communication activities. This suggests that many of the respondents felt they had gained those attributes through their initial involvement, but in order to continue their role were more motivated by enjoyment, career opportunities, or a sense of 'reward' from having participated. It is unclear however whether these students are able to consciously recognise such skills development and use it effectively as evidence when seeking employment.

This work has explored the experiences of students involved in delivering STEM communication activities within the South-West of England during March 2011. The research drew on responses to questionnaires distributed both before and after the students' first events, and demonstrates strong positive reactions to such experiences.

Students who become involved in STEM communication activities are generally focused on altruistic motivations (helping others) and/or personal enjoyment or an element of 'having fun'. Whilst payment and degree credit can pay an important role in enabling students to participate in such activities, these more material considerations are not the main motivating factors. Furthermore, students with some previous experience in STEM communication events were much more likely to select external and/or enjoyment-related factors than those who were new to the activities.

As expected, within specific cohorts there were some differences in their reported motivations. Broadly speaking, the respondents from the Bath maths module reported personal factors (such as CV credit, skills development or careers aspects) as being more motivating, whilst the physics volunteers considered these factors as being less important. Unsurprisingly, the UWE SSCs who were paid for their input demonstrated a greater level of interest in 'being paid', whilst the Bath students currently completing a dedicated maths communication module were more interested in 'gaining degree credit'. However, once they had participated in an event the Bath students reported a much lower motivation relating specifically to gaining a degree credit. This suggests that there can be a transformative effect for many students through their involvement in delivering STEM communication activities.

When asked to indicate their emotions relating to delivering the activities, very few negative emotions were selected by the respondents: out of 12 emotions classed as 'negative', six were not selected either before or after the event delivery. Furthermore, all of the negative emotions were reported to reduce after the event, with additional strong increases observed for being 'confident', 'proud of myself' and 'capable'.

Recommendations

The following recommendations arise from the project team's experience across this project:

- There are a wide variety of influences that affect students' decisions to become involved in delivering STEM communication activities; it is important when trying to recruit students to participate that a wide variety of such factors are highlighted, including both internal and external factors.

- The combination of a skills training session with a 'dry run' (practice) event proved very successful with all of the groups involved in this programme.

- Students who are originally attracted to participate by material factors (such as payment or degree credit) frequently report a reduction in such motivations after participating in an event. Such transformative effects may be further developed by for example offering such students volunteer opportunities at a later date (e.g. through the STEM Ambassador programme once they are in the workforce).

- There is evidence of some students potentially not recognising the transferable skills developed as part of their participation. This may indicate a need for follow up / reflective sessions after the activities which support students in drawing out such learning so that they are better able to articulate such development in later employment situations.

Appendix One: 'Before' Questionnaire

Introduction

We are interested in finding out how best to support people like you in getting involved in public communication activities relating to STEM (science, technology, engineering and mathematics) subjects. This survey is part of a wider project comparing the involvement of university students and volunteers in STEM communication activities within the South West region. It should only take 5-10 minutes to complete. All information will be treated confidentially and none of the responses will be attributable to any individual person. Please therefore provide answers which are as honest and complete as possible.

If you have any questions about the research or its purpose please contact the research and evaluation leader for this project, Karen Bultitude <<contact details provided>>.

Thank you very much for taking the time to complete this survey.

To ensure that your data is anonymous we will use an identifier code that is unique to you, but one that the researchers won't be able to associate with you.

Please enter the first three letters of your mother's maiden name: _____

Please enter the 2-digit day of the month you were born (e.g. 14th April would be '14'):_____

Please enter the last two letters of your home postcode: _____

Previous Experience and Support

1. Have you ever participated in STEM communication activities before? Yes No

If 'yes' please briefly describe your previous experience: _____

2. If 'yes', roughly how many times in the past 12 months have you done each of the following?

Lecture/Talk to school students	Once	2-3 times	4-5 times	More than 5 times
Lecture/Talk to a public group	Once	2-3 times	4-5 times	More than 5 times
Workshop with school students	Once	2-3 times	4-5 times	More than 5 times
Workshop with a public group	Once	2-3 times	4-5 times	More than 5 times
Drop-in activities (e.g. at a science festival or similar public event)	Once	2-3 times	4-5 times	More than 5 times
Public debate or discussion	Once	2-3 times	4-5 times	More than 5 times
Participated in an institutional Open Day	Once	2-3 times	4-5 times	More than 5 times
Careers Stand/Event for school students	Once	2-3 times	4-5 times	More than 5 times
Other	Once	2-3 times	4-5 times	More than 5 times

(please specify):_____

The following questions apply to all participants – if you haven't been involved in STEM communication activities before then answer them in relation to the upcoming events which you will be involved in soon.

3. What planning and/or preparation have you undertaken to get ready for your involvement in the events?_____

4. What support have you received for your involvement in the events (e.g. documentation, briefing sessions, resources, personalised advice, supervision etc.)?

_____

Motivations and Barriers

5. Please briefly describe the upcoming events where you will deliver science communication activities (e.g. venue/location, likely audience numbers/demographics, your own role, how far in the future the event(s) are, the type of activity involved (e.g. see the options for Q2 above) etc.)

6. Please rank the following factors in order of priority regarding how strongly each one would motivate you to be involved in delivering STEM communication activities (*1 = highest priority, 10 = lowest priority*):

_____ Gaining degree credit

_____ Being paid

_____ Having fun

_____ Encouraging others to study STEM subjects

_____ Encouraging others to take a greater interest in STEM subjects

_____ Developing transferable skills

_____ Looks good on my CV

_____ My friends are involved

_____ It's relevant to my future career path

_____ I enjoy sharing my interest in/enthusiasm for STEM subjects

Please briefly describe any other factors that encouraged you to get involved, and where you would rank them:_____

7. What barriers do you perceive to either yourself or other students/volunteers being involved in STEM communication activities (e.g. time, other priorities, expectations of friends/family)?

_____

8. Looking at the list below, what do you think is the main reason to engage with the non-specialist public?

[*This question is taken from the Royal Society's survey (2006) although we adjusted the phrasing from 'science' to 'STEM' to match the rest of the content.*]

_____ To be accountable for the use of public funds

_____ To contribute to public debates about science and scientific issues

_____ To contribute to discussions about the social and ethical issues science can raise

_____ To generate / stimulate additional funds for universities and colleges

_____ To recruit students to your subject

_____ To ensure the public is better informed about science and technology

_____ To raise awareness about your subject

_____ To raise awareness of STEM generally

_____ There are no reasons to engage with this group

_____ Other (please specify): _____

Expectations and attitudes to the upcoming events

9. Please indicate which of the following accurately describe how you are feeling about being involved in the upcoming events (you may select as many options as you think are appropriate):

   [*Relevant emotions take from a larger list by Jan* Parker]

Calm	Proud of myself	In control
Rushed	Concerned for others	Overwhelmed
Frustrated	Inadequate	Afraid
Tense	Stressed	Bored
Introspective	Inspired	Grateful
Stimulated	Energetic	Surprised
Cheerful	Exhilarated	Curious
Confident	Capable	Passive
Relaxed	Creative	Fascinated
Privileged	Connected with others	Responsible
Uncomfortable	Comfortable	Confused
Excited	Anxious	Clever

Other (please specify):_____

10. How well prepared do you personally feel you are to engage with the non-specialist public? [*Adapted from Royal Society (2006) , replacing 'equipped' with 'prepared'*]

    Very well prepared

    Fairly well prepared

    Not very well prepared

    Not at all prepared

    Don't know

11. What do you hope to achieve through your participation in the STEM communication activities? *Please be as explicit as possible.*

    _____

12. What do you think people you interact with at the event(s) will get out of the experience? _____

    _____

13. What additional training / planning / preparation /support would have helped you to get ready for the role? _____

14. Please use this space for any other comments regarding your involvement in STEM communication activities: _____

About You

Please note that this information will only be used for statistical purposes to compare responses amongst different demographic groups, and will NOT be used to trace comments to particular individuals.

15. Gender: F M

16. Age group: 16-25 25-34 35-44 45-54 55-64 65+

17. Degree programme (including current year of study if applicable): _____

18. Institution: University of Bath University of Bristol UWE, Bristol Other (please specify):

19. Is English your native language? Yes No

20. What is your ethnic group?
[*question phrasing taken from the ONS instructions regarding the 2011 Census*]

A. White
- English / Welsh / Scottish / Northern Irish / British
- Irish
- Gypsy or Irish Traveller
- Any other White background (please specify): _____

B. Mixed / multiple ethnic groups
- White and Black Caribbean
- White and Black African
- White and Asian
- Any other Mixed / multiple ethnic background (please specify): _____

C. Asian / Asian British
- Indian
- Pakistani
- Bangladeshi
- Chinese
- Any other Asian background (please specify): _____

D. Black / African / Caribbean / Black British
- African
- Caribbean
- Any other Black / African / Caribbean background (please specify):_____

E. Other ethnic group
- Arab
- Any other ethnic group (please specify): _____

Appendix Two: 'After' Questionnaire

Introduction

This survey follows on from the first questionnaire you completed prior to taking part in a STEM communication activity. We would like you now to reflect on your experience(s) and tell us how it was for you.

All information will be treated confidentially and none of the responses will be attributable to any individual person. Please therefore provide answers which are as honest and complete as possible. It should only take 5-10 minutes to complete.

If you have any questions about the research or its purpose please contact the research and evaluation leader for this project, Karen Bultitude, <<contact details inserted>>. These surveys are part of a wider project comparing the involvement of university students and volunteers in STEM communication activities within the South West region. We are interested in finding out how best to support people like you in getting involved in public communication activities relating to STEM (science, technology, engineering and mathematics) subjects.

Thank you very much for taking the time to complete this survey.

To ensure that this survey can be correlated with your previous responses, please enter the data below to generate your unique identifier code.

Please enter the first three letters of your mother's maiden name: _____

Please enter the 2-digit day of the month you were born (e.g. 5th April would be '05'): _____

Please enter the last two letters of your home postcode: _____

Recent Experience

1. How many STEM communication events (where an 'event' is defined as activities taking place on different days or in different locations) have you participated in recently?
   1 2 3 4 5 6+
2. Which STEM communication activities have you participated in recently? (please tick all that apply)
   _____ Big Bang Fair (London, March 2011)
   _____ Bath Taps into Science (Bath, March 2011)
   _____ Changing Perspectives (Bristol, March 2011)
   _____ Devon County Show (Exeter, May 2011)
   _____ Maths Masterclasses (miscellaneous locations and times)
   _____ Schools workshop (miscellaneous locations and times)
   _____ Other event(s) please give date & brief details: _____

Support & Preparation

3. What planning and/or preparation did you undertake to get ready for your involvement in the event/s?
   _____
4. What support did you receive for your involvement in the event/s (e.g. documentation, briefing sessions, resources, personalised advice, supervision etc.)?
   _____
5. For the first event you took part in, did you feel…?
   _____ Very well prepared
   _____ Fairly well prepared
   _____ Not very well prepared
   _____ Not at all prepared
   _____ Don't know

6. For subsequent events (if applicable) did you feel..?

   _____ Very well prepared
   _____ Fairly well prepared
   _____ Not very well prepared
   _____ Not at all prepared
   _____ Don't know
   _____ Not applicable

7. Please explain any similarities or differences between your responses to questions 5 & 6.

   _____

8. What other support, training, resources or preparation do you think would have been helpful beforehand? _____

9. Is there anything which you feel you could have done differently beforehand to prepare yourself?

   _____

10. Did you or other students/volunteers experience any barriers to being involved in these STEM communication activities (e.g. time, other priorities, expectations of friends/family/lecturers/supervisors)?

    _____

Attitudes to the events

11. Please indicate which of the following accurately describe how you feel now, having been involved in the events (you may select as many options as you think are appropriate):

    [*Relevant emotions take from a larger list by Jan Parker*]

Calm	Proud of myself	In control
Rushed	Concerned for others	Overwhelmed
Frustrated	Inadequate	Afraid
Tense	Stressed	Bored
Introspective	Inspired	Grateful
Stimulated	Energetic	Surprised
Cheerful	Exhilarated	Curious
Confident	Capable	Passive
Relaxed	Creative	Fascinated
Privileged	Connected with others	Responsible
Uncomfortable	Comfortable	Confused
Excited	Anxious	Clever

    Other (please specify):_____

12. What do you think you achieved through your participation in the STEM communication activities? *Please be as explicit as possible.* _____

13. What do you think people you interacted with at the event(s) got out of the experience?

    _____

Motivation for future events

14. Please rank the following factors in order of priority regarding how strongly each one would motivate you to be involved in delivering more STEM communication activities in the future (*1 = highest priority, 10 = lowest priority*):

    _____ Gaining degree credit

    _____ Being paid

    _____ Having fun

    _____ Encouraging others to study STEM subjects

    _____ Encouraging others to take a greater interest in STEM subjects

    _____ Developing transferable skills

    _____ Looks good on my CV

    _____ My friends are involved

    _____ It's relevant to my future career path

    _____ I enjoy sharing my interest in/enthusiasm for STEM subjects

Please briefly describe any other factors that would encourage you to continue being involved, and where you would rank them:_____

15. Do you think you will take part in more STEM communication activities in the future?

    _____ Yes, definitely

    _____ Maybe

    _____ Not sure

    _____ Probably not

    _____ Definitely not

    Please give your reasons briefly: _____

16. Do you envisage any barriers to being involved in more STEM communication activities in the future (e.g. time, other priorities, expectations of friends/family/lecturers/supervisors)?

    _____

17. Please use this space for any other comments regarding your involvement in STEM communication activities: _____

About You

If you completed the first survey (relating to your perceptions BEFORE the events) then there is no need to provide this information again. However if this is the first survey you have completed relating to your role in STEM communication, please provide basic background information below. Please note that this information will only be used for statistical purposes to compare responses amongst different demographic groups, and will NOT be used to trace comments to particular individuals.

18. Gender: F M
19. Age group: 16-25 25-34 35-44 45-54 55-64 65+
20. Degree programme (including current year of study if applicable): _____
21. Institution: University of Bath University of Bristol UWE, Bristol Other (please specify):
22. Is English your native language? Yes No
23. What is your ethnic group?
    [*question phrasing taken from the ONS instructions regarding the 2011 Census*]

    B. White
    - English / Welsh / Scottish / Northern Irish / British
    - Irish
    - Gypsy or Irish Traveller
    - Any other White background (please specify): _____

    B. Mixed / multiple ethnic groups
    - White and Black Caribbean
    - White and Black African
    - White and Asian
    - Any other Mixed / multiple ethnic background (please specify): _____

    C. Asian / Asian British
    - Indian
    - Pakistani
    - Bangladeshi
    - Chinese
    - Any other Asian background (please specify): _____

    D. Black / African / Caribbean / Black British
    - African
    - Caribbean
    - Any other Black / African / Caribbean background (please specify):_____

    E. Other ethnic group
    - Arab
    - Any other ethnic group (please specify): _____