

RESEARCH ARTICLE – STUDENT AUTHORED

What makes a successful outreach kit?

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Abstract

The research has been carried out in order to create an effective portable maths outreach kit, using readily available sources and collating the information. The report explores the types of outreach and their benefits. Our findings indicate that an outreach session should be interactive with a range of activities. Research also showed that most young people do not see mathematics as a career option so for maths outreach to be effective there should be a strong focus on linking the activities to careers. The research highlighted the importance of avoiding stereotypical views regarding gender, age and ethnicity within mathematics and other STEM careers, encouraging young people to consider a STEM career.

Keywords: Outreach, Student Project, Mathematics, Careers.

1. Introduction

If done well, outreach in maths can be an effective tool to enthuse young people about the subject outside of school lessons. Not only does it increase and expand learning techniques, it can be used to help students gain confidence and develop a positive attitude towards the subject area. There are various forms of outreach such as day events, industry speakers, university visits and block programs. For this report we have focused our research on a portable outreach kit that can be adapted to a variety of situations at short notice.

The main purpose of this project is to improve what Nottingham Trent University (NTU) has to offer in regards to mathematical outreach. This research was undertaken to identify the key requirements of effective outreach and put the knowledge gained into practice to develop 3 outreach kits. These kits, of varying sizes, should then be able to be transported and used by any member of staff or student ambassador. These kits will be used by NTU in the future, improving the current mathematical outreach on offer.

The research will look at effective types of activities and games, career information required, stereotyping and safeguarding children using available publications.

2. What Makes Effective Outreach?

There are many things to consider when putting together a maths outreach kit that leaves a lasting effect on the participating students. It is important that the activity matches to a mathematical objective and the goal is clear (Way, 2011). Outreach is common at day events such as science fairs and within designated time slots at school. This means that interaction time with the students can be short; therefore the activity shouldn't be too complicated and can be picked up quickly. One way of doing this is to create a series of games with a similar structure that the students rotate between. An effective outreach kit is usually interactive- with solo and multiplayer activities. It can be a good idea to keep multiplayer games to a maximum of 4 players to avoid long waits between turns and hence losing interest (Way, 2011). Depending on the age group, using objects varying in size, material and colour will make the student feel less like they are doing maths, and more like

they are having fun. If the participants are enjoying themselves, it may lead to motivation to get more involved in maths. Developing activities with direct links to the National Curriculum can assist the students' learning outside of the classroom. Within schools, outreach sessions can provide teachers with an informal method of assessing the levels at which pupils are working (Way, 2011).

An outreach kit that is portable can be used at multiple venues and should be able reach a large target audience that includes a range of age groups. In most cases a limited amount of information will be known about the participants in advance so creating a combination of activities, games and puzzles that cover a wide range of interests is key. Additionally, it is important that the activities appeal to both girls and boys (Centre for Science Education, 2015). As the audience will be largely unplanned, the activities should be able to be adjusted to suit different age and ability levels. This will also create the chance for students with different strengths to help each other out. Including games with an element of chance will allow less able students a chance to win and therefore build their confidence with mathematics (Way, 2011). Including multiplayer games and activities based on team work maths outreach provides students with a chance to engage in discussion and develop both their problem solving and social skills. Strategic puzzles will encourage students to use their initiative and develop creativity (Way, 2011).

Hewson (2011) writes that there is a lack of interest amongst students within mathematics. He also suggests it is not uncommon for young people to have a negative attitude towards mathematics, preventing them from giving it a fair chance and therefore limiting their ability to develop a fascination within the subject. They may not be aware of how many aspects of everyday life are based on maths. Putting a strong focus on linking the activities to real life situations will help the students realise the many career opportunities within the field of mathematics. Eaton and Morton (2012) say that the key to effective outreach is "long term impact to compliment short term effects of an outreach activity".

3. Linking Activities with Careers

"The world of work, can make a strong contribution to the motivation of young people towards a career and a lifetime in STEM" (National Science Learning Centre, 2008).

Outreach has an important impact on raising a student's aspiration to university, resulting in an increase of students partaking in higher education (More Maths Grads, 2009). The More Maths Grads project outlined that "making students aware of the range and interest of jobs which use mathematics is at least as important as enriching the mathematics these students know" (p. 9). To some extent, outreach can help bridge the gap between the mathematics taught in schools, the everyday use of mathematics in life and the careers it offers. This will help shift the attitude "I could never see myself ever using [mathematics] in my day-to-day life" (Rodd et al., 2014).

Outlining how students' understanding of key aspects of mathematics can be applied in a real-world context is key. It may not be enough for the students to just be interested in mathematics as the More Maths Grads Project identified in their good practice guide "many school students (and a large number of teachers) are only vaguely aware of the range of career opportunities available to a mathematical graduate". They also stated this can be a "great inhibition to those that enjoy mathematics but may feel their career options are limited" (More Maths Grads, 2009).

The STEM careers awareness leaflet (Centre for Science Education, 2009) suggests that young peoples' career choices are heavily influenced by their families. This is supported by the UK Engineering report 2009 (EngineeringUK, 2009) in which 73% of those surveyed agreed with this response. It is therefore important to engage all audiences in outreach and "it is important that the role of parents should not be underestimated" (EngineeringUK, 2015). The ASPIRES project

(ASPIRES, 2013) found that “families exert a considerable influence on students’ aspirations” (p. 3) and that “that most young people and their parents have a narrow view of where science can lead”. Outreach can be a useful tool in changing families’ views on STEM careers; for example at The Big Bang Fair 2015, EngineeringUK found perceptions on engineering can be improved with 68% and 70% of parents and teachers saying they were more likely to recommend a career in engineering to an accompanying young person.

Some outreach activities may directly link to potential career paths such as industry speakers or Higher Education visits (to demonstrate the research). Others however may not have such a strong link and may be lost on participants of the activity.

Eaton and Morton (2012) highlighted that even if it is unfeasible to adapt an activity explicitly to include careers advice, “a short summary handout of the careers linked to the task or for those who deliver the activity to explain how they got to do their job” can “make the activity more meaningful and open up opportunities that young people may not have considered”.

Another way is to use role models and ambassadors (a representative of a career or university course), who can be a great way to break down stereotypical views on Mathematics and STEM careers in general. They can provide a “link to young people that helps make STEM real and interesting” (Eaton and Morton, 2012). The More Maths Grads Good Practice Guide (More Maths Grads, 2009) outlined HE students can be effective as ambassadors as the young person can often relate to the HE student. The Maths Outreach report (Institute of Mathematics and its Applications, 2011) showed that of the universities mathematics departments they surveyed, many universities run a Student Ambassador scheme and they all utilise students for some form of outreach activity.

It is also important when demonstrating careers to visitors to highlight the vast number of career pathways open in STEM so that visitors are able to “explore the really wide range of roles available beyond this immediate experience” (Eaton and Morton, 2012). This can be done by explicitly providing detailed information about a select few jobs and by linking to the skills that a certain activity demonstrates. An alternative is to provide an overview to demonstrate the wide range of roles available and signpost places which can offer more information such as Maths Careers or Futuremorph.

One of the things that was repeated in the literature was the importance of imparting career information to young people and their families, showing the breadth of jobs open to them and challenging the stereotypical view that mathematics careers are limited to being an accountant or a teacher.

4. Equality and Diversity

One problem that an effective outreach kit should attempt to overcome is the continuing gender stereotype that girls are less interested in STEM subjects than boys. A survey carried out by the Department of Education and Professional Studies Kings College London showed that among 12-13 year old students, 18% of boys and 12% of girls aspire to become scientists – in comparison, 64% of girls aspire to careers in the arts (ASPIRES, 2013). Outreach talks and activities can relate STEM learning to the real world and give it a meaningful context relevant to girls’ lives. The survey also revealed that “a student is most likely to express science aspirations if he is male, Asian, has high/very high levels of cultural capital, is in the top set for science and has a family member who works in science or a STEM related job” (ASPIRES, 2013).

One way to deal with these stereotypes is by managing who is being reached. Only in certain situations it is possible, but contacting the schools/teacher/advisors prior to the outreach session can ensure that the group of students involved will be diverse, with a balance of genders, backgrounds and ethnicity. Images and any fictional characters that are used within activities shouldn't impose these stereotypes, but include a range of ages, gender and ethnicities (Centre for Science Education, 2015).

Another benefit to activity-led outreach can be that once the students are familiar with the structure of the games, any language barrier becomes unimportant (NRICH, 2011a).

In order to create suitable activities for any participants with visual, hearing or learning disabilities measures can be taken. Large handouts, bright colours and a range of textures are all examples of techniques that can be helpful. By liaising with the school or organisation in advance, an outreach kit can be adapted to suits the needs of those using it (Centre for Science Education, 2015).

5. Safe-guarding Children

Safeguarding will be important in particular in outreach as in general you are likely to be in contact with vulnerable groups. It is therefore important to adhere to the guidelines and legislation set out to protect these vulnerable groups. In general organisations will normally have their own safeguarding policy but if this is not in place it is worth reading the government legislation on the issue (HM Government, 2015).

A DBS check can be required if either someone will be left alone with a child, or if they will get to know the student over a period of time. This may apply to ambassadors on defined programmes but may not apply to ambassadors assisting on open days and at 'one-off-events'. DBS Checks can take several weeks to have arranged and if required should be sought as early as possible. If the outreach is taking place in a school it can be useful to consult them for best advice (More Maths Grads, 2009).

6. Discussion

Outreach can be a key tool in changing the attitudes towards STEM careers; not only amongst young people but those of any age group. There is a common misconception that there are limited career opportunities within the field of mathematics, and STEM in general. Research indicates that young people do not relate the maths material they are learning in school to real life situations and potential career paths. If used effectively outreach can be used as a tool in correcting this disposition.

This research highlights the importance to avoid perpetuating stereotypes within mathematics. The subject is often stigmatised for being male dominated, thus putting females off. Informing the participants and breaking this stereotypical opinion should be one of the aims when planning outreach. An effective outreach kit should contain activities that can be enjoyed by all individuals and does not discriminate in any way.

The outreach is unlikely to have a lasting impact unless the participants are engaged by the activities. One method of motivating the participants is through the use of games, puzzles and challenges. By interacting with both the activities and each other they can enjoy working with mathematics outside of the school environment. By linking the activities with the National Curriculum, pupils can advance on their current knowledge and extend it to its practical applications. It seems there are a high number of young individuals that have not given maths a fair chance; successful outreach can change this negative attitude towards mathematics. Outreach

can be used to build confidence as it gives participants a chance to experience the sense of satisfaction that persisting with maths can bring in an informal situation.

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