Pair-mentoring: A Project to Improve the Achievement and Attitude in Science of Students Aged 16 in England

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Abstract

Within England there has been a growing recognition of the need to increase students' attainment in science especially amongst disadvantaged students whose schools receive additional state funding to support their education. There is, in England, currently no paired mentoring programme in which undergraduates, studying STEM subjects, are paired up with disadvantaged students (aged between 15-16) while they are studying towards their science GCSEs (public examinations). This peer-mentoring project in which students, from socio-economically disadvantaged backgrounds, are paired with undergraduate students was designed and implemented in order to help improve both their academic achievement in science and their attitudes towards studying science and related subjects in the post compulsory phase of their education up to, and including, university level. The project is a comparative study involving a control (n=42) and intervention (n=42) group from across four state secondary schools in England. Unlike previous evaluations of mentoring projects, that relied solely upon participants' (mentors, mentees and programme coordinators) self-evaluations, this study uses student school test and public examination data as a measure of academic achievement in addition to questionnaires to investigate their attitudes towards science. This paper reports on the way that this project was designed, issues arising in its implementation, as well as preliminary results regarding its effectiveness.

1. Introduction

Over the last 40 years educators have examined strategies to improve and benefit the learning environment for all students of all backgrounds – and especially those whose background is deemed as disadvantaged. These approaches aim to either improve academic performance or help students develop skills and attitudes. Inherent in much of the literature available on these strategies is an acknowledgement of the multiplicity of the terms used which is indicative of the intended outcome (academic improvement or attitude development) and the relationship between the students and the person who acts as the helper. Whilst we recognize the variation in the terminology used in the literature we believe that the most appropriate term to describe the relationship between a more experienced individual and a less experience one is that of 'mentoring' which includes helping mentees prepare for and achieve academic advancement (which is actually the focus of peer-tutoring) whilst at the same time mentees can also benefit from the mentors' help in developing an awareness of resource availability (which is what the role of a sponsor is all about). We generally use the term mentoring here to refer to all the one-on-one or small group teaching activities in which a more experienced individual tutors a less experienced or younger student.

1.2 The origin of mentoring

Both the concept of mentoring and the term date back to the Ancient Greek myth of Homer's Odyssey, an epic poem thought to date back at least 3000 years [1]. As the story goes, Odysseus, a leader in the Trojan War, entrusted the care of his son Telemachus to a family friend named Mentor. While Odyssey was away in the siege of Troy, Mentor's role was to act as a parental substitute figure, teacher, role model, advisor and counsellor providing guidance and support to the inexperienced Telemachus. The myth has been used in modelling mentoring as a relationship in which a more experienced person aims to shape the development of a less able and experienced person through support and instruction [2].

1.3 Mentoring: Its role and benefits

The cognitive processes involved in such a mentoring relationship have been investigated by various authors over the years and many of them have emphasized the value of the verbal communication

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and questioning [3]. The mentoring relationship could be more fully understood through a social and cultural constructivist view of cognitive development [4]. In this sense, it could be seen as an exploration through social interaction with a more knowledgeable and experienced person within the mentee's zone of proximal development (ZPD). Vygotsky defined the ZPD as:

> "The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p.86) [5].

Although the ZPD was developed as a way of viewing what children are coming to know, Vygotsky also noted that students become able to solve problems beyond their actual development level if they are given support and guidance in the form of prompts or leading questions from someone more advanced. We suggest that this more advanced individual could be a mentor whose help and support could make students able to internalize the new information and become more able to perform independently in a next similar situation. The student accesses knowledge and expertise through the mentor, whose role is more that of a facilitator rather than that of a teacher [6]. This view of mentoring focuses on a communicative nature of learning in which advancement is achieved through one-on-one communication and negotiation between the mentor and the mentee. In comparison to other, more traditional approaches paired mentoring enables students to become more actively involved in the teaching by having greater ownership of the learning process with opportunities to respond, make errors and be corrected being high. In Tinto's words:

> "Students who are actively involved in learning, that is who spend more time on task especially with others, are more likely to learn, and in turn, more likely to stay." (p.3) [7].

2. Context of the study and the pair-mentoring programme

Educational settings exhibit a variety of mentoring programmes designed and implemented for different purposes, but the last four decades have seen the emergence of a growing body of work on mentoring programmes designed for disadvantaged students also known as 'pupil premium' students within England -i.e. children from low-income families who are eligible for free school meals or had been looked after continuously for more than six months and children whose parents are currently serving in the Armed Forces (known as Pupil Premium students). The goal of these programmes is to improve students' academic achievement in particular examinations in order to be on par with those of their peers as well as supporting their learning and development in certain subjects and to encourage progression to study the subject post compulsion.

2.1 A review of mentoring programs

Reviews and surveys on key mentoring projects in schools which have been carried out until late-1990s have provided evidence for the effectiveness of these programmes [5] [4]. For example, the meta study conducted by Reisner et al. [8] on tutoring and mentoring programmes in the USA in which disadvantaged primary and secondary students were paired-up with college and university students indicated that such programmes were effective in terms of improvement in students' academic performance, attitudes towards education as well as self-esteem and self-confidence.

One of the paired-mentoring programmes outside the USA, which has become a source of inspiration for our project, as well as many other initiatives around the world, is the Perach Project in Israel. The project was established by a handful of students from the Weizmann Institute of Science, who acted as mentors for children of different ages from all sectors of society. Evaluations of the project indicated improvement of students' social skills, academic achievements as well as an increase in their self-confidence and motivation to learn [9].

A programme which shares many similarities with the Perach Project is the Baloo and You programme implemented in Germany. The title is based on the characters of the well-known fairy-tale 'The Jungle Book' with the Baloos taking part being mainly high school, college or university students and the Mowglis being unprivileged primary school children ranging from six to ten years of age. Programme evaluations indicated several positive results in different areas amongst which were mentees' development of their ability to concentrate and cope with stress, enhancement of their self-organization and self-assessment skills as well as improvement of their participation in school [10].

2.2 Rationale of the programme

Within England there have been numerous government initiatives to widen participation and increase the number of students continuing onto science related courses at further and higher education level. This need is greater, however, with regards to Pupil Premium students in comparison to their wealthy

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peers with statistics showing that the formers are far less likely to obtain high marks in their GCSE results [11] whereas the latter are twice as likely to pursue higher education [12]. Additional funding has been given to schools in order "to raise the attainment of disadvantaged pupils and close the gap between them and their peers" [11]. There has not been any specific initiative to address that issue of raising disadvantaged students' attainment in GCSE exams aiming, at the same time, to improve their attitudes towards studying post compulsory science and pursuing a science career.

Even more importantly, although the literature abandons with information about the effectiveness of mentoring programmes, most of such initiatives implemented in the past were self-evaluated by the participants (mentors, mentees and programme coordinators) with corroborative data not being available in terms of their effectiveness in improving academic skills and educational prospects of students [13]. Similarly many of the studies on the effectiveness of mentoring and tutoring projects for disadvantaged students implemented in the past lack the breadth, depth and rigor of data that would permit conclusions to be drawn in comparison with other types of educational interventions [8].

3. The programme and study

We have designed a project in which undergraduates, studying STEM subjects, are paired up with Pupil Premium students (aged 15-16) while they are in their final year of compulsory education and are studying towards their science GCSE exams. The aim of the project is to improve the students' academic achievement in science and their attitudes towards studying science and related subjects in the post compulsory phase of their education up to, and including, university level. As part of the project, we have also designed a study to evaluate its effectiveness.

3.1 Design aspects and preliminary findings

There were initially 52 undergraduate students recruited from a wide variety of STEM backgrounds (Table 3.1). There is gender predominance with 77% of the mentors being females. Half of the mentors are in the second year of their three year degree study and half in the third year. All mentors were selected after a personal interview and on the basis of their GCSEs and A-levels (national examinations before university entry). The average length of expected service in the programme is 28 weeks with the undergraduates being expected to mentor their mentees in science subject areas one hour per week throughout most of the 30 week school year. There is also a six hour one-day session planned to take place just before their GCSE exams at the end of the year with the focus being the preparation for their examination. Mentors have been offered stipend to cover both their hour of mentoring as well as their travel expenses. In addition, some of the mentors have benefited from references for future positions on teacher training courses as well as future internships in teaching. All mentors are required to participate in three orientation meetings in which project goals and services are described. This is an opportunity for guidance, supervision and feedback to occur between all the participating parties to unsure that goals, expectations and needs of the programme will be met. There is also a web forum platform developed in which mentors can share their feelings on the project, discuss any issues arisen and the mentoring techniques they follow. A mixed questionnaire is also administered to them three times to record their feelings and opinion about the effectiveness of the programme, Key results from the first questionnaire students completed after three to four weeks of mentoring are summarized below (Table 3.2-3).

There were also 104 students selected from four different schools in the same city. Each school provided us with a list of their disadvantaged students meeting the Pupil Premium criteria and the selection was made on the basis of their predicted grade (the grade that the school estimates will be achieved) by excluding extreme cases –either too high or too low grades- on the assumption that a student predicted a high grade would not have much to benefit from the project whereas a low grade

Sports Development and Coaching	1
Forensic Science	2
Bio-veterinary Science	5
Psychology	8
Biomedical Science	7
Biology	9

Zoology	3
Psychology with Forensic	1
Animal Behaviour and Welfare	2
Biochemistry	4
Forensic Chemistry	1
Law	2
Pharmacy	3
Chemistry	2
Sociology	1
Adult Nursing	1

Table 3.1 Mentors' background

How important undergraduates think their help is for their mentees	Percent	Undergraduates' comments
Very Important	22.2	*I think my help is very important as my mentee has spoken about her desire to have one-on-one help, which will allow her to ask all the questions she doesn't feel comfortable asking in class. She was also finding science boring but since we started she thinks it could be exciting too.* (3rd Year Biologist)
Important	63.9	*I think my help is important for my mentee as I hope to be able to help them find the best way for them to learn and revise the subject material. Some encouragement from an older student from a science background will help them to realise they are more than capable of achieving as high grades as their peers as well as building their confidence and ambition to continue their studies in these subjects* (2nd Year Bioveterinary Scientist)
Moderately Important	11.1	
Slightly Important	2.8	

Table 3.2 Undergraduate's written thoughts about their role after 3-4 weeks of mentoring

one would be more likely to achieve better than predicted in comparison to any other student biasing this way the effectiveness evaluation of the project. These 104 students were randomly divided into the experimental and control group. As such, there a total number of 52 mentor-mentee pairs at the beginning of the programme which, either due to schedule conflicts, mentees' absenteeism or mentees and mentors turnovers was dropped to 42.

All students, from both groups, complete an attitudes questionnaire three times, once soon after the beginning of the programme, then just before their mock exams and just before the exams. They are asked to use a Likert scale to respond to questions about how they feel about learning science in school, science outside school, the mentoring programme they participate as well as their beliefs of self with respect to achievement and ability to master school science. The data between the two

How important undergraduates think such programmes are for students	Percent	Undergraduates' comments
Very Important	69.4	*It is important to give students time and attention to help them focus on their work and revision. It is even more importantly for disadvantaged ones. Even if these student are very capable it is still appreciated when they have someone that they can talk to about work and any other issues that can cause them stress.* (3rd Year Biologist)
Important	30.6	*It is very important because all students, regardless of background, should receive the support needed to excel in academic studies and improve their future. Disadvantaged students in particular may need extra help due to their social background and may not wish to ask for it.* (3rd year Biomedical scientist)

Table 3.3 Undergraduates' written opinion about the mentoring programme

groups are compared to measure any change in the mentees' attitudes towards science whereas, in terms of measuring any change in their achievement, we use data from student school tests (mock GCSEs) and public examination results (GCSEs).

In addition, the study uses interviews to record mentees feelings about the programme and its effectiveness. Mentees opinions about the project after the first four weeks included:

- *I am really enjoying science now and I think I will be doing better in my exams.*
- *My mentor is really nice. I feel free to ask questions which helps me more than anything else.*
- *I was really struggling with science but now I think I can do more.*
- *This is really helpful and I really feel special for being chosen to take part in the programme.*

3.2 Final comments
To date the project has shown a variety of positive outcomes including improving attitudes of both mentees and mentors – to the extent that some mentors have applied (and been successful) for secondary teaching programmes. In terms of the programme evaluation, we are still in an early stage with data being collected only by the participants. However, as can be seen from the data presented here, the programme is a promising one with changes in mentees' attitudes towards science already being reported. We are continuing with the collection of more corroborative data with regards to attitudes change as well as, most importantly, any improvement in mentees' achievement.

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