Encouraging Students into Computing and Engineering related Degree Courses by Introducing Programming in Schools

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ABSTRACT

Widening access to Higher Education (HE) has become a prominent issue within the United Kingdom (UK) in recent years. The UK government (UK gov.) and Higher Education Funding Council for England (HEFCE) are currently aiming to reform education amongst 14 to 19 year olds. Higher Education plays a vital role in the success of this reform. The details of the reforms are set out in the Department for Education and Skills (DfES) White Paper "14-19 Education and Skills" published in February 2005, followed by the "14-19 Implementation Plan" (http://publications.dcsf.gov.uk/). It has been determined that there is a low participation in education in post-16 year olds; therefore these reforms aim to create opportunities for all young people to continue learning until at least the age of 18 and to give them the qualifications and aspirations to progress to third level education.

Recent evidence, including the recommendations of the National Council for Education Excellence (NCEE) (http://www.dcsf.gov.uk/ncee/), indicates that links between schools and HE institutions are integral to widening participation. This paper introduces the project "Widening Access By Introducing Programming in Schools" (WABIPS), which aims to strengthen existing links and to establish new links between the School of Computing and Intelligent Systems (SCIS) at the University of Ulster (UU) and the secondary education sector by providing regular tuition in computer programming for Year 13 and 14 pupils in a range of schools.

1. Introduction

WABIPS and SCIS acknowledges a responsibility to school pupils and their teachers to provide the information and experience necessary for the pupils to aspire to third level education within the computing and engineering disciplines. This issue is eminent at a time when public funding is scarce and availability of places more competitive, hence any shortfalls in the system come at a high cost to the individual and society and never more than in recessional times. Recent

evidence, including the recommendations of the National Council for Educational Excellence (NCEE, 2008, 2009), indicates that links between schools and tertiary level institutions are integral to widening participation. WABIPS provides a partnership between tertiary and secondary level education enriching the school curriculum and facilitating a communication medium for the schools by increasing accessibility to education and life at third level. This project is about an articulation between effecting change for the 14-19 year old student (Balls, 2008) through learning, engagement and sustainability in computing and engineering technologies.

Foster (2005) has pointed out that in order to exist in any global economy and as a global competitor we need a highly skilled workforce capable of attracting international investment. He postulates that this responsibility of producing the skilled workforce lies with third level education facilitators. The purpose of WABIPS is to provide Year 13 and 14 pupils with sufficient knowledge in Java programming to help them make more informed decisions when undertaking further study and a career within the computing and engineering disciplines.

1.1 Sustainable Objectives

This project developed an 'Introduction to Programming' course which is delivered in local secondary level schools on a weekly basis (1 hour per week) from September to June. The course addresses fundamental programming concepts such as variable declarations, conditional statements, loops, and object orientation amongst various fun and engaging ideas made available through a third generation programming language, in this case 'Java'. The aim is to firstly encourage pupils into computing and engineering related disciplines but also to provide them with adequate knowledge that they will fully comprehend what degrees in these subject areas involve. Ultimately the objective is that this project should improve retention within these subject areas as potential students should enter university better informed about their subject choice hence making the transition from secondary to tertiary level education more seamless.

In this first year of WABIPS our aim has been specifically to address the issues of widening access and non-completion by targeting schools that currently have pupils who progress to our courses. Non-completion is a significant problem within UU and the UK with an average non-completion rate of 9.7%. A significant proportion of non-completion rates within computing and engineering related subjects are primarily due to early leavers (who often indicate that the course was not what they had expected) and also those who fail the first year of their degree. The WABIPS project aims to address this by introducing programming in secondary schools,

thus giving the students a feel for the types of material they will cover when studying STEM subjects (Science, Technology, Engineering and Maths) in higher education. In addition, since there are typically two programming modules in the first year of a single honours programme, learning the fundamentals prior to admission should be highly beneficial in improving student performance and ultimately decreasing non-completion.

The sustainable objectives of the WABIPS project are in the provision of providing school pupils with the fundamental programming skills required for the technological communities of computing and engineering, both in industry and academia. In addition to providing core skills, establishing links with STEM subject teachers and careers teachers within the targeted schools enhances the collaborative effort required for success. The prolongation goal will be achieved by providing all the necessary material for the schools and their staff through access to SCIS members for the future.

2. Project Implementation

This is year one of the project and we have launched WABIPS using four schools from which we receive degree applications; participation details are given in Table 1 for term 1, school names are given as SJC, OIC and SBC for anonymity. Table 2 represents the school participation for term 2. In addition to the three schools from term 1 there is an additional school name given as LC in term 2. We are encouraging further applications from these schools, and attempting to convert applicants to actual students who will successfully complete their degrees. WABIPS will provide the secondary school pupils with fundamental programming skills and an insight into what they will study in future years at UU within computing and engineering. By providing potential applicants with a foundation to the programming aspects of the degree programme at secondary school level, confidence and self-efficacy with these programming concepts should result in greater participation and a heightened sense of achievement for each student should they sit on a degree module hereafter.

Table 1: Pupil participation Term1.

School	Total No. Pupils	Male	Female
SJC	11	11	0
OIC	11	8	3
SBC Yr. 14	7	4	3

Table 2: Pupil participation Term 2.

School	Total No. Pupils	Male	Female
SJC	11	11	0
OIC	11	8	3
SBC Yr. 13	15	10	5
LC	4	2	2

The learning theories that were implemented to deliver the introductory programming to the secondary school pupils was reflective of building on prior knowledge from STEM subjects already covered up to GCSE level. The theory and the practical aspects of the computer programming module were taught in a way that reflected programming connections with the real world through relevant examples. In essence this promoted confidence through repetition of prior knowledge, which was extended into new and layered knowledge for programming. The introduction of programming was therefore not seen as an isolated, scary and completely new practice, but instead one that embraced many facets of education and learning and then applied them in a new subject relating to technology.

WABIPS has both female and male instructors to facilitate in the delivery of the classes thereby neutralising the impression of the computing domain as a predominantly male one. Role modelling can break the stereotypical view that students often hold of computer scientists being male, which is more reflective of what the news media and the film world propagates.

3. Evaluation

Feedback on the course was obtained via a questionnaire that was designed to gather information regarding the current subjects that the pupils are studying for their A Level exams and their views in terms of applying to further education. The questionnaire was also designed with the view to capturing more general information that could be used to further tailor the course to suit the audience. Two questionnaires were designed. The first V1 was developed for capturing the information of the Year 13 group and the second V2 was designed to evaluate the decisions of the Year 14 group especially in relation to degree subjects and university application preferences, which the Year 13's have as yet time to decide upon. The V1 and V2 questionnaires were re-introduced at the end of term 2, to indicate any significant changes which may have occurred over the extended period from the groups.

3.1 Term 1 Evaluation

Using a sample group of 29 participants with a breakdown of 23 (79%) male participation, 10

(43%) yr13 and 13 (57%) yr14, 6 of 29 (21%) female participation, 2 (33%) yr13 and 4 (67%) yr14, the evaluation of the questionnaires produced the following results: 26 participants (90%) are taking STEM subjects, of which 18 (69%) are male and 8 (31%) are female, 3 participants (10%) are not taking STEM subjects for their A Level exams.

Sixteen participants (55%) found the java programming more challenging than they had anticipated (10 male and 6 female) and 11 participants (38%) found the java programming less challenging than they had anticipated (9 male and 2 female). All students felt that the java programming was enjoyable regardless of its challenges and all preferred practical over theory based classes. None of the participants had any prior programming skills, but all were adept at using modern communication technology and had owned various communication and technological gadgets. All pupils recommended this course for others who would follow after them and many expressed their gratitude for the opportunity that they had received in preparation for university.

Sixteen participants (55%) had considered applying for a computer science degree. Twenty two (76%) pupils after participating in the java programming course would now consider applying for a computer science degree, of which 20 (91%) of those are encouraged to undertake computer science at Magee. The results indicate that a 37.5% increase of pupils are interested in applying for a computer science degree after participating in WABIPS, with an increase of 25% of pupils interested in applying for a computer science degree at Magee. These results from term 1 are illustrated in the bar chart in Figure 1(a).

3.2 Term 2 Evaluation

Using a sample group from term 2 of 33 participants with a breakdown of 25 (76%) male participation, 14 (56%) yr13 and 11 (44%) yr14, 8 of 33 (24%) female participation, 6 (75%) yr13 and 2 (25%) yr14, the evaluation of the questionnaires produced the following results: 33 participants (100%) are taking STEM subjects, of which 25 (76%) are male and 8 (24%) are female, for their A Level exams. This new figure taken from the sample set would indicate that there is an increase of 11% of pupils from last term now taking STEM subjects. This is explained by the new school joining in term 2 LC and also a replacement of SBC Yr. 14 with SBC Yr. 13.

Twenty-five participants (76%) from term 2 found the java programming more challenging than they had anticipated (all 25 male) and 8 participants (24%) found the java programming less challenging than they had anticipated (all 8 female). Again all pupils felt that the java programming was enjoyable regardless of its challenges and all preferred practical over theory

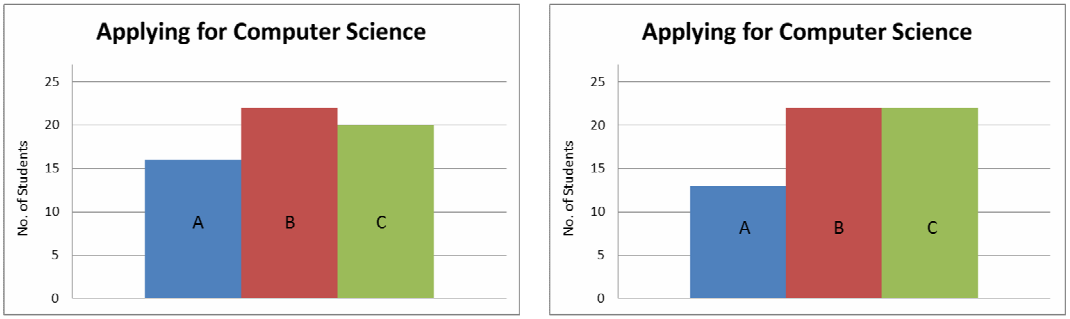
based classes. Seven male participants (21%) had some prior programming skills, and again all pupils were adept at using modern communication technology and had owned various technological devices. Again all pupils recommended this course for others who would follow after them and were pleased to have availed of this unique opportunity now accessible in secondary schools through WABIPS.

Thirteen participants (39%) had considered applying for a computer science degree. Twenty two (67%) students after participating in the java programming course would now consider applying for a computer science degree, of which 22 (100%) of those are encouraged to undertake computer science at Magee. The results indicate that a 69% increase of students are interested in applying for a computer science degree after participating in java programming through WABIPS with all of these pupils interested in applying for a computer science degree at Magee. These overall results from term 2 are illustrated in the bar chart in Figure 1(b). The breakdown of the information presented in the bar chart is as follows:

A – charts the number of students who initially considered applying for a computer science degree;

B – charts the number of students who after participating in the Java programming course would now consider applying for a computer science degree;

C– charts the number of students who would be encouraged to undertake computer science at Magee.



(a) Term 1 (b) Term 2

Figure 1: Overall impact of WABIPS on applying for Computer Science at Magee

4. Conclusion

The WABIPS project is an innovative widening access initiative to take programming out to local schools and to enhance the skills of our young populace who may consider computing or engineering as a potential career path. This project has the potential to improve pupils' understanding of what computer science at HE level means. WABIPS is addressing the issues

of under representation within SCIS in terms of social background, gender and religious beliefs. As a result this project will have a significant impact on widening access to computing and engineering subjects, whilst also addressing retention issues that are evident within these disciplines. WABIPS will continue in the future to provide Year 13 and 14 school pupils with the fundamental skills required in programming to enable them to confidently pursue a higher education qualification in a computing or engineering discipline. WABIPS will also encourage pupils from underprivileged areas, who may typically not consider higher education, to undertake further study and to encourage female students to pursue careers in STEM subjects in a bid to rebalance the female gender deficit that exists. WABIPS wishes to promote university education and to provide the opportunity for school pupils to view state-of-the-art facilities locally.

Ultimately, WABIPS will increase student figures and improve on the non-continuation rates in computing and engineering related STEM subjects. In addition establishing a gender balance amongst the pupils and by drawing in those pupils from low participation schools will broaden the diversity for future computing and engineering courses run at the University of Ulster. This project will strengthen existing and further establish lasting relations with schools in the secondary sector. This in turn will enhance the profile of SCIS, the Magee campus and the University of Ulster within Northern Ireland and the UK as a provider of sustainable computing and engineering degree courses.

5. Acknowledgements

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