Promoting Post 16 Stem Related Education by Introducing Java Fundamentals in School

S.A. Coleman, H.M. Sayers, A. Hinds, K. McCreadie,
University of Ulster (UK)
sa.coleman@ulster.ac.uk, hm.sayers@ulster.ac.uk,
a.hinds@ulster.ac.uk, mccreadie-k@email.ulster.ac.uk

Abstract

Recent evidence, including the recommendations of the National Council for Educational Excellence [2, 3], indicates that links between schools and tertiary level institutions are integral to encourage post-16 students to continue into Higher Education (HE). Hence, we established the project "Widening Access Through Introducing Programming in Schools" (WABIPS), which provides a partnership between tertiary and secondary levels, enriching the school curriculum and facilitating a communication medium for the schools by increasing accessibility to, and insight into, third level education. This project focuses on effecting change for the 14-19 year old student [1] through learning, engagement and sustainability in computing and engineering technologies.

For three years WABIPS has enabled educators from HE to go out to schools and deliver Java programming classes, either as compact three day courses or once per week over the academic year. In the first year of the project, we specifically targeted schools that already have a large number of students progressing to higher education, with the aim of providing students with a better insight into what they will study if they pursue a computer science related discipline. In the second year, we specifically addressed the gender imbalance often encountered in STEM related subjects, by targeting students in female schools, and in the third year we are now addressing the issue of religious imbalance found in Northern Ireland. To date over 200 students have completed the WABIPS programme.

Recently we have conducted an evaluation with all of the students that have completed the WABIPS programme to investigate whether participation in the course has encouraged them to progress to higher education, increased their interest in STEM related subjects, or, for those progressing to HE, has assisted with first year HE study. The results to date are very positive.

1. Introduction

As early as 1918, compulsory school attendance was raised to 14 years old with an understanding that everyone up to the age of 18 should receive at least some form of part-time training or education [4]. Over the years the compulsory school leaving age has increased to 16, although the benefits of remaining in education until 18 are widely recognised. Of course, the term 'education' is very broad, ranging from education in the tradition classroom setting, to vocational courses in Further Education institutions and apprenticeships in working environments. However, there is still a recognised issue in trying to encourage post-16 year olds into education. Within the UK, 62% of the university students come from the top two social classes [5]. This in itself is unacceptable as the background from which a young person comes should not determine their progression into post-16 education particularly as it is known that staying in education enables young people to gain invaluable qualifications and life skills, earn a higher wage and ultimately lead a healthier, happier life [5]. Education is also valuable in raising social awareness; it strengthens relationships between different types of people, removing fears of differences and encourages tolerance within society [5]. In addition, as more people from a given community are learning together, interactions between cultures are increased and societal values and wisdom may be shared through the community for generations [5]. In June 2012 a report was also issued stating that, in the UK, there was a drop of almost 32,000 young people remaining in post-16 education between 2010 and 2011. Additionally there was an increase of approximately 8% in young people that were considered NEET – not in education, employment or training [6]. This was considered a clear sign that more needed to be done in the UK to provide young people with the skills that universities and businesses require.

The future of both society and the economy lies in encouraging young people to remain in education to strive for the best that they can possibly achieve. There are a number of ways that we can aim to achieve this. Firstly young people need to be aware of the benefits of staying in education; the facts,

such as an average young person who stays in education earns £100,000 more over their lifetime than those who don't, should be provided to our young people at an early stage in their education. Suitable education routes should also be provided for young people so that they can select a route that suits their needs and skill sets and in the UK this is achieved through schools, further education colleges and universities. Industry and employers in general should also be involved in educational development to ensure that young people are provided with skill sets that correspond to their expectations. We should also enable our young people to participate in further education by providing them with the correct training in school and with information that enables them to make informed decisions. This is really the motivation behind the WABIPS project; we aim to provide young people with programming skills at school to firstly provide them with insight into the nature of what they might study within computer science related programmes, enabling them to make informed decisions on their career choice, and also to provide those who choose to continue with the skills that will be essential when they embark on their first year in a computer science related discipline.

2. Project Overview

This project developed a short 'Introduction to Programming' course to be delivered in a number of local secondary level schools over a period of three years. The course addressed fundamental programming concepts such as variable declarations, conditional statements, loops etc. in a fun and engaging way. The aim was to provide Year 13 and 14 pupils (16-18 year olds) with sufficient knowledge to help them to make informed decisions about undertaking further study and a career in computing and engineering disciplines, with the subsequent effect of improving retention within the subject. The project aimed to promote STEM subjects to girls (typically underrepresented in the subject area), and the targeted schools ensure that both Catholic and Protestant children from under-represented areas are encouraged to make the progress to higher education.

In the first year of WABIPS we specifically addressed the issue of non-completion by targeting schools that currently have pupils who progress to courses within the School of Computing and Intelligent Systems (SCIS) in the University of Ulster. Non-completion is a significant problem within Northern Ireland and particularly at Ulster with a non-completion rate of 14.4% (2004/05 entrants) which was significantly higher than both the other regional universities and the UK benchmark of 9.7%. Within the Faculty of Computing and Engineering, and more specifically SCIS, there is quite a high rate of non-completion, mainly due to a high rate of early leavers (who often indicate that the course was not what they had expected) and failures in first year.

SCIS has been working hard to improve its retention figures and in the academic year 08-09 was well below the Faculty average. Initiatives have included the introduction of weekly small group tutorials, and extended studies advice and induction sessions. There is never room for complacency, however, and continual monitoring is carried out with changes and improvements implemented where possible. The WABIPS project has helped significantly in this respect. There are two programming modules in the first year of all single honours programmes within SCIS, and, for those students to date who have completed the project at seconday level, learning the fundamentals prior to admission, performance has been well above average and the feedback excellent. In addition, the School has continued to better its retention performance, although it is recognised that WABIPS is one of many factors contributing to this success.

In year 1 of the project, we launched WABIPS using four schools from which we already receive applications. In this way, we were both encouraging further applicants and helping to convert applicants to actual students likely to successfully complete their degrees whilst providing them with fundamental programming skills and an insight into what they would study in the coming years at Ulster.

In the second year of WABIPS, we addressed the issue of gender in particular by focusing on all-girl secondary schools. According to an internal audit, in terms of full-time undergraduate students Ulster is a 'female' university with 58.9% of the full-time entrants in 2005-06 and 57.1% of the entrants in 2006-07 being female. However, within SCIS over this same period the percentages of female full-time entrants were 34.8% and 22.1% respectively and this is significantly lower than the overall university value. The actual number of entrants based on gender is provided in Table 1 and although it highlights that the number of female part-time students is quite high, overall there are still less female entrants (both full-time and part-time) than male entrants. Although these figures conform to

traditional gender patterns in engineering and computing disciplines, gender imbalance is still an important issue to be addressed.

	2005-06 (#students)	**2006-07** (#students)
Female FT	55	34
Female PT	67	56
Male FT	103	120
Male PT	32	49

Table 1: Gender breakdown of entrants to SCIS

In the second year of WABIPS, therefore, whilst continuing to run the course at the schools identified in the first year, the project expanded to specifically include two additional female schools from which numbers of applications were currently very small. In addition, we ensured that the tutoring team responsible for delivering the programming course had a good gender balance.
In the third yar of WABIPS, we addressed the issue of religious imbalance, in terms of the Catholic – Protestant divide. At the University of Ulster as a whole over 60% of full-time undergraduate students are Catholic, but the Magee Campus, where SCIS is located, records the highest proportion of Catholic students in all faculties. This can be attributed to a large extent to the demographics of the local area, but nevertheless there are significantly low numbers of applicants from local Protestant schools. We specifically targeted Protestants schools in year 3 of the project. The project is currently in its third year, therefore an evaluation on this aspect of the project is not yet available.

3. Discussion

A questionnaire was designed for the students who participated in the WABIPS programme either over the school year or via a three day course. The questionaire was issued to approximately 200 students across Northern Ireland and we received 68 responses which we have subsequently analysed. For those who progressed to study at Ulster, access to the students' records and results has allowed for further analysis. To date participation in the programme has been comprised of 134 males and 75 females, and questionaire responses were received from 42 males and 26 females. The questionaire aimed to address a number of questions, and the results and responses are outlined below:

How many people chose a Computer science (or related) degrees as a result of the course?

In total 12 students said they had chosen to undertake a computer science or related degree as a direct result of participating in the WABIPS project. This corresponds to 18% of the overall responses received from:

- 7 x Computer Science (6 male/ 1 female)
- 1 x BSc Computing Information Technology (1 male)
- 3 x Business Information Systems/Technology (1 male /2 female)
- 1 x Information and communication technology (1 female)

How many people chose not to do Computer science as a result of the course?

We assessed this via quotations from the free response area of the questionnaire.
"Decided computer science wasn't the route for me - good that I done it though"
"Java programming was interesting, but I decided I would rather not do programming at university"
"It confirmed my decision on not applying to ICT"
This is also a useful outcome since it shows that these participants were able to make an informed decision on a possible career path which they had been considering. There was no compulsion on pupils to participate in WABIPS – all participants were there by choice. Informed decisions help avoid wrong decisions, which in turn should improve first year retention figures.
A number of other useful comments were drawn from the questionnaires:
"I found I enjoyed programming & I want to do it at uni."

"I did more research on computer related courses. In particular those involving code and programming" ***From the same student****: "*I would be very interested in doing follow up courses and would also be interested in similar extra-curricular activities."
"It helped to decide to apply for a computer related course" ***From the same student****: "I had never studied computer programming before and I thoroughly enjoyed this course. It has been very useful when deciding what course to study at university as I now wish to study computer science."*
"It helped me determine that I wanted to complete a computer related degree"
"I am now interested in programming and a computing degree would be relevant"
"It has shown me that programming is something I enjoy and influenced my decision to aim to study programming at university."
"I enjoyed the course and realised I might like to do it in the future"
"From mechanical to electrical and electronic engineering"

4. Evaluation

As the course was delivered across Northern Ireland with the aim of encouraging post-16 year olds to progress to higher education, there was no expectation that all students would progress to study only at the University of Ulster. Our aim was to prepare pupils for computer science related disciplines at any university to help to solve a UK wide problem. In the last academic year, we identified six students (four females and two males) in first year within SCIS who have participated in the WABIPS project; it should be noted that the WABIPS course is delivered only in secondary schools and not grammar schools where pupils are more likely to progress to HE.
We analysed the results for all Semester 1 modules taken by the six students, comparing their overall performance to date with that of other students in their cohorts. Table 2 presents overall average marks for the Programming 1 module; the module average was 68% and the average for the students who participated in WABIPS is 75.2%, - 7.2% higher than the average student.

	Programming
Average:	68
WABIPS:	75.2
Difference:	7.2

Table 2 Programming I results (%)

We conducted a further cross-correlation using the marks from the other Semester 1 modules that the students have undertaken and the results are presented in Table 3. We can see from Table 3 that the students who took part in WABIPS obtained higher than the average mark in all modules except Business Information Systems. The results could suggest that the students that were keen enough to undertake the 'Introduction to Programming' course were in general good students or it could suggest that by having a good basis of fundamental programming, they were able to spend equal time on all modules and contribute strongly to coursework etc. in all areas. It is often found that students dedicate a lot of time to Programming 1 as they tend to find it the most difficult Semester 1 module.

	Introduction to games	Systems Analysis and Design:	Maths 1	Business Information Systems
Average:	59	59	69	52
WABIPS:	67	65	74.33	47.66
Difference:	8	6	5.33	-4.34

Table 3. Module results (%)

5. Conclusion

The WABIPS project is an innovative initiative to take programming out to local schools in Northern Ireland to encourage post-16 year olds into higher level education by both enhancing their skills to enable them to consider computing or engineering as a potential career path, and by improving their

understanding of what computer science at university level means. We have presented the initial feedback and findings received from pupils who have participated in the project over the past three years. We have also presented a follow-on study involving six HE computing students who participated in the WABIPS project at school prior to entry. The results indicate that these students are currently performing well above average, and we will continue to monitor this performance as they progress to subsequent years. We will extend this analysis over the coming years when we have a larger number of students entering first year having completed the WABIPS project. To meet popular demand from the secondary sector, we have delivered additional three-day courses at other schools during 2012 and these have been scheduled to continue for the next two years. Results will therefore expand as we continue to monitor the numbers who progress to computing and engineering study in HE, and their progression throughout their degrees for those who choose to study at Ulster.

References

[1] E. Balls, Foreword in: "Reducing the number of young people not in education, employment or training (NEET) The Strategy" Published by the Department for Children, Schools and Families, ISBN: 978-1-84775-086-0, 2008.www.dcsf.gov.uk

[2] National Council for Educational Excellence, 2008.http://www.suttontrust.com/research/report-to-the-national-council-for-educational-excellence/

[3] National Council for Educational Excellence, 2009. http://www.dcsf.gov.uk/ncee/

[4] Raising expectations: staying in education and training post-16 (https://www.education.gov.uk/publications/eOrderingDownload/Raising%20Expectations%20Policy.pdf)

[5] Learning Works – widening participation in further education (Kennedy report)

[6] www.independent.co.uk/news (28 June 2012)