Computing in Schools: a University Perspective

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1. Introduction

In the last few years, the University of Exeter has seen a continuous decline in the number of students applying to study Computer Science or a related degree. Four years ago the University investigated the reasons for this. Discussions with students and staff at the University and local secondary schools suggested that a contributing factor could be how the subject was perceived and handled in schools. A pilot scheme was developed to examine whether the University could help address this problem. The scheme proved successful and has now been extended to become 'Inside the Machine': an outreach programme designed to raise awareness of the subject of Computer Science and encourage students to consider it as an exciting and worthwhile subject to study at degree level. This report examines the experiences of running the scheme and how successful it has been in its objectives. It also discusses the role that Universities could play if Computing is to be improved in schools.

1.1. Terminology

Throughout this report the term *Computer Science* means an examination of: the theoretical foundations of computation, the development of programs and information systems based on these foundations; and, software engineering methods. The subject entails relatively sophisticated programming proficiency together with mathematical familiarity. *Information Technology (IT)* involves learning how to efficiently use software to aid business and other applications; it requires analysis and understanding of the way in which system components work and fit together, but little programming or mathematics is needed to support this. Information and Communications Technology (ICT) refers to the subject that is taught in many schools. Experience has shown that ICT is different from IT since the former usually involves basic computer skills (e.g., word processing, spreadsheets and simple web pages). ICT does not appear to include an analysis and understanding of how system components work and fit together.

2. Inside the Machine

In arranging sessions for Science Week, workshops had been found to be an effective way of sparking interest in a subject; they allow students to interact with a subject and get a better understanding of the concepts that they are being taught. For these reasons, a workshop-based pilot was developed.

2.1. The Pilot Scheme

A ninety minute workshop was designed to examine what intelligence is and how intelligent machines might be developed. A local girls grammar school volunteered to host the session which was given to a group of year eleven ICT students.

The workshop was well-received but, on reflection, April was not the best time in the year since the students were preparing for study leave and GCSE exams. However, we were able to gain some useful information, using anonymous questionnaires, on how the students felt about the subject, the workshop and whether the workshop had helped to change their opinion of the subject. The majority of students had no idea what computer science entailed before taking the workshop: a few students did not even know such a subject existed. Those students who had some idea of the subject thought it involved only robots. The students were asked to rate how much they enjoyed the workshop with 1 indicating they did not enjoy it at all and 5 very much so. The average score was 3.6. The majority of students who took the workshop said that they would recommended the workshop to one of their peers. Sixty percent of students stated that the workshop changed their opinion of computer science since 'it was not so boring' and 'not all about science'. Nearly half of the students believed that they would now consider taking Computing at AS/A2 level instead of ICT. It should be noted that the pilot school did offer both subjects at AS and A2 levels. However, they had observed a marked reduction in the students opting for Computing and had begun sending those students opting for the course, to the neighboring boys' grammar school.

2.2. The Current Scheme

Feedback from the pilot scheme showed us that such a scheme could be useful in provoking interest in Computer Science and, therefore, possibly lead to more students considering studying a related degree at University. We also used the feedback to help improve the original workshop and extend the scheme to include six workshops, two lectures and a conference.

The pilot scheme had indicated that by year eleven students have already decided on what subjects they wished to study further and, more importantly, the ones that they did not. Since the scheme is designed to ignite interest and enthuse students about the subject, it was decided to that year eight to year nine students should be the target audience. Although workshops are targeted at this age group, over the past four years, workshops have been adjusted for student audiences aged between eleven and eighteen.

Each workshop is led by a university Computer Science academic and is themed around an aspect of Artificial Intelligence; the area that is the focus of research within Computer Science at the University of Exeter. Workshops comprise common features such as what is Computer Science and why it is considered different to ICT. However, the main content depends on the theme of the workshop. When designing the workshops it was seen as crucial that they be as interactive as possible and, therefore, all concepts are illustrated through suitable games and activities. For example, the pilot workshop allowed participants to examine the concept of intelligence and what properties a machine must exhibit to be considered intelligent. Students were able to compare existing chatbots with most advanced chatbots to see what progress has been made. The majority of the workshops are not computer-based. In one workshop, students investigate how machines learn with the use of card games.

In the past year, two lectures have been added to the scheme. These are designed to cover more advanced concepts and, therefore, are aimed at sixth form students. One lecture looks at the different research fields in AI and the questions that they are trying to answer. Another lecture introduces one of the degrees offered by the University and highlights how computers can be used in business. Lectures are designed to retain interactivity and do contain some suitable activities (e.g., card games to highlight machine learning).

Following the first successful Computing Conference hosted by the University in 2010, a second, larger event is being planned this year for year nine students. There will also be a third conference for sixth form students as part of Science Week in March 2010. At CCfS 2010, three workshops were given. The event concluded with a team-based programming competition; based on Robocode, participants were asked to program a robot which would attack the their competitors' robots. It was assumed that students had had

no previous experience of programming and all knowledge needed for the competition was taught on the day.

2.3. Feedback from the Scheme

At the end of each workshop each participant is asked to complete a short questionnaire to establish what each participant thought the subject of Computer Science involved; how it is different from ICT; if their views have changed due to taking part in the workshop; and, gain general feedback from the workshop itself. Since the scheme began approximately 150 students have attended one of our sessions; 84 of these have filled out a questionnaire.

The first part of the questionnaire asked the student to explain what they thought the subject of Computer Science involved and if they thought there were any differences between this and I.C.T.. Although some of the students did have some understanding of what the subject was; many believed it was '*boring*', '*nerds being nerdy*' or had not heard of it before. Very few students realised that there were differences between the two subjects.

The second part of the questionnaire focused on the workshop itself. Students were asked to rate how much they enjoyed the workshop from one to five with five being very enjoyable. Out of the 84 responses, three students chose not to answer leaving an average score of 4.16. Very positive responses were given when asked if their opinion of the subject had changed. Although some said that their opinion had not changed, the majority of the students who gave responses stated that it had improved their opinion. Responses were given such as '*Yes, I know what [Computer Science] means now and it is very interesting*', '*I thought [the subject] was brilliant*' and '*more fun than I thought [Computer Science] would be*'.

3. Discussion

The scheme, 'Inside the Machine, has now been running for four years. The organisation, co-ordination and running of the scheme have highlighted many important points.

Experience has shown that the subject of Computer Science is perceived and treated very differently in the schools that have hosted sessions. Although many schools support the subject of Computer Science, and are keen to promote understanding of the subject, some schools have been found to adopt stereotypes that may persuade a student not to choose a subject. For example, a not uncommon view overheard from teachers and careers advisors is that it should only be considered by boys or it is a boring subject to study. If more students are given the opportunity to consider studying Computer Science or a related degree, it is crucial that these stereotypes are not adopted by these key influencers.

The schools and ICT teachers that have hosted our sessions have been very pleased with how their students have responded. Very few of the schools we have visited have ICT teachers with a relevant ICT or Computing qualification. By sending an academic into the school, students are offered a chance to explore a subject that they may not otherwise have had exposure to. It also takes some pressure off teachers who are not confident with concepts such as programming. In some cases, it has boosted confidence; one ICT teacher who attended CCfS 2010 and participated in the programming workshop has now got the confidence to try and teach programming in their own lessons. In the programming workshop, it was assumed that none of the students had had any experience of programming before. Students were split into teams of four with each team assigned a mentor (a PhD student or academic). In the first forty-five minutes students were taught the basic concepts needed for the competition. Although only the basics of Java were taught, at a very low level, all of the students were able to program an entry for the competition in an afternoon. We found students did not find it boring or too difficult. Our workshops have shown that students become enthused by a subject if they can interact with it.

A local secondary school has seen the number of students opting to study Computing at AS and A2 level fall. One reason for this is that ICT is now compulsory at GCSE level: some students wish to continue studying a subject they know rather than switching to one which they have not experienced (i.e.

Computing). The lack of Computer Science at AS and A2 level may also be a reason why students do not choose to study Computer Science or a related degree at University. Computer Science at University is often tarred with the same brush as what students consider ICT (i.e., spreadsheets and word processing that they have encountered at school). The differences between Computer Science and ICT are not always appreciated.

4. Conclusion

The past few years have witnessed a rapid decline in those choosing to study a Computing related degree. Discussions with local schools indicated that part of the problem may be the way in which the subject is perceived and treated in schools. A pilot scheme was launched and it was found that this was the case.

To try and overcome this problem the University developed its own outreach scheme, 'Inside the Machine', which aims to enthuse students about Computer Science using a range of interactive activities. The scheme has proved very successful and has strengthened links with local schools.

If the way in which Computer Science is perceived in schools does not change, the numbers of students choosing to study the subject at University will continue to fall. Universities will play an important role in changing attitudes towards the subject; it is often confused with basic "office skills" and many ICT teachers do not possess the confidence or knowledge to teach interesting technical activities or the theoretical concepts that at the foundations of Computer Science.

Outreach can provide a basis for a way in Universities can attract more students. However, the cost of outreach could prove expensive and schools cannot afford to pay for such activities. 'Inside the Machine' relies on academics and postgraduate students volunteering. Without their generosity such a scheme could not take place. If more outreach projects are to be set up, there will need to be more financial support from organisations such as HESTEM.

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