

WHAT THEY THINK – STUDENTS' PRECONCEPTIONS OF COMPUTING

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Abstract — *As teachers within Higher Education we know what we expect from our undergraduate students. At the start of the academic year, when the new undergraduates arrive, we have certain expectations about them; about their understanding of certain concepts and the ways in which they will approach their studies. We don't always know particularly in the current climate of the constantly changing school curriculum, what they initially expect from us, and what past experiences they are drawing upon to form these expectations. The students undoubtedly hold a variety of preconceptions about the courses they have chosen; students choose Computing modules based upon these preconceptions. This paper presents the findings of a small-scale study designed to address this issue.*

Index Terms $\frac{3}{4}$ Confidence, expectations, past experience, student perceptions.

INTRODUCTION

At the start of the academic year, when the new undergraduates arrive, we have certain expectations about them; about their understanding of certain concepts and the ways in which they will approach their studies. The students also hold a variety of preconceptions about the courses they have chosen. These are necessarily based upon their prior experiences; most of which (for us) are gained within the UK secondary school system.

Whether we love them or loathe them computers pervade education; we all communicate via email, search the World Wide Web for information and, within engineering, they are essential. We expect our students, regardless of their backgrounds, to become competent at using them both as a tool and a resource – being computer literate is essential within all modern education, not just within science and engineering. To further this expectation we provide courses and modules aimed at helping our students, whether they are beginners or advanced, to use computers effectively and to provide them with the skills needed to function productively within their main discipline; we want our students to feel comfortable and confident in order that they may focus on the real content. But what do we actually know about their learning prior to arriving at university? Students and the academic culture have changed significantly since most of us were students and the more we know about the current experience the better prepared that we can be to provide the help and support today's students require.

Some of our students arrive with a less than ideal understanding of the content of the school syllabus, but even

if they have they do not necessarily know or understand what we think they do, and they are unlikely to apply themselves to their studies in the ways that we expect.

Employing a constructivist framework for educational development involves students actively participating in the construction of their own learning whilst, at the same time, educators are also active in the process. Starting from where they are at is crucial and in order for us to achieve this scenario as quickly as possible it is beneficial for us to develop some notion of the previous educational experiences of our students. This cannot be gained simply by looking at syllabus content, as *how* is equally as important as *what*; learning must always take place within a social context.

TALK TO THE STUDENTS

When asked why they have chosen particular Computing modules students' choices tend to fall into three broad, but distinct, categories.

1. They are interested in the subject.
2. They feel it is a necessary preparation for life after University.
3. They think that IT skills will help them with their studies in their main discipline.

Why students fall into these categories must be, at least partly, determined by their perceptions of Computing and, for many, these must have been formed whilst at school.

One of the vital elements in determining this is level of confidence [6]. The more frightened and nervous students are the less positive their expectations. Practice and experience are the only true means to gain confidence in any key skill, and this strongly suggests that one important factor to be investigated could be the type of school attended.

It is also widely acknowledged that female students display less confidence with Computing based subjects than their male counterparts, although factors such as attending a single-sex or co-educational school have been shown to have an effect upon this [1,8]. It is yet another widely held belief that girls fare better in a single-sex school environment, whilst boys fare better in a co-educational one. Do the students own perceptions and self-measured confidence levels bear this out? Evidence suggests that any discouragement / lack of encouragement encountered by female students has occurred at a pre-university level [5]. This is not a paper about the small proportion of female engineering students, rather an investigation into the basis for the preconceptions held by all our students.

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WHAT DID WE DO?

The investigation was split into 3 distinct phases.

1. A questionnaire survey that could be statistically analyzed to create a framework within which to analyze the results of subsequent stages.
2. An elicitation of students' actual opinions about what computers and IT mean to them – help us to start from where they are at; a fundamental precept of constructivism.
3. Interviews with students that provided us with the opportunity to explore issues raised in previous stages.

The Institutions

The students who participated in this survey were taking Computing modules at the University of Leeds (UoL) and the University of Kent at Canterbury (UKC). UoL is a large inner-city institution in the north of England, whose major non-academic appeal to undergraduates is the night-life, whilst UKC is a much smaller institution in the south of England; it's biggest non-academic enticement for students is said to be the sporting facilities [10].

Previous work [4] has shown that the profile of students at these institutions is similar and, in particular, that the students hold very similar opinions and attitudes towards their studies.

STAGE ONE – THE SURVEY

The results presented in this paper are based upon 348 responses to a questionnaire administered to students at two different UK Universities during the 1999/2000 academic year. The students were not Computer Science majors, but those who had chosen to opt for Computing modules to enhance their computing skills in order to complement their other studies and which could eventually lead to a degree of the type *X with Computing*.

The Questionnaire

Students were asked to provide some basic information about their previous Computing experience, the school they attended, and the title of the degree program for which they had registered. The purpose of this was twofold: It enabled us to categorize their responses to some open-ended questions about their perceptions of Computing, and to determine whether any patterns of response emerged which were linked to particular past experiences.

The students were asked to rate their confidence with the use of computers on a scale of 1 (terrified) to 5 (very confident). A major feature of the analysis involved seeking evidence for any possible causal factors, which can be explored further at a later date, and in this respect confidence could prove to be a crucial issue; lack of confidence with

computer use could easily lead to students focusing upon this rather than the rest of their studies.

The Analysis

As confidence is believed to play such a significant role in *why* students fall into a particular category we have analyzed the level of confidence admitted by respondents in relation to ethnicity; age; gender and type of school attended, in order to determine whether any patterns emerge which are worthy of further investigation.

The Origin of the Students

Only 20 of the 348 respondents were non-UK citizens, and all were in the age range 19-24. This does not correspond well with the proportion of all undergraduates from a non-UK origin (15%), but findings are included here for the sake of completeness.

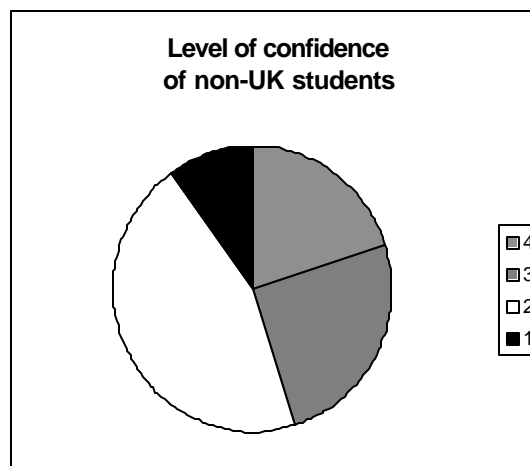


FIGURE 1

Figure 1 shows the confidence levels of the non-UK students. None of these students classified themselves as being “very confident”, indeed 55% of them classified themselves as “not confident” or “terrified”, but this is hardly a surprising when we consider that none of these students is a native English speaker. It must be a daunting prospect for a young person to embark upon a technical degree in something other than their first language.

The number of students involved in this group is too small for any meaningful statistical analysis so the remainder of the numerical analysis in this paper relates to the 328 responses from UK students who previously attended a UK secondary school.

Type of School Attended

Anecdotally we often assume that students who previously attended a public (fee paying) school will have more confidence and arrogance than those from within the state

sector. An initial analysis was performed to determine whether there actually was a significant difference between the mean confidence levels of the 72% of the students who had previously attended state schools and the remaining 28% who had been pupils in a public school. As this revealed no significant difference, the figures have been further sub-categorized, by type of state or public school attended, and the results are presented in table 1. Within the UK state education system there are three major categories of secondary (11 – 18) school. In some counties grammar schools take pupils who pass an examination at age 11, whilst high schools take the children who did not pass; in other counties comprehensive schools take all children within their catchment area regardless of ability and no examination is sat.

TABLE 1

School type			Confidence
Public	Boarding	20.5%	3.1
	Day	7.4%	3.0
State	Comprehensive	42.8%	2.9
	Grammar	14.8%	3.1
	High-school	14.5%	3.0

Statistical analysis of the figures suggests that again there is no significant difference (at the 5% level) between the mean confidence levels of students, regardless of the type of school previously attended. Public school does not appear to foster any greater degree of computing confidence than state school.

Confidence and Age

Some of the more mature students may have left school more than 25 years ago, and computer use has only really become widespread in schools since the introduction of the compulsory IT National Curriculum 10 years ago. This suggests that students in the younger age groups are more likely to have previously used computers, particularly in an educational setting. It, therefore, seemed appropriate to determine whether or not age affected the level of confidence our students initially held. Table 2 shows the mean self-assessed confidence rating by age group for the participating students. The number of students responding from each age group corresponds closely with those expected if we had used a stratified sampling technique.

TABLE 2

Age group		Confidence
18	38%	2.9
19-20	48%	3.0
21-24	9%	3.1
25-44	3%	2.9
45+	2%	2.5

The figures suggest that there are no significant differences between the confidence levels of the students in the younger age groups, but do reveal, perhaps unsurprisingly, that the students in the 45+ group are less confident than their younger (below 25) counterparts. The number of mature students involved, however, is too small for meaningful statistical analysis.

Gender

Back in the mid 1980s when computers first began to be introduced into schools it was observed that girls appeared to be less fascinated by them than boys; taking a much more pragmatic approach to the subject [6]. Spender [11] maintains that this is still the case and that not enough has been done to entice female students to find out more. With this in mind it is perhaps slightly worrying that the gender balance of the students responding to the questionnaire, 48% of the respondents were female, was not closer to the overall gender balances at both UKC (55% female) [12] and UoL (53% female) [13].

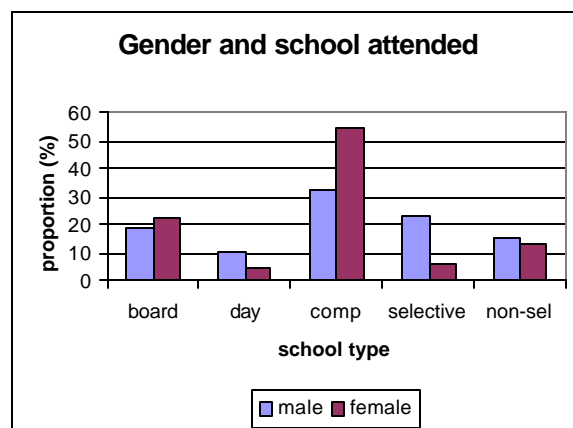


FIGURE 2

Figure 2 highlights the fact that a higher proportion of female than male students attended a comprehensive school, but as the UK State school system varies from county to county this is unlikely to be an important finding. Since the numbers in some categories were very small and no significant differences were detected in the calculations we have looked at single-sex and co-educational establishments without further sub-categorization. 25% of the female respondents attended a single-sex school, as did 12% of the males.

The overall figures for confidence levels analyzed by gender suggest that male students are slightly more confident than their female counterparts. The overall mean level of confidence admitted by the male students was 3.1 compared to 2.9 for female students.

This statistically insignificant difference, however, does not necessarily paint an entirely accurate picture. Whether attending a single-sex or co-educational school makes any

difference could easily be hidden by these overall numbers, as highlighted in figure 3.

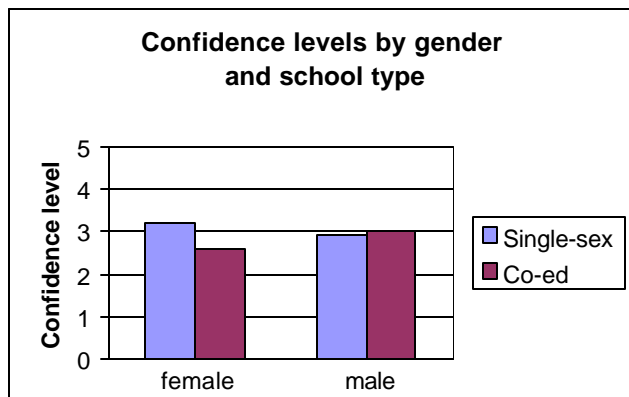


FIGURE 3

The male students who attended a co-educational school did rate themselves as having slightly more confidence than their counterparts from single-sex schools, but the difference is negligible. The female students, however, do demonstrate a statistically significant (at the 5% level) difference in confidence dependent upon whether their school background was single-sex or co-educational. Amongst our female students those who have previously attended a single-sex school appear to have more confidence.

STAGE TWO – STUDENTS' PERCEPTIONS

Taking a constructivist approach to education we, as educators, need to help our students to adapt their imperfect model of the concepts to match our own model of reality [2]. In order to do this successfully we need to have some idea of the conceptual models the students actually hold. We asked participating students three simple questions, which they found surprisingly hard to answer. The answers that they did provide, however, fell into categories that correspond closely with their admitted levels of confidence, but do not show any noticeable gender divisions.

What is a computer?

Many answers to this suggested *"a tool"* or *"a useful tool"*. Another common theme running through the answers to this question is that of networks and communication, which highlights the primacy of the Internet in current perceptions of computing.

Many answers also display the attitudes and concerns of the respondents. Those with little confidence suggest that a computer is:

- *"A nightmare"*
- *"Absolutely amazing, I hope I can cope"*
- *"It's a big gray box which hates me and has scary buttons"*.

More confident respondents suggest:

- *"A friend"*
- *"The Future"*
- *"A fantastic resource which offers thousands of opportunities to thousands of people, which are not often used to their full potential"*.

What is I.T.?

In response to this question, approximately 15% of the respondents merely replied *"Information Technology"*. A large proportion responded with a variation on

"Gaining a knowledge of computers, how they work and how to use them",

thus showing some conceptual understanding of what the subject entails. However an alarming number answered

- *"?"*
- or
- *"No idea"*.

Only students rating their confidence as below 3 provided such responses. This suggests that many of our less confident students may actually hold no tangible conceptual model of the subject they have just opted to study.

What is Computer Science?

This question elicited even more *"Don't know"* or *"No Idea"* answers than the previous one. There is no doubt that this is due partly to the fact that the students questioned are not Computing majors. One would hope (but could not guarantee) that asking the same question of CS undergraduates would elicit far fewer uncertain responses. Nevertheless, a number of insightful responses were received:

- *"The scientific side rather than the purely practical stuff"*
- *"IT with programming"*
- *"How computers work"*
- *"Something which very clever (maybe a tad nerdy) people do"*.

STAGE THREE – THE INTERVIEWS

The analysis of the initial survey results prompted us to talk to a group of students in order to gain some kind of explanation for the findings. This took the form of semi-structured group interviews with a number of self-selected volunteers. The actual interviews were relaxed and informative. The students prompted each other and provided some useful insights.

Did experience match expectation?

Some second year undergraduates were included in those interviewed in an attempt to determine how closely (or otherwise) the courses they took in the previous year matched up to their initial expectations. Disappointingly, these students added little new data, but did reconfirm our

belief that students who undertake courses because some form of Computing is compulsory are much less positive about their experiences than those who choose freely.

A strange result explained

The interviewed students were also asked if they could explain an unexpected response that occurred on many of the questionnaires. More than half the students who stated that they had gained experience of Computing only at school also stated that they had been self-taught. Given that IT is a compulsory National Curriculum subject in England, we were expecting student responses to indicate that a teacher had taught them.

The students unanimously agreed that (in their experience) most school IT teachers know less about Computing than many of the pupils. In an animated discussion they said that they found it more effective to ask a knowledgeable friend for help than to ask a teacher. As one student said:

“We were “taught” VB in GCSE computing, “taught” meaning 3 of us taught ourselves from the help file, then taught the rest of the group and the teacher.”

This is a serious issue, and although it is not part of our focus, it may explain one of our more mysterious findings.

DISCUSSION

The media constantly bombards us all with images depicting how important computers and Computing are in our lives. How we need the relevant skills to become effective employees (or more importantly for our students, how to get the job in the first place). What can students do but apply for Computing courses in the hope that they won't be left behind in the technological rat race.

From a staff perspective this necessarily leads to a cohort with a large range of abilities and past experiences. Differentiation between ability levels is difficult when the cohort is large, especially when the diversity of backgrounds is also considered. It relies upon staff having the ability to react quickly to the individuals who experience difficulty; having to demonstrate a level of contingency upon individual students that is hard to achieve. It is tempting to simply alter delivery styles in the hope that the students' experiences will be improved, but changes should, where possible, be grounded in what the students actually need [3].

What Next?

Despite containing some open-ended questions, the initial survey was predominantly based upon the statistical analysis of quantitative data. It was useful in highlighting *what* is happening, but it is rather impersonal and does not provide us with any information about *why* the students feel as they do. In order to find out more detailed information we needed to embrace a qualitative methodology for the next stage of the work. The combination of quantitative and

qualitative methods enables us to discover not only what is happening, but also to gain an understanding of the perspectives and actions of the students [9].

Several important themes have emerged, and have suggested foci for further investigations. In particular, the numbers of non-UK and mature (45+) students were too small to analyze statistically, but the small numbers are not a problematic issue when using qualitative research methods.

- Does lack of confidence imply a lack of experience? It could be due to many factors such as different school experiences, or simply worrying about what the majority of the students actually know.
- The more mature members of the cohort do not appear to rate themselves as being as confident as the younger students are. This may be due to their having less experience, or possibly simply their thinking that they have less experience.
- The female students who attended single-sex schools have significantly more confidence with Computing than their counterparts who attended co-educational schools. Does this mean that they have greater ability? If not, why are they more confident? If they do, why?
- How students with different initial confidence levels adapt to the course, and how they progress throughout the year needs to be explored. Do the experiences of the confident students bear out their assertions? Do the less confident students gain confidence throughout the year, or do they simply muddle through because they have to complete the course?
- The issue of motivation is also important. Motivation appears to be a factor in the type of help seeking behaviour demonstrated by our students. It is not something that could be easily investigated here, but nevertheless cannot be ignored.

Much of the evidence presented here has reinforced suspicions and confirmed previous anecdotal evidence. The students' perceptions of computing and computers have proved enlightening, and the issues that they have highlighted will feed into future course design and practice.

The aspects explored within this survey have been based within British educational culture. The experiences of students in other cultures will not be identical – teachers will have different expectations of their students and may have different views of what makes the educational experience 'ideal'. The students from different cultures will also bring different expectations to the situation as a result of their differing past experiences.

We are aware that no teacher can ever anticipate all the difficulties that every one of their students may face. Students must, as always, be encouraged to tell us when they do not understand, and to ask for more information when necessary. Learning to ask for help can be of value in itself, because it encourages students to become conscious of their uncertainty. This self-awareness can grow, and a large part

of our task may be to help them understand what the problem is that they are expected to tackle.

Donaldson [7] stresses the importance of a learner's need to feel that they are in control. Extrinsic motivation (outside reward) is less likely to lead to effective learning than intrinsic motivation (reward from the activity itself); we like controlling ourselves. The appropriate use of educational techniques and technologies can help to make learners aware of, and reflect upon their own thought processes; which is important in gaining control over them. One of the major elements in this is the structuring of the learning experience; we cannot do this effectively until we know our students better and time is, as always, limited. Any help that an increased understanding of their past experiences can bring must be beneficial.

ACKNOWLEDGMENT

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