Teaching psychology to computing students

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The aim of this paper is two-fold. The first aim is to discuss some observations gained from teaching psychology to computing students, highlighting both the wide range of areas where psychology is relevant to computing education and the topics that are relevant at different stages of students' education. The second aim is to consider findings from research investigating the characteristics of computing and psychology students. It is proposed that this information could be considered in the design and use of psychology materials for computing students.

The format for the paper is as follows. The first section will illustrate the many links between the disciplines of psychology and computing; highlighting these links helps to answer the question that many computing students ask, what can psychology offer to computing? The second section will then review some of the ways that psychologists have been involved in the teaching of psychology to computing students, from A/AS level to undergraduate and postgraduate level. The third section will compare the profiles of computing and psychology students (e.g. on age, gender and motivation to study), to highlight how an understanding of these factors can be used to adapt psychology teaching materials for computing students. The conclusions which cover some practical suggestions are presented in the fourth section.

What can psychology offer to computing?

THERE IS A symbiotic relationship between computing and psychology: psychologists have helped in many ways to understand the way that computer systems are developed and used, but also an understanding of computers has helped psychologists to model and investigate human cognitive and social processes. This article will focus on the former but it is important when teaching computing students to acknowledge the contributions from computing to further understanding in the field of psychology. For example, computational modelling is a tool often used in cognitive psychology to allow psychologists to visualise hypotheses about the functional organisation of mental events that couldn't be directly observed in a human.

Over the past 50 years, psychologists have tracked and researched the development and impact of computers and they have also been instrumental in their design and evolution. To design, develop and evaluate user-friendly technology students need to understand and consider how people perceive, remember, feel, think and solve problems, i.e. the domain of cognitive psychology. It is also important for students to consider individual differences and social behaviour if effective interaction between people and computer systems is to be achieved, i.e. the domain of personality and social psychology. An understanding of these topics in psychology enables students in computing to consider the potential capabilities and limitations of computer users and helps them to design computer systems that are more effective (usable) and affective (enjoyable). Applied psychologists have been involved in these areas for many years and often work in departments other than psychology (e.g. Human Computer Interaction (HCI), Human Factors or Ergonomics). In addition to covering the foundation areas of psychology and HCI, it is also important that computing students are taught evaluation methods and that they are able to consider the social impacts regarding the implementation and use of computer systems in organisations and society. The next section will cover the way that psychologists can help in the teaching of ethics in computing and also look at the important role that psychologists have in teaching research methods.

A review of experiences teaching psychology to computer students

In this section, some experiences of teaching psychology to computing students at different stages of their education – from A/AS level to undergraduate and postgraduate level – will be reviewed.

Teaching psychology to A/AS level computing students

In 2004, a British Psychological Society 'Public Engagement' grant supported the organisation of a one-day event for students enrolled on computing A/AS level courses to demonstrate how psychology can help to understand and develop computer systems. Preparation for the event involved talking to A/AS level computing tutors and studying the syllabi for the various computing courses. This revealed that, although various modules/units covered Human Computer Interaction (HCI) or 'interaction design', there was very little psychological background to support the HCI guidelines that were taught. Three foundation areas in psychology were identified that were considered important for students prior to discussing HCI. These were: cognitive processes (including the topics of perception, attention and memory); individual differences (including age, gender, personality, cognitive style); and social processes (including group-working and communication). The event started with lectures covering these three areas of psychology and this was followed by a human factors consultant who applied the areas of psychology to computing, in a discussion of user-centred design. For example, to illustrate the role of cognitive factors in the use of computer systems case studies linked cognitive load with car driving behaviour and the use of web pages. To illustrate individual differences case studies involved a consideration of the ageing population in design of ATM machines, how gender and personality can affect performance using a drawing package, and stress in air traffic controllers. To illustrate social processes, the ways that 'groupware' such as video-conferencing and decision-support systems can influence the way people interact and communicate was covered. Subsequently, a selection of practical workshops was offered to demonstrate how psychology has influenced the design, evaluation or implementation of computer software and hardware. For example, students could devise their own website using psychological principles and study the impact of in-car technologies on working memory.

To evaluate student learning and experiences, a questionnaire was distributed at the end of the day and two questions addressed the aims of the event. Students were asked, *Has the event today changed your perception of the role of psychology in computing, and if so in what way?* The general consensus to this question was an overwhelming yes, with 90 per cent positive comments. The qualitative comments revealed that many students could now see more clearly the links between psychology and computing, for example, one said, 'It has helped me to realise that there is more to consider than just putting all the information in the (software). The human factor plays a bigger part than I thought'. The second question asked, *Can you give an example of an aspect of human and computer interaction introduced today that has stayed in your mind?* The responses included: 'How much the layout of a computer interface affects humans'; 'Social aspects and user requirements. How users use the technology', and 'How similar the processing is between humans and computers.' The most enjoyable features of the day were the workshops and the least enjoyable were the lectures, therefore future events aimed at pre-degree students could include more practical activities.

Teaching psychology to undergraduate computing students

The area of HCI is now well covered on most computing degrees. However, undergraduate computing students often have little understanding regarding the way empirical methods (an integral part of all psychology degrees) can be used to evaluate computer systems. To address this, psychologists can usefully give guest lectures on computing degrees on the topics of empirical methods, internet-mediated research and ethics.

A range of empirical methods but ideally students need to experience these methods, therefore, it is helpful if the teaching experience includes case studies and practical workshops with associated scientific reports as coursework. For example, workshops which compare qualitative methods (e.g. observation, focus groups) and quantitative methods (e.g. questionnaires and performance scores) to evaluate the use of computer games have been used and this has illustrated the different methodological approaches well.

Still on the topic of methods, using the Internet to conduct research receives less coverage on computing degrees than might be expected. As with traditional experimental design, designing an Internet-based experiment or survey requires careful consideration. Although computing lecturers have the technical skills to conduct online surveys, they often have less understanding of experimental design and what can be done with the data. There are many benefits of internet-mediated research (for example, access to a larger population), however, many psychological and methodological issues need to be addressed by computing students and researchers; the issues covered include:

- ethical issues, e.g. whether informed consent can be gained online and how debriefing will take place;
- the difficulty in ensuring that the participant is who they say they are and that they are answering in an honest way;
- how to gain a representative sample;
- how to construct questionnaire items to avoid bias;
- issues of data screening and sample attrition rates need to be considered;
- the demographic profiles and questionnaire scores of those who did and did not take part in online experiments or surveys need consideration.

The teaching of ethics to computing students is not new. For some time, the teaching of ethics has been a requirement on degrees accredited by the British Computer Society (BCS). Since the classic text by Johnson (1985), coverage of ethics has increased as computers become more pervasive in daily life. For example, issues of information security such as privacy, ownership, access and liability and reliability have become more important. These advances have led to the most recent edition of Johnson (2001) including much work drawing on psychology, e.g. covering the psychological and social implications of internet use. However, despite the increasing need for ethics teaching sometimes there can be pressure on computing departments in meeting this requirement. This is mainly due to it being a difficult area for computing staff to teach which, according to Dark and Winstead (2005), is because the area of ethics is not positivistic in nature. Also, there is a lack of context-related materials, although the Learning and Teaching Support network (LTSN) have recently been addressing this (LTSN, 2004). This has often resulted in situations where lecturers with little background in ethics are teaching it to computing students. As a psychologist teaching guest lectures/workshops on ethics a different perspective can be offered to computing students. Teaching materials can be based on the work of Dark and Winstead (2005), who discuss the use of educational theory and moral psychology to inform the teaching of ethics in computing-related fields. In their paper, they discuss ideas on moral development and the nature of morality, specifically as it relates to changes that educators may be trying to elicit within computing students when teaching ethics. The ways that a computer scientist and a psychologist teach ethics can be quite different, with the former more likely to use a positivist approach and the latter an approach based on educational theories. For example, a positivist approach would define what is right and what is not right (i.e. define truth) and then address what happens if one does not do what is right or does what is wrong. However, many psychologists would disagree, saying that you cannot teach right and wrong and that although there are many laws which computer students need to know about, regarding what is wrong/right in society, there are not many things that are ethically questionable that are not illegal (and possibly vice versa!). In summary, philosophers have long recognised that it is almost impossible to 'teach' a student ethics, rather teachers need to advance students' sense of moral development and reasoning (Kohlberg & Kramer, 1969), something covered on all psychology degrees. With this in mind, it is also important to consider the age and experience of students when designing teaching materials on ethics (covered further in the next section of this paper). In summary, psychologists have a lot to offer in the teaching of ethics to computing students. Greene and Hiadt (2002) go as far as discussing ethics purely in psychological terms regarding the cognitive, affective and social aspects when they state that the origins of human morality are 'emotions linked to expanding cognitive abilities that make people care about the welfare of others, about co-operation, cheating and norm following.'

Teaching psychology to postgraduate computing students

I have delivered a unit on a postgraduate Advanced Computing degree which covered the work of social psychologists in studying the ways that technology can affect social interaction, attitudes and behaviour. As this unit was aimed at primarily part-time, 'mature', employed students there was a strong focus on how students could make practical use of the research findings in their work. After covering the major topics within social psychology (conversation and communication; group processes; interpersonal perception and attraction; social influence; attitudes, and conflict), applied topics can be covered such as:

- Computer-mediated communication: for example, the ways that online group discussion, using bulletin boards and video conferencing, can impact on interaction and decision-making and how to make online meetings as effective as face-to-face meetings;
- Affective computing: covering the role of emotion in computing systems and how to design systems that are effective and affective – this is a rapidly expanding topic in HCI and one which many students have little background understanding, therefore, this lecture provides a review of emotion involving definitions and early and current research directions;
- New technology and organisational change: covering the role of occupational psychologists in computer system implementation (e.g. the issues for the management of staff working online and remotely) as well as internet-based methods for recruitment and selection of personnel and training employees.

Feedback from students indicated that they appreciated the 'academic' approach, where practical ideas were grounded in psychological research. Also, postgraduate students were more interested, compared to undergraduate students, in the philosophical debates regarding the psychological implications of internet use. Four issues discussed were:

- Is deviance online any different from deviance in face-to-face contexts?
- Can people become addicted to the internet in the same way as other addictions?

- Does the internet reduce social involvement and psychological well-being?
- Does a person's face-to-face identity differ from their e-identity?

Also, I have delivered Masters-level guest lectures to students which cover psychological research within a very specific area of software design and development: one on e-commerce and one on computer games (further detail can be found in Taylor, 2002). In the first of these lectures, the important links between commercial internet use and psychological research in the areas of individual consumer behaviour and trust in e-commerce exchanges and relations between company and consumer are explored. The lecture on computer games looks at how the design of games can facilitate 'flow' and introduces students to the area of Positive Psychology which is rapidly gaining ground within mainstream psychology.

Research investigating the profile of computing students

The variation between students studying different disciplines has been well documented regarding age, gender and approaches to studying (e.g. Richardson, 1994). Those studies which have specifically investigated the profile of computing students will be reviewed here. It is proposed that some of these factors may affect the way that psychology teaching materials are perceived by students and their level of engagement with the materials. In some areas, these factors could be considered in the way that materials are designed and presented.

Gender

The composition of most psychology and computing degree courses are significantly skewed, with females making up the majority of psychology degrees and males making up the majority of computing degrees. Table 1 presents data taken from the Higher Education Statistical Agency (HESA) (2007) comparing males and females for computing-related and psychology-related subject areas. There are no figures give for psychology separately as a discipline, therefore, Table 1 shows the three subject areas where psychology degree data is included by HESA, depending on the focus of the degree. It can be seen that in the UK in 2005/2006 females made up only 21 per cent of students graduating with computer science degrees, while they made up 82 per cent of students graduating with a degree in a 'Subject allied to medicine'.

Table 1: Data taken from HESA (2007) comparing males and females for computing-related and psychology-related subject areas.

HESA subject area	Females %	Males %
Computer Science	21	79
Engineering and Technology	16	84
Biological Science	65	35
Subject allied to medicine	82	18
Social Studies	59	41

There have been many attempts to explain the reasons why males and females are attracted to different disciplines. A review of these studies shows very little support for cognitive abilities being the differentiating factor (e.g. Halpern, 1992, found similar abilities when comparing social with physical sciences). Recent research has looked at personal values or interests or motivation factors to investigate what Radford and Holdstock (1995) term, 'what people want to do rather than what they can do.'

Wilson (2003) used quantitative and qualitative methods to further understanding of how computing is perceived. In her paper she argues from a constructionist approach that, rather than any real difference in skill, female and male differences are a 'product of historical and cultural construction of technology as masculine' (p.128). For example, she notes that girls at school have been shown to be superior to boys in some areas of programming, but that they lack encouragement and interest so that by the time they reach 18 years of age they have already opted out. Wilson identifies teaching styles which appeal to female students as those with an emphasis on relational and contextual issues and co-operative learning through teamwork and group projects. While styles preferred by males are those emphasise the formal and abstract and independent learning. Therefore, when teaching psychology to computing students (dominated by male students) traditional methods used in psychology classes such as seminar discussions may not be the most effective.

Age

Psychology degrees tend to attract a significant number of mature entrants who have frequently been employed in other careers, have many life experiences or are returning to work after raising a family. While computing degrees tend to attract direct-entry A-level students. It is important to consider age, stage of moral development and life experience of students when designing and presenting materials on the topic of ethics. For example, an environment needs to be created that allows students to safely reflect on and explore their (sometimes immature) moral beliefs relative to the current issues in computing.

Motivation to study and learning style

Age is closely linked to the motivation of students to enrol on a University degree. Many psychology entrants enrol to help develop an understanding of themselves and others and to develop 'people' skills useful later in a range of careers. In contrast, many computing students see the degree as a stepping stone to gaining employment in the computing industry. Radford and Holdstock (1995) investigated differences between reasons why students chose computing and psychology degrees. Students were given a list of 60 items on the 'outcomes or benefits of Higher Education' to rank. These ranged from passing exams, learning to work with others, development as a person, develop problem solving skills, etc. The results showed that the most important items differentiating the two fields were:

Computing:
Develop problem-solving and computer skills;
Clear, logical thinking;
Increasing future earning power;
Practical, work-related experience.

Psychology:
Development as a person;
Understanding other people;
Understanding oneself;
Greater personal independence.

After factor analysis, Radford and Holdstock (1995) identified two factors related to choice of discipline: (i) personal development versus social relationships; and (ii) 'people' oriented versus 'thing' oriented (thinking about as well as directly dealing with people and things). The implications of this for teaching psychology to computing students are two-fold: (i) that computer students may be less open to thinking about people problems when computers are designed and implemented; and (ii) that it is important that students are aware that the way people use technology and their interactions with others can be as important as functionality.

A considerable amount of work has been published on the relationship between personality type and learning in Further and Higher Education, although there is relatively little focussing on students from specific disciplines. Recently, Layman, Cornwell and Williams (2006) collected personality types of students studying a software engineering course using the Myers-Briggs Type Indicator (MBTI). Their intention was to consider each of the four dimensions of the MBTI to help them create a teaching style and materials to appeal to as many of their software engineering students as possible. Layman et al. reported the distributions presented in Table 2, where it can be seen that the profile, in terms of the majority for each type, is of an Introvert, iNtuitive, Thinking and Judging (i.e. of the 16 types it is an INTJ type).

Table 2: MBTI categorical breakdown for students studying software engineering (data taken from Layman, Cornwell & Williams, 2006).

Myers-Briggs Dimension	%
Extraversion : Introversion	46 : 54
Sensing : Intuition	18 : 82
Thinking : Feeling	75 : 25
Judging : Perceiving	76 : 24

Layman et al. (2006) discuss each dimension with respect to preferred teaching approach within a software engineering course. For example, as they had almost equal numbers on the Extraversion : Introversion dimension, there were equal amounts of groupwork (preferred by Extraverts) and individual work (preferred by Introverts). With regard to the Sensing : Intuition dimension, which relates to how people prefer to receive data, they report that most of the instructors on the course taught in a style that suits Intuitors; by using lectures to emphasise concepts, as opposed to factual data. With regard to the Thinking : Feeling dimension, thinkers are rational and logical in their decision-making, while feelers make decisions based on intuition and personal consideration. Therefore, it was expected that most software engineering students would prefer to learn where materials are presented objectively as matters of fact, e.g. 'these are the steps of the waterfall process'. In contrast, personal consideration and emphasis on human elements and social relevance are particularly important to feelers. Finally, on the Judging : Perceiving dimension, it was found that in their sample, judgers hold a majority over perceivers. Judgers tend to be organised, decisive and to like concise, concrete explanations, therefore a clearly presented lecture will often contain the type of information that appeals to them. On the other hand, perceivers are flexible and open to change and, therefore, comfortable with ambiguity and more likely to prefer discursive essays. Although Layman et al. do not compare their computing course with a psychology course, it would be reasonable to assume that different teaching styles are likely to appeal to computing and psychology students dependent on the Myers-Briggs dimension that dominates.

It is important to recognise that students studying for computing degrees are likely to have been taught in different ways and may approach studying in different ways, compared to those studying for psychology degrees. From personal observation, computing students are generally more familiar with assessments which have definitive answers, while psychology students are more accustomed to discussing the relative merits of both sides of a debate and to provide a balanced view rather than a definitive answer. This would support the extensive work by Kolb (1981) investigating learning styles and subject discipline. Also, from personal experience, psychology degree students tend to be more open to furthering their understanding of their own learning style, compared to computing degree students.

Conclusions

I would like to conclude by reflecting on my experiences to offer some general tips for those about to embark on teaching psychology to computing students.

As with all interdisciplinary teaching (including service teaching), materials need to be adapted effectively to provide appropriate links to the other discipline. In the case of computing, psychology materials need to be linked to topics taught on the computing course and to show an awareness of the professional context of computing. Learners appreciate this understanding of the computing curricula and of topical issues in the computing press. It is important to deliver the materials at the correct level, taking into account the relevant intended learning outcomes and educational stage. At the pre-degree level, the emphasis needs to be on practical activities and workshops can be used to demonstrate how interaction design recommendations based on psychology can be put into practice. Indeed, examples of poor design in well-known computer systems can be used to illustrate where psychology has not been applied to interaction design! At undergraduate level, students appreciate more detail as to how research was conducted and they need to develop skills to allow them to consider different psychological research methods to evaluate computer systems. At postgraduate level, students are interested in hearing about ground-breaking research where psychology is being applied to computing, but also they appreciate discussing the philosophical debates in computing. It is important not to overwhelm students (at any level) with psychological content but to provide web-links and references to support the concepts being covered. Similar to being prepared regarding the curriculum and educational level of your intended learners, some understanding of the profile of your intended learners can assist in developing psychology materials for computing students. For example, the style of presentation of psychology activities can be adapted to better match the approaches to studying of computing students.

Finally, it is important to recognise that students will have a certain perception of what psychology covers. When I first started teaching psychology to computing students, they used to be less knowledgeable about psychology and tended to think the discipline was only concerned with treating psychological disorders. However, the knowledge and expectations of all students, including computing students, regarding the discipline of psychology has changed significantly – largely as a result of the media representation of psychologists. In the last five years, reality TV shows frequently feature resident psychologists and many documentary programmes involve psychological consultants. As a result, it is useful at the start of any contact with computing students to briefly cover what is psychology and what is not psychology and to differentiate between academic psychology and 'popular' psychology. This helps to contextualise the wider role of psychologists in the many areas of modern life relating to computing and technology.

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