Teaching Cognitive Science as Classics

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Abstract

Cognitive science is usually taught as a postgraduate course, or as a relevant group of undergraduate units brought together as a major course of study in cognitive science. This paper argues that more basic units can be taught somewhat as classics used to be, aiming to incorporate quite basic but essential learning into undergraduate degrees, and should even be introduced into school courses. This argument is supported by a brief description of experience in such tertiary teaching. As a foundation for such "neo-classic" teaching, those working in cognitive science should review their image of their discipline, and should seek common cause with workers in the field of information systems.

INTRODUCTION

Cognitive science is primarily thought of, by those who practise and promote the "science," as multidisciplinary, that is, as a coöperation of disciplines rather than as a discipline in its own right. This viewpoint has long been promoted (e.g., by Gardner 1985).

Progress in cognitive science may well depend for some time on specialists in traditional areas such as medicine, psychology, humanities, and philosophy studying cognition in their own ways. But there is no real reason why cognitive studies in those traditional areas should individually continue to be regarded as drawn from otherwise disparate umbrella disciplines. Key specialties such as neuroscience, cognitive psychology, linguistics, and the philosophy of mind, really should be regarded as specialties within a common discipline.

The cognitive science specialties could be likened to the various branches of physics, or of geography, which are regarded as part of an encompassing physics or geography discipline. Just as physics is the study of the physical universe, and geography is the study of the surface of our planet, so cognitive science is the study of cognition. Just as physics and geography employ a variety of techniques, and evaluate their data from a variety of viewpoints, so does cognitive science. If cognitive science is multidisciplinary, then so are physics and geography. In that case, just as basic physics and geography are taught in schools as important, if not essential, areas of knowledge, so should a basic cognitive science be taught in schools. Indeed, the importance of understanding the human mind and its working suggests that the study of cognitive science in schools should be regarded as essential rather than merely important.

One barrier to this is the absence of any apparent precedent. This paper describes experience with teaching a general cognitive science at tertiary level that could be taken as such a precedent.

The Genesis of a Precedent

Fresh from a course of study in cognitive science at the University of New South Wales, the first such in Australia, I took up a lecturing position from the beginning of 1989 at the then Tasmanian State Institute of Technology where teaching of a new three-year undergraduate degree in Applied Computing was just starting. By the time third year teaching was being prepared, I had persuaded the Head of Department that it would be a good thing to offer teaching in cognitive science to would-be computing professionals.

My motivation in pressing for this was related to my reasons for studying cognitive science in the first place. In some thirty years in the computing industry I had observed a richness and variety of very naive views on the human mind professed by workers in (and students of) computing, views which, probably due to an overdeveloped attachment to the machinery of the industry, held the human mind closely to resemble the workings of a digital computer. Such views are reinforced by “the unfortunate anthropomorphic language used about computers” (Checkland 1988), and the even more unfortunate use of terms like *machine learning, knowledge acquisition,* and *artificial intelligence* to refer to what programs do.

It seems fair to claim that students of computing would be able more realistically to appreciate the nature of their professional work if they were given some understanding of how the human mind works, and some inkling of its superlative richness and variety. To help induce such appreciation, I have thus for some years been teaching two optional cognitive science units, one at third year level, one at honours level, the first a prerequisite for the second. These units are taught through four class contact hours a week over a fourteen week semester, two hours lecture per week and two hours seminar.

COGNITIVE SCIENCE

The first unit covers three main areas: • neuroscience, • cognitive psychology, and • neural computing, in roughly equal amounts, but with the neural computing given a practical treatment appropriate to the students’ needs.

The Objectives

The unit outline issued to students gave a list of the topic areas to be covered, as well as the objectives of covering them. The objectives are quoted here, and, together with the lecture schedule quoted later, they suggest the topics in enough detail to save having to quote the topics list here as well.

> After doing this unit, a student should be acquainted with important aspects of the operation of the human brain, and be able to
>
> **a.** identify and describe the functions of, and the relationships between, the various parts of the central nervous system at the neuronal and gross physiological levels,
>
> **b.** describe and explain different computer-based neural network models, and be able to use at least one of them,
>
> **c.** identify and describe general aspects of human perceptual and cognitive psychology, and machine-based models of such aspects of psychology,
>
> **d.** identify and explain significant features of the man/machine interface, in particular the non-textual interface, with computing systems.

The Lectures

Lectures are for two hours a week, with roughly one hour spent on neuroscience, and the other mostly on cognitive psychology. In the following schedule the fourteenth week is not given as it is customary here that student work for that week not cover new material, so that that lecture is solely for review.

0	Introduction				
1	Neurons	Behaviour	7	The eye	Vision
2	Synapses	Motor behaviour	8	Memory systems	Factual memory
3	Neurotransmitters	Procedural memory	9	Potentiation	Learning
4	The nervous system	Robotics	10	Brain physiology	*Folk* psychology
5	Brain anatomy	Ergonomics	11	Brain malfunction	Misbehaviour
6	Cognition	Perception	12	Brain development	Intelligence

Lectures are given to 20 to 35 students, and attendance is always gratifyingly regular, perhaps because the relatively small classes (and the third year standing of the students) makes discussion possible. Also, most students seem very interested in the subject matter, though some remark that they never expected to be able to study such things in a computing course.

The Seminars

The seminars have to be for classes of at most twelve students, because each student is required to give three presentations, and there is really only comfortable time for three presentations in their weekly seminar. Most years there are three seminars a week, though for the first one or two weeks I do the seminars by myself to introduce the work in neural computing, which is not covered at all in the lectures.

For the presentations, each student is given a neuroscience topic, a cognitive psychology topic, and a neural computing topic. For each topic, the student has to give a twenty minute presentation, lead discussion, and hand in a report. All three components are assessed.

All students are expected to use in their own time all the five or six neural network models covered, and a tutorial presentation is given on them in most seminars. The first model is the Hopfield network and the students use a program written by one of the first students in the unit. Otherwise they use programs provided with an early textbook by McClelland & Rumelhart (1988).

For the other assigned topics, students are referred to a book chapter, or an article, often from *Scientific American* which students almost always find relatively easy to understand and which is usually superbly illustrated.

ADVANCED COGNITIVE SCIENCE

The second unit also covers three main areas, and follows the same pattern of treatment. In this case the areas are • philosophy of the mind, • linguistics, and • computational linguistics, in roughly equal amounts, with strong practical treatment in this unit being given to the computational linguistics.

Having much smaller classes, this unit was never as well developed as the other, and has been dropped for some time, except as a guide to individual study for the few students wishing to do it. The objectives, quoted here from the unit outline issued to students, should give some idea of the material covered.

> After doing this unit, a student should be acquainted with important aspects of the operation of the human mind, and be able to
>
> **a.** identify and describe the stages of development, and the functions, of the various components and aspects of language, spoken, written, and signed, and the neural correlates of the functions,
>
> **b.** identify and explain various linguistic models and be able to use computer-based phrase-structured grammars,
>
> **c.** describe and discuss stages in the development of the philosophy of the mind and the various current and recent theories of the mind and its consciousness, in particular theories motivated by experience with digital computers,
>
> **d.** describe and discuss significant similarities and distinctions between human intelligence and artificial intelligence, and between human and artificial decision systems.

What is not conveyed by these objectives is the intended emphasis on the social essence of intelligence, and of language and mentality, an emphasis allowing consistent and persistent contrasting of man and machine.

DISCUSSION

The teaching of these two units has been attended by some difficulties. At first, the units were taught consecutively in first and second semesters, and some third year students were allowed to take the honours unit. Under these conditions enough students enrolled in the second unit to make up a viable class. Of recent years, timetabling has forced the two units to be offered in the same semester, and this has so reduced enrolments for the second unit that it has had to be taken as an independent study unit by the few students who wish to do it under these conditions.

More recently, “rationalisation” of the teaching of computing at the University of Tasmania has reduced the possibilities of teaching optional units, so the teaching of both units is at an end and the first unit will now be taught out.

Text Books

Prescribing a textbook has been a real problem because of the breadth of material covered. The one prescribed for the first few years (Stillings et al. 1987) for both units had an emphasis on artificial intelligence, and went beyond what I was trying to teach in many topics, and gave too little detail on many other topics. I considered prescribing books like those of Churchland (1986) or Gregory (1987) or, more recently, Gazzaniga (1995) , but felt that these otherwise excellent texts were, respectively, wrongly focussed, inappropriately arranged, and overkill for my purposes. But without a text at all the students felt a bit unsupported in territory unfamiliar to them, so I have for a few years now been prescribing Hock (1995), not as a text for the unit, but as a resource for assignment topics. This has been fairly successful, with quite a few students commenting on the stimulation they have got from readings in it, and, since all students have the text, it allows better discussion of the topics selected from the text.

The problem for a unit of study like my *Cognitive Science* is that there is no shortage of good texts on neuroscience, or on cognitive psychology, or on neural computing, but none combining all three, or even the first two, at a suitable level. And an analogous observation applies to a unit of study like my *Advanced Cognitive science*. What is needed, both for tertiary level and for high school level teaching of basic cognitive science is a pair of text books such as might be suggested by titles like *The Brain and Its Body* and *The Mind and Its Brain*.

Attitudes

The students choosing to do my units seem to be thoroughly interested in what they are learning. Several students have commented that they chose to do the unit to get practice in making presentations but came to be intrigued by what they studied. Discussions in the seminars have occasionally been given unusual reality by contributions from students with different neurological disabilities, ranging from migraines to after-effects of brain tumour removal from the primary visual cortex.

While I am confident that students finish with a better appreciation of the complexity and variety of the human neural system, I feel their studies nevertheless seem to them rather peripheral. There are no prominent practising cognitive scientists or engineers that spring to their minds, and the figures in the area that do are such as Oliver Sacks, a neurologist, or John Searle, a philosopher, or Marvin Minsky of the artificial intelligentsia.

The difficulty here is that individual applications of cognitive science are seen as applications in the original umbrella disciplines, and cognitive science, unlike older sciences, has no associated technology applying its findings. To be successful, a science needs to be seen as directly supporting a technology, or a branch of engineering. There is, however, a nascent discipline which could be developed to fulfil that rôle, and it is called *Information Systems.*

Information Systems

Many universities have departments of Information Systems, typically within Business or Commerce. These suffer from two basic difficulties. Some of these departments are unable to differentiate themselves sufficiently from sister computing departments and eventually the two merge back together. Other of these departments are unable to attract enough student enrolments, and so merge into more general management departments.

These difficulties might well be overcome by the particpants taking to heart the computing industry's standard definitions of their two most basic terms—*data* and *information.* These long-standing definitions (Tootill 1966) may be summarised as having *data* mean the representation of facts or ideas according to some convention, and *information* mean the meaning that people give to data. These definitions clearly imply that only people can process information, and that computers can only process data. Consistent and stubborn application of these standard definitions would serve to contrast the disciplines of computing and information systems (the first difficulty solved), and by the way would make plain the relevance of cognitive science to information systems.

The second difficulty arises because having the information systems discipline within Commerce or Business means that only information systems applied to business or management are considered relevant. But nowadays, with computers so widely used, all professional activities have their information systems, and all professions need support from information systems specialists. The second difficulty could therefore be overcome by treating Information Systems as a very general technology (possibly with a better name) with its own particular curriculum. The interest here, though, is that the science on which information systems must base its technology can only be cognitive science.

Whether it realises it or not, Information Systems needs Cognitive Science. And Cognitive Science would get more recognition, and great benefit, from allying with Information Systems.

RECOMMENDATIONS

Two broad areas of endeavour would be of great benefit to Cognitive Science.

Promotion

Cognitive Science should be seen and promoted as an umbrella discipline in its own right.

Cognitive Scientists could

- consider whether the name Cognitive Science is a help or a hindrance, and work for its replacement if it is deemed a hindrance,
- seek to establish a general journal for the discipline, one in which this kind of paper might find a home,
- work to have cognitive science teaching incorporated in undergraduate degree courses, and
- push to have basic cognitive science taught in schools.

Consolidation

Cognitive Science should be fostered as the science underlying Information Systems.

Cognitive Scientists could

- make themselves familiar with appropriate Information Systems journals, which should soon indicate possibilities for coöperation,
- start contributing to these journals,
- befriend, and offer mutual support to, Information Systems people where you work, and
- invite the Information Systems profession to Cognitive Science conferences, attend Information Systems conferences, and move to hold joint conferences.

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