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Psychology and its role in information technology

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This paper discusses a role for psychology in the development of information technology. Because of the popularity of psychology as an undergraduate major, psychology's expertise in measurement, and the assertion of some that cognitive science provides the scientific basis for advancements in information technologies, psychology has a responsibility as a discipline to advance information technology and to educate students about this technology. Studies suggest that higher education in psychology can facilitate reasoning about general issues. A process-oriented course in psychology and computers is suggested as a way of incorporating computer literacy into the psychology curriculum. The role of the Society for Computers in Psychology is also discussed.

As President of the Society for Computers in Psychology (SCiP), I would like to consider the role of psychology in the information technology revolution and how that role might change as we move into the next century.

Psychology's Role in Enhancing Computer Literacy?

Information technology is a term that is used fairly frequently because it embraces the many ways in which computers are used. It includes telecommunications, a wide range of media (software, CD-ROM, interactive video and sound), several kinds of computers (supercomputers, mainframes, and microcomputers), and applications. Psychology is a discipline with some history in the use of information technology for both instruction and research. In fact, the proceedings of our annual meetings published as the April/May issue of *Behavior Research Methods, Instruments, & Computers* record and document the many ways in which computers are used in psychology. The question that I would like to address deals with the role that psychology plays in the development of information technology. What responsibility, if any, does our discipline have for training students in computer literacy?

Although our use of information technology is well documented in the proceedings of this society, the responsibility of our discipline for furthering the development of technology and for educating students in these technologies is uncertain and not well spelled out. It is these issues that I wish to address. What role does psychology have in the computer revolution? Why should our discipline be concerned about computer literacy or adopt any responsibility for the computer literacy of the students?

Reasons Why We Should Get Involved With Computer Literacy

There are three reasons that I think mandate a role for psychology. First, psychology is a popular major (Eckerman, 1991; Turner & Bowen, 1990). In relation to other disciplines, we teach a lot of students. On my campus at the University of North Carolina, Charlotte, for example, we have over 800 undergraduate majors, around 800 undergraduate minors, thousands of students enrolled in our service courses (general, educational, and abnormal psychology), and over 50 graduate students in masters programs. Probably there are many reasons for psychology's popularity. There is the intrinsic interest of the students in the course material. Our courses answer questions that students are asking about themselves and about their relationships with others, and that makes our discipline more appealing than others such as chemistry or physics.

Other more pragmatic reasons for psychology's popularity are rooted in the shifts in employment opportunities toward those of a service economy and toward service sector jobs that imply some dependence on "people skills." So, through sheer numbers, we have the potential of influencing many students. Whatever we decide to emphasize in our classrooms has an impact on students in general at the university. Recently, there has been an emphasis on critical thinking, and we are encouraged to stress classroom exercises in critical thinking. Texts by Zechmeister and Johnson (1992) and Benjafield (1994)

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have outlined techniques that would be useful for psychology instructors. Perhaps we have a similar responsibility with respect to computer literacy.

Several decades ago, when I was an undergraduate student, it was possible to ignore technology in the search for knowledge. I do not believe that this is still possible. To be a knowledgeable person implies some degree of computer literacy. As we move into the next millennium, we will need to be even more familiar with computers than we are at present. We will depend on technology to a greater extent. Some say we will live in "smart houses" and drive "smart cars." Computer applications will be user-friendly and productive, for the most part. We will accomplish more in less time through the use of computer tools. This is already apparent in the research grade software that is available for psychological research. It is no longer necessary to program in Pascal, BASIC, or C to set up an experiment in perception or learning. Tool-based packages such as PsyScope, SuperLab, and Micro Experimental Laboratory (MEL) can be used readily by research assistants with minimal programming skills. Figure 1 shows a sample of the script from a perception study that I presented at the meeting of the Psychonomic Society. The best part of writing the

```
#Script-Version 6
#Background-Color      64816  65535  62833
#Background-Pattern    0      0      0      0
#Background-Size       1      512    384
#Input-Method   adb1   0      2      0
#Timing-Method  tmr2

#Codes
format   p     w
itemtypev      I
t/f      t     f
item     a     c
ISI      0     100    200    300    400    500

#Responses
tT
Ff

#Events
* Event Event  Response               Terminate      Correct
** Name Type   Action  Duration  On   Response
instructions   visl    2         0    1       0
ap1-o    visl  1       0         1    0
ap2-o    visl  1       0         1    0
ap3-o    visl  1       0         1    0
ap4-o    visl  1       0         1    0
aw1-o    visl  1       0         1    0
aw2-o    visl  1       0         1    0
aw3-o    visl  1       0         1    0

#Visual
* Event File   Dir    Vert   Horiz  Vert   Horiz  Misc.  Play   Lead
** Name Name   ID     Size   Size   TLC    TLC    Flags  Time   Time   Reserved
instructions   INS1   202    0      0      0      0      1062   286    0      0
ap1-o   AP1-O  202    0      0      100    0      1058   83     600    0
ap2-o   AP2-O  202    0      0      100    0      1058   85     600    0
ap3-o   AP3-O  202    0      0      100    0      1058   85     600    0
ap4-o   AP4-O  202    0      0      100    0      1058   85     600    0
aw1-o   AW1-O  202    0      0      100    0      1058   55     600    0
aw2-o   AW2-O  202    0      0      100    0      1058   54     600    0
aw3-o   AW3-O  202    0      0      100    0      1058   -1     600    0
aw4-o   AW4-O  202    0      0      100    0      1058   59     600    0
cp1-o   CP1-O  202    0      0      70     0      1058   590    600    0
#Trials
* Codes:format. itemtypet/f     item   ISI
instructions
1       p      v      t      a      0
2       p      v      f      a      0
3       p      I      t      a      0
4       p      I      f      a      0
```

Figure 1. Sample script from a perception experiment.

software for the experiment, of course, was that neither I nor my research assistants had to write the code for running the experiment. The script was produced by the software program (SuperLab) after we set up the displays with a tool-based art program and imported the stimuli as PICT files.

Students will need to be at ease with world-wide networks for communications. For most of the 20th century, we have emphasized the need to speak a foreign language in order to become globally aware. I think that as we gain ease with Internet and electronic mail, global awareness will come as a by-product of the ease of doing business across a network. Faculty offices are connected to departmental local area networks (LANs), which often include student labs. These, in turn, are connected to campus LANs, which are connected to national and international networks. In this year's SCiP program, we heard about world-wide networks. As many of you know, communication is irrespective of physical distance. It is almost as easy to collaborate with someone in another state or country as it is to work with a colleague in another building on campus. If you are a subscriber to the teaching in psychology (TIPS) network or to Psycoloquy, you know that we frequently hear from our British and Australian colleagues, among others, on a number of issues.

If we decide to emphasize computer literacy, we will reach many of the students enrolled at the university. For this reason alone, we in psychology are better positioned than computer science, mathematics, or engineering to teach students about tool-based applications and general computer literacy. For statistical, spreadsheet, and database applications, critical thinking skills are far more important than programming skills in the use of software to solve problems. This fact alone places computer literacy in the realm of the psychology curriculum.

A second reason for assuming some responsibility for computer literacy is our expertise in measurement. We are able to evaluate the impact of computers. Although there are other disciplines that may be more suited to teaching students about specific applications—such as computer science's expertise in teaching programming languages, engineering's expertise in hardware design, and business's expertise in information management—psychology is without peer in its ability to evaluate the effectiveness of such applications particularly to instruction. In teaching students about technology, we can emphasize the wise and judicious use of the technology. Castellan's (1993) work has been particularly helpful in this regard. He identifies technical accuracy, pedagogical soundness, substantive fidelity, integrative flexibility, and cyclical improvement as the important criteria for the evaluation of information technology. I think that many of you will agree that his work set the standard for evaluation.

Third, cognitive science represents the leading edge of the information technology revolution. Clark (1992) has argued that cognitive science provides the scientific basis for developments in information technology through its concern with the study of intelligent behavior. Although it is interdisciplinary, cognitive psychology is one of the contributing sciences. Our concern with understanding cognition and the functioning of intelligent systems provides a base for the development of intelligent machines and communications systems. Clark points out that psychologists are needed to identify the dynamics of human–computer interaction and to assist in the development of instructional systems, among other things.

For these reasons, and probably for a number of others that other psychologists can generate, psychology has some role in teaching computer literacy. If we wish students to graduate with a bachelor of arts degree, or with any of our graduate degrees, and if we wish our students to be knowledgeable, we are implying the necessity of some degree of computer literacy.

Is Training in Computer Literacy Beneficial?

Is there any evidence that formal training in computer literacy will make a difference in a student's ability to solve everyday problems? Is there any evidence that what we do in higher education matters in a general sense? Does formal training improve reasoning about everyday events? Twentieth-century education has concentrated on domain-specific knowledge, and there is no doubt that our psychology curriculum does a fair job of teaching psychology content. But to what degree will that training generalize to problem solving about everyday events?

Nisbett and his colleagues (Fong, Krantz, & Nisbett, 1986; Nisbett, Fong, Lehman, & Cheng, 1987), who have considered these issues, point out that although pre-20th-century education was dominated by the doctrine of formal discipline, this notion was heavily criticized by more modern work. The doctrine of formal discipline held that studying abstract rules would facilitate reasoning about concrete problems. However, Thorndike (1906) showed that training was domain specific and that it evidenced little transfer, and Piaget (Piaget & Inhelder, 1975) suggested that everyday reasoning was governed by abstract rules that were intuitive and could not be taught.

Nisbett and his colleagues (Fong et al., 1986; Nisbett et al., 1987) considered whether reasoning could be taught by providing brief formal training in inferential rules. They taught subjects about statistical principles such as the law of large numbers (i.e., that estimates of population parameters based on large sample sizes are more reliable) and tested whether this training influenced reasoning on a variety of everyday problems. Their findings showed that those who received full training were more likely to use statistical reasoning in their answers. Partially trained subjects were better than the controls but not as good as the fully trained group. Formal rule training improved statistical reasoning for all kinds of events, not just for probability problems. Training was domain independent. Moreover, they compared college students who were grouped on the basis of their statistics training and showed that the frequency and quality of the statistical answers increased with the level of statistical training.

Nisbett also reported on the results of a study of four graduate programs. First- and third-year graduate students in four different fields were tested on several different kinds of inferential skills. Although no differences in performance were reported for the first-year students, there were dramatic differences after 2 years of graduate training in a specific discipline. Psychology students showed the strongest improvement in performance on statistical and methodological reasoning. Medical students showed smaller but significant improvements, whereas law and chemistry students showed no significant improvements. The results were in accord with the prediction that students trained in probabilistic disciplines such as psychology and medicine would show gains in the ability to apply statistics and methodological rules to both scientific and everyday problems, in comparison with students trained in disciplines such as chemistry, where the training is primarily in necessary and deterministic causes. Nisbett concluded by saying that all of this evidence suggests that people can be taught to reason, and he supports "the process-oriented theories of intelligence that emphasize the pragmatic experiential context in which intelligence evolves in the context of everyday problem solving" (Nisbett et al., 1987, p. 631.)

What does all this have to do with computer literacy? I am indeed glad that psychology graduate students show a dramatic improvement in their ability to apply inferential rules after 2 years of graduate study (especially since this kind of gain is not seen in chemistry graduate programs). But even more important is the evidence that reasoning can be facilitated by higher education and that psychology in particular can be influential.

I believe that a similar sort of process occurs with the acquisition of computer literacy if we emphasize a process- rather than a content-oriented approach in our student laboratories. Chute (1993), in describing his classroom 2000 project, which implements state-of-the-art technologies in instruction, indicates that content is not as important as process when one is using computing technology. When we are teaching students about the scientific method, for example, the students learn by doing. Software provides the tools by which students can do research on their own. Chute emphasizes the educational benefit of tool-based software that permits the students to be creative. I have had the privilege of watching this process in my students as well as in my son as he gets introduced to software of increasing sophistication. Through no effort on my part, I have watched my son get excited about using drawing tools to create figures for his own amusement or to complete a middle-school assignment.

The same kind of excitement can be observed in a group of upper-division undergraduates and graduate students who are enrolled in a presession course called Microcomputers in the Social Sciences. Unlike any of the psychology courses offered during the semester, this course is process- rather than content-oriented. It is a 10-day course with 4-h sessions each day. This format works because each class session is divided into two segments, with the first for introducing and demonstrating a topic, and the second for the students to practice with the application and to work on a daily assignment. Using a Macintosh PowerBook 180 connected to an LCD display panel (Sharp Model QA75), I can demonstrate for the class how to get started with each application, and I can highlight the special features of each program. To introduce students to programming in a tool-based environment, for example, we start with HyperCard. Students are required to write a HyperCard script on a topic of their own on the first class day. The syllabus in presented in Table 1. The topics vary daily, and the students are introduced to a variety of applications, from data analysis programs through network communications to programs that permit the setting up of an experiment.

Although the goal of the class is to provide students with computer skills needed for research, I think that much more is accomplished. Since the students basically learn by doing, they develop a strategy for interacting with software that can continue after the completion of the course. As the students' computer literacy is enhanced, they lose their fear and develop some confidence in their own abilities in applying computer tools to solve real world problems. The success of this course suggests that after a very brief introduction on my part about the specific application, students can learn by doing to turn the abstract into the concrete. Most students with some practice can become quite creative in their applications, and it is not unusual to have daily assignments that far exceed my expectations. Obviously, the more practice the students get with the applications, the more detailed their programs are. However, the course is viewed as just a starting point. From there, the students move on to do independent research with a faculty member, or graduate students begin their thesis work. I recommend such a course in every psychology program. Technology changes so quickly that it is not enough to learn a skill to be successful in a job. When job skills become outdated, people must be both willing and able to continue to learn. A process-oriented approach is valuable because it trains students to learn on their own.

The laboratories associated with traditional courses such as Research Methods are a starting point for training students in computer literacy, but by themselves they are not sufficient. Although they expose students to computer-based applications such as data analysis and data gathering, they do not go far enough. The focus of the course is upon covering the course content and teaching domain-specific material. Grading in these courses is often a function of mastery of course material, with some writing involved. These courses provide

Table 1
Syllabus for Microcomputers in the Social Sciences

Day	Topic	Assignments
1	Introduction & HyperCard	1. Macintosh basics 2. HyperCard Tour 3. Write a HyperCard script
2	Data Analysis–Descriptive & Nonparametric	Use SYSTAT for problems
3	Data Analysis–ANOVA—Between Designs	Use SYSTAT for problems
4	Data Analysis—Within & Mixed Designs	Use SYSTAT for problems
5	Data Analysis	Use SuperANOVA for problems
6	Communication Through Networks	1. Send E-Mail message 2. Use First Search to find two references
7	Data Gathering	1. Use SuperLab to create an experiment or survey 2. Run the experiment on two subjects
8	Spreadsheets	1. Use Microsoft Excel to calculate descrip statistics 2. Import SuperLab Files
9	Word Processing and APA style	1. Write & print a letter with MacWriteII 2. Write a lab report in APA style
10	Project Due	Final project should include a lab report in APA style, SuperLab script, 2 data files

the prerequisite experiences for the microcomputer course that I teach. A process-oriented course is needed for computer literacy to become established at a professional level.

What Role Does SCiP Have in All of This?

SCiP provides a forum through which we learn to help influence what goes on in academic institutions. SCiP is in a unique position to influence psychology, because we are not a special interest. Our members represent specialties from experimental to clinical psychology, and our interests, reflected in the choice of topics for our paper sessions, are evenly balanced between instructional and research applications. Perhaps it is time to move beyond the practical concerns of what kind of computer one should buy or which software one should use, toward shaping the role of psychology in the computer revolution. How can computers be used to add to the knowledge base? How can psychology instruction be changed to incorporate training in computer literacy? SCiP members often spearhead faculty efforts to increase the availability of computers. A number of the past presidents of SCiP (Null, 1988; Castellan, 1991) have reported at the annual conference about their attempts to work on their own campuses and, in the case of Cynthia Null, at a more national level, to shape policy in terms of information technology.

As I indicated earlier, another of SCiP's major contributions may be the documentation of the many ways in which computers are used in psychology through the publication of our proceedings in *Behavior Research Methods, Instruments, & Computers*. As a way of evaluating the impact of the proceedings issue of this journal, I asked our research librarian to calculate the citation frequency of the articles in the proceedings issue in comparison with that for other issues of the journal. Table 2 presents the mean number of citations for articles published over a 4-year period. Citations of articles in the proceedings issue are more frequent on the average than citations of articles published in the other issues of the journal for this time period. Although this is a limited way of looking at impact, the data do show that the proceedings issues are cited somewhat more frequently than other issues of that journal. Moreover,

Table 2
Mean and Standard Deviation (*SD*) of Citations for the Articles in the Designated Issues of *Behavior Research Methods, Instruments, & Computers*

	Proceedings Issue	Other Issues
	1992	
No. of articles	41	61
Mean citations	.63	.25
SD citations	.86	.57
	1991	
No. of articles	46	40
Mean citations	1.087	.65
SD citations	1.15	1.23
	1990	
No. of articles	32	57
Mean citations	1.50	1.33
SD citations	2.67	1.65
	1989	
No. of articles	43	63
Mean citations	2.21	1.67
SD citations	2.55	2.57

these data suggest that our annual meetings have some impact.

Also, in considering the role of SCiP, I thought I would share with you my list for the 10 best reasons for being a member.

1. *To keep up with advances in research tools.* As a researcher in perception, I want to keep my laboratory up to date, but I have only minimal technical assistance and limited time. I do not want to invest a lot of time reinventing the wheel by developing software when a reasonably good program exists. For example, there is always much concern about the sensitivity and reliability of millisecond timing in microcomputer applications. There are many pitfalls to programming with timing applications. I would rather not experience first-hand each and every pitfall every time I want to begin a new research project. I prefer to take advantage of the research tools that have demonstrated reliability. The SCiP program contains a number of presentations that speak to the issue of research tools.

2. *To update instructional software.* As technology changes, there is a need to update laboratory exercises. New instructional software is introduced at our annual meeting. At present, for example, multimedia applications are in vogue. Presentation programs such as Powerpoint offer some useful tools for enhancing classroom demonstrations and grabbing the attention of students who are not interested in reading textbooks. I am experimenting with these presentation tools to spice up my lectures and make them more appealing to the current generation of students. I am particularly encouraged by the interest that a number of publishers have shown in the development of classroom materials on CD-ROM. This media shows a lot of promise for the delivery of educational materials. I predict that in certain courses, such as Sensation and Perception and Physiological Psychology, we will see textbooks on CD-ROM rather than in hard copy.

3. *To find out what works.* A lot of software is available commercially, but it is often difficult to determine student reactions, or whether the software will fulfill expectations. At our meetings, we have always emphasized the evaluation of software applications. Presenters are not hesitant about placing a piece of software within a context and evaluating it against similar materials.

4. *The opportunity to meet the people who are authoring academic software.* Mel, SuperLab, MacLaboratory, PsyScope, and Eye Lines are a small fraction of the available materials that have been authored by SCiP members. The annual meeting provides members with an opportunity to have an input into future developments in instructional software.

5. *To understand new methods of data analysis.* Data analysis tools have grown more sophisticated and versatile. Traditional forms of data analysis are not always the only choice. Recently, we have had a number of symposia on visualization tools, and Loftus (1993) has told us that a picture is worth a thousand p values.

6. *To find out what's new.* Vendor displays have been used over the years to provide an informal forum for discussion at our meetings. Innovative hardware and software products are presented.

7. *The opportunity to ask questions about specific research or instructional applications.* With the emphasis on tool-based software, there is some flexibility in how software can be used. Hints about effective techniques can be true time savers.

8. *To find solutions to research and instructional applications that are specific to psychology.* Although there are many computer conferences, they tend to be dominated by a specific vendor or software application. Our conference is dominated only by a shared interest in applications for psychology. We are not in the business of hawking commercial products.

9. *To meet others who have common instructional or research applications.* Working together, we can sometimes develop solutions that would not be possible alone.

10. *Because the annual meeting provides an opportunity to discuss developments in information technologies as they relate to the discipline of psychology.* Research tools developed for a specific area of research may be useful when applied more broadly.

In summary, to answer the question raised at the outset and to reinforce the basic theme of this address, there is the need for psychology as a discipline to accept some responsibility for developments in information technology. As cognitive scientists, our work provides the basis for technological developments. As we learn more about cognition, this understanding can be applied to the development of intelligent machines and communications systems in the manner spelled out by Clark (1992). This also imposes some responsibility on us as researchers and instructors to incorporate computer literacy into our course work. For the reasons mentioned earlier, such as our popularity and expertise in measurement, we are positioned better than faculty from other disciplines to make an impact in this area. There is a need to adopt a more process-oriented approach to instruction as well. If we are to prepare students for the challenges of the 21st century at either the undergraduate or the graduate level, we must clarify our responsibility in this area. Within psychology, there is an almost universal consensus that research and statistical skills are needed by our students. I wonder how many would also include some emphasis on computer literacy. I believe that we should make it a priority.

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