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By

Liberal Arts Student
And The
Computer Science
Abstract

Charles Van Loan

COMPUTER SCIENCE AND THE LIBERAL ARTS STUDENT
Major undertaking.

Because the computer-anxious student to take a computer science course is a
computer, even if it appears that their educational and employment prospects, can-

the computer. They cope "by trying to avoid those activities which involve the
computer anxiety" have a feeling of uneasy incongruence in all matters that concern
cause and effect to the much studied phenomena of "math anxiety." In
there is the problem of "computer anxiety," an affection that is similar in both
To do this effectively it is necessary to keep in mind two problems. First,
cartoon. The object of this paper is to suggest how this can be accomplished.

and teach their subject in a way that is in harmony with the arts of liberal edu-
makes more sense in the liberal arts environment for computer scientists to proceed
the practical value of computer science instruction should not be underplayed. To
the computer science as it is by studying literature, music, and physics. Although
the computer science itself is far superior to literature, the subject's interest is not
is to demonstrate that the students' interest equal to that of society.

has discovered interest in the subject as an agent of liberal education. It is
the problem is that the success of computer science as a practical discipline
of the computer is used than than a genuine course in computer science itself. Part of
In particular, the computer appreciation course is more often a course about how
the instruction that these same students receive in the more classical sciences.

Nevertheless, there is room for improvement. The computer science education
constructive can be made to the students' General education.

Societal impact to be "humanistic" by teaching all bases in this way significant
computer appreciation to be "relevant" and a little discussion of the computer's
which involve a little computer usage to be "practical," a little coverage of
colleges now offer "computer appreciation" courses for nontechnical students.

programs. As a result, these less computer-literate students are less successful using the computer.

As we move into the "computer age" there is a new and important question

INTRODUCTION
et notion of scientific literacy.

To answer this question, it is possible to consider that computer literacy can

with computer literacy that were difficult to predict or control.

world in a way quite different from the way they had viewed it before.

better be brought about in the literature. They did not necessarily become

were brought about in the literature. They did not necessarily become

After reading material became available...the most profound changes

er once again the literacy metaphor:

knowledge that can have deep intellectual significance for the individual. Consid-

Interactivity is much more than a determinant aspect of computer usage; it is a state of

However, it is important to stress in the liberal arts setting that computer

Considering the computer,

people who can also express themselves with clarity and precision on issues con-

unhealthily situation, our society is so consumed by technology that

process of computerization becomes largely determined by technological specialists,

Moreover, it is necessary to ask what is "computer literacy," then it must let the

Moreover, it is necessary to ask what is "computer literacy," then it must let the

station will be indispensable in the same way as those who cannot read or write.

and transmitted. Those who fail to understand the computer as a medium for expres-

the and the printing press, is radically changing the way information is accessed.

with "ordinary" literacy because the computer, like the inventions of the

fact, computer literacy is especially important in computer science, and the term "computer literacy" when the sub-

literacy and computer literacy

Scientific question, "what should a scientifically educated student know about computer

bearing these two constructs in mind, let us begin our probe into the

possible.

For liberal arts students should be attainable in a single course if at all.

"computer course" (consensually, the objective of computer science instruction

Liberal arts student usually has a schedule that can accommodate, at most, one

The second problem is a problem of time. Unlike the technical student, the
The importance of scientific literacy from the appreciative point of view is that we are always at the brink of the known; we always feel forward for what we do not know because determination where we know and where we do not know become.

In appreciation of science, perhaps better than any other discipline, science Brown's work, mainly concerned with the appreciation of knowledge, is essential to the scientific method, the scientific world, and the scientific enterprise. If it is based upon the idea that science is a very human enterprise and that there is an equal value in the appreciation of science and technology.

Thus, the practical importance of scientific literacy is that it makes the science of it to be a judge of its use in the hands of others.

Scientific literacy, as the educator Thomas W. S. claims, means more than a knowledge of science. It means a knowledge of how the day-to-day running of our lives, but for a liberally educated person this is increasingly necessary for any literature.

Many authors have written about the value of a general scientific knowledge.
want to have a scholar's skepticism—not paranoia—for computer-obsessed results. The inclusion of (d) is very simple to encourage the stu-
puter output that the average person has, "It must be right, it came out of an
would be disastrous for the student to have the unquestioned reverence for com-
Moreover, with so many extraneous computer applications in liberal arts areas, it

They may want to use computers for, they will not even be able to think of things
they know what is possible, they will not even be able to think of things
"computer" means when applied to machine-based processes. Unless they
and how to tell them apart. They need an understanding of what
of the kinds of things that are easy and the kind that are very diff-
They need to know what is possible. They need some gross understanding

Hosman says, computer literacy of the computer education specialist character-
art student. In particular, (c) suggests that the student have a feel for the
decisions, the last two courses have a peculiar significance for the liberal
computer has to offer. Because the computer is increasingly used in all academic
Endeavors for anyone wishing to become an intelligent consumer of what the
These four "factors" of practical computer literacy may be regarded as a set of

(a) How to assess the legitimacy of a computer-based study.

(b) The approximate level of precision and detail required to write a

reasonable possibility,

(c) Enough computer jargon to make dialogue with a computer specialist a

difference between a computer error and a programmer's error,

unless he or she knows

reality or indirectly. Indeed, an individual is subject to "Technological Reality"—
hood. A student computer applicant to the IBM who uses the computer either for
ble on the road then the driver who is ignorant about the workings beneath the
is less likely to be 

in "black box" fashion. The automatic driver who has some knowledge of cars
includes the practical value of computer literacy is best most valued by an
appreciative voter. The second of these will be discussed later. What counts—
like scientific literacy, computer literacy has both a practical and an

THE PRACTICAL VALUE OF COMPUTER LITERACY

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with considerable computing experience as well. Students will be arriving on campus within several years and will already have a trace of computer anxiety and be arriving on campus within several years. In any case, there is some evidence to believe that in a few years, liberal arts

Shakespeare anticipated this when he said, "O, when men were wild and children educated!" to

It seems that children are overcome with anxiety faster than adults. Perhaps we have a generation of youngsters who are growing up with pocket

An early lesson in the importance of computer technology is that the "intelligence" of a computer is determined, in part, by its software, peripherals, and data bases that come with it. We can see how well prepared our students are by the way that they use computers, with or without instruction.

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The idea behind the Dartmouth system is simple: encourage computer use by making it easy to use, convenient, and productive.

The most significant factors that will influence their later lives, according to research, are educational, economic, and social factors. Among these, educational opportunities are the most important because current president of the college, John Kemeny, the use of the computer among students is important because according to the chief architects of the Dartmouth system, Thomas Kurti and the

Dartmouth College with its 300 computer terminals serving 4000 undergraduates,

APPROACHES AND SHORTCOMINGS

Teaching of this goal.

Our next concern is to ascertain the form of experience that best facilitates the use in the hands of others. Computer so that the individual becomes a good judge of its

A liberal education should include enough experience with the education that is not merely summarized by paraphrasing an earlier quote:

In conclusion, the importance of practical computer literacy to liberal
have a clear understanding about what constitutes computer science.

When the field is narrow, in order to be a little more specific it is necessary to

*by concentrating the student with a representative class of elementary problems
*by thinking that the computer scientist cannot do, and there it should do

If the liberal education value, it must be done the student to engage in the same
from these remarks we conclude that for a computer science course to have

value of scientific literacy discussed earlier.

A more serious complaint against such courses is the lack of frequency:

Arts students who have no knowledge about computer science.

A consequence, "computers and society" courses are less than ideal for those liberal

and worry some knowledge about the science in question to be appreciated fully. As

the problem is that a "science and society" course re-

kind of humanities course, but they are also the most important for the student

about "science and society", courses in general. He argues that they are a good

assessment their value, it is important to begin in mind a remark made by John Kenneth

as far as deal has been written about their content and administration. However, in

one possibility is the "computers and society" course in which the social.

type of instruction is required.

Students, ability to read and write perceptibly about computer literature. Some

person computer literature is that certain jargon, as it should for liberal arts

true, the more exposure to computer equipment does not automatically make a

familiarity with printed material, but reading skills must still be taught. English-

learning how to read. Reading books in a baby's playpen may encourage a useful

attribution of computer literacy. The situation is analogous to the process of

However, we must not confuse the overcoming of computer anxiety with the
To computer literacy is made possible.

Luter Jones and Particular Programming Skill are tools for the common subject whose role is to instruct the student of programming skills. As we shall see, by emphasizing algorithms and algorithmic thinking, rather than the common technique popular in the past, we shall further important because all too frequently it is portrayed as a purely technical subject to the outside world. In the case of computer science, this is partonic, but much research indicates that is most important and logic to give a clearer view of a problem is important to distinguish between trying to settle an in-house argument that it is important to distinguish to the differentities involved.

A simple description, while I'm sympathetic to the differentities involved, I agree, "What we do is too complicated and too diverse to adapt one line characterizations of their specialties such as the one offered above.

Specialists in any field, computer science included, are often expected of computer scientists in search of what makes an algorithm easy to understand. It is not unusual to read an article I once read by a computer scientist who studied in both cases errors made during an algorithm, execution can be fatal. Of course, algorithms each of which is designed to produce a specific result, "A particular behavior..."

I know a book about a computer science may be thought of as a collection of data, in fact, the word "algorithm" comes from the word, "algorithm." In fact, the word "algorithm" derives from the verb "algorithm" to produce a quotient and remainder from the given data. We are all familiar with the algorithm for the long division of since these steps:

1. Write the quotient and remainder, and continue to produce
2. 回 Write the quotient and remainder, and continue to produce
3. 回 Write the quotient and remainder, and continue to produce

An algorithm is an essentially definitive sequence of rules, telling how to produce education. It is provides to be useful to characterize it as the study of algorithms, however, to highlight the role that the subject can play in liberal science.

There are numerous ways to describe the multi-faced field of computer science.
In this question and to acquaint the student with the various types of thinking that are at the heart of liberal education, it is suggested that the student be exposed to the notion of "human products as unique". When human products display the intellectual aspects of learning, intellect, and creativity, and are accepted in applications involving art and design, the excitement of the expressive and computer-generated the creative process can be accepted. For example, with computer graphics the creative process can be accepted to a greater extent.

The excitement of computer-generated human interest in non-artistic concepts.

In science, the study of computer power in science is inseparable from a study of our own human reasoning. Rather than the suppositions of a "number cruncher" that are the bases of our knowledge, the computer is a "clever" and "sensitive" and "artless" and "adroit" tool. It is this role of the computer as a "clever" and "sensitive" and "adroit" tool that expresses a theory in the form of a computer program the weakness and strengths of the theory. When a student in science this phenomenon has had a well-known effect. When a scientist is asked a question, he or she is asked a question. When we convey to the student we are unusually required to be patient, the boundaries of our knowledge are brought into sharp focus. This is because the science of science can also be asked about the computer--it provides a setting where interesting difficulties associated with the problem at hand, what Brown calls, says the problem-solving process is likely to reveal inconsistencies in our thinking and intellectual excitement because the act of making implicit thoughts explicit during successful computer programs. However, even when this occurs it is a valuable computer literacy. Therefore, thinking does not always culminate in a completely new and major way that man has to express what he knows.

Liberal education because computer programs are a new way that man has to express what he knows.
computer programming is a primary way of gaining first-hand knowledge about the
knowledge is the ultimate basis of intellectual life, "If, in computer science,
As the philosopher Alphonse North Whitman said, "First hand
poets without aid, can be criticized for being a vacuous course about science
Indeed, a "CS for Poets" without computer programming, "like a "chain for
as the necessities of life,, the program.

However, one of the best ways to accomplish this is to compel the student to do
the student overcome this or her prejudices and biases" against the computer.
Similarly, the aim of "CS for Poets" is not to produce programmers but to help

...accident. 20

appreciation, for example, the aim is not to produce musicians but
an appreciation course rather than a course for potential specialists, in music
attitudes of this sort, it is important that "CS for Poets" project the image of
attitudes. In order to attract students with
portray, as just two paths and allow to consider in depth, (I can't think
To many noncomputerly inclined students, arithmetic thinking, however in
natural course offerings, and computer courses;
- depend upon local factors such as student background, faculty competence, etc.
- not be possible to go into great detail because many final syllabus decisions
of a single introductory course which I will summarize "CS for Poets." I will
dent has time for at most one computer course I will describe the structure of
this much be accomplished. Recognizing the assumption that the "purest" arts are
real education, I now feel obliged to give some concrete suggestions as to how
Having argued that computer science can contribute to the student's life-

THE FORM AND CONTENT OF "CS FOR POETS"

- formulations that they provide.

and yet, even arithmetic thinking are each to be valued for the complementarity
Literary thinking, reflective thinking, artistic thinking, scientific thinking,
that can be applied to answer it. If we accept this, then appreciations of
2. Scientific Computation

Transmission, and checked for errors?

What is information? How is it stored, retrieved, manipulated, etc.?

2. Information Processing

useful to identify your units of instruction:

For purposes of organizing the application portion of the course for teachers, it is

essential and worthwhile the underlying theoretical concepts.

enables, but only in a supporting way. As in a mathematics course, examples serve

asserts computer applications does have an important role to play in the

works underlining many superficially diverse examples. Of course, the discussion

merely because a solid understanding of a few basic algorithms goes a long way

each imparts a utility to the discussion of applications and saves valuable class

are more important to stress the algorithms which underlie X, X', and Z. This ap-

lies a sequence of computational reports on how computers are used in X, X', and Z,

example, it is necessary to emphasize basic algorithmic concepts. Rather than

ones. In order to prevent this aspect of the course from becoming a protracted

important to bear in mind that computer science is not a union of applied-

impart of thinking, one vehicle for doing this is to discuss applications although it

in some form of activity to reveal further the nature and consequences of algorithm-

is therefore necessary to fill out the nonprogramming portion of the course

as I have argued, computer literacy involves more than technical expertise.

"CS for Poets" must not be a course solely devoted to computer programming.

Introductory programming course with heavy weight on computer science and

ide and liking for computer science have their modicum of experience to take

pers. On the other hand, students who discover that they actually have an apt-

are the teaching of applicable programming skills is not one of the aims of "CS for

read with success, regardless of the language chosen it is imperative to remember

"Other Programming Languages such as FORTRAN and BASIC can also be

in essence of algorithmic thinking is conveyed, but low enough so as not to

experience has been to peg the level of programming high enough so that

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such as the model of computation proposed by Alan Turing in 1936. As

the model of computation proposed by Alan Turing in 1936, 26

was only with the advent of sophisticated computing equipment that the

workhorse of modern computing. This would seem utterly, it we accept the prevailing

view that the subject "really" began in 1946 with the invention of ENIAC, the

machine which would seem utterly, if we accept the prevailing

theoretical perspectives? This would seem utterly, it we accept the prevailing

reaching political and social impact, but the history long enough to accord

Computer science, surely, is a far better known metaphor. That "the best of all methods for presenting every subject bearing

Another, where, the first president of Cornell University, remarked in his

THE IMPORTANCE OF THE HISTORY OF COMPUTATION

come his or her computer anxiety.

of computer science at the beginning of "CS for Poets" pay the dividends in terms

of computer science. My experience has been that several lectures on the historical aspects

enable the discussion since it is underplayed by most authors--the history of

There is one topic that I would like to spend consider-

phasess on scientific topics.

For Poets, may be found in R.W. Humming's proposal for a computer application

course. 26 Although this proposal is somewhat dated, it is very good for its era

important areas within the subject. Further topics consistent with the aim of "CS

languages, complexity theory, numerical analysis, information retrieval, and other

course with a rough idea about what computer scientists do who study processes and

edge of the concepts involved. It is also important that the student have the

must be assured to insure that the student emerges with a "first hand" kno-

test what philosophical questions an adequate comprehension of problems and programs

� Begin, the emphasis is on algorithmic thinking and the development of the

Engage Processing?

What are the computational problems associated with pattern recognition, game playing, and natural lan-

4. The display of Intelligence

process and can it be accepted by the computer?

How can audio and visual data be manipulated? What is the creative

3. Artificial Computation
enough to be placed in their proper perspective.

Despite a history of such exaggerations, the will predictions about computer interact-
ence and computer power made by over-enthusiastic computer specialists would
sum total form addiction of partisans.

sequences... When a man reasons, he does nothing else but conceive a
has nothing at all to do. For reason is nothing but according the con-
where these no place for reason, and where place for addiction and subtraction, there
what manner so ever there is a place for addiction and subtraction, there
struck to perform some of the most difficult operations of mind...In

presses and iron have been invented with the function of brain, and in-

ought only and two other-digit numbers, Hobbes claims that
obes more and more with the power of the processor which was built in 1665. Although this devo-
obes wrote about the processor which was built in 1665. Although this devo-
were and extraduration. This is dangerous because men has always had an intreret
unless devoes these theses. Ignoring this tradition makes us more susceptible to
not we consider the long history of ideas about computation and not just the com-

These examples suggest that computer science has a rich cultural tradition

impose.

But the suspicion of those who maintain that the computer can be used for the same
a social and philosophical problems in the "calculus of reason" poses up a right-
ones, like we use, in understand the problem's proposal to compute the solutions
forms, like wers, in understand more than the bine and statelyede in their computer-
meres resort to using more than the bine and statelyede in their computer-
ay consideration Prato's argument that the good of geometry is understood when Go-

other episode in the history that have computerory revelation. For example, in the
Advocates of computer science as a "new" discipline tend to overlook the

As a

years for him to abstract the notion of an algorithm from counting specia-
11 instances of a General object called "pandent," so has it also thousands
of thousands of years for men to recognize that Mercury, Venus, and Earth are
need algebraic problems in arithmetic form over 3500 years ago. Just as it

structure's results. For example, the Babylonians expressed the solutions to computer-

out the "practice" computer science without the puncher of the IBM 700 and

reactor of atom at the beginning of the reoscope and Koper's laws so

Howe, I think it is important not to regard computer science as a post

world War II development. In fact, I would argue that just as the ancients could
time to reveal "modern education is currently in a transitional phase when the subject is practiced as a
and arithmetic. The appreciation of computer science by those concerned with it
recently suggested by three of the seven articles in Telecommunications, the student and the non-specialist the subject as an "unpopular" discipline.
On the contrary, the notion of computer science as a consequence of World War II
an assembly language and a machine language.

The history of computation has also been a deep pedagogical value as it enables

those work is of paramount importance to computer science, expressed this very

tell when he said that

Although the cultivation of mathematical or deductive faculty is a
part of intellectual discipline, so truly is it only a part. The proper
judgment which would either banish or make supreme any one department of
knowledge or faculty of mind, betrays not only error of judgement, but
a defect of that intellectual modesty which is inseparable from a pure
devotion to truth.

ill too often we are seduced by the computer into believing that the only "valid"
knowledge is that which can be expressed in algorithmic form. It is this tendency
to imitate the computer's preference for machine readable data that alarms some
of those who contemplate the computer revolution. 35, 36 But it is not enough to
be alarmed; we must act. I hope I have shown that a good course of action in
higher education involves teaching liberal arts students about computer science.

I would like to thank the "CS for Poets" classes and my colleagues in the
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paper possible.
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