A community of individuals—Cooperation and individualization in computer science education

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ABSTRACT

A model of education based on cooperation among responsible individuals is presented. Earlier models are discussed which involve traditional competitive-based courses as well as the more recent individualized mode. The latter has been used by the author for several years, utilizing both a Personalized System of Instruction (PSI) and Computer-Based Education (CBE). Now, however, cooperation has been introduced as an explicit and integral part of education. This was done in the belief that most serious problems of our day are amenable to a cooperative problem-solving process. The techniques utilized in an introductory computer science course include: study partners for PSI units, computerized personal data base design by a small group, mutual design and use of interactive programs, use of cooperative exercises (computer and otherwise) and parties. The future of these efforts remains unknown, but there is a strong belief that cooperation is a preferable model to competition in the world to come.

INTRODUCTION

In this paper, the concepts of community and the individual are compared and contrasted. The realization of these concepts has been implemented in the classroom by maintaining a delicate balance between cooperative efforts and individualized instruction. Preserving this balance is advocated as a preferable alternative to either the traditional lecture mode or, more recently, the primarily individualized mode of instruction. Considerable experience has been gained with the individualized mode, utilizing both Personalized Systems of Instruction (PSI) and Computer-Based Education (CBE) over a period of several years. The explicit introduction of cooperation into the computer science classroom is of more recent vintage. It comes in response to a belief that cooperative efforts are most likely to solve the difficult problems of today, and to fears of interpersonal isolation which may result from exclusive or primary reliance on individualization.

DEFINITIONS

Community— a social group or class having common interests
Common— belonging equally to two or more; shared by all alike; joint
Cooperate— work together toward a common end or purpose
Cooperation— an association of persons for mutual benefit
Individual— of or relating to a single human being; by or for one person
Individualize— to modify or suit a particular entity

WHY IS A COMMUNITY OF INDIVIDUALS DESIRABLE?

Whenever I meet a class for the first time, one of the first questions I ask them is: “Why?” “Why are you in this course?” “Why are computers becoming such an integral part of our lives?” “Why is understanding their uses and potential so important?” To me, asking “Why” is an essential first step in looking at a new idea. No particular solution is guaranteed to result. Rather, many times, an increased awe and reverence for the phenomenon results. Nevertheless, when the phrase “community of individuals” first began to have some significance for me as an instructor, I needed to ask, and perhaps answer, the “Why” question.

I believe that a community of individuals, working together in cooperation toward mutual goals represents the most hopeful and realistic structure whereby the majority of the important problems confronting us today can be solved. The difficulties and enigmas which surround us today are legion and increasingly severe. For cogent and striking presentations of the present and possible futures, recent issues in The Portable Stanford Series are outstanding. Of particular import is Harman’s An Incomplete Guide to the Future. Wars, unemployment, famine, inflation, civil rights, crime, welfare, corruption—the list appears endless.

From the collection of the Computer History Museum (www.computerhistory.org)
Few of these, if any, are solvable by one person. What are the alternatives: to continue to accept such problems as "natural" or treat them as "inconveniences"? I, at least am not willing so to do. Rather, it is my firm belief that a dedicated community of strong individuals offers a viable and desirable alternative.

ALTERNATIVE MODELS IN EDUCATION

The belief in a dedicated community of strong individuals is manifested within the framework of introductory computer science sources at Indiana University-Purdue University at Fort Wayne. I strongly believe in the impact that models have on our later lives. Hence, I try to include in classroom situations those values which have positive significance for me, i.e., community of and cooperation among mature persons. It is this model I wish students to consider seriously now and in later life.

Students will definitely have other models from which to choose. One of the most common and powerful ones is based on competition, and is usually found in a traditional lecture-oriented course. In earlier papers, my thoughts were shared about where and when competition may be appropriate, e.g., sports, and where it is not appropriate, e.g., education. In a recent address, Howard Casmey, Minnesota commissioner of education, noted that education today is "predicated on failure." However, a grade of A or B in a course must indicate that a student has demonstrated mastery of the subject. It must not indicate that she/he is in the top 10 percent who demonstrate mastery in a predefined, usually short, time frame, e.g., an hour exam, a two hour final, a one semester course, or a four year degree, etc.

So we are led naturally to another, and rapidly growing, model in education: that of individualization. To again quote Casmey,

"To me 'individualized instruction' connotes 'mastery learning.' It's neither a concept nor a process in and of itself, but rather a concept that requires a process. It is the great humanizing factor in education, because failure is no longer possible. All students now succeed; some at a faster or slower rate than others, but all learn and all succeed."

"If one of our children has more difficulty in learning to tie his shoe, and does not accomplish this task until he is six years old, we do not label the child as a failure. We know that, barring any specific physical problems, he will be able to accomplish this task as his manipulative skills develop."

"This is what the educational process should be and we've known this for 50 years."

Casmey goes on to espouse the use of computer-based education. Personalized systems of instruction are also vitally concerned with individualized instruction. This model is leading to persons increasingly able to become adults, i.e., persons who assume responsibility for their own actions. It is a model I view with great respect and admiration. I have used it for the last four years in several courses. It continues as a vital and integral part today. However, and here I quote the frustrated and honestly concerned housewife who, when asked about her homework, replied, "It's good, but it's just not enough!" As I recall the story, she also went on to say she needed someone to share in those responsibilities.

My feelings about individualized instruction are similar: it's good; I like it; I encourage my students to use it; but it is simply not enough! The process does promote a more adult, independent attitude. Students do gain an acceptable and accurate self-image: "I can learn this subject pretty much on my own." To many people, young and old alike, this is a dramatic change from "I'm dumb. I never could do math (or English or physics, etc.)." In fact, it was the latter type statement that first prompted me to consider seriously a major shift in my courses from lecture to individualized.

However, it has been several years since that time, and I've come to realize that strong individuals, by themselves, do not constitute a complete picture. You and I really do live in a community, several of them in fact. I do not wish to live a life apart from others. I wish to participate, as a strong person, in mutual efforts with the other strong people to solve significant problems and to share with them at increasingly open and intense levels. The latter quality is not a "teachable" one in my opinion, but rather flows naturally from significant mutual content-based concerns. Therefore, it is this model of a dedicated community of responsible individuals that I value highly, and consequently emphasize in many of my courses.

COOPERATIVE COURSE EFFORTS

The course in which major efforts have been expended to incorporate cooperation is CS 220, Introduction to Algorithmic Processes. Section enrollment is usually between 20 and 25, and consists primarily of science majors ranging in age from 18 to 30. It represents the first direct exposure to computers for all but those with some experience in high school. A course which several take after CS 220 is CS 461, Algorithmic Languages, which relies extensively on individualized instruction.

The primary cooperative efforts in CS 220 include the following: study partners for PSI units, data base design by small groups, mutual design and use of interactive programs, use of cooperative exercises, and parties.

Study partners for PSI units

As is well known, a personalized system of instruction, also known as the Keller plan, has become one of the most noteworthy and exciting instructional methods in recent years. Earlier referenced papers of mine discuss it at some length, as well as in References 15 and 16. It is appearing in
more and more university settings, both as documented from within and without. From within, the Center for Personalized Instruction at Georgetown University holds annual conferences. They also publish a newsletter and a journal. All these publications relate the increased use and very positive results in final exam scores, retention, transfer, attitudes, facilitation, and self-image. From without, recent issues of Change magazine contain several articles on PSI as one of the most promising innovative educational concepts.

An integral part of PSI is breaking material down into digestable pieces or units. For CS 220, there are 15 such units (two of them review ones), plus a final. Within the normal PSI framework, each student works through the objectives, suggested procedure, and unit test by herself/himself. Within the cooperative PSI framework, each student is assigned a partner on the first day of the course. The partner is usually of the opposite sex, roughly the same year in school, but not necessarily in a related discipline. During the next couple of class days, the partners introduce each other to the class informally.

The PSI partners are encouraged to work together on the objectives and suggested procedure of each unit. The evaluation of course, is administered separately. Since most of the units involve designing and implementing computer programs, a variant of "egoless" programming is suggested.

The partnership is particularly beneficial in the first several weeks. The intricacies of working with strange machines and procedures are not as intimidating to two people as to one. Therefore, when the units become more concerned with concepts instead of interactive terminals, batch jobs, remote job entry, keypunches, etc., partnerships may deepen, dissolve, or reform. By this time, the partners are often working at different rates. So, they may feel free to work with others, or in some cases, by themselves. In any case, all the students now have first-hand experience in cooperating with another for a common goal.

As those familiar with PSI know, the peer tutors or proctors perform many of the roles just mentioned. The three peer tutors for CS 220 are excellent, in my opinion. The students view them as "willing-to-help" experts, and have no hesitation about asking them questions. However, the tutor is not a true partner—she/he has been through the course earlier, whereas the student is still working on it. Hence, I believe both the tutor and partner have valuable roles to play in the learning process.

Automated personal data base design by small groups

After nearly one-half of the semester has passed, most students have a working knowledge of the primary programming concepts. It then becomes feasible to introduce them to a design project. Since such projects outside the academic world are usually cooperative in nature, this is a good opportunity for small groups of three to four to work together. I wanted the design to be for a realistic area and one of some importance. Automated (computerized) personal data banks immediately come to mind. A group in the College of Education at the University of Illinois under the direction of Bruce Hicks has also investigated such issues. In CS 220, however, the students are not only users of such data banks, they will also be designers thereof.

The sample list of such data banks included in the appendix is almost solely student-generated. Here is an application in which interest is quite high. Outside speakers come in to discuss the issues of privacy and society's need for organization. Students have the necessary skills to build such a data base. The task lends itself readily to sharing ideas and feelings, especially about one's right to privacy. The complete assignment is given in the appendix.

Mutual design and use of interactive programs

After some introductory simple programs which all students are to complete, students are given a choice. They may either work on problems assigned in the unit, or they may choose one of their own, so long as it is of comparable complexity. Several people have opted for the latter. Here they can use the computer directly for a problem in their discipline, or they can design and implement a game, simulation, drill and practice, etc.

In any case, whether the students work on a preassigned problem or one of their own, they are encouraged to seek out an "intelligent but naive" classmate to be a typical user. This user, who is often their partner, takes the program. She/he writes comments relating to directions, accuracy, style, etc., and then signs and dates the listing. She/he is not expected to examine the coding itself. If necessary, the author then modifies the program before turning it and the signed listing in as part of the unit test.

Students realize this as a cooperative venture—one day they may be the designer/coder, the next they may be the "naive" user. They expend considerable effort making certain their program executes properly and is designed for human use. Not entirely by accident, they are learning the components of good computer-based education lessons, both as a designer and a user.

Use of cooperative exercises, computer and otherwise

Until relatively recently, this topic virtually did not exist. However, there appears to be an increasing awareness that a model of cooperation is at least as important for education as that of competition. Star Trek, Moonwar, Battle-ship, etc., all have a certain fascination, but how about cooperative games also? In a recent issue of Computers and Society, Bruce Hicks discussed several such games. "SOS" is available on PLATO and "Lost and Forgotten Island" is available in Basic. In these games, cooperation is espoused for the mutual benefit of all players. After playing these, students (and instructors) now have some models for community-building lessons. There have also been several
programs in issues of Creative Computing (a great magazine!) which promote cooperation rather than shooting down Klingons.3

I do not restrict cooperation to be viable only when interacting with the computer. This is, however, an increasingly important type of CBE lesson, in my opinion. Students also share together in discussion about films. Controversial ones such as The Right of Privacy or A Matter of Survival (both available from Indiana University) prompt conversation in which significant and honest feelings are exchanged. People learn to relate to others who may have strong, but different, thoughts. Many of the exercises in Values Clarification by Simon, Howe, and Kirschenbaum are also useful in this domain.22

Recently, Judy Edwards, new president of the Association for Educational Data Systems (AEDS) brought to my attention the BLUE/GREEN classroom simulation dealing with cooperation within a company framework. This type of activity is growing in popularity as witnessed by the recent formation of the New Games Foundation. Quoting from the director, Pat Farrington, we have:

"If people center on the joy of playing, cooperating and trusting rather than striving to win, they become part of the process—not spectators. . . . We try to create individual responsibility—helping people create their own games. . . . We’re into cooperating rather than competing."

It would appear that more and more people are realizing that cooperation is an increasingly vital element in our lives. That is why I am concerned that students have first-hand experience with this model.

Parties

One of the essential ingredients of community is knowing one another. Parties provide an excellent first step for learning one another on an informal and non-threatening basis. And, because they are so much fun, we try to have several!

The "content excuse" for most parties is the celebration of a student’s birthday. Donuts and cider usually provide a common basis for sharing physical sustenance while the class continues. Frequently the student may indicate their special plans for the day.

The date of birth is ascertained from the first program taken by the students. An interview program Query, written in Basic, asks them for their favorite food, and tries to identify them by their preference in later interviews. It then asks them for their birthday, and goes on to ask if they have any questions. The latter feature is used as a note/comment/question file throughout the course. The student has the option of refusing to answer any question, e.g., for privacy reasons. She/he also has the option of terminating the interview and thus having no record kept.

These informal in-class celebrations allow us to learn a little more about a person than simply what courses they are taking. They are also supplemented by a get-together every semester, often at the instructor’s home. Each person brings their appetizer speciality, and the evening is spent with good food and informal conversation. The latter often arises from a game that each person brings, as well as programs and games available over the interactive terminal I bring to the party. Again, people put out individual efforts to build for common goals and mutual benefit. Cooperation is not an impossible model. It is, I believe, a most possible, desirable, and necessary one for any world in which human beings form a part.

SUMMARY AND FUTURE

In summary, I have tried to indicate why I believe cooperation to be a valuable and integral part of education. It is compared to a traditional mode, usually based on competition, and then to the more recent mode of individualized instruction. The latter has often been implemented, in my courses and others, within a PSI environment and frequently involves computer-based education. These individualized techniques have done much to eliminate the idea that only 10 percent of students are able to master the material presented. However, most serious problems in the world are solved by a community of responsible people. For just one example, Howard Casmey, in the address referred to earlier, dwells at length on the necessity of partnership (cooperation) between companies and education for gaining widespread acceptance of quality CBE.

It is in this belief that cooperation is introduced explicitly in my introductory computer science courses. The primary cooperative efforts are:

1. study partners of PSI units,
2. design of a computerized personal data base by a small group,
3. mutual design and use of interactive programs,
4. use of cooperative exercises, computers and otherwise, and
5. parties.

I am under no illusion that these are the only or best ways to introduce cooperation explicitly. Other techniques with which I am familiar include: computer clubs for hobbyists and micro-computer users, computer uses for elders (another project of Hicks),4 designing programs for the school itself or local community, and, of course, the very widespread efforts in primary and secondary education. Learning exchanges, open classrooms, individually-guided education (IGE) programs, etc., are all oriented toward subject mastery. They also usually occur in a self-paced environment and often involve interpersonal exchanges.5 I personally would be very grateful if the reader would share additional references for cooperative efforts, games, programs, etc.
What of the future? Only the future itself knows. But I would hope that my understanding of people and the learning process would grow and mature. It may well be that cooperative efforts are "not all they're cracked up to be." The values of one's own self and of one's God are probably pre-eminent. Yet at the same time, we live, love, work, and learn in a community of others. I am grateful for that opportunity, enjoy helping others, and enjoy being helped by a community of caring and responsible individuals.

REFERENCES

3. Ahl, David (editor), Creative Computing, Morristown, New Jersey.
11. Sherman, J. Gilmour (Editor-in-Chief), Journal of Personalized Instruction, Center for Personalized Instruction, Georgetown University, Washington, D.C.
19. PSI Newsletter, Center for Personalized Instruction, Georgetown University, Washington, D.C.

APPENDIX—DATA BASE DESIGN FOR PERSONAL INFORMATION

<table>
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<tr>
<th>Group Project CS 220 Ken Modesitt</th>
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<td>I know everybody's income and what everybody earns; and I carefully compare it with the income-tax returns;</td>
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<td>To everybody's prejudice I know a thing or two; I can tell a woman's age in half a minute—and I do!</td>
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<tr>
<td>Yet everybody says I am a disagreeable man! And I can't think why!</td>
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—KING GAMA IN GILBERT AND SULLIVAN'S PRINCESS IDA

There is today a vast array of data about you and me stored in computerized data bases. The following list, although very incomplete, contains types of organizations and institutions which can input and access data about you from thousands of computers throughout the nation.

Federal Government
- Census Bureau
- FBI
- IRS
- Selective Service
- Armed Forces
- Social Security Administration
- State Department (Passports)

State Government
- Police
- Department of Motor Vehicles
- Department of Revenue

County Government
- Tax Assessor
- Board of Elections

City Government
- Banks and Savings and Loans
- Educational Insurance
- Utilities
- Employer
- Credit Cards
- Professional Organizations

Special Interest Groups
- Alumni
- NRA
- John Birch Society
- Book Clubs
The potential good from wise and careful use of such automated personal data systems is considerable. And so is the potential harm! I am particularly concerned about the latter. Incidents, some humorous and some serious, abound which relate to computerized personal information systems. Can you think of several?

In response to a growing concern about the role of the individual in such computerized systems, the United States Department of Health, Education, and Welfare published a special report. "Records, Computers, and the Rights of Citizens" (1973) is on reserve in the library. The report recommended the enactment of a Federal "Code of Fair Information Practice." The Code rests on five basic principles that would be given legal effect as "safeguard requirements" for automated personal data systems. The following is taken verbatim from the report (pp. 40-41).

"Here then is the nub of the matter. Personal privacy, as it relates to personal-data record keeping must be understood in terms of a concept of mutuality. Accordingly, we offer the following formulation:

An individual's personal privacy is directly affected by the kind of disclosure and use made of identifiable information about him in a record. A record containing information about an individual in identifiable form must, therefore, be governed by procedures that afford the individual a right to participate in deciding what the content of the record will be, and what disclosure and use will be made of the identifiable information in it. Any recording, disclosure, and use of identifiable personal information not governed by such procedures must be prescribed as an unfair information practice unless such recording, disclosure or use is specifically authorized by law.

This formulation does not provide the basis for determining a priori which data should or may be recorded and used, or why, and when. It does, however, provide a basis for establishing procedures that assure the individual a right to participate in a meaningful way in decisions about what goes into records about him and how that information shall be used.

Safeguards for personal privacy based on our concept of mutuality in record-keeping would require adherence by record-keeping organizations to certain fundamental principles of fair information practice.

There must be no personal-data record-keeping systems whose very existence is secret.

There must be a way for an individual to find out what information about him is in a record and how it is used.

There must be a way for an individual to prevent information about him obtained for one purpose from being used or made available for other purposes without his consent.

There must be a way for an individual to correct or amend a record of identifiable information about him.

Any organization creating, maintaining, using, or disseminating records of identifiable personal data must assure the reliability of the data for their intended use and must take reasonable precautions to prevent misuse of the data."

Your cooperative group assignment is to design an automated personal data system for a content area of your choice. Feel free to use those listed earlier. Your design should include the principles just articulated and any others you would like.

What features would you want in such a system were you a user and/or entry thereof?

Would you want to see your record?

What information can others input about you?

Can you challenge and change your record? How?

Who has looked at your record? When?

Who can erase information?

Can you prevent someone from looking?

How do you know incorrect or outdated information was really erased (corrected)?

Is the information used only for that purpose for which it was collected?

How would you find out if a record of you is being kept?

Are there levels of information access?

Can you inspect the records of your mate, friend, children, employer, etc.?"
Is certain information purged automatically after a certain period of time?

The above questions represent only a very few which could be asked. You will undoubtedly uncover others as your project unfolds. You might ask others what questions they have.

The project is a design one only; it does not involve coding (unless you wish to). However, the design should proceed in a top-down manner, expanding various steps where necessary. The final written result of your effort should be a set of structured programs given in increasing detail. The most detailed one should be one able to be coded directly into some programming language.

A typed copy of your design will be presented to class during the last two weeks of class. (I will supply the mimeograph service if you give me the typed copy two days before handing it out.) In addition, your presentation for that day of class may take any form you wish, as long as each group member has a role. Your group might role-play a “typical day in the life of a computerized dating service,” for example. Or someone might indicate how a user might try to use/access your system, honestly or otherwise. Perhaps you could incorporate members of the class in your presentation. In any case, you are to hand in two questions (and their answers) which could be answered only by a person attending your presentation. Some of these will appear on the final exam.

Good luck and hope you enjoy this “realistic” assignment involving the world and computers and other people!

Ken

P.S.—Another excellent reference is Privacy Journal. I have several copies in my office.