AN EXPERIENCE COMPONENT FOR

UNDERGRADUATE COMPUTER SCIENCE EDUCATION

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INTRODUCTION

There has been much discussion during the past few years concerning the responsiveness of computer science education to the needs of industry (1,2,3,4, 5,6). One of the suggestions that frequently comes from these discussions is that computer science programs provide students with more "real world" project-oriented experiences during their academic careers. This need was carefully considered in 1974 when a computer science program was established at Hope College. The approach taken was to carefully define an experience component which is a required part of every computer science major's program. This paper describes this experience component and reports the results of its first two years of operation.

OBJECTIVES

The objectives of the Hope College experience component are:

1. To provide the student with experience appropriate to the student's career goals.
2. To reinforce concepts and techniques learned in the classroom.
3. To motivate the study of additional topics in computer science.
4. To give the student flexibility in the design of an academic program.

The latter objective is particularly important since Hope College is a small liberal arts college with limited resources for computer science education. Each computer science major has the opportunity to design an experience component that is responsive to the student's needs and offers learning opportunities beyond those found in the curriculum.

The experience component has four phases: computer operations, consulting, internship, and independent study/ research. The first two are informal in that no academic credit is awarded for their completion. They are, nevertheless, an implicit requirement for each computer science major. The latter two phases do carry academic credit and represent a required part of each major's academic program. These four phases are described below.

COMPUTER OPERATIONS

The first encounter a student has with the experience component is working as a computer operator in the Hope College Computer Center. Most students begin working as operators in their sophomore year and continue as long as their interest and other activities permit. The selection of student operators is made by the computer center staff from among students who submit applications for the positions. Approximately 15-20 students work as operators each year. This gives all majors an opportunity to participate since there are about 10 sophomore majors each year.

After being selected to be an operator, a student completes a training program conducted by the computer center staff. This training program is designed to introduce students to the hardware and the operating procedures of the center. Next the student serves as an apprentice to some more experienced students. Finally, after the apprenticeship is completed, the student begins work as a computer operator. Most of the student operators work during the evening shift when the Hope College computer system is devoted primarily to running student jobs. The students work in teams of two and they have complete responsibility for the operations of the system. The more experienced operators are often given opportunities to assist in prime time operations.

As a result of this operations experience, the computer science major learns a great deal about the hardware and software of the system. In addition, the student becomes familiar with the staff and internal procedures of the computer center.

CONSULTING

A computer science major of junior standing has enough course work and oper-

ations experience to begin the consulting phase of the experience component. This phase gives the student exposure to a variety of computer applications and provides some welcome spending money. The consulting is done with one of three different groups: Hope College students, Hope College faculty and staff, and off-campus computer users.

Upperclass student consultants are present in the computer users' room of the college computer center every afternoon and evening to assist other students in the use of terminals and keypunches and to guide them in the debugging of programs. This experience gives the consultant insight into the programming process and practice in communicating with uninitiated users. The computer center pays the student consultants for providing this service.

Throughout the year many members of the college staff request assistance from students in system design and programming. All upperclass computer science majors have at least one such project on which they are working at any given time. The projects range from maintaining departmental software to designing and implementing a system for computerized football scouting reports.

In recent years there has been an increase in requests for student assistance from computer users outside the college community. These requests are usually for specific projects by users of the Hope College computer system, but there have been other opportunities for part-time employment in operations and programming.

Although Hope College is not large (enrollment about 2100) and it is not located in a large metropolitan area (Holland, Michigan, population 28,000), there are enough opportunities for student consulting to allow each computer science major to consult as much as time and schedule permit and to find work which is directly applicable to that student's interests.

INTERNSHIP

The internship in computer science is a three semester-hour course which each Hope College computer science major is required to complete during the senior year. The objectives of this internship, beyond those listed for the entire experience component, are:

1. To provide the student an opportunity to experience the importance and relevance of ideas learned in course work.
2. To broaden the experience of the student by exposure to new computer systems and applications.
3. To enable the cooperating organization to receive the benefits of the special talents and background of the student.
4. To improve the Hope College computer science program by allowing the cooperating organization to examine the department's product and give input to the department's program.
5. To increase interaction between Hope College and the cooperating organization in the field of computer science.

Once an organization agrees to host an intern, the Director of Internships, who is a Hope College faculty member, determines by discussion with the organization's personnel the projects that are available. The director then arranges for each student intern to interview one or more organizations to identify a suitable project.

After the project is determined, an employee of the cooperating organization is appointed the mentor of the internship and given direct responsibility for supervising the intern's work. The mentor, the faculty director, and the student intern then draw up a contract which specifies the tasks the student is to complete to receive credit for the internship. As a general guideline, it is recommended that the student devote a minimum of ten hours per week to the project. The exact amount of time as well as a work schedule are usually included in the contract.

The student intern meets each week during the semester with the director to report on progress made and problems encountered. The mentor is included in two of these weekly meetings, about one-third and two-thirds of the way through the semester. In addition, a luncheon meeting is scheduled in the middle of the semester and is attended by all interns and mentors. At this meeting each intern introduces his or her mentor to the group and describes the internship project.

Evaluation of the intern's work is done jointly by the director and the mentor. Criteria for evaluation are found in the contract. The mentor prepares a written evaluation which is discussed at a meeting of the mentor, director, and intern, and then placed in the student's permanent departmental file. The final grade for the course is assigned by the director.

In addition to fulfilling the stated objectives, the internship has had the added benefit of preparing the student for a computer science career in at least three ways. First, it gives the student confidence in his or her ability to work effectively in a production environment. This confidence is often reflected by the student in job interviews. Second, the letters of recommendation which the mentor can write and contacts which the mentor has in the business community greatly assist the student's job search. At least one student each year has been offered a job by her or his interning organization. Third, in many cases the student gains experience with hardware

and/or software which is not available at the college but which increases the student's marketability.

Again, the fact that Hope College is located in a small community has caused no difficulty in locating organizations willing to work with interns. In the first two years of the program, nine different organizations have volunteered to host interns. The projects have involved documentation and maintenance of existing systems, participation in the design and implementation of new systems, and design and maintenance of hardware and software components.

INDEPENDENT STUDY/RESEARCH

The final phase of the experience component is the independent study/research course required of all senior computer science majors. This course is taken during the semester the student is not doing an internship. It is suggested that students planning to go to graduate school take independent study/research in the first semester so the results of their project can be a part of their graduate school application packet. For the same reason, students planning to seek employment after graduation are encouraged to do the internship in the first semester of their senior year.

The student initiates the independent study/research project by asking a member of the computer science faculty to supervise his or her project. The student is to choose the topic and define the project with guidance from the faculty supervisor. The project may be selected to fill a gap in the student's training or to allow the student to follow up on some interests which originated from earlier work. Common areas for projects have been systems programming, artificial intelligence, and information systems.

Each week during the semester, all students and supervisors participating in independent study/research projects meet for a common seminar. At this seminar each student regularly presents progress and problems for discussion. Each project culminates in a written work in some appropriate form. In some cases, this is not a paper, but a suitably documented system of programs. The student is also required to make an oral presentation of the results to the local student ACM chapter.

CONCLUSION

The experience component has been in full operation at Hope College for the past two years. The results have been encouraging because the students have been enthusiastic about all phases and recent graduates report that the experiences have been very beneficial both on the job and in graduate school. Potential employers of graduates have also expressed satisfaction with the program. Such a program places an additional burden on the faculty because of the number of individual projects, but the effort seems well worth it when measured against the benefits to the student.

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