6APT: TEACHING GENDER EQUITY WITH AND FOR COMPUTER SCIENCE

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ABSTRACT

We describe the Carnegie Mellon Summer Institute for Computer Science Advanced Placement Teachers (6APT), an NSF-funded three-year project that delivers integrated instruction in gender equity and the C++ programming language. First offered in the summer of 1997, 6APT integrates gender equity and disciplinary issues for several purposes:

- Recruiting: The College Board has begun a shift in programming language from Pascal to C++ for the 1999 Advanced Placement exam. The need of teachers for training in C++ allows us to attract teachers who are initially indifferent to gender equity issues, as well as those who are more enthusiastic.

- Pedagogy: The specific focus of the course allows us to situate the gender equity material squarely in the programming classroom and lab, and equally to incorporate equity issues into technical discussions of programming pedagogy.

- Legitimacy: Direct involvement of computer science experts at a well-known university center of CS underscores the importance of gender issues and lends authority to the course.

Our early experience in the program has borne out our expectations along these lines, and participant reports are enthusiastic. We are engaged in extensive follow-up activities, both for participant support and evaluation; we present some preliminary results.

INTRODUCTION

The proportion of American girls and young women pursuing computing as an area of specialization is dismal: only 17% of high school computer science advanced placement test takers are female [Stumpf and Stanley, 1997], as are just 18% of the computer science majors at the top university computer science departments [Andrews, 1996]. Much research indicates that this shortage of representation at higher levels stems largely from the “inherited problem”: a variety of forces throughout the K-12 years, but especially in secondary school, deter girls from pursuing computing [Tobias, 1993]. This disparity of representation has negative impacts on the national technical workforce, on the future development of computer science, and on the economic opportunities available to women.

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The barriers to girls’ participation include active deterrents, as well as subtler but no less influential effects of an environment that fails to recognize the differences, socialized or otherwise, between male and female students’ preferences. For our purposes, the most important of the active deterrents are teacher conduct [Hall and Sandler, 1982; Sanders, 1995], which has been found often to devalue and discourage female participation; and interactions with male peers [Sanders, 1995; Schofield, 1995], in which problems of sexism are compounded by social and developmental issues among the boys and girls involved, most poignantly so in the setting of the computer laboratory. Among the subtler effects are the interaction of pedagogical style with differences in cognitive style and preference between boys and girls [Turkle and Papert, 1990]; the choice of examples and activities used in courses [Rosser, 1990]; and the considerations that lead male and female students to study computer science [Fisher, Margolis and Miller 1997]. The good news is that teachers can learn to intervene against these influences in favor of gender equity [Sanders, 1995].

In 1999, the Educational Testing Service will change the programming language used in its computer science advanced placement test, from Pascal to C++. This presents a singular opportunity: most of the approximately 1500 teachers of advanced placement computer science (APCS) courses need training in C++ as well as in appropriate pedagogy for the new language and its object-oriented style of programming.

In response, we have created the Summer Institute for Computer Science Advanced Placement Teachers (6APT), which combines this retooling with training in gender equity issues and practices that will enable teachers to recruit and retain more female students. Over three years, 6APT will enroll from 15-20% of the nation’s APCS teachers, and indirectly influence more. APCS courses represent a particularly salient opportunity to increase women’s participation in computer science, since girls tend to be well represented in early computing courses, but continue to advanced courses in far smaller numbers than boys [Linn, 1985; Schofield, 1995].

The direct consequence we hope to achieve through this program is a substantial and permanent increase in the number of high school girls who elect and pass the Advanced Placement Computer Science course at their schools. This will result, accordingly, in a substantial increase in women college students with strong preparation in computing. Since advanced placement courses and their instructors tend to hold positions of prestige at their schools, we also expect a large secondary impact whereby the climate and pedagogy of all computing courses in participant districts’ high schools are improved.

This project embodies an unusual collaboration between experts in computer science and experts in gender equity issues. We believe this collaboration yields two major benefits. First, it has enabled us to interweave gender equity material with the presentation of technical material, helping the participants to see how to use both together in their classrooms. Second, the prestige of Carnegie Mellon’s computer science program, and its close association with the APCS program, give credibility and appeal both to the training program and to the idea of gender equity training among a segment of the APCS teacher population who might otherwise be nearly unreachable.

PROGRAM STRUCTURE AND CONTENT

The 6APT course provides four key elements:
1. background information on the gender situation in Computer Science and related areas, and related cultural and pedagogical issues.
2. technical knowledge of C++ and programming with objects.

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3. specific skills and techniques for gender-sensitive pedagogy, classroom practice and management of peer interactions, integrated with C++ course materials (assignments, background lessons, etc.)

4. issues in creating change in one's home institution.

The course is structured as a six-day session, with two sessions scheduled in each of the summers of 1997 through 1999. Each session enrolls approximately forty teachers, for a total participant population of 240. The project faculty are assisted in each session by two teacher assistants, recruited from the group of high school teachers who grade the APCS exam as well as prior GAPT participants. These teachers provide hands-on assistance with the programming portion of the program, and also contribute their perspectives on classroom issues.

Each day of the program involves lecture/discussion sessions on programming in C++, lecture/discussion/activity sessions on gender issues, and computer lab time. Computer classes are held in computer-equipped classrooms, with a machine available to each participant. The gender sessions use a mixture of lecture, large group and small group activities, to appeal to different learning styles and to integrate the participants' experiences with discussions of research and best practices. Participants complete a brief feedback form each day, and a more complete evaluation at the end of the workshop.

FOLLOW-UP

Subsequent to the training, we are staying in close contact with the participants, both to evaluate the program and to support their efforts in the classroom and in sharing their skills with colleagues. We have the good fortune to be working with a group that is adept and comfortable at electronic communication, so we use the Internet as our primary means of follow-up. We also use mail and phone as back-up, particularly aggressively in our effort to complete the evaluation task.

Beyond our follow-up activities in the service of evaluation, detailed below, we are using the Internet to attempt to provide an unusual degree of post-program support and collaboration. We have established an electronic mailing list that allows participants, and their colleagues, to consult with program staff and each other regarding their classroom experiences, in both the computing and the gender dimensions. This has been successful in engaging a large portion of the group—more than 60% have sent mail to the list, and we've had private communiqués from more.

OUTCOMES AND EVALUATION

Part of the project is an evaluation of both its progress and its results. The ultimate measure of the success of the project will be changes in the enrollment and success of high school girls in advanced computer science courses. Ancillary outcomes include practices adopted by participants in their classrooms, dissemination to their colleagues, and dissemination to other APCS teachers and trainers.

Formative evaluation of the program has two components. We collect very brief, daily evaluations during the training workshops; such instruments have proven helpful in tuning the course's schedule and pedagogy. We follow these up with an evaluation questionnaire at the end of the workshop. As anticipated, the daily formative evaluations have been of great value in real-time tuning of the program. We begin each day (after the first) with a brief discussion of and reaction to the previous day's feedback. On several occasions, we have been able not only to make course corrections in terms of presentation

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style and pace, but also to defuse anxieties about the programming material and concerns with the gender equity material.

We have also found our longer final-day survey, which serves both formative and summative functions, of great help in revising the course and its schedule. We were able not only to adjust some of the presentation for greater effectiveness, but also to revise the scheduling of sessions to facilitate leisure time activities without reducing class time.

Summative evaluation focuses on the impact achieved, relative to the program’s goals. This will include both quantitative and qualitative measures of success. Participants complete an extensive survey before attending the training, and annually throughout the project (thus supplying us with longitudinal information). In order to achieve high rates of participation, we pay participants stipends upon completion of the first annual survey. We follow up by electronic mail and telephone where necessary. We also invite participant input on an ongoing basis via the Internet.

Note that our approach uses historical data as a control in assessing the program’s effectiveness. Given the many possible influences (regional, economic, social, etc.) on the recruitment and retention of girls in these courses, we believe this represents the most reliable comparison we can make. Also note that in addition to objective measures, we are asking for subjective evaluations of classroom issues; while this data cannot be taken as straightforward indication of impact, we believe it will form a useful basis for further research.

**LIKELIHOOD AND SIGNS OF SUCCESS**

Although this project treads new ground in a number of ways, several factors give us confidence that we will succeed in providing training that will substantially boost the enrollment of high school girls in advanced computing courses. This impact will depend both on teachers’ motivation and likelihood of enrollment in the training, and on their success in applying what they’ve learned.

First, teachers have been eager to attend the course. In the first offering of the course: despite some bulk mailing glitches, we received more than 120 applications for 80 seats. For 1998, we received about 240 applications for 80 seats.

As for the teachers’ success, two general groups of findings argue that the training we plan can be highly effective. First are the findings, such as Jo Sanders’s and a variety of others, showing that most teachers are unaware of many of the issues that affect girls’ pursuit of technical courses, including subtle discouragements that they themselves may unwittingly commit. This indicates potential for change through knowledge. The second group of findings shows that gender equity practices, once learned in a fairly compressed way, can indeed have substantial impact on girls’ participation in advanced courses [Rayman and Brett, 1993; Rossen, 1990]. Note that the recruiting power of the C++ component, by design, can draw in teachers for whom gender equity is not the primary reason for attending. One question for our evaluation is the difference in outcomes between this group and those motivated primarily by gender equity concerns. In any case, we believe it is particularly critical to provide the less motivated group with information regarding gender equity.

End-of-course survey results have been extremely positive, with participants rating the usefulness of the course highly for both the computer science content (4.9/5) and the gender content (4.6/5). They expected to readily incorporate new gender equity techniques into their classrooms (4.2/5), while expecting introducing C++ to be

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somewhat harder (3.7/5). Although follow-up surveys for the first year’s participants are still in progress, we have received reports of enrollment changes in some participants’ schools for the 1998-99 school year, as follows:

- Egg Harbor, NJ 9% girls to 25%
- McKinney, TX 5% girls to 31%
- San Diego, CA For the first time, more than 1/3 of the class is girls
- Fresno, CA 8% to 25%
- Dayton, OH Computer programming, 17% to 34%
  Advanced computer programming, 7% to 20%
- Midland, TX Pre AP, 13% to 27%
  APCS I, 31% to 51%

**STATUS AND FUTURE PLANS**

Having completed three offerings of the course, we are encouraged by the enthusiasm of the participants (anecdotally and in their evaluations), by our own feeling of having taught most of what we set out to teach, and by some informal results. Our formal follow-ups, of course, will tell the tale.

Two sets of issues concern us as we go forward. One is how to raise the involvement and success rates of our “alumni,” especially in making the transition from awareness to action. The other is how to leverage our course design efforts to reach beyond the original circle of 240. In the first category, we have implemented the following:

- Seeding the mailing list with information, observations and topics for discussion.
- Offering a periodic “6APT Challenge” to the alumni, where we invite them to try something out and report back on the results. Examples include surveying their students on computing as a gendered discipline, or designing an appropriate programming assignment.
- Conducting a mini-symposium in which the most active/effective alumni receive travel grants to return to Carnegie Mellon to present their experiences and ideas, and to plan future efforts.

In the second category, beyond sharing gender equity information with teachers on opportune occasions (such as the College Board AP grading session), we are exploring strategies for extending 6APT-style education to a much broader audience. We believe that our approach extends readily to all high school programming classes for which technical instruction can be helpful to teachers. In particular, we are considering constructing a web site containing computer programming teaching resources that are gender-inclusive; “training trainers” to deliver a similar course; and delivering a course via teleconference to satellite groups.

**CONCLUSIONS**

Several key ideas in 6APT seem to recommend themselves to future programs. First and foremost is the combination of gender equity education with disciplinary education for which demand is strong. This helps in recruiting, in order to preach beyond the choir, as well as in situating the gender material to make it more readily learned and applied. This approach relies on building a team with deep expertise in both fields. The second idea is
to build instruction around participants' classroom experiences, complementing their own observations with conclusions from the research literature. This makes the theory more accessible and builds ownership of the ideas. Finally, encouragement, planning and support of action by the participants are likely to be keys to ultimate effectiveness.

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