Proceedings of the Frontiers in Education conference
FIE-2004, Savannah, Georgia, pp T2D 1–6.

Java Engagement for Teacher Training: An Experience Report

Raja Sooriamurthi, Arijit Sengupta
Information Systems Department
Kelley School of Business, BU 560A
Indiana University
Bloomington, Indiana, 47405

Suzanne Menzel, Katie A. Moor, Sid Stamm
Computer Science Department
Lindley Hall 215
Indiana University
Bloomington, Indiana, 47405

Katy Börner
Library and Information Science
Main Library 019
Indiana University
Bloomington, Indiana, 47405

{raja, asengupt, menzel, kmoor, sstamm, katy}@indiana.edu

***Abstract*— Starting with the 2003 academic year, the advanced placement (AP) exams in computer science conducted by the college board moved from a C++ to a Java based curriculum. In order to assist high school computer science teachers with the transition from C++ to Java, the ACM together with the college board conceived of Java Engagement for Teacher Training (JETT) workshops. In the Fall of 2003, Indiana University organized such a workshop. The outreach workshop was held over two days and was attended by 35 high school computer science teachers from Indiana and several nearby states. The workshop was conducted as an inter-disciplinary effort with faculty and support from Computer Science, Information Systems, Informatics, and the School of Library and Information Science. Sessions spanned the gamut of foundational concepts of object-oriented programming in Java to network games. A theme of the workshop was to address the problem of the ever-shrinking pipeline of women in the IT field. With this in mind, we also conducted a separate session titled "Where have all the women gone?" Judging by participant feedback, the workshop was a resounding success. This paper describes our experience in organizing the JETT workshop, the lessons learned, and outlines our plans for the future to build upon this K-16 relationship-building exercise.**

Index Terms — Computer Science Education, K-12 initiatives, Women in Information Technology, Teaching the art of Teaching.

I. Introduction

Each year, the college board (www.collegeboard.com) offers high school students two exams in computer science (termed A and AB) for advanced placement credit. Typically these exams represent the culmination of a year long AP course. The content of Computer Science A is a subset of the content of Computer Science AB. As outlined by the Advanced Placement Program: Computer Science A emphasizes the object-oriented programming methodology with a concentration on problem solving and algorithm development and is meant to be the equivalent of a first-semester college-level course in Computer Science. It also includes the study of data structures, design, and abstraction, but these topics are not covered to the extent that they are in Computer Science AB. Computer Science AB includes all the topics of Computer Science A, as well as a more formal and in-depth study of algorithms, data structures, design, and abstraction. For example, binary trees are studied in Computer Science AB but not in Computer Science A. Further details on the form and content of these AP exams are available from the Advanced Placement Program web site [1].

Starting with the 2003 academic year and the 2004 examinations, the advanced placement exams in computer science moved from a C++ to a Java based curriculum. This evolution has been motivated by the fact that most college-level introductory programming courses emphasize an object-oriented approach using Java.

In order to assist high school computer science teachers with this transition from C++ to Java, the ACM together with the college board conceived of JETT: Java Engagement for Teacher Training. The immediate goal of JETT is to provide high quality pedagogically-oriented workshops and resources in Java for secondary high school computer science teachers hosted by universities. In addition, the JETT program offers all secondary computer science educators a rich, centralized, online Java repository hosted by the ACM [2].

In the Fall of 2003, Indiana University was one of the early organizers of a JETT workshop. This paper reports on our experience as well as our future plans based on the resounding success of the workshop.

II. Goals of the IU JETT workshop

In addition to the primary goal of aiding high school teachers with the transition from a C++ based curriculum to a Java based curriculum we also had the following broader goals:

- *The Information Technology (IT) field changes rapidly.* The workshop will enhance the technical expertise of Indiana high school teachers, keeping them abreast of the latest developments to initiate the training of the next generation.
- *IT departments in high schools are generally small and isolated.* The workshop will offer high school computer science teachers from Indiana and the greater mid-west area the opportunity for a collegial experience with their peers and with University faculty.
- *Many high school IT teachers have a narrow, programming-oriented view of the field.* The workshop will provide a rich and balanced look at IT, while

showcasing what Indiana University has to offer in both research and pedagogy.

- *Women are under-represented at all levels in IT.* The workshop will increase awareness of, and explore the forces behind, the ever-widening gender gap in IT [3]–[5].
- *A mutual learning experience for all those involved in the K-16 education pipeline.* The workshop will help to showcase the different IT related departments of Indiana University: Computer science, Information Systems, Informatics, Library and Information Science. It will also help increase the interaction between high schools and IU.

As is discussed in the remainder of this paper and judging from the feedback of the participants we have made a strong start towards realizing these goals.

III. The Structure of our Workshop

At Indiana University research and pedagogy in the broad field of Information Technology is housed in four departments: Computer Science, Information Systems, Informatics, and the School of Library and Information Science. Each department does research in and emphasizes the teaching of different aspects of the varied mosaic of IT. As a reflection of that, the JETT workshop was conducted as an inter-disciplinary effort with faculty, students and support from all of these disciplines.

Thirty-five high school teachers from the greater mid-west region (Indiana, Kentucky, Ohio, Illinois, Iowa and Kansas) attended. Following the ACM recommendations, the workshop consisted of sessions addressing:

- Basic Java
- Concepts of Object Orientation
- Timers, Threads and GUIs
- Java Foundation Classes
- Network Games
- Algorithms and Data Structures

Prior to the workshop we had sent out a questionnaire to all registrants requesting feedback on their prior comfort level with the concepts of object orientation and the Java language. Based on the responses, we partitioned the participants into two tracks, introductory and advanced level, termed *decaf* and *espresso* respectively. But participants were free to move between and switch tracks according to their personal preference. Parallel sessions on all of the above themes were held for both the tracks. The difference was the level of detail and breadth of coverage. In retrospect, running the workshop as two parallel tracks turned out to be a very good idea as we were able to match the backgrounds and meet the needs of the participants more effectively.

All of the above sessions were conducted in computer labs. Lectures were interspersed with hands on exercises. In addition to the session instructor, each lab was assisted by several under-graduate students from all the IT related departments at IU. The workshop participants were thus able to get more closer one-on-one attention as they worked through the hands on exercises.

A Case-Study in Object Orientation: In addition to concepts of object-orientation and the Java language, both computer science AP courses and exams require familiarity with a detailed case-study involving a moderately sized application — a simulation of a marine biology system. This case study consists of 11 Java files (excluding `jar` files for the GUI and other utilities) spanning 1900 lines of code. Joe Kmoch, from Washington High School, Milwaukee, Wisconsin and a member of the AP Computer Science Development committee, conducted a session on the details of this case study and its role in the AP exams and possible ways of teaching it.

Further details on the ACM recommendations for a JETT workshop are available online [2]. All the details of our workshop, including the course material handed out to the participants, is also available online [6].

IV. How to Teach: Issues, Styles and Tips

Apart from content (Java + Object Orientation) the workshop participants were keen on learning new techniques to present the material to their students. Hence in the various sessions, home works and class room exercises used by IU faculty were shared with the participants. Over breakfast a special session devoted to various active learning techniques was conducted. The following outlines some of the discussion that arose. More details are available in a separate paper [7].

The dilemma with teaching effectively is three-fold: It is difficult to gain and keep students attention, understand their points of view, and cater to their various learning styles.

It is of utmost importance to gain and keep students' attention: without this, it is impossible to instruct! Unfortunately, this is the most difficult task. Not only is attention span dwindling (many sources claim it to be under twenty minutes) but many times students are initially disinterested. Disinterest can come from negative rumors about the class, preoccupation, or a requirement to take the class. It just gets worse when concepts are repeatedly covered even though repeated immersion is important.

A teacher who can understand her students' points of view has an advantage: she can customize her class to fit the students. The students' perception of the instructor, the CS field, and the world are all important factors in determining the best way to instruct. If a student has a negative view of these essentials, it is important to turn that around. If the view is positive, the teacher must make sure to uphold that image.

Catering to different learning styles is probably the most beneficial thing a teacher can do for her students. Every student wants to learn in a slightly different way, and if an instructor locks into one presentation or immersion technique, most of her students will become disinterested or not learn as much as they should. This diversity is especially an issue in high school where students are exposed to a subject for the first time.

The solution to all these problems is not easy. Therefore, an instructor must stay in tune with the students needs, desires, and preferred styles in order to customize each lesson for its target. Some suggestions that were discussed:

- Attention can be gained and kept in many ways: do unexpected things in the classroom. Attempt joy in class (learning *should* be fun)! Change techniques regularly to cater to short attention spans [7].
- Learn who (*really, who*) the students are. Attempt to break down negative images and build positive ones. Consider the students' social lives — in high school, this is the most important thing for a student. Make CS rewarding. Show the students how they can change *their* world.
- Finally, teach around the cycle of learning styles as Richard Felder suggests [8]. This will give all the students an equal chance to learn. In fact, ask them how they want to learn and implement their ideas. This will motivate them, get their attention, and cater to their styles all at once.

There are many resources and sites on the web for AP CS teachers. Perhaps the most useful resource may be the experience of other teachers. One of the best features of the JETT workshop was the opportunity it provided to bring together teachers with the same concerns to share their experiences.

V. Where are all the women?

An important theme of the workshop was to discuss the problem of the ever shrinking pipeline of women in the IT field and what could be done about it. With this in mind, IU's office of women's affairs funded all the women students assisting with the labs in the workshop. On the second day of the workshop we conducted a session devoted to gender issues titled *"Where have all the women gone?"*. The discussion revolved around the recruitment and retention of women.

A. How can we recruit women?

Recruiting talented women into computer science courses will take a team effort between (a) high schools (b) universities and (c) the computer science community as a whole.

One of the most prominent images in media today is the "computer geek". Computer geeks are portrayed on television as anti-social, uncultured, badly dressed people who hack on their computer all the time. The stereotype drives young talented students (female and male) away from the field of computing because they do not want to be associated with geeks or are afraid they may become one themselves.

The best way to dispel the geek stereotype is to show students not all computer scientists are "geeks." Carnegie Mellon's Women at School of Computer Science group created the Roadshow to break the stereotype that all people interested in computers are geeks, increase the visibility of women in computing, and give students a glimpse of computing fields (it's not just programming, programming, programming!). The Roadshow consisted of a powerpoint presentation that had pictures of the women who presented when they were younger, pictures of people in computing doing activities they enjoy and information about interesting computing fields (i.e. Robotics, Human Computer Interaction, etc.).

- Be aware of your voice, gestures, and body language
- Do not "talk down to girls"
- Ask high-order, open ended questions to all students
- Put girls in touch with female scientists
- Encourage questioning and exploration for all students
- Recommend home computers be placed in centralized locations
- If your classes are not 50-50, notify administrators
- Talk to parents and counselors to help encourage women

Fig. 1. Promoting gender equity in the classroom [9]

High school teachers can help fight the "geek stereotype" by inviting guest speakers to speak at their school. Technical guest speakers can get students interested in various computing fields and show that not all computer people fit their computer scientist stereotypes. The IT departments at local universities can be a great place to meet researchers who can volunteer as future guest speakers.

Teachers can videotape themselves and see if they are following the gender equity guidelines listed in Figure 1. Since the computer science curriculum is largely dictated by the advanced placement exam, teachers can be encouraged to start clubs at school that offer interdisciplinary programming, multimedia, and/or technical projects. Over 40% of women want to do interdisciplinary work (i.e. art, medicine, education, etc.) [3]. From creating a school web page for alumni to playing with Lego Mind Storms, students from any area (including young women) can find something interesting to do in a programming, multimedia, and/or technology club.

B. Retention

Once we have recruited young women into our high school computing courses we must keep them there. Teachers must ensure the lab environment is an inviting place for all students. The physical layout of a lab may attribute to the culture of the computer lab. Typical lab layouts have rows of computers. Rows are ideal because many computers can fit in a room and students can work independently. However, research has shown that rows do not allow friends to sit next to each other and feel more comfortable in computing environments. Thus, groups become intermixed. Unfortunately students who do not want to intermix with their stereotypical idea of a computer scientist stop working in the lab. Clustering computers in groups, instead of rows, allows groups of students to work in the same laboratory without fear of being labeled as a "geek."

Of course, moving computers around into clusters may be costly and unrealistic. Teachers can also decorate the lab with posters of positive role models (*men and women*) in computing. Teachers can get posters of women in computing

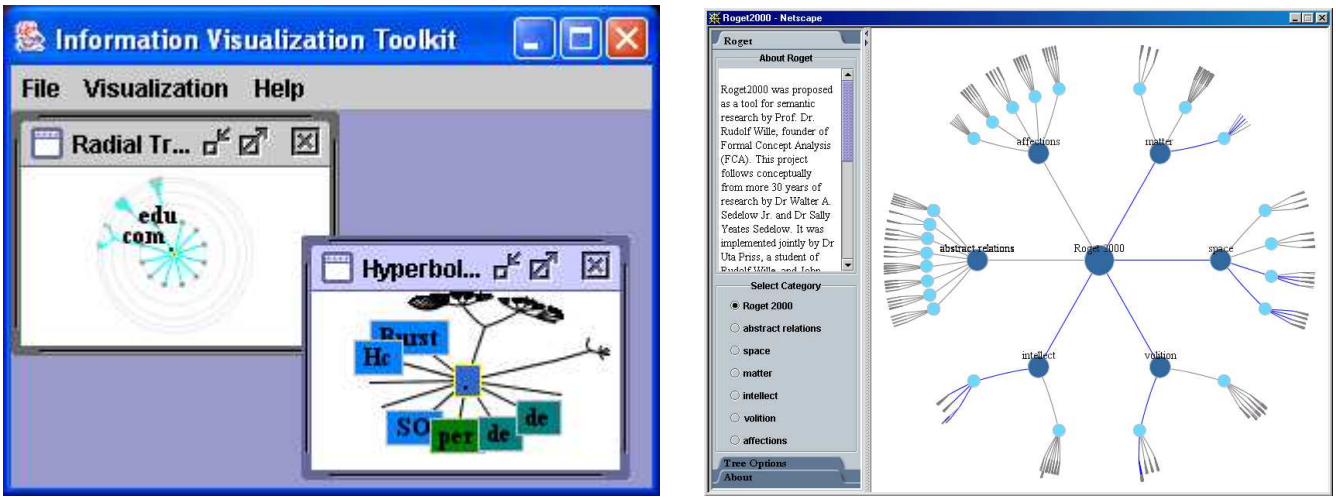

Fig. 2. The InfoVis Toolkit

from The Anita Borg Institute for Women and Technology (anitaborg.org).

The most important thing for teachers to remember when it comes to their computing lab is to monitor student behavior. Students have not been in the real world and may not have learned about appropriate, professional behavior. Teachers should ensure appropriate language is always used and screen savers, desktops, and other images are suitable for the lab environment envisioned.

If students show promise in computing but are bored with the class work, opportunities for challenging and interesting projects should be introduced. Students can read high level computer science papers to capture their interest in other computing fields. Teachers can look for or organize a regional programming contest with the students' help. Teachers can get involved with local universities, participate in local workshops, or computer science education conferences (such as SIGCSE — sigcse.org) to get ideas for exciting projects.

High school teachers are ideally positioned to promote realistic notions about the technological professions and to bolster the confidence of female students who have the aptitude to succeed. Educating educators on this point enables them to become agents of change at their home schools. The sooner teachers learn about gender-related differences in learning and how pedagogical approaches and teaching styles, as well as peer culture, contribute to causing or closing the gender gap, the sooner we can stop wondering where all the women have gone.

VI. Showcasing Research Initiatives

The last session of the JETT workshop was entitled *Information Visualization in Java*. This session introduced a Java software library for research and education in Information Visualization [10], [11]. The session introduced algorithms that transform data and information that are not inherently spatial into a visual form, thereby allowing the user to observe, interact with, and comprehend large amounts of data. Figure-2 shows a sample radial tree and hyperbolic tree visualization of a directory hierarchy. Web sites, classification hierarchies, organization hierarchies, newsgroup structures, etc. could be visualized analogously.

The library comprises common preprocessing, data analysis, and data layout algorithms, as well as algorithms that enable users to interactively explore data sets. It comes with a set of learning modules that give a description of the data analysis and visualization task, usage hints on how to run and use a particular algorithm, a challenging scenario to use an algorithm or to analyze and/or visualize a data set, discussion of the results, and references to research papers, online demos, and (commercial) applications.

The open source library and the learning modules are available online at `http://iv.slis.indiana.edu/sw/`.

The participants felt that the application was visually stimulating so as to catch the possible interest of a high school senior for a term project.

VII. Movie + discussion

In the spirit of women in computing, on the evening of the first day of the workshop we screened the movie *To Dream Tomorrow: A Portrait of Ada Byron Lovelace*. This one-hour, scholarly, interdisciplinary documentary film tells the story of Ada Byron Lovelace, her work with Charles Babbage, and their contributions to computing over a hundred years before the time usually thought to be the start of the Computer Age. This film was researched and directed over a period of four years by scholar/film-makers, Jo Francis and John Füegi [12] who were present for the screening and then led a lively discussion.

VIII. Personal Reflections from the JETT Workshop

After the JETT workshop, we asked each presenter to share with us what they felt about being apart of the JETT experience. More specifically, we wanted to know more about

the feedback they got from workshop participants and anything they would have done differently. Here are some of the responses we received from our presenters.

A. Where have all the women gone? by Katie A. Moor

The JETT workshop was a great way to meet local high school teachers and share ideas. After my presentation, I spent most of my time answering questions, exchanging email addresses for further discussions, and networking with teachers interested in getting more girls in their computer science classrooms. I am very excited to participate in another workshop like this.

I arrived a few minutes early to the lecture hall to upload my presentation. Surprisingly, I ran across two teachers who were attending the workshop in the empty lecture hall. I started talking with the two men. One teacher said, "Oh, do you all want to go grab lunch? The next presentation is about women in computing and I know all about that already." I told him I was the women in computing presenter, but if after five minutes listening to my presentation he still felt he knew everything, he could leave - no hard feelings. After the presentation the teacher who "knew everything" came up to me and apologized for his comment and then asked me lots of questions about issues I raised during the talk. We still keep in email contact.

I think this story is reflective of a lot of people in computer science. Everyone knows the number of women in computing must be increased in order to develop more well-rounded software for a diverse population of people, however most teachers think they are doing all they can to increase the number of women in their program. My presentation touched on why it is important to have women in computing, why women do not go into computing, and how we can improve computing environments for women. The workshop reviews and ongoing discussions via email shows me that our women in computing component gave teachers ideas to take back with them to increase the number of women in computing.

Something I wish I would have touched on in my presentation is the need to increase the number of minorities in computing. The number of women in computing is low, however the number of minorities in computing is pitifully low. People need to encourage all students to participate in computing independent of race, ethnicity, or gender.

JETT allowed the Women in Computing (WIC) group at Indiana University (IU) to network with high school teachers. WIC at IU is creating a "Roadshow" similar to Carnegie Melon's Roadshow to show junior high and high school students what computer science really is (not just programming, programming, programming) and not all computer scientists are "geeks." WIC at IU plans on visiting participating schools in the Fall of 2004.

B. My Perspective as a High School Teacher by Michael Chabin [13]

As a high school computer science teacher I am acutely aware of the issues the IU initiative addresses and of the urgent need to address them. Two, in particular are of special relevance to me.

First, is that many high school IT teachers have a narrow, "programming oriented" view of the field. Syntax and technique are often taught by rote. High level skills of analysis and abstraction often languish because students so rarely see a problem they haven't been shown how to solve. This employment-oriented approach to computer programming is well intentioned but misguided. Students taking the AP exam this year will not be ready for the workplace until 2009 at the earliest. Who knows where Java will be then? High School students need programming, not for the job market, but for college and they need more than just programming. Today's high school students need a broad introduction to the entire field of computer science if they are to have any hope of understanding the profound implications IT has for the world they are about to inherit. To prepare them teachers need access to first-rate, research oriented university computer science departments. The IU Initiative provides that access.

A second critical problem addressed by this initiative is the under-representation of women in all levels in IT. Winning women and other bright students to IT means dispelling the myth that programming is simply a way for nerds to compete. We can do so by emphasizing the parts of computer science that appeal to all intelligent students. Those are not difficult to find. How can a student who likes biology fail to be curious about self-organizing systems or evolutionary code? It is hard to imagine a student how likes history and government who wouldn't be intrigued by the social implications of data mining. Is there anyone who isn't disturbed and intrigued and excited by artificial intelligence with all its implications? Obviously, introducing high school students to such problems means giving their teachers better access to the field. that, of course, is the whole point of the IU initiative.

IX. Lessons learned and Future plans

The JETT workshop was a learning opportunity not just for the participants but also for the organizers. The overwhelming response from the participants was favorable and they have asked us to conduct a longer workshop over the summer. We are currently in the process of securing funding for such an event.

During our post-mortem session, as we analyzed our JETT workshop, the following issues arose which may be of benefit to other universities contemplating a similar workshop:

- Conducting two parallel tracks, one at the introductory level and one at the intermediate level, helped to keep everyone actively involved.
- The broad range of topics was attractive. While the participants primarily came to learn how to teach Java and object orientation in their AP classes, they found the other sessions on gender issues, teaching styles, educational recreation to be a useful complement.
- While the attendees were interested in content they were also keen on determining how to deliver the content. Hence in addition to instructing the participants on what

to teach it was also important that we give tips on *how* to teach the material.

- We had invited representatives from various book publishers to exhibit their latest offerings in teaching Java. This provided yet another angle for the participants to discuss their experiences.
- The workshop provided a good opportunity for all the participants to network and share their war stories. We are pleased that participants continue to correspond with IU faculty on these issues. A few have visited our campus again in search of possible project ideas they could give to their students.

Overall, the workshop has been an enjoyable and fruitful experience for all concerned. We are looking forward to hosting similar workshops in the future.

Acknowledgments: Raja Sooriamurthi was supported in part by a Course Development Grant from the Kelley School of Business, Indiana University. Katie A. Moor was supported in part by a National Physical Science Consortium Fellowship and by a stipend from Sandia National Laboratories/CA. Katy Börner's work on the InfoVis library is supported by a Pervasive Technology Lab Fellowship, an SBC Fellow Grant, and the National Science Foundation under IIS-0238261. We are grateful for the financial support for the JETT workshop from the Department of Computer Science, Kelley School of Business, School of Informatics, College of Arts and Sciences, and the Office of Women's Affairs.

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