

Introduction

The MIT-AITI program has successfully completed its third program in its third year of existence. The program has expanded this year to include a high school in Kenya and a whole new program in Ghana. These are the first steps in its plans to expand the program's impact on Africa's technological advancement.

A total of 13 MIT students were selected from a big pool of applicants to participate in this year's program. Seven students were selected to teach Java and related web development tools over a six-week period to both college level and high school students in both countries.

The teaching was intense and rigorous, but also flexible to accommodate student's needs. The trip to Ghana was the first extension from the original AITI project at Kenya, and its success demonstrates the modularity of AITI and the potential for future expansion to other countries in Africa.

This summer's program focused on increasing student's knowledge of programming languages as a tool for developing Internet applications. This kind of effort is essential to bridging the digital divide. The program met the initial goals of MIT-AITI:

- 1) introducing web technology to African schools by teaching students and faculty how to write simple applications that utilize resources on the web
- 2) providing a means through which cultural interaction between MIT students and the students in the African schools could be possible
- 3) providing a community service opportunity for MIT students to apply their technical engineering expertise towards the advancement of internet technology in Africa

This report gives an account of the summer program by documenting the implementation details, problems encountered, impact and benefits of the course, as well recommendations for the future.

Overview

This year's project was held in two countries, Kenya and Ghana. The program in Kenya ran during June and half of July for a period of six weeks. The Ghana phase ran for four weeks during the month of August. In both countries Java programming was the main course. In addition to Java there was a JSP (Java Server Pages) and ASP.NET course offered to Strathmore College in Kenya. Moreover, an impromptu UNIX course was offered to a number of teachers in Ghana on their request. The courses were taught during five days throughout the week. There were different schedules for the schools in both countries. The details of how the courses were carried out are explained in the next section.

Implementation

This section details how the Java classes were carried out, the number of students taught and their backgrounds. It discusses the implementation in each country separately.

Ghana

Students

The majority of the students in the AITI-Ghana project were from Presbyterian Boys Secondary School, but there were also many students from Achimota High School. All of the students had completed secondary school and were in different stages of their post-secondary education. Some of the students had previous computer experience, but few had extensive programming experience. All students were comfortable with basic computer applications but had some apprehension about writing a computer program. In

general, the students were interested in computer related topics but lacked the confidence to work in the computer industry. This course was an important first step in gaining that confidence.

Schedule

1. Course Schedule

The course began with a week on introductory programming concepts such as variables, and basic control structures, followed by methods and classes. The Java software development kit was then introduced, with a general lecture on how to locate information on the specific classes. By request, a make up lecture was given mid-course for those who had missed lectures, which covered the introductory material again.

Two special topics lectures at the end of the course covered more general computer related topics such as useful sites on the WWW for finding educational and practical information, ways to configure browsers in order to speed up access to the net, and an overview of the Linux operating system.

2. Daily Schedule

The course was held M-F 10am to 4pm with an hour for lunch for 4 weeks. This meant that lectures and lab sessions were typically 2.5 hours long. The class included approximately 60 students. Initially approximately 40 students were registered for the course, but within the first two or three days, about 20 more students added the course. We divided the class into two sections. While one section attended lecture, the other section worked on problem sets in the lab. Each section had about 30 students.

Two midterms and a final exam were given, both on Fridays. On exam days, a review was given in lecture and students were encouraged to review past problem sets in lab. The exams were designed to highlight commonly seen difficulties in the lab. Exam days

followed a slightly different schedule, with each session only lasting an hour and a half, and all of the students taking the exam simultaneously at the end of the day.

Curriculum

1. Choice of Java

With only one month to teach programming skills and basic programming concepts, some care had to be exercised as to the choice of computer language to use. Java was primarily chosen for two reasons, it offered easy to use support for a large number of programming tasks, such as graphics, web based processing, animation etc., as well as wide support for machines and operating systems. The Java compiler and supporting libraries are also available free from a number of manufacturers including Sun and IBM, and this was obviously an important consideration.

We also felt that as Java is a relatively advanced computer language, offering support for object based programming, and code organization; knowledge of Java would provide a good basis for any student who subsequently needed to learn other languages such as C, C++, Fortran etc.

2. Class Operations

Class was divided into two sessions, one based around practical exercises in the computer laboratory, and one formal lecture session. An LCD projector was used to project lecture slides and demonstrations, augmented by white board, and occasional pen and paper exercises. Lectures typically lasted about 2 hours, including question and answer sessions.

During the lab sessions, which in practice continued through lunch hours, and as long as the lab was held open, students worked individually on assigned problem sets, which

were downloaded from a central server. The lab was equipped with sufficient 400Mhz Pentium computers, running Windows 2000, that each student had their own machine. Normally at least 4 of us would be present in the lab to answer student questions, and it seemed that this high level of assistance was helpful in stopping students from becoming frustrated, with typical beginner issues such as badly worded compiler error messages, and confusion over language syntax issues.

3. Syllabus

The first week (a short week) of the course was geared to introducing concepts of computer programming and features of JAVA versus other programming languages. The problem sets focused on understanding the importance of good syntax.

The second week was dedicated to laying the framework for a solid understanding of JAVA. Concepts such as variable types and classes were taught. The problem sets included some prewritten code to which students added their own code.

The third week built on previous concepts and introduced the concept of interfaces and super classes. In the problem set, students had the opportunity to write a program, which computerized a local game in Ghana called "Oware." A good score on the final exam depended on a thorough understanding of this problem assignment.

Impacts and Benefits

The enthusiasm shown by the students was a clear indication of the fact that the project was, in fact, a necessity for them. We learned, just from talking to a great portion of the students, that such opportunities to learn programming were rare and the available chances were too expensive for the majority of the students. They showed a great deal of appreciation.

One thing that was evident in the end was that most of the students had learnt java well enough to use it in developing various applications. The average performance in the quizzes was impressive, implying that we had accomplished the main goal of the project. The surprising thing was that for most of them, this was their first programming experience and they understood the concepts very well.

We spent the last few days of the project teaching the students about libraries available for their usage, types of applications they could develop with the knowledge they had acquired, and the opportunities that lay at their feet now that they had the knowledge of programming in Java, which they could use to learn other languages if they needed to.

Most of the students we taught were alumni(ae) of the high schools we went to and were first and second years students in university with a clear idea of the fields they would be majoring in (the system in Ghana requires students to declare their majors before they join university). Learning Java was therefore relevant to their current state since they could figure out how to apply the skills they learned to develop applications that would be specific to their area of concentration. Some of the students who were interested in entrepreneurship came up with very interesting ideas and discussed them with us.

We would be leaving out an important part of the project if we did not say that each member of the team learned a great deal from the experience. This was very enriching in many aspects and in the end, each person got a chance to learn from interacting with the students and from the project as a whole.

Problems Encountered and Future Recommendations

Since this was MIT-AITI's inaugural project to Ghana, there was naturally an abundance of lessons we learned that could benefit future projects. They range from simple items that we wish we had brought to logistical issues that require better planning.

Without hesitation, future projects should take with them as many programming books as possible. Textbooks, it turns out, are a scarce resource in Africa. Given the poor telecommunications infrastructure, web-based documentation is not practical. Our students proved to have an immense intellectual curiosity and desire to learn. With more books, that learning could have continued more fruitfully after the conclusion of our project.

One of the most useful pieces of equipment we took was a portable CD Writer. Using the CD writer, we were able to make custom CDs for each student that contained the Java Development Kit, documentation, all of the course notes and assignments, and the student's code. This proved popular with the students. We only wish that we had brought more blank CDs with us so that we could have produced more material.

Photocopying was a problem, because Presec did not have any efficient photocopy or printing facilities on site that we were allowed to use. In order to get any photocopies produced, we had to first go to the University of Ghana, where the CS department let us use their printer. After making photocopies of these printouts at Achimota, we had to transport back to Presec so we could distribute them to the students. This took a long time and our students didn't get all the handouts they needed. In future years, we recommend that AITI take a small portable printer to shorten the time cycle. Also, a Kinkos like service, if it exists in Accra, should be sought out and utilized. Finally, AITI should specifically have photocopying in the budget. For this project, the photocopy fees came out of the team's stipend.

In terms of logistics, our hotel (Selina Lodge) was satisfactory, though it was difficult to get transportation to Accra from Selina because the nearest taxis were a ten-minute walk from the hotel. There are many other hotels in the proximity of East Legon, so next year's project should try to explore other options, particularly ones that are in closer proximity to taxis or other transportation.

Transportation between Selina Lodge and Presec was provided by the school's van. At the end of the project, we had to compensate Presec for the petroleum consumed as well as the driver's salary. The van never arrived at a consistent time, making it difficult to start class on time every day. Given both this and the fact that the van ended up being quite expensive, we recommend that future projects should simply hire two taxis for transportation to the school. AITI should specifically budget for this cost.

Finally, there is the intricate issue of student fees. This year, students representing Achimota were asked by Presec to pay a laboratory fee for using the facilities at Presec. This is understandable since Presec needs to pay for the electricity to run the computer lab. However, we feel that such an arrangement is in conflict with AITI's goals. Our mission was to teach students from Achimota and Presec regardless of need.

Kenya

Students

The MIT AITI program taught a total of 120 students - 45 in Alliance High School and 75 in the Strathmore College. The students from Alliance who participated in the program covered the spectrum of 9th through 12th grade. Students from Strathmore were freshmen and sophomores in the college.

Schedule

1. Course Schedule

The course began with a week on introductory programming concepts such as variables, and basic control structures, followed by methods and classes. The Java software development kit was then introduced, with a general lecture on how to locate information on the specific classes. During the last week, the students in Strathmore College were given lectures on JSP and ASP.net.

2. Daily Schedule

In Strathmore College, lectures were given in the morning from 9am-12pm. After a lunch break, labs started around 2pm and ended at 5pm. During the 2 hour lunch break, some lecturers were available to help out students who had extra interest or needed extra help. Half of the team left Strathmore everyday at 3pm and went to Alliance High School, where the classes started at 4pm when the students were done with their normal school day. In Alliance, the labs and the lectures were combined together.

Curriculum

1. Choice of Java

Please look at report section on Ghana.

2. Class Operation

The lecturers prepared class notes and handed them out before class. An LCD projector was used to project lecture slides and demonstrations, augmented by white board, and occasional pen and paper exercises. Lectures typically lasted about 3 hours, including question and answer sessions. The MIT students had divided up the lecture topics and dates amongst themselves so that they could prepare and teach the lectures.

In Strathmore, the lab was equipped with sufficient fast Pentium computers that run Windows 98, and the students had their own machine. There were two different labs, wherein two MIT lecturers were present in each lab to answer student questions. In Alliance, the computers were slow, and students had to share them to do their problem sets.

During each lab session, the students worked on their homework. The questions were practical and oriented towards making them implement the knowledge they have gained during the morning lectures. They were also given a midterm and a final exam.

3. Syllabus

The first week of the course was geared to introducing concepts of computer programming and features of JAVA versus other programming languages. The problem sets focused on understanding the importance of good syntax.

The second week was dedicated to laying the framework for a solid understanding of JAVA. Concepts such as variable types and classes were taught. The problem sets included some prewritten code to which students added their own code.

The third week built on previous concepts and introduced the concept of interfaces and super classes. The rest of the weeks covered advanced Java subjects and lectures on JSP and ASP.net. The students were given mid-term as well as final exams to test how much they have gained from the six-week course.

Impacts and Benefits

The intensive program provided this group of young Kenyan students with an idea of computer programming and basic skills in Java, which they can build upon to further learn the language or even, branch to other Object Oriented Programming (OOP) languages. This sets up a human resource pool for the Information Technology (IT) sector in Kenya. These pool of students will be among the pioneers in the rising IT sector will certainly greatly contribute to the economic development of Kenya.

The MIT AITI team also brought to the schools not only technical knowledge, but also different styles of thinking and approaches of solving problems. The students were exposed to the MIT- Engineering style of learning, which is very different from their original ways of learning. From the students' feedback, we found out that the AITI program was especially successful in facilitating student learning. The active interaction between students and teachers in the classroom, the hands-on emphasis of the program, and the directional guidance for advanced students in pursuing advanced topics by themselves were deemed as key ingredients that helped the students grasp the material.

The teachers in Alliance High School were taught the Java course as well, which was conducted at a faster pace and a deeper level than the students' course. This course ensures that the teachers will be able to help the students to move forward after without the presence of the AITI team. Furthermore this creates continuance and sustainability of the project by its multiplier effect.

The team has taught in two of the best schools in Kenya – the Alliance High School and the Strathmore College. The presence of the team has brought very positive effects on campus. In addition to the courses we provided, we also gave speeches to students on campus in terms of IT development and career choices in Strathmore College. We have given speeches to students in Alliance High School as well. In addition, we visited Alliance High School (for girls), and gave a motivational speech there from our own experience. These talks were inspirational and many of the students learnt that by hard work they could achieve their dreams.

The MIT team members have also learned a lot from the program and the students they taught. The team is composed of American and international students of MIT, ranging from sophomore to Ph.D. students. The teaching experience in Kenya not only provides them a chance to practice their teaching and presentation skills, but also an opportunity to know about the country, the culture, and its beautiful people. For most of them, this trip is their first contact with the continent of Africa. They were amazed by the students' enthusiasm and ability in learning. They were also deeply touched by the effort of the people in developing the country. The MIT-AITI program is such a great channel for communication and mutual understanding. The team members are very proud of being part of the program and they think their six weeks' teaching was a very rewarding experience. All team members have expressed their interest in helping development of Kenya and Africa in general. From their own experience, they highly recommend this program to other MIT students.

Problems Encountered and Future Recommendations

The following section is a collection of several suggestions for future AITI initiatives. These ideas were discussed at length with teachers and administrators at both Strathmore and Alliance at the conclusion of the 2002 program. The suggestions address challenges such as equipment constraints, high student/teacher ratios in labs, course selection, and the quality/direction of teaching students with varying levels of experience.

A. Course Preparation

Because of the amount and the novelty of some of the material we had to present, we arranged a sequence of meetings to prepare our course notes before arriving in Kenya. For the Java, JSP, and ASP courses, our task was to design a new curriculum. Since the task was time-consuming, much of the later work for the course notes was completed in Kenya. For future initiatives, it would be optimal to plan even earlier prior to the trip with the goal of finalizing all course notes. Using the current archive of lecture notes, problem sets, exams, and solutions, this effort will now be much easier.

B. Course Selection

We wanted to teach relevant, useful, and current material in computer science. As a result, we opted for a fundamental Java course at both schools, with JSP and ASP mini-courses added in the final weeks at Strathmore College. For future programs, it is important to consult thoroughly with teachers and principles of both schools before the trip to determine which courses would benefit students the most. One way to address the constant change in computer and Internet technology is to focus on concepts of programming rather than the specifics of a particular language. For example, we introduced numerous examples involving data structures while teaching the Java course. The JSP (and ASP) extensions were important as well, because they demonstrated how to apply programming skills to the Internet for potential business applications. Currently, we are working on a menu of courses so that we will give each school a chance to choose which courses from the menu they would like to be taught there.

Besides courses offered this past summer, new courses could be introduced or substituted. In Alliance high school, the teachers have already received an introductory course in Java, and it would be appropriate for them to learn more advanced topics next summer (e.g. network applications). However, for students, it is important to realize their

potential for understanding as well as their previous background in computer science. It is not possible to teach vast amounts of material in 6 weeks, even with extended four-hour lab sessions.

C. Teaching Students with Different Backgrounds

While teaching the students at both Strathmore and Alliance schools, we found that each student was different in terms of his/her previous experience. This was clear in the exam scores; the scores ranged from below average to perfect. As a result, we were forced to use the first exam as a pseudo-diagnostic test to split the class into two separate labs based on previous experience. For future AITI initiatives, it is important to give a diagnostic test in the beginning of the first class. Using the diagnostic test, teachers can focus on students who need more help in the first few weeks. Splitting the class into two lab sessions worked well and each student was able to work at his/her own pace.

D. High Student/Teacher Ratios

It would be ideal to have more teachers in the AITI team for lab sessions. Lab sessions require individual attention, and often one teacher would have to help over 30 students. However, even without increasing the number of AITI teachers per student, a few improvements will work well. First, some of the administrators and lab workers at both Strathmore and Alliance can help during lab sessions. At Alliance school, the teachers have already been trained and can now teach students in Java. Second, towards the end of the program, we began organizing smaller tutorial sessions in between lunch and the lab sessions for any students to ask questions. Other ways of sustaining education are to use online tutorials and published materials. Furthermore, we are considering asking the students we have taught during the past summer to volunteer as lab assistants during the next summer phase. This will give them a chance to update their knowledge, help their fellow students, and increase the availability of assistants during the lab sessions.

E. Equipment Constraints

This year, members of the AITI team brought personal laptops for completing work. These laptops were also used to connect to projectors in the classroom. One AITI laptop was available for storing and developing course material. We found that sharing computers worked well for the most part, but it would be ideal to have more AITI laptops. Currently, we have requested for laptop donations or summer loans from the MIT Academic Computing Service (ACS).

At Strathmore, the computers were reasonably fast for teaching our courses. However, Alliance school did not have a fast network. Installing software at Alliance took a long time due to server problems, and in the future, a new faster server might be appropriate. Students at Alliance shared stations, and the teachers worked in a smaller lab without connection to the Internet. It would be ideal to have Internet connections in both labs, and possibly a larger lab environment for the students. Furthermore, we are planning to write proposals to companies such as Apple, HP, IBM, and Microsoft in order to get hardware as well as software donations to the schools.

Finally, in both schools, printing problem sets, lecture notes, and exams was difficult because we had to transport and collect our files on a disk. It was a rush to have material ready in time in the morning. One improvement would be to have a central AITI locker at each school for course materials, and possibly a method of remote login to transfer files directly.

F. Books

This summer, according to recommendations of the past, we donated several books of computer science to start a library at both schools. In the future, these libraries will hopefully grow as more reference material is added.

Conclusion

With EIF funding of \$50,000, the program was implemented in four schools during the summer of 2002: Strathmore College and Alliance High School in Kenya, and Achimota High School and Presbyterian Secondary School in Ghana. A total of 13 MIT students traveled to Africa for a total of 10 weeks, and succeeded in teaching a total of 180 students and 10 teachers. The students were given courses in Java, with additional short lectures in JSP, ASP.net, and UNIX. The knowledge of the students was measured through mid-term and final examination. The summer was a success story for AITI, because we expanded to one more school in Kenya, and two new schools in Ghana. This was a good demonstration of the scalability and sustainability of MIT-AITI, and the welcome reception it has received from the African Schools. We were able to provide a venue for MIT students to share and practice their engineering knowledge, as well as develop the engineering and information skills of the students and the teachers at the African schools, thus promoting the main objectives of EIF and AITI.

Participants

Paul K. Njoroge

Paul is a graduate student in electrical engineering and computer science pursuing his doctorate degree. His interest in web development and its applications provided the impetus to start this program. He believes the program offers a platform on which students can learn the latest technologies and programming techniques. Building upon what they learn here, the students will be in a better position to contribute to the burgeoning IT sector in Africa.

Solomon Assefa

Solomon Assefa is currently a PhD student in the Electrical Engineering and Computer Science department at MIT. He finished his undergraduate education at MIT (B.S in EECS, B.S. in Physics, and M.Eng in EECS). He has been involved in AITI along Paul Njoroge and Martin Mbaya since 1999. During summer of 2002, he traveled to Kenya and Ghana. In Ghana, he was setting up the program and taking care of logistics before the arrival of the Ghana team in August. His visions include giving AITI a strong foundation in the current countries, expanding to additional countries, and providing equipment support to the current schools.

Yaron Binur

Yaron is a sophomore in electrical engineering and computer science. He plans to concentrate on artificial intelligence. After serving for three years in the elite unit of the Israeli army, he decided to take two years off to work and travel. Participating in the MIT-AITI program allows him to combine his love for travel with an invaluable experience in teaching.

Evelyn Eastmond

Evelyn is a sophomore in electrical engineering and computer science with a minor in technical theatre at MIT. She enjoys developing web sites and is working to improve her web development skills whenever possible. The MIT-AITI program allowed her to increase her proficiency in object-oriented programming as well as develop her teaching skills. Volunteering is a very important aspect of her life and she was very excited at the opportunity to combine her two passions with the program as well as get a chance to learn about a beautiful country such as Kenya.

Peilei Fan

Peilei is a PhD candidate in international development in the urban studies department at MIT. She expects to complete her studies next spring. She also holds a M.S. in electrical

engineering and computer science from MIT, a Master of city planning from Rutgers University and a B.S. in Computer Science from Nanjing University, P.R. China. Her main interest lie in the area of high-tech industrial development in developing countries; how to acquire technological capability and other crucial resources that are required for achieving industrial competitiveness. She has been a teaching assistant in MIT's introduction to computers and engineering problem solving (1.00) for the past two years and loves to teach. The MIT-AITI program provided her with a unique opportunity to combine her experience in teaching, information technology and international development.

Ethan Howe

Ethan is also a sophomore in electrical engineering and computer science. Ethan's academic interests include physics, computer science, economics and foreign languages. He has taught and tutored both middle school and high school students. His interests in exploring new activities lead him to participate in this year's program. He hoped to benefit from learning from the students while teaching them how to programming.

Naveen Goela

Naveen is a senior in electrical engineering and computer science at MIT. He expects to complete a second degree in mathematics and a minor in economics. As a member of the MIT-AITI program he was eager to teach and challenge the students. He draws his experience from his past involvement in several companies, MIT's lab in software engineering (6.170) administration, and the A.I. lab.

Davis Wamola

Davis has just completed his M.Eng in electrical engineering and computer science at MIT. He also has a B.S. in electrical engineering and computer science with a minor in economics from MIT. He is interested in software development and web technologies hence his involvement in the MIT-AITI program. As a Kenyan, he is also eager to teach students from his alma mater and help bridge the digital divide.

George Heming

George is a Ghanaian and currently a junior in the Electrical Engineering and Computer Science Department. His current academic interests are in Communication Systems and Signal Processing. He has been involved in AITI for the last two years and played a very active role in realizing the expansion of the program to Ghana this year. He is very much interested in Africa's development and hopes to apply his knowledge in the African Telecommunications Industry. Outside the classroom, his pursuits include arts and design, sports as well as reading.

Selam Daniel

Selam Daniel is a senior at MIT graduating with degrees in Chemical Engineering and Business Management. Her parents are immigrants from Eritrea, but she has been raised almost entirely in the United States. She is very interested in community development projects in third world countries, especially Africa and Latin America. She hopes to work in the field of international development.

Flora Amwyai

Flora, from Kenya, got to know about MIT through the founder members of AITI when they had their first project in Kenya. This gave her the motivation to apply to MIT and she's now a sophomore in Electrical Engineering and Computer Science, considering a double major in Economics. She was part of the team that went to Ghana this summer, where she was very impressed by the enthusiasm shown by the students who got the chance to learn programming through the project.

Christopher Emig

Christopher Emig is a junior majoring in Biology and Computer Science. An entrepreneur since age 6, Chris loves devising "crazy" ideas for new business ventures and discussing them with his friends and coworkers. Originally from Napa, California he owns and operates a consulting business serving several corporate clients in the San Francisco Bay Area. Recently, he has found a new focus in the technological and economic advancement of developing nations.

Jacky Mallet

Jacky is currently a PhD student in the Media Lab. She is interested in bridging the divide by applying the technical knowledge that she has gained at MIT.

Samidh Chakrabarti

Samidh is a PhD student in the MIT electrical engineering and computer science department. He was a participant in implementation of the summer 2001 project in Kenya. This year, he traveled to Ghana to use the knowledge he gained through AITI and handle the new expansion in Ghana.