ADAPTIVE HYPERTEXT FOR THE FRONTIERS PROGRAM

An Interactive Qualifying Project Report

submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

____________________________
Timothy E. O’Brien

Date: October 14, 1999

Approved:

________________________________
Professor Karen A. Lemone, Advisor

1.Internet

2.Education

3.Computers
1 Abstract

The goal of this project was to design a simple adaptive hypertext system for the Computer Science Section of the 1999 Frontiers Program. This system was realized through the use of a survey, taken before and after the program, which determined the students’ programming knowledge. Survey responses before the program were used to place students in appropriate sections of the course material. Survey responses after the program completion were used to judge the overall effectiveness of the web-based material.
2 Executive Summary

The WPI Frontiers program is a two-week academic program designed for students in their junior year of High School. The computer science section of this program features a curriculum based on self-paced course material available over the World Wide Web.

The objective of this project was to provide a method for placing students in an appropriate starting point in the program material. This was accomplished through the use of a simple adaptive hypertext system. This system consisted of a single survey that was conducted at the beginning of the program. The results of this survey determined the placement of the students in the program material. The survey was designed to evaluate the student’s general programming ability as well as their knowledge of object-oriented concepts and the Java programming language. This same survey was conducted again at the end of the program to determine the student’s overall progress.

This project succeeded in the sense that background information can now be gathered quickly from the students and this information can be used constructively to allow students to bypass material that is already known. However, this project has shown that the students are able to complete the provided material without learning the concepts within it. This realization has prompted the effort to enhance the simple adaptive hypertext system for future Frontiers programs so that the students’ progress may be monitored more closely.
3 Introduction

The Frontiers Program

The WPI Frontiers program is a two-week academic program designed for students in their junior year of High School. This program introduces students to college life and assists students in choosing a major by introducing them to the type of academic work done in their chosen field. The teaching staff for this program usually consists of WPI faculty members as well as college students. The program is divided into two sections, a morning and an afternoon section. This IQP was involved with the morning computer science section of the Frontiers program.

Goal of the IQP

The goal of this project was to address the varying backgrounds of students in the Frontiers program through the development of a simple adaptive hypertext system. This system accounted for student’s varying experience by placing them in the appropriate section of the self-paced program material for the morning section.

Overview of Methodology

To accomplish this goal, a survey was constructed to evaluate the students’ individual background knowledge. The survey questions were designed to separate students into groups following the existing structure of the program material. The material used for the morning section of the program consisted of three basic sections; RoBOTL, JavaBOTL and Java. The possible starting points for students were the beginnings of these three sections. The survey was conducted through the World Wide Web, and results were gathered through email. Students were then categorized by their
responses and spoken to individually regarding the starting point that would be best for them.
4 Research

4.1 Adaptive Hypertext

With the recent availability of computers in the classroom, many tools and techniques that take advantage of this processing power have been developed to aid students in their learning goals. One promising technique still being researched is known as adaptive hypertext. This technique aims to guide the student through course material based on the student’s current knowledge and skill level. The student’s abilities are monitored throughout the learning experience, and guidance is provided based on criteria provided by the instructor.

Adaptive Hypertext in Educational Systems

Instructional material, either in hypertext format or in print, is structured by the author in such a way as to provide the best path through the material for the average learner. This structure is influenced by the author’s knowledge of the content, and their knowledge of how this material should best be presented to students. This approach; however, does not take into consideration the knowledge of the student or their goals. The material cannot be restructured based on the specific needs of the student. The author may also choose to provide a table of context, or an index as a navigational tool for the students. However, the student may not always know when to use such a tool, or where to continue in the material. The content may need to be indexed differently depending on the student’s needs.

Through the use of adaptive hypermedia systems, it is possible to change the content or appearance of material based on an understanding of the user. Adaptive

---

hypermedia systems may be defined as “all hypertext and hypermedia systems which reflect some features of the user in the user model and apply this model to adapt various visible and functional aspects of the system to the user.”

**Adaptive Navigation Support Techniques**

Adaptive Navigation Support (ANS) techniques are used in adaptive hypermedia systems to provide directional support to the user. Such techniques make use of the user model to provide direct guidance, order links, hide irrelevant pages or annotate links.

Systems may provide direct guidance by deciding what content the user should view next by taking into consideration the user’s goal and other model parameters.

Adaptive ordering of material may be accomplished by sorting the links on a page according to the user-model. This ordering can only be applied to non-contextual links however. Indices, content pages and contextual links should not be sorted, as their order is usually predetermined and independent of the user-model.

Adaptive systems may also hide irrelevant material by not displaying links to pages which do not relate to the user’s goal, or which the user does not have enough knowledge to understand.

Adaptive annotation is a technique that modifies links by adding comments indicating the content of the pages behind them. Annotation can be accomplished through the use of text, icons or text styles. For instance, a link may be marked as completed or read through the use of a green circle to the right of the link if all material on the linked page has been visited.

---

4.2 Adaptive Textbooks

Content Structuring Using Adaptive Annotation

Adaptive electronic textbooks use knowledge about their domain, or content, in the form of a domain model, as well as knowledge about the user of the system in the form of a user model. The domain model may be simply a set of basic concepts. A more complex domain model may be represented as a network, with nodes representing concepts, and links representing various kinds of relationships between concepts. The structure of this network represents the structure of the domain covered by the hypermedia system.

This domain model is then used to construct a model of the user’s knowledge of the domain. For each concept represented in the domain model, a value estimating the user’s knowledge of that concept is stored in the user model. This type of user model is known as an overlay model. This value may be a binary value that simply indicates whether the concept is learned or not learned, a qualitative value such as good, average or poor, or a quantitative value such as the probability that the student knows the concept.

An adaptive textbook based on the domain model is InterBook, developed by Brusilovsky, Shwarz and Weber. The two main parts of their adaptive electronic textbook are the glossary and the annotated textbook. The glossary is a combination of a traditional index and glossary. The structure of the glossary resembles the pedagogical structure of the domain knowledge. Each glossary entry corresponds to a domain concept, and links between glossary entries correspond to links between domain concepts in the domain model. The annotated textbook is usually a textbook in normal format,

---

3 Brusilovsky, P., et al. A Tool for Developing Adaptive Electronic Textbooks on WWW.
consisting of chapters and sections; however, a list of concepts covered in each section is also provided. Brusilovsky et al. call this list the spectrum of the section. It is also possible to represent the role of each concept in the spectrum. InterBook is capable of representing two types of concept roles, an outcome or a prerequisite. The concept is denoted an outcome if the section presents knowledge related to the concept. The concept is a prerequisite if the knowledge represented by the concept is necessary to understand material in the section.\

**InterBook Functionality**

Based on the user model, links are generated on the fly between the textbook and the glossary. Due to the number of links presented to the user, adaptive annotation based on the user model is used to provide the user with visual clues identifying the educational state of the material behind the link. Different colors and fonts are used to represent material that is learned, not learned, ready to be learned, or not annotated by the author. Currently, it is not possible to determine learned material in InterBook since tests are not supported. Instead, a check mark is simply used to denote visited pages.

This system is also able to provide prerequisite-based help. Using the domain model, a list of links to sections containing prerequisite concepts for the current section can be generated. This list can then be sorted according to the usefulness of each link. For example, links pointing to nodes containing unknown concepts would be placed first.

Future plans for InterBook include the use of an interview before creating the student model in order to gain a better understanding of the student’s goals and knowledge.

---

4 Brusilovsky, P., et al. *A Tool for Developing Adaptive Electronic Textbooks on WWW.*
Systems such as InterBook only allow for the acquisition of conceptual knowledge, while other tutoring systems only provide procedural knowledge. In order to create a fully self-sufficient tutoring system, it must support the learning of both types of knowledge, conceptual and procedural. Such a system has been created in an experiment in distributed adaptive tutoring. This system is composed of InterBook and a system called PAT Online. PAT Online is responsible for testing the student’s problem solving skills based on the concepts learned through InterBook. InterBook guides the student through the material based on those concepts that were successfully used through problem solving in PAT Online.\(^5\)

**Empirical Evidence to Support Adaptive Systems**

In a study conducted by Brusilovsky and Eklund, user model based link annotation was found to increase comprehension as compared to non-annotated pages with the same content. One of the main findings of the study was that this type of adaptive navigation support (ANS) is only useful if the student is willing to take the advice of the system. Those who follow the suggestions of the system are able to take advantage of the structuring that has been done for them from an expert’s point of view. The test results show a strong correlation between the number of suggested links followed, and the student test score. Those who followed suggested links more often received higher test scores.\(^6\)

Although users are able to benefit from the annotated links, the added interface component of such systems might distract students from the actual content. In this study,

\(^5\) Peter Brusilovsky, Steven Ritter and Elmar Schwarz. “Distributed intelligent Tutoring on the Web”
\(^6\) Brusilovsky P., Eklund J. “A Study of User Model Based Link Annotation in Educational Hypermedia”
the students using the annotated system *initially* performed worse than those not using ANS.\(^7\)

\(^7\) Brusilovsky P., Eklund J. “A Study of User Model Based Link Annotation in Educational Hypermedia”
4.3 Learning Theory

Constructivism

Constructivism explains learning by suggesting that we generate and refine rules and models of the world based on new experiences. The basic principles of the constructivist theory are the following:

- The purpose of learning is to find meaning; therefore learning should begin with those issues in which students want to find meaning.
- Learning should focus on concepts in relation to one another, not as disconnected knowledge.
- Teaching requires knowledge of the student’s mental model, and how this model influences assumptions and deductions based on the student’s knowledge.
- Since the purpose of learning is to find meaning, assessment should be combined with the learning process to provide a measure of the quality of learning.

Constructivism affects the curriculum by emphasizing that course material should take into account an individual student’s prior knowledge, as well as provide hands-on problem solving. Teachers following the constructivist theory should make connections between concepts and have students analyze, interpret and predict information.8

Neuroscience

Neuroscience is the study of the human nervous system, the brain, and the biological basis of consciousness, perception, memory and learning. Neuroscience provides evidence that complex thought strengthens physical connections in the brain. Curricula taking neuroscience into account should promote complex thinking.9

Learning Styles

The fact that students handle information in different ways can be explained through the use of psychology. The learning styles theory is based on research that demonstrates the effects of heredity, upbringing and current environmental demands on how students perceive and process information. According to this theory, students can be classified as either concrete or abstract perceivers of information, and as active or reflective processors of information.

Concrete perceivers take in information through physical means and experimentation. Abstract perceivers take in information through analysis, observation and thinking. Active processors understand new information by immediately applying this new material to some problem. Reflective processors understand information by taking time to think it over.

In order to account for the diversity of learning styles, a curriculum should address intuition and imagination as well as analysis and sequential problem solving.10

Right Brain / Left Brain

Students’ styles of thinking may also be categorized according to the structure and functions of the two hemispheres of the brain. The theory of left/right brain thinking

suggests that the thinking done in the left hemisphere of the brain is mainly logical, sequential, rational, analytical, objective and focused on specific parts of a concept rather than the whole, while thinking done in the right hemisphere can be categorized as random, intuitive, holistic, synthesizing, subjective and accounting for the ‘bigger picture’. Teaching material aimed at left-brain thinking should focus on analysis, logical thinking and accuracy, while material aimed at right-brain thinking should deal with aesthetics and creativity.\textsuperscript{11}

\textsuperscript{11} Funderstanding. \url{http://www.funderstanding.com/theories.html} (6 Oct. 1999)
4.4 Assessment

Reasons for Assessment

As a first step in developing an assessment system, the reasons for collecting information about students should be clearly identified. These reasons may be used to classify the assessment as a *high-stakes*, or *low-stakes* assessment. High-stakes assessments have specific consequences for schools, programs or students such as a student’s graduation. Low-stakes assessments are evaluations used in the classroom to provide information about the teaching and learning processes that can be used to guide student/teacher interactions. Alternative assessments are often used to determine student performance in an effort to tailor material to students, but can also provide a direct measure of a student’s performance. These types of assessments may be classified as either high-stakes or low-stakes.12

Matching Assessment to Purpose and Content

After defining the purpose of the assessment, as well as the standards, goals or concepts to be assessed, one should consider how this relates to the design of the actual assessment. When the goal of assessment is to provide a measure of a student’s knowledge of specific principles or skills, multiple choice or short answer tests may provide this information. However, these types of assessments do not provide information on the overall quality of an educational program or measure a student’s ability to perform logical, scientific tasks. To measure a student’s *understanding of* specific principles, the student should be observed while applying these principles,

---

possibly in a lab or one-on-one setting. This will provide information on the student’s strengths and weaknesses, and allow for the planning of appropriate instructional material.\textsuperscript{13} \textsuperscript{14}

**Authentic Assessment**

Authentic assessment aims to test the student’s collective abilities by presenting students with real-world problems testing a variety of relevant skills and knowledge. The goals of the authentic assessment technique are:

- To have students develop their own responses rather than dispense one from a predetermined list of choices.
- To encourage higher order thinking
- To synthesize with classroom instruction
- To provide a method for directly evaluating holistic projects
- To relate closely to classroom learning
- To teach students to evaluate their own work

Authentic assessment aims to express fairness in testing through the use of ‘appropriate’ measures. Appropriate measures of assessment are personalized, natural and flexible. These measures should address specific abilities and target the student’s skill level. This type of assessment should emphasize the evaluation of the student’s performance based on a well defined set of criteria, but should not place a rank or value on the student’s performance as compared to others.

\textsuperscript{13} Match Assessments to Instructional Content and Student Performance Goals. Pathways to School Improvement. \url{http://www.ncrel.org/sdrs/areas/issues/methods/assment/as7goals.htm} (6 Oct. 1999)

\textsuperscript{14} Match Assessments to the Purposes for Assessment. Pathways to School Improvement. \url{http://www.ncrel.org/sdrs/areas/issues/methods/assment/as7purp.htm} (6 Oct. 1999)
Classroom Assessment Techniques

This category of assessment deals with the evaluation of the quality of the student’s learning. In other words, these techniques are meant to evaluate how well the student is learning the concepts presented in the material. These techniques are not meant to evaluate student performance, but to provide material for teacher-student discussions on how to improve the student’s learning, as well as to give students an understanding of the quality of their learning. The basic steps in the classroom assessment process are to choose a learning goal to assess, choose an assessment technique, apply the technique, analyze the data and share results with students and then respond to the data. Classroom Assessment Techniques utilize evaluation tools that check for background knowledge, identify areas of confusion, determine students’ learning styles, target and build specific skills, and enable students to self-assess their learning level.

Performance Assessment Strategies\textsuperscript{15}

Selected response tests consist of questions that require the examinee to choose between several provided answers. Since all students are given the same answers to choose from, selected response tests ensure a standardized environment. This environment is suited to large numbers of examinees since tests may be graded quickly.

Constructed response tests require examinees to develop their own answers to questions. This type of test is well suited to essay writing or problem solving. Due to the variety of possible responses, grading of such questions must be done according to certain standards to ensure fairness. These types of tests may more accurately reflect the examinees skill level, but also require more grading time. This type of exam cannot be

graded easily through the use of computers, as selected response tests can, as there is not a fixed domain of answers with which to compare the examinee’s response.

Self-Report assessment requires those being examined to report their level of skill. If this type of assessment is used, measures may need to be taken to ensure that the examinee does not simply give the socially acceptable response. These measures may include numbering students rather than using their names, and specifically stating that there are no “correct” answers.

The use of extant data may also be a helpful assessment strategy. For example, data collected on the number of days employees are absent as well as the turnover rate for the company could be used to determine whether a program on improving employee morale is necessary.

**Approaches to Developing and Interpreting Performance Tests**¹⁶

There are two basic approaches to developing and interpreting performance tests; norm-referenced and criterion-referenced. Norm-referenced tests give the evaluator information about an examinee’s performance relative to other examinees. Tests of this type usually consist of multiple-choice questions covering a range of specific points. This type of test is useful mainly for grouping students according to how their score falls in the overall distribution of scores. For example, if 80% of examinees scored lower than 90 on a given test, those students scoring 90 are said to have scored in the 80th percentile.

Two weak points of norm-referenced tests are the fact that they usually need to be completed in their entirety for scores to be meaningful, and some questions may contain a certain twist so that even those students knowing the material may not be able to answer

the question. Criterion-referenced tests evaluate how the examinee performs relative to a fixed performance standard. Such tests are able to pinpoint strengths and weaknesses in instruction since their questions are designed to test specific skills or processes, not just specific definitions or pieces of knowledge. These tests can contain essay or short answer questions that ask the student to demonstrate specific skills and require a complete understanding of the knowledge tested. Questions in such tests can be added or subtracted without taking away from the interpretability of the results, since each question or group of questions corresponds to one of the test’s objectives.

**Constructing Performance Measures**\(^{17}\)

When constructing performance tests from scratch, the following basic steps should be followed:

1. **Determine the Objectives That Are Being Measured**

   When determining what objectives will be measured, it should be taken into consideration that each objective should be broad enough to allow for about five questions that evaluate whether it has been learned.

2. **Develop a Blueprint**

   The purpose of a test blueprint is to describe the skills that each type of question will measure, the specific nature of the question, and the features of correct or incorrect answers.

3. **Write the Test Items**

It is recommended that more test items be written than will actually be needed, since some items may be discarded after testing them out with a mock group of examinees.

4. **Review and Edit the Test Items**

After constructing the test items, they should be reviewed by another person or group for readability, plausibility of answer choices, and correspondence to the test blueprint. The possible answers should also be examined for potential biases toward groups of examinees. One example of this bias is the following: those examinees that have learned one programming language rather than another should not have any advantage or disadvantage when answering general programming questions.

5. **Field Test the Questions**

Before constructing the final test, the items that have been constructed should be tested using a sample group of examinees. In this way, empirical evidence can be obtained to verify that these questions are a suitable measure of the skill being tested. The size of the test group depends on the size of the program you are evaluating.

6. **Acquire Reliability and Validity Data**

Test validity is a measurement of how accurately an evaluation’s results reflect the true knowledge of the examinee. One way to interpret validity is the following: “validity is the extent to which you can rule out interpretations of an instrument’s results other than the one you wish to make”. Test Reliability refers to the consistency of test results over time. A valid test will usually yield reliable
results; however a test may be reliable while giving incorrect information about the examinee.

Proving the validity of a test first requires showing that test performance does not rely on other factors such as a student’s ‘test-taking’ skills, or recurring answer patterns in multiple-choice tests. Once these factors have been ruled out, demonstrating that those who possess the skill in question score well on the test, and those who do not possess the skill score poorly can show the validity of a test.

One method for testing reliability is to administer the test once, wait for a short period of time without additional teaching, then administer the same test again. When the results of the two tests are compared, the results should be identical. If the results are different this implies that the test questions are flawed since the knowledge of the students has not changed.
5 Methodology

After evaluating the time involved in developing a moderately involved adaptive hypertext system that would provide content restructuring through adaptive annotation and other techniques, the decision was made to construct a simple survey requiring less time and maintenance. This survey would allow for an initial model to be generated of the student’s knowledge prior to their exposure to the Frontiers material. This model could then be used to judge where students could initially be placed in the self-paced web-based material.

5.1 Survey Objectives and Blueprint

The first step to generating a blueprint for the survey was to identify possible groupings of students based on their prior knowledge and experience. The initial grouping that was chosen consisted of the following categories:

1. Students who knew very little to nothing about programming
2. Students who had programming experience but were unfamiliar with Java
3. Students who were already familiar or had extensive experience with Java

This categorization was later refined to take into account both the student’s conceptual and procedural knowledge. The final categorization took into account actual programming experience as well as knowledge of textbook definitions.

The next step was to identify how these groupings related to the web-based material used for the Frontiers program. This correlation was accomplished with the help of the instructor for this course. Her knowledge of the material and the students’ progression through it were necessary to understand this relationship. Those students with no programming experience would be placed at the beginning of the RoBOTL
material where they could develop basic programming skills. Those students who had previous programming knowledge but were unfamiliar or had little experience with Java would be placed at the beginning of the JavaBOTL material where they could learn object-oriented concepts and Java syntax, while building on their existing programming skills. Those students who had previous experience with Java, and demonstrated their skills through the survey would be placed at the beginning of the Java material.

The final step was to identify specific areas to test that would identify the level of experience that each student possessed. This process took into account that the survey should ultimately test both object-oriented and non-object-oriented knowledge and programming experience as well as Java knowledge and programming experience. In this way an adequate amount of knowledge concerning the student’s background could be obtained. The areas that were tested include the ability to recognize programming terms like ‘variable’ and ‘array’ and how these constructs are used, the ability to understand and code ‘logical loops’ and ‘conditional statements’, and the ability to recognize and utilize object-oriented concepts such as ‘inheritance’. These specific areas are discussed in greater detail in the following section on the survey items.

After the information that was needed to write the test items was gathered, the questions were written and reviewed by the instructor for correctness and readability. The test items written consisted of both multiple choice as well as constructed response items. Although this approach limited the automatic placement of students in appropriate sections of the material, creating a mixed item type test allowed for a more accurate measurement of the student’s programming knowledge.
5.2 Survey Items

The first ten questions of the survey request basic background information from the students. This background information includes such details as the student’s name, familiar operating systems and known languages. In terms of the adaptive hypertext portion of this project, these results let us know if the students were familiar with computers, and if they had acquired any programming knowledge at all.

Questions eleven through fifteen were designed to test the students’ basic programming knowledge and experience. The first three of these questions, listed below, asked the students to identify the programming constructs: ‘variable’, ‘array’ and the ‘floating-point’ data type.

11. The art of programming is built upon the ability to access a piece of data using a name. This name is known as a/an:

   ( )Data Name   ( )Variable   ( )Data Type   ( )Reference

12. When programming, one often wants to store pieces of similar (same type) data in an indexed manner. This can be accomplished through the use of a special collection of locations known as a/an:

   ( )Reference   ( )Struct   ( )Array   ( )Pointer

13. Let’s say you want to store the value of pi (3.14159…) as accurately as possible to do some calculations with circles in your program: which of the following hypothetical data types should you use to store this value?

   ( )Integer   ( )Single Precision Floating Point
   ( )String   ( )Double Precision Floating Point
The final two of these questions presented the students with a pseudo-code ‘while loop’ that incremented one variable, and a similar loop with a conditional statement inside. The aim of the following two questions was to judge the student’s exposure to real-world programming situations in order to test the level of their programming experience.

14. Looking at the following pseudo-code, what is the value of $x$ when the program has finished?

```
X = 0
While x does not equal 10
{
    x = x + 1
}
```

**Answer:** $x = 10$

15. Looking at the following pseudo-code, what is the value of $x$ when the program has finished?

```
X = 0
Y = 1
If y equals x then
{
    x = x + 1
}
else
{
    y = y - 1
}
```

**Answer:** $x = 0$
Questions 19 through 22 were designed to evaluate the students’ knowledge of object-oriented concepts such as classes, data hiding and inheritance. The following questions were used in the survey:

19. In object-oriented languages, a class is:

   ( ) A general template that is used to create objects with similar features
   ( ) A template that can only be used to create one specific type of object
   ( ) Describes an object’s attribute values
   ( ) Used to sort objects based on their type
   ( ) I’m not sure

20. Using classes it is possible to create objects that may be used without any knowledge of their inner workings. This technique is called:

   ( ) Encapsulation ( ) Data Hiding ( ) Variable Limiting
   ( ) Really Useful ( ) I’m not sure

21. Suppose you have a class with a variable x in it. How could you provide a way for someone that wants to use your class to change the value of x without ever having to deal with x directly? (Hint: functions)

   **Answer:** Create a member function that takes as a parameter, the new value of x. The value of x in the class is updated to this parameter value.
22. Using inheritance:

( ) It is possible to create a hierarchy of classes

( ) You can define classes that include methods and variables of other
classes

( ) Sub-classes only need to define differences from, and/or additions to,
the parent class

( ) All of the above

( ) I’m not sure

The final set of questions, listed below, tested the students’ knowledge of and
programming experience with Java. Questions 25 through 29 aim to get a basic
understanding of the students’ experience with Java. Questions 30 through 32 test the
students’ Java programming skills as well as their ability to use object-oriented
techniques with Java.

25. Describe the largest Java program you have written. How many lines of code?

26. Describe the most complex piece of Java code you have written.

27. Have you ever written a Java applet? If so, describe one you have written.

28. Have you written a Java program that displays graphics? ( ) Yes/No

29. Have you written a Java program that plays sounds? ( ) Yes/No
30. Suppose you have an array of 10 numbers ranging from 0 to 5, write a function that will loop through these numbers adding 1 to each number that is greater than zero.

**Answer:**
```java
for(int x = 0; x < 10; x++)
{
    if (array[x] > 0) array[x]++;
}
```

31. Create a simple class definition with two class variables and one class method.

This class can be anything you want, just keep it simple.

**Answer:**
```java
class Something
{
    int var1;
    int var2;
    public DoSomething();
}
```

32. Using the simple class you just wrote, create another class that is a sub-class of it, with two additional class variables.

**Answer:**
```java
class SomethingElse extends Something
{
    int var3;
    int var4;
}
```

In addition to the questions created for the initial survey, two questions were created to test material covered during the program. These questions tested knowledge of Scheme and C++. 
5.3 Using the Survey

On the first day of the Frontiers program, the students were instructed to visit the survey page and answer the questions. The results were received via email, and the students were sorted according to the groups that had been previously determined. This sorting process was done by hand, and took approximately one hour. On the following day, students were individually counseled on how they should proceed with the web-based material. This process did not strictly follow the categorization of students by their responses alone, but took into consideration the half-day that was spent with the students before the evaluations were processed.

During the entire program, the students’ progress through the material was monitored. Every time a student completed a section of the material, they notified a member of the staff and the date and section were recorded. As the records of this information will show, the students did not notify us every time they finished a section. On the final day of the project, the students filled out the same survey again.
6 Results and Analysis

6.1 Modeling Student Knowledge

This year, there were two students who had never programmed before. We suggested that these students go through all of the course material. Three students provided incorrect answers on the general programming questions and were counseled to stay in the RoBOTL material. Four students provided most of the correct answers in the general programming section, but we felt they should also stay in the RoBOTL material. Eight other students answered the general programming questions correctly, and we felt that they should move to the JavaBOTL material. One of the remaining students did not answer the ‘loop’ or ‘conditional’ questions correctly in the general programming section, but after talking with him, we felt that he had the experience to move on to JavaBOTL. The remaining student had more experience than other students, and had answered many of the object-oriented questions correctly on the survey. We suggested that this student also move to the JavaBOTL material; however he progressed through it in one day.

6.2 General Programming Knowledge vs. Classroom Experience

Those students who answered the general programming questions (loop/conditional) correctly had the following background characteristic in common which separated them from the others in this group: knowledge of a language such as Pascal or C that was learned in a structured class environment such as a high school class. The same characteristic holds for the rest of the questions on the survey. Those who had experience taking a class in a higher-level language like C or Pascal were more likely to
answer questions correctly. In the second group, all but one student had a previous
programming class.

<table>
<thead>
<tr>
<th>Question #</th>
<th>Class - Correct Class</th>
<th>Incorrect NoClass</th>
<th>Correct NoClass</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>11</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

This table shows the relationship between course experience and performance on
the general programming section of the initial survey. As you can see, those who had
exposure to a programming class were more likely to get the correct answer on these
questions as opposed to those who had no previous programming class.

6.3 Survey Validity

In order to gather more data to determine the validity of this survey, two computer
science students and one biology student from WPI also completed this survey after the
program. This data along with the results collected from the program show that a few
questions in this survey are not valid. Question 11 would seem to be invalid because all
students were expected to get the correct answer; however, the responses do follow a
pattern as noted in the previous section. The responses from the two computer science
experts and one biology student also fall into this pattern, since the computer science
students answered correctly and the biology student did not. This question may simply
need to be asked in a different way to get more correct answers. Both computer science
experts as well as many of the more experienced Frontiers students answered question 19
incorrectly. This question most likely had poor wording, and should not be used in future
surveys. The following question about Data Hiding was also answered incorrectly by one
of the computer science experts, and most of the more experienced Frontiers members.
This question expects that the student knows the subtle difference between the terms ‘data hiding’ and ‘encapsulation’. To remedy this problem, the term ‘encapsulation’ should not be used as an answer choice for this question.

6.4 Student Progress

Despite our suggestions, almost all the students moved on to the JavaBOTL material after finishing only a third of the RoBOTL sections. Only four of the students who were advised to continue with the RoBOTL material did so, completing almost all the projects. Because so many students moved themselves ahead so quickly, there were fourteen students who completed the Java material by the end of the program. Compared to the eight students who reached this level last year, this is large improvement, but the fact that they completed the tutorials did not guarantee that they had learned the material. The survey statistics in the next section will show that the concepts were not learned by many of the students.
6.5 Survey Statistics

The following results show the learning progress of the students through a comparison of results from the survey taken before the program and the same survey taken at the end of the program. These results are grouped according to where students were suggested to start in the material.

Students starting with RoBOTL

Basic Programming: Questions 11 – 15

<table>
<thead>
<tr>
<th></th>
<th>Q11</th>
<th>Q12</th>
<th>Q13</th>
<th>Q14</th>
<th>Q15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Solinsky</td>
<td>[I] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[I] - [NR]</td>
<td>[C] - [NR]</td>
</tr>
<tr>
<td>Dave Bohner</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[I] - [I]</td>
</tr>
<tr>
<td>Tim Rosenblatt</td>
<td>[C] - [I]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[I] - [C]</td>
</tr>
<tr>
<td>Matt DelGiudice</td>
<td>[C] - [I]</td>
<td>[I] - [C]</td>
<td>[C] - [I]</td>
<td>[I] - [I]</td>
<td>[NR] - [I]</td>
</tr>
<tr>
<td>Mark Pauly</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
</tr>
<tr>
<td>Shaun Calhoun</td>
<td>[I] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Mike Andren</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [I]</td>
<td>[NR] - [I]</td>
</tr>
<tr>
<td>Partick Adie</td>
<td>[I] - [I]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Zashanah Hume</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
<td>[NR] - [I]</td>
<td>[I] - [I]</td>
<td>[NR] - [NR]</td>
</tr>
</tbody>
</table>


Content Format: [Before] – [After]

The results of this first section of the survey show that three students did not provide any correct answers at any time. One student was incorrect on all questions; however the answers were consistent between the two surveys. The remaining two provided incorrect answers on the questions that were attempted.

The results for Q11 [Variable] seem to show that this question was a source of confusion for some people in this group. Two people modified their original correct answer to an incorrect choice. Three students were consistently incorrect, while two changed their incorrect answer to a correct one. The most common incorrect answer for
this question was Reference. This question did not seem to be a success, and may need modification.

The results for Q12 [Array] show that 5 out of 9 people consistently provided the correct answer. One student modified an incorrect answer to a correct one. These results indicate that 6 out of 9 students in this group seemed to understand, or had learned during the program what arrays are.

The results for Q13 [Floating Point] indicate that 5 out of 9 people in this group had a consistent understanding of how to store floating point numbers. One student modified a correct response to an incorrect one.

The results for Q14 [While Loop] show that 4 out of 9 students understood the ‘while loop’ that was presented in the question. Three students were incorrect on both surveys, and the remaining two students were incorrect those times they provided an answer.

The results for Q15 [x y Conditional] show that only 3 out of 9 could demonstrate that they understood the conditional statement on both surveys. One student provided the correct answer on the initial survey but not on the final one.

Overall, three students were consistently provided correct answers to the questions in this part of the survey. This conclusion excludes the results of Q11 since the results are so varied.
Object Oriented Terminology: Questions 19 – 22

<table>
<thead>
<tr>
<th></th>
<th>Q19</th>
<th>Q20</th>
<th>Q21</th>
<th>Q22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Solinsky</td>
<td>[I] – [I]</td>
<td>[I] - [NS]</td>
<td>[NR] - [NR]</td>
<td>[I] - [I]</td>
</tr>
<tr>
<td>Dave Bohner</td>
<td>[C] - [C]</td>
<td>[NS] - [I]</td>
<td>[NS] - [C]</td>
<td>[NS] - [NS]</td>
</tr>
<tr>
<td>Tim Rosenblatt</td>
<td>[NR] - [I]</td>
<td>[NR] - [C]</td>
<td>[NR] - [C]</td>
<td>[NR] - [NS]</td>
</tr>
<tr>
<td>Matt DelGiudice</td>
<td>[NS] - [I]</td>
<td>[NS] - [I]</td>
<td>[NR] - [NR]</td>
<td>[NS] - [NS]</td>
</tr>
<tr>
<td>Mark Pauly</td>
<td>[C] - [C]</td>
<td>[I] - [I]</td>
<td>[NR] - [NR]</td>
<td>[NS] - [C]</td>
</tr>
<tr>
<td>Shaun Calhoun</td>
<td>[NS] - [NS]</td>
<td>[NS] - [NS]</td>
<td>[I] - [NR]</td>
<td>[NS] - [NR]</td>
</tr>
<tr>
<td>Mike Andren</td>
<td>[NR] - [I]</td>
<td>[NR] - [NS]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [C]</td>
</tr>
<tr>
<td>Partick Adie</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
<td>[NR] - [NR]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Zashanah Hume</td>
<td>[NR] - [NS]</td>
<td>[NR] - [NS]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NS]</td>
</tr>
</tbody>
</table>


Content Format: [Before] – [After]

The results for Q19 [Class] show that two students found the best answer on both surveys. All other students in this group who attempted to answer this question chose incorrect answers. After reading the question over, the answer choices were somewhat similar to each other. Rewording this question may show that more people actually understand what a class is.

Looking at Q20 [Data Hiding] shows that only one person was able to get the correct answer on the final survey. The most common incorrect response to this question was encapsulation. These terms are sometimes used interchangeably, and students may be confused about the differences between encapsulation and data hiding.

Two students out of nine were able to identify a possible use of a member function, Q21, on the final survey. Nearly every other student chose not to answer this question.

Finally, the results of Q22 show that three students were able to identify all possible characteristics of inheritance on the final survey. Many students also chose not to answer this question or said that they were not sure of the answer.
Java Programming Experience: Questions 30 – 32

<table>
<thead>
<tr>
<th></th>
<th>Q30</th>
<th>Q31</th>
<th>Q32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Solinsky</td>
<td>[NR]</td>
<td>[NR]</td>
<td>[I]</td>
</tr>
<tr>
<td>Dave Bohner</td>
<td>[NR]</td>
<td>[C]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Tim Rosenblatt</td>
<td>[NR]</td>
<td>[C]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Matt DelGiudice</td>
<td>[NR]</td>
<td>[NR]</td>
<td>[C]</td>
</tr>
<tr>
<td>Mark Pauly</td>
<td>[NR]</td>
<td>[C]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Shaun Calhoun</td>
<td>[NR]</td>
<td>[NR]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Mike Andren</td>
<td>[NR]</td>
<td>[NR]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Partick Adie</td>
<td>[NR]</td>
<td>[C]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Zashanah Hume</td>
<td>[NR]</td>
<td>[NR]</td>
<td>[NR]</td>
</tr>
</tbody>
</table>


Content Format: [Before] – [After]

Before the Frontiers program, none of the students in this group answered any Java questions. The final survey results show that only one student was able to complete all Java questions correctly. Three other students were able to correctly conceptualize the response for Q30 [Loop with conditional statement], but their answers had syntax errors. Only one additional student was able to write a class definition in Java.
Students starting with JavaBOTL

Basic Programming: Questions 11 – 15

<table>
<thead>
<tr>
<th></th>
<th>Q11</th>
<th>Q12</th>
<th>Q13</th>
<th>Q14</th>
<th>Q15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gregg Visi</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Joe Havelick</td>
<td>[I] - [I]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Simon Sanchez</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Adam Wong</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Neil Whitehouse</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[I] - [I]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Scot Simpers</td>
<td>[C] - [NR]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[I] - [I]</td>
<td>[I] - [I]</td>
</tr>
<tr>
<td>Jeff Model</td>
<td>[C] - [C]</td>
<td>[I] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Daniel Wallance</td>
<td>[C] - [C]</td>
<td>[I] - [C]</td>
<td>[C] - [C]</td>
<td>[I] - [C]</td>
<td>[C] - [C]</td>
</tr>
<tr>
<td>Michael D’Angelo</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
<td>[C] - [C]</td>
</tr>
</tbody>
</table>


Content Format: [Before] – [After]

The results for this group of students are not as interesting, but clearly an improvement over the previous group. Most students had no incorrect answers in this section. One student answered Q11 incorrectly, which may be due to wording problems. Scot’s answers to Q14 and Q15 were inconsistent and very far from the correct answers. Neil answered Q14 with the same wrong answer both times. With the possible exception of Scot, the results show that the students in this group had a good understanding of basic programming concepts.
Object-Oriented Terminology: Questions 19 – 22

<table>
<thead>
<tr>
<th></th>
<th>Q19</th>
<th>Q20</th>
<th>Q21</th>
<th>Q22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gregg Visi</td>
<td>[C]</td>
<td>[I]</td>
<td>[NR]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Joe Havelick</td>
<td>[C]</td>
<td>[I]</td>
<td>[C]</td>
<td>[C]</td>
</tr>
<tr>
<td>Simon Sanchez</td>
<td>[I]</td>
<td>[I]</td>
<td>[NR]</td>
<td>[NR]</td>
</tr>
<tr>
<td>Adam Wong</td>
<td>[I]</td>
<td>[I]</td>
<td>[NS]</td>
<td>[NS]</td>
</tr>
<tr>
<td>Neil Whitehouse</td>
<td>[C]</td>
<td>[C]</td>
<td>[I]</td>
<td>[I]</td>
</tr>
<tr>
<td>Scot Simpers</td>
<td>[NS]</td>
<td>[C]</td>
<td>[I]</td>
<td>[I]</td>
</tr>
<tr>
<td>Jeff Model</td>
<td>[NS]</td>
<td>[C]</td>
<td>[I]</td>
<td>[I]</td>
</tr>
<tr>
<td>Daniel Wallance</td>
<td>[C]</td>
<td>[C]</td>
<td>[I]</td>
<td>[C]</td>
</tr>
<tr>
<td>Michael D’Angelo</td>
<td>[I]</td>
<td>[I]</td>
<td>[NR]</td>
<td>[NR]</td>
</tr>
</tbody>
</table>


Content Format: [Before] – [After]

The results for this section of the survey show that the object-oriented knowledge tested was not learned by many of the students in this group, even though this group was the more experienced group.

The results for Q19 show that many of the students in this group were able to locate what I felt to be the best definition of a class. One of the incorrect answers, a template that can only be used to create one specific type of object, was chosen twice. Both the correct answer as well as the previous incorrect answer contains subtleties that may be open to interpretation. Those who chose either answer could provide adequate arguments that support their choice as the correct one.

Results for Q20 show that only three people could correctly distinguish data hiding from encapsulation. The incorrect answer chosen most often was encapsulation.

The results for Q21 and Q22 I consider to be the most important results of this section, since these questions dealt with programming tasks that the students performed during the program many times. Q21 deals with member functions and their use in retrieving or setting private variables. Only two people were able to correctly identify that the solution to Q21 was to provide a member function. This could possibly suggest
that the students who did not answer correctly did not have enough time to absorb the experience that they received from following the tutorials. In the JavaBOTL section of the program, students dealt with inheritance; however only three students from this group were able to correctly identify all three of the possible answers for Q22 as correct.

**Java Programming Experience: Questions 30 – 32**

<table>
<thead>
<tr>
<th></th>
<th>Q30</th>
<th>Q31</th>
<th>Q32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gregg Visi</td>
<td>[NR] – [NR]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
</tr>
<tr>
<td>Joe Havelick</td>
<td>[NR] – [I]</td>
<td>[NR] - [C]</td>
<td>[NR] - [C]</td>
</tr>
<tr>
<td>Simon Sanchez</td>
<td>[NR] – [I]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
</tr>
<tr>
<td>Adam Wong</td>
<td>[NR] – [C]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
</tr>
<tr>
<td>Neil Whitehouse</td>
<td>[NR] – [I]</td>
<td>[NR] - [I]</td>
<td>[NR] - [NR]</td>
</tr>
<tr>
<td>Scot Simpers</td>
<td>[NR] – [NR]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
</tr>
<tr>
<td>Jeff Model</td>
<td>[NR] – [I]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
</tr>
<tr>
<td>Daniel Wallance</td>
<td>[NR] – [C]</td>
<td>[NR] - [C]</td>
<td>[NR] - [I]</td>
</tr>
<tr>
<td>Michael D’Angelo</td>
<td>[NR] – [C]</td>
<td>[NR] - [NR]</td>
<td>[NR] - [NR]</td>
</tr>
</tbody>
</table>

**Legend:** [I] – Incorrect    [C] – Correct    [NR] – No Response

**Content Format:** [Before] – [After]

Since seven of these nine students went on to the Java section of the course, many completing it, these results are somewhat surprising. The results for Q30 [Loop with conditional] show that only three of the nine students in this more experienced group were able to write a simple loop correctly. Three of the students who were incorrect had a syntax error or two, or incorrect array range, but they demonstrated that they knew the concept. The other student who was incorrect wrote the conditional statement, but no loop. The results for Q31 show that even fewer students, only two, could construct a simple class definition consisting of a couple variables and one method. Q32 shows that almost nobody in this group can deal with inheritance. Only one person in this group was able to get the correct answers for the three questions in this section.
7 Conclusions

7.1 Survey Benefits

This year, the teaching staff of the Computer Science section of the Frontiers program was able to easily gather a broad range of background information about the students. Using this background knowledge, the students could be placed in the appropriate section of the course material. During previous summers, this knowledge would have to be obtained through conversations with students. Since the students outnumbered the staff approximately six to one, this survey was a welcomed addition to the program.

This survey also provided information that was invaluable to those structuring the program. After analyzing the students’ results from the survey taken on the final day of the program, it was clear that the students had not learned as much from the web-based material as was previously thought. Most students failed to answer correctly the questions that dealt with material taught in the program. This lack of learning was attributed to a lack of interest in the existing projects. The students were often browsing the web, or working on projects of their own rather than the material provided. Many students; however, did progress through much of the material provided, but as the final survey showed, there is a difference between completing a tutorial and learning the material within it.
7.2 Future Work

First of all, for this survey to be more effective the changes outlined in the Survey Validity section of the Results and Analysis chapter should be completed. This will ensure that the test more accurately reflects the student’s knowledge.

Second, the results of this program show that the course material covered was not completely understood during the time allowed. In order to better guide the students through the material, the staff should have the ability to monitor what the student has learned not only at the end, but also at intermediate steps in the program. In this way, the staff can be certain the students have learned the material in previous sections before they tackle more complex problems. Based on the results of intermediate tests, students may or may not be allowed to continue. This ‘security’ could be obtained by following these steps:

1. The student completes a test after finishing a unit of work.
2. The results of this test are evaluated according to a set of rules defining correct answers.
3. If an adequate number of questions are answered correctly, a web page providing a link to the next section is shown to the student.

The same goal could also be accomplished by incorporating adaptive navigation support into the course material. This method could be accomplished by actually hiding existing links within the pages if the student is not yet ready to follow them. This method would require the web server to work in conjunction with a database containing student information. This database would be updated after each test was given. When displaying
a page containing links that depend on the student’s knowledge, the server would query the database to find out if the links should be shown or not.

Actually hiding the links could be accomplished in various ways. Microsoft Active Server Pages is a server side scripting language that allows page formatting to be done on the server. This requires; however, that the web server be running on a Windows platform. This would be the ideal solution to this problem; however the amount of work needed for this solution to work with the existing infrastructure of the ReCourse system may be extensive.
Bibliography


AI approaches to language learning.


gopher://vmsgoper.cua.edu:70/00gopher_root_eric_ae%3A%5B_tessay%5Deval.txt


An examination of what a language is, how it works, and how it is learned. Also, how learning a second language differs from learning a primary one. Focus on learning language in context of culture, not merely grammar/translation exercises.


Eklund, John, and Peter Brusilovsky. *The Value of Adaptivity in Hypermedia Learning*

gopher://vmsgoper.cua.edu:70/00gopher_root_eric_ae%3A%5B_tessay%5Dmisuse.txt


Haynie, W. J. III. Effects of Multiple-Choice and Short-Answer Tests on Delayed Retention Learning 


Textbook used for Cognitive Psychology. Covers topics such as: speaking, writing, bilingualism, problem solving and creativity, deductive reasoning and decision making.

Discussion of the transfer of learning: generalizing what we have learned, and using that knowledge to solve related problems. Contains 9 chapters resulting from a Lecture at the University of Calgary


Discusses how to construct performance measures as well as how to gather data on their effectiveness.


Educational and Cognitive Psychology point of view: What motivates learning? How knowledge can be made personal for better learning/remembering. Addresses specific domains including math, science, etc. and addresses secondary school level.


Offers models/specific methods for implementing content based instruction (using subject matter rather than grammar) through eleven case studies


Part I gives a broad, informal overview of the theoretical underpinnings of teaching and learning in higher education from a variety of perspectives—educational, psychological, social, etc. Also discusses the nature of the modern class and student. Part II presents a collection of different practical teaching formats and models, from lecture to discussion, student work-groups to individualized computer lessons.
References Without Author


Discussion of Learning and Assessment Theories.

*Glossary of Education Terms and Acronyms.* Pathways to School Improvement. [http://www.ncrel.org/sdrs/areas/misc/glossary.htm](http://www.ncrel.org/sdrs/areas/misc/glossary.htm)

*Improving Your Test Questions.* University of Illinois at Urbana-Champaign: Office of Instructional and Management Services.


*Match Assessments to Instructional Content and Student Performance Goals.* Pathways to School Improvement. [http://www.ncrel.org/sdrs/areas/issues/methods/assment/as7goals.htm](http://www.ncrel.org/sdrs/areas/issues/methods/assment/as7goals.htm) (6 Oct. 1999)


WBTIC is a non-profit resource for those interested in developing and delivering web-based training, online learning, or distance education. Here you will find a WBT primer, surveys, discussion forums, and resource links.
Appendices

1. Frontiers Survey and Source Code
2. Survey Results
1: Computer Science Major #1
2: yes
3: built
4:,,,winnt,,,,
5: yes
6:,,,,,,,,
7: yes

8: 10 years
9: ,Assembly, Basic, C, C++, HTML, Java, Scripting, Lisp, Lisp, Pascal,,, Scheme, VB
10:,,,,,other
11: variable
12: array
13: double
14: 10
15: 0
16: yes
17: yes

18: C++
19: A template that can only be used to create one specific type of object
20: Encapsulation
21: get and set methods
22: correct
23: on
24: selfWeb,,,,
25: n/a
26: n/a
27: n/a
28: yes
29:
30: for (int i = 0; i < 10; i++)
   if (array[i] > 0) array[i]++;

31: class Blah {
   private int x;
   private int y;
   public Blah() { x = 0; y = 0; }
}
32: class Blah2 extends Blah {
   private int xl;
   private int yl;
}

33: Yes
34: Yes
35: definesProc
36: combo
A template that can only be used to create one specific type of object

Create method function:
```c++
void setx(DT newx) { x = newx; }
```
where DT is data type of x.

Events management program (~5000 lines)

Yes, I wrote an image side-show gallery.

```c++
void foobar () {
   int a;
   for (a=0; a<10; a++) if (array[a] > 0) array[a]++;
}
```

```c++
public class MyClass {
   private int a,b;
   public foobar() {}
}
```

```c++
public class MyChildClass extends MyClass {
   private int aa,bb;
}
```

DefinesProc

Combo
1: Biology Major #1
2: yes
3: purchased
4: dos, win3, win95, winnt, unix,
5: yes
6: type, music, websurf, webdesign, other
7: yes
8: 4 years
9: Assembly, Basic, C, C++, HTML, Scripting, Lisp, Pascal, Scheme, VB
10: hsclass, colclass,
11: reference
12: array
13: double
14: 10
15: 1
16: no
17: yes
18: C++
19: correct
20: notsure
21: I don't remember
22: incorrect
23: on
24:,,,
25:,
26:
27:
28:
29:
30:
31:
32:
33:
34: No
35: definesVar
36: combo
3. Student Progress Tables