ALTERNATIVE APPROACH FOR TEACHING PROGRAMMING SUBJECTS

Zalili Musa, Ruzaini Abdullah Arshah, Rozlina Mohammed, Rohani Abu Bakar, Tuty Asmawaty Abdul Kadir, Aziman Abdullah, Adzhar Kamaluddin

University College of Engineering & Technology Malaysia
Locked Bag 12, 25200 Kuantan Pahang
zalili@kuktem.edu.my, ruzaini@kuktem.edu.my, rozlina@kuktem.edu.my, rohani@kuktem.edu.my, tuty@kuktem.edu.my , aziman@kuktem.edu.my, adzhar@kuktem.edu.my

ABSTRACT

This paper will discuss new approaches in teaching programming skills. We discover two main elements in programming skills, which are problem solving and syntax of language. In KUKTEM, we are trying to emphasize these two elements to our students. The discussion then will reach to the extent of how do we adopt this elements in teaching and how the result from the students' assessments reflects the effectiveness of this approach. At the end, this paper hopefully results a new approach, which enable a high competency in students' programming skills.

KEYWORDS

Curriculum, Computing, Problem-based Learning

INTRODUCTION

Learning to program is fundamental in degree level in IT education. Today, teaching programming effectively in the universities or collages is such a big challenge. The phenomena [1], [2] of having (1) graduates only capable of writing simple program, (2) final years students trying to avoid programming subject, (3) assignments become burden for students are normal. These components become mechanisms in discouraging students to develop their programming skill. There are six major contributors for the problem above to be looked into (1) teaching methods (2) course delivery and materials (3) assessments (marks distribution) (4) teaching and learning infrastructure (5) students' knowledge background (pre-requisite) (6) and students' learning style and motivation. [3]

In general, teaching programming appears to be a straightforward task. Most lectures are only fluent in one or few programming languages might not be looking at the prospect of learning other languages, whereas knowing various programming languages is important when teaching programming.

There are paradigms in approaches. The materials are arranged neatly to fit into the lecture course and can be readily organized according to the lecture progress. Sometimes the materials presented are taken from predecessors. As a result, lectures are lack of creativity in delivering programming skills, students tend to follow the prepared materials without fully understand the theory behind. Assessment is simply a matter of devising some suitable programming tasks. Sometimes, marks distributions do not reflect the students' programming skills. High score doesn't mean they are capable of writing programs at the given standard or specifications.

CURRICULUM STRUCTURE

KUKTEM is a technical skill base university. It employs the concept of 'learning by doing', therefore the need for higher competency in programming is crucial. The new approach has been carried out to this specific area of in programming.

The curriculum setting will generate the idea of how the approach to be carried out. Let us take BSC software engineering for example. BSC is divided into 3 fundamental areas, which are general subject, core faculty and core program, as shown in Figure 1a. As shown in Figure 1b, seventy three percent of the skills are technical skill, the rest are technical knowledge. This higher portion of technical skill seems just right in achieving its goal.

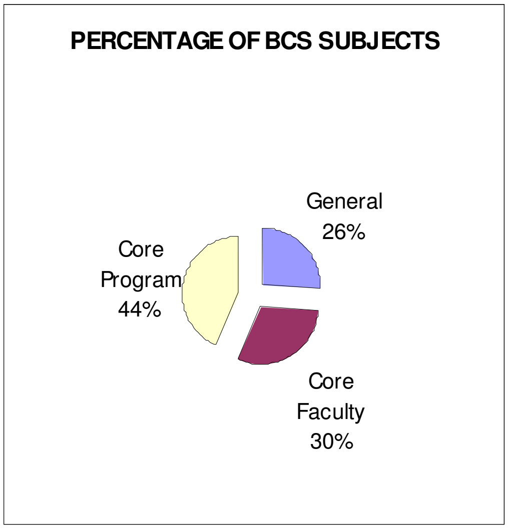

Figure 1a : Percentage of BCS Subjects

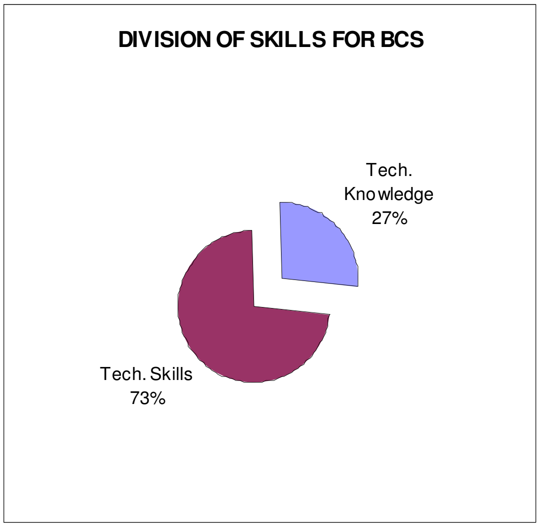

Figure 1b : Division skill For BCS Curriculum

In IT, the critical part of programming is nothing but proficiency in programming. It is the entire collection of activities such as description, development and being able to implement such an effective algorithm solution.

Programming subject are included in most sub areas in Figure 2. Students are exposed throughout the stages starts from foundation towards applied stages. However there are 2 factors which are important in skill base learning; ownership and practice. Ownership is an internal motivator that drives one for further practicing [6]. And at the same time students have a freedom to explore the subject within their interest.

Programming languages evolves and it is necessary for students to cope with the latest languages. Degree students are taught with several programming languages. In Figure 3 during the first stage of learning the skill, students are taught with C and C++ programming languages. Actually these basic languages only becomes as a 'jumpstart' mechanism in learning other languages. As the stage moves on, students are required to apply their skill in developing a small project for Graphic User Interface (GUI) together with Application Development Workshop. Usually, during GIU class students are allowed to use the language they are familiar with. Now, students are required to develop a small-scale project using other languages during their workshop session. The forth generation programming languages are highly preferable. The project is then to be completed with documentation accordingly so that it can be awarded with Application Development – Level 2 by MLVK (National Vocational Training Council).

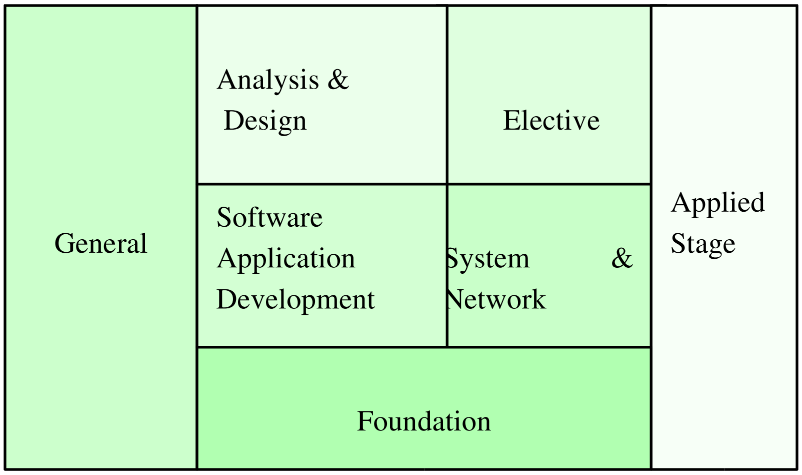

Figure 2: Approach in BCS Curriculum

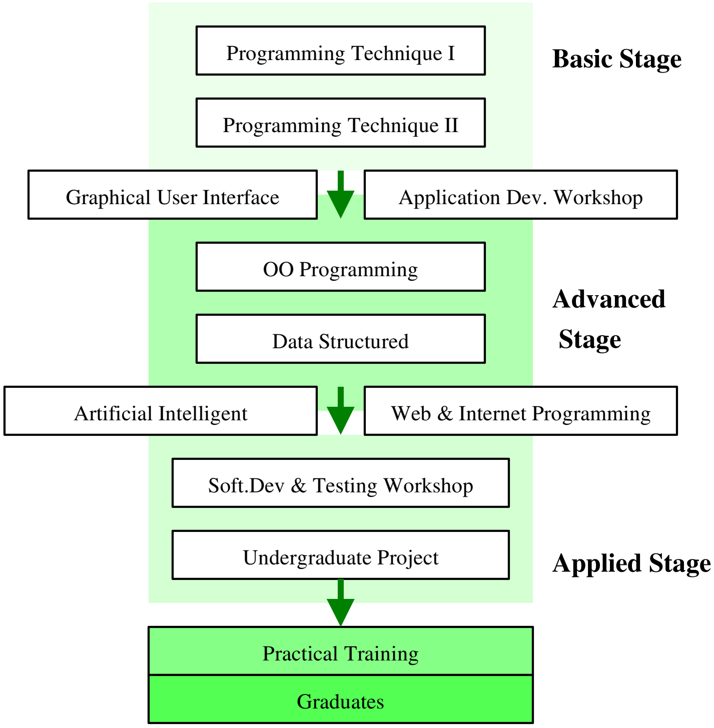

Figure 3 : Stages in Programming

The second stage is to enhance object-oriented and data structure skills. At the advanced stage, students are capable implementing their knowledge in several subjects such as Artificial Intelligence and Web &

Internet Programming. The final stage is an applied stage. At this stage, students are required to apply their skills and knowledge to complete series of software workshops and their undergraduate project which formally known as a final year project. Software workshops consist of three series: (1) Software Development Plan, (2) Software Requirements, and (3) Software Development and Testing. These workshops are running at different semesters. The task is to produce a middle-scale project, complete with a standard documentation. It is compulsory that the product (system) is practical and to be commercialized. The project is done of five to six students. Student should find their own user or target user for their product. The undergraduate project is done individually; quite similar to what has been implemented in other universities.

At the applied stage, students are strongly encouraged to develop a ‘real’ project. The reason is to ensure that our students have a ‘real-world’ experience in software project development environment. Their commitment has giving them more sense of belonging and rewarding as well.

HOW DO WE IMPLEMENT?

There are two main skills in computer-programming course: (1) syntax and semantics of the language, and (2) problem solving skill. These skills are delivered through lecture, tutorial and lab sessions [4].

Knowledge on syntax and semantic can be dig up from any materials related to programming languages. The skills on syntax and semantic can be polished up through some exercises or practical sessions. Assessment of the knowledge on syntax and semantic is straightforward task. However, a proper assessment mechanism must be prepared in order to assess the problem solving skills. Problem-based learning (PBL) is identified as a suitable approach for teaching computing and developed employability skill. [9]. Therefore, we are adopted the PBL especially during tutorial and lab sessions.

Students know that they should be competent to do programming in order to pass their exams. At the same time, the same skill and knowledge are relevant to MLVK requirement. Students will be awarded with a certificate. Thus, the required skills suit industries needs. In order to achieve the target, we have creates a few assessments method during lecture, lab and workshop sessions.

KUKTEM interpret subject credit according to meeting hours as shown in Figure 4. Meeting hours are consists of lecture, tutorial and lab session.

Subject’s Credit	Lecture	Tutorial	Laboratory
1	1	1	2

Figure 4

For example, our first programming subject is Programming Technique 1. It is a four credits subject. Four credits are equivalent to two hours lecture and four hours laboratory sessions per week. Normally, programming subject did not have tutorial session because we need to spend longer time during laboratory sessions.

Lecture Session

As same as conventional methods, students are provided with a lecture session in a lecture hall or classroom. We start our lecture session by reviewing lesson, and then move to the next lesson. After delivering an important key in that lesson, student will be provided with programming example to ensure they understand what they have learned in class. After that, simple questions about the implementation of that concept are given.

There are three categories of assessment during lecture session: (1) quiz, assignment and writing test. We defined a quiz as a short questions to test their understanding, related to what they have learned during lecture. We might include a very simple problem solving mechanism as a quiz. For one quiz, students should spend only 15- 20 minutes to answers the questions. Usually, quiz will be held at the end of every chapter's lecture. Appendix 1 shows the sample of quiz.

Assignment is purposely to test the problem-solving skills. Students are provided with problem solving question. They need to submit their assignment within one to two weeks after they receiving the questions. Normally, the questions will test student's capability to solve the problem from case study and then develop the programming to solve it. Assignments can be considered as a part of practical test. Example of question for assignment can be found on Appendix 2.

Written test are prepared to evaluate student's capabilities on programming concept. The test are done twice per semester, which are mid-term exam and final exam. For written test, we make a several type of questions such as multiple-choice questions, true-false questions and also some question on creating a fragment code and/or a complete program. Mid term test will cover from first topic until week seven's topic, meanwhile the final exam will cover materials from week eight to week fourteen.

Lab Session

Laboratory sessions for each subject are held three or four hours per session (depends on credit hours of the subject). For the three hours lab session, it will be run on one session, meanwhile if the lab session covered four hours, the lab session will be separated into two session; two hours for per session. The main purpose of the lab session is to look at student's capabilities to solve a small case study and some issues on syntax and semantics.

During the lab session, students are allowed to discuss among themselves to find out the solution. Through this approach, we are developing their team working, and communication skill eventually. Student will be provided with 'Lab Sheet' for each lab session. Lab sheet is a list of questions or case study related to topic that they have learned in the class. Students need to submit their lab sheet after the session. Normally, each lab sheet will give 1% mark out of their assessment marks. Appendix 4 shows the sample of Lab Sheet.

Besides lab exercises from lab sheet, we have laboratory exam called Hands-on Test (HOT). During HOT, students need to develop a program based on questions provided at laboratory within specific time. Students need to ensure their program is free syntax error. The mark will be given based on their output and the way they write that program. Normally, this will be held three to four times per semester carried out 30 to 40 percent of the assessment marks. HOT is an open book examination. Students are allowed to bring whatever material they think will help them to answer HOT questions. Normally, a HOT question is one case study problems, which is divided into several stages, based on their difficulty. An example of HOT question can be found at Appendix 3.

On the other hand, students need to attend another session of laboratory we known as workshop. During workshop sessions, students are divided into small groups. Actually, workshop is not only to sharpen their programming skill but workshop is a place where they can learn and apply a complete software development life cycle. During the workshop session, students need to develop a complete system from scratch supervises by one lecturer as a project supervisor. In order to achieve grade 'A' for the workshop, students need to have their own and real client for theirs' proposed system. Other lecturer will evaluate progress of workshop project and student from other group might react as a reviewer. Workshops' coordinator is responsible to arrange a few agenda for the workshop. The agenda are such as inviting experts from industries, project proposal evaluation, project progress presentation, and project progress evaluation. The presentation and the evaluation sessions seems like a viva or oral examination for any dissertations

IMPACT OF THE IMPLEMENTATION

The above teaching approach has been implemented at KUKTEM since two years ago. Major impacts of the implemented approach are review in this section.

Tremendous impact on programming capability

In general, our students do not have any background knowledge on programming. Less than five percent of them have basic influence on programming during their matriculation program while the others are non-computer background. At a beginning, most of them are not interested in computing area.

After 'go-through' the learning cycle, there's a tremendous improvement on their programming capability. After one semester, they are capable to think on how to develop a complete working project. It was proven during workshop sessions. Besides programming, they are capable to create and deliver complete documentations according to standard documentation procedure. Internal lecturer together with external experts has guided them in order to complete their software development and documentation. During workshop sessions, students have opportunity to expose and communicate with various levels of practitioners in computing area. We are conducting a few open sessions between students & industries. We have received a very positive response from the industries.

Increased the motivation to learn

As cited in Beumont and Fox [9], (1) staff and students rate PBL higher in their evaluations and enjoy it more than traditional teaching, and (2) PBL students use higher-level strategies for understanding and self-directed study. Having implemented in KUKTEM, PBL have increased the student's motivation to learn programming subjects even though learning to program is the most difficult part in some computing courses. Students have a capability to learn on their own; therefore they are capable to produce a computer program by using any languages that is not taught in class. These capabilities show a positive sign that their motivation to learn has been increased.

CONCLUSION

To succeed, there are a few issues that must be taken into consideration. One of the issues is increase in workload and contact hours for the lecturers. In general, lecturers are responsible to conduct lecture and/or tutorial session, whereas we are responsible to handle lecture, tutorial, lab and workshop sessions.

However, using a few mechanisms can reduce the above problem: (1) A reliable ‘automatic grading system’ for quizzes and exams. The system should capable to handle objective, subjective & programming test. (2) ‘Automatic plagiarism detection’ is needed for assessing student’s programs, (3) ‘Lab demonstrator’ is might be suitable in helping lecturer to conduct lab sessions.

Hopefully, several approaches and assessment method that was applied at KUKTEM will be ensure that our forthcoming graduate is well equipped with programming and problem solving skill in order to fulfill industrial needs and expectations.

REFERENCES

[1] Jenkins T, *Teaching Programming – A Journey from Teacher to Motivator*, LTSN-ICS One Day Workshop on the Teaching of Programming, 2001

[2] Deraman A. *Teaching Software Factory: An Approach to programming skill Improvement*, Programming Science Workshop, Cyberview Lodge Resort Cyberjaya, Malaysia, August 2003.

[3] Ahmad R. et.al. *First Programming Course: Perception and Performance of Students*, Programming Science Workshop, Cyberview Lodge Resort Cyberjaya, Malaysia, August 2003.

[4] Chalk P, 2nd Annual Conference of the LTSN Centre for Information & Computer Science , 2002.

[5] Sophatsathit, P., A study of Programming Skill Development in Education, Department of Matematics, Faculty of science Chulalongkron University.

[6] Scott, M.G, Guided Active Discovery : A New Kind of Education, Article Useractive, Inc

[7] ACM. Computing Curricula. 1991 : Report of the ACM/IEEE-CS Jint Curriculum Task Force, 1991.

[8] Wilensky, R., The Psychology of Computer Programming. Van Nostrand Reinhold, 1975.

[9] Beumont C, Fox C , Learning Programming: Enhancing Quality Through Problem-Based Learning, 4th Annual Conference of the LTSN Centre for Information & Computer Science, 2003

APPENDIX 1: SAMPLE OF QUIZ

Name:		MARKS: [3]
Metric No.:		
Section:		

File Input & Output

1. This question is specific to the Windows platform. Suppose you want to open a file program.java inside the directory C:\JavaProgram\FileIO. What is the actual String value you pass in the constructor for the File class?

   [1 marks]

   Answer:

.

2. Assume bufReader, a BufferedReader object, is properly declared and created. What is wrong with the following? Suggest your own solution.

   [2 marks]

   double d = bufReader.readInt();

Answer:

APPENDIX 2: SAMPLE OF ASSIGNMENT

Project 1

MyJava Coffee Outlet runs a catalog business. It sells only one type of coffee beans, harvested exclusively in the remote area of Irian Java. The company sells the coffee in 2-lb bags only, and the price of a single 2-lb bag is $5.50. When a customer places an order, the company ships the order in boxes. The boxes come in three sizes: the large box holds twenty 2-lb bags, the medium 10 bags, and the small 5 bags. The cost of a large box is $2.00; a medium box, $1.00; and a small box, $0.50. The order is shipped using the least number of boxes with the cheapest cost. For example, the order of 25 bags will be shipped in two boxes, one large and one small. Develop an application that computes the total cost of an order. Use any appropriate technique for input and output. Display the output in the following format:

```
Number of Bags Ordered: 52 - $ 286.00

Boxes Used:
            2 Large     - $4.00
            1 Medium              - $1.00
            1 Small     - $0.50
Your total cost is: $ 291.50
```

Project 2

Repeat Project 1, but this time, accept the date when the order is placed and display the expected date of arrival. The expected date of arrival is two weeks (14 days) from the date of the order. The order date is entered as a single string in the *MM/dd/yyyy* format. For example, November 1, 2002 is entered as 11/01/2002. There will be exactly two digits for the month and day and four digits for the year. Display the output in the following format:

```
Number of Bags Ordered: 52 - $ 286.00
```

Boxes Used:

2 Large	- $4.00
1 Medium	- $1.00
1 Small	- $0.50

Your total cost is: $ 291.50

Date of Order: November 1, 2002
Expected Date of Arrival: November 15, 2002

APPENDIX 3: SAMPLE OF HANDS-ON-TEST

HANDS-ON-TEST #2

INSTRUCTIONS

1. Save your program in a directory named **HOT2b** in a diskette to be submitted at the end of the session.
2. Please save the program in another diskette as your backup copy.
3. Your diskette should contain program file **only**. Please delete other file(s) before submission.
4. This test paper has **2** printed pages.
5. Complete all of the tasks

Start with the name of your God…

Case Study

MyJava Coffee Outlet runs a catalog business. It sells only one type of coffee beans, harvested exclusively in the remote area of Irian Java. The company sells the coffee in 2-lb bags only, and the price of a single 2-lb bag is $5.50. When a customer places an order, the company ships the order in boxes. The boxes come in three sizes: the large box holds twenty 2-lb bags, the medium 10 bags, and the small 5 bags. The cost of a large box is $2.00; a medium box, $1.00; and a small box, $0.50. The order is shipped using the least number of boxes with the cheapest cost. For example, the order of 25 bags will be shipped in two boxes, one large and one small.

MyJava Coffee Outlet decided to give discounts to volume buyers. The discount is based on this table

Order Volume	Discount (% of total price)
>= 25 bags	5%
> 50 bags	10%
>= 100 bags	15%
>= 150 bags	20%
>= 200 bags	25%
>= 300 bags	30%

Each bag of beans costs RM5.50. Compute the total charge including discount and shipping costs.
The output should look like this:

```
Number of bags ordered          Discount            Boxes Used          Total charge
------------------------------------------------------------------------------------
43- RM 236.50                   5% - RM11.83        1 Large             RM 229.67
                                                    2 Medium
173 – RM 951.50                 20% - 190.30        80 Large            RM 761.20
                                                    1 Medium
                                                    1 Small
```

Tasks

1. List 3 of the program tasks

[3 marks]

2. Create the class diagram of the program

[7 marks]

3. Write a complete program.

[20 marks]

Name:____

Metric Number: .____

Course (tick '❁'): **HDCS** **HBCS**

HBCN **HDBCN**

Set: 2 b

Grading Scheme

Tasks	Marks
1	[3]
2	[7]
3	[20]
Marks	

APPENDIX 4: SAMPLE OF LAB SHEET

Topic: Defining Your Own Classes

Objective (s):
1. Identify appropriate variables & constants
2. Creating a class, including data member(s), function member(s).
3. Creating a main function in a separate file

Related Material (s):
1. Lecture slides
2. Sun Microsystems websites at:
   - ✓ http://java.sun.com/j2se/1.4.2/docs/api/

Lab Sheet 3

Task 1: Simple class

Question 1

Determine the output of the following program.

```
/*
        Program Question1
*/
class Question4
{
        private int x, y, z;
        public void start()
        {       int x, y;
                setup();
                x = y = 10;
                modify(x, y);
                printout();
        }
        private void setup() {
                x = 100;
                y = 200;
                z = 300;
        }
        private void modify( int x, int y ) {
                z = x + y;
```

```
            x = z;
            y = 2 * z;
        }
        private void printout() {
            System.out.println(“x = “ + x);
            System.out.println(“y = “ + y);
            System.out.println(“z = “ + z);
        }
    }
    /* Main Class */
    class Q4Main {
        public static void main( String[] args ) {
            Question4 q4;
            q4 = new Question4();
            q4.start();
        }
    }
```

Question 2

Improve the following program Question1 by converting the class to two classes: the main Q5Main class and the instantiable Question5 class. Avoid duplicating the same code for computing the circumference of two circles. Define a private method in Question5 that accepts the radius of a circle as its parameter and returns the circumference of the circle.

```
    /*
        Program Question2
    /*
class Question5 {
public static void main( String[] args ) {
    InputHandler input = new InputHandler(); //see Section 4.7
    double radius;
    double circumference;
    int smallRadius, largeRadius;
    double smallCircum, largeCircum;
    //compute circumference of a smaller circle
    smallRadius = input.getDouble(“Radius of smaller circle:”);
    radius = smallRadius;
    smallCircum = 2 * Math.PI * radius;
    //compute circumference of a larger circle
    largeRadius = input.getDouble(“Radius of larger circle:”);
    radius = largeRadius;
    largeCircum = 2 * Math.PI * radius;
    //Display the difference
    System.out.println(“Difference in circumference of two circles”);
System.out.println(“Circumference of smaller circle: “ + smallCircum);
    System.out.println(“\n”);
System.out.println(“Circumference of larger circle: “ + largeCircum);
    System.out.println(“\n”);
    System.out.println(“Difference: “ + (largeCircum – smallCircum));
    }
}
```

Question 3

Is there any problem with the following class? Is the passing of an argument to the private methods appropriate? Are the data members appropriate? Explain.

```
    /*
        Problem Question3
    */
    class MyText {
        private String word;
        private String temp;
        private int idx;
        public String firstLetter() {
            idx = 0;
            return getLetter(word);
        }
        public String lastLetter() {
            idx = word.length() – 1;
            return getLetter(word);
        }

        private String getLetter(String str) {
            temp = str.substring(idx, idx + 1);
            return temp;
        }
    }
```

Task 2: Arithmetics, Constant & Variables

Question 4

Write a Distance class that can express distance in both meters and feet and inches. 1 ft = 0.3048 m.

Question 5

Using the Distance class from Exercise 4, write an application that inputs distance between two cities in kilometers and displays the distance in miles. 1 mi = 1.6093 km. Do not modify the given Distance class.

Question 7

Write a program that computes the total ticket sales of a concert. There are three types of seatings: A, B, and C. The program accepts the number of tickets sold and the price of a ticket for each of the three types of seats. The total sales are computed as

```
totalSales =    numberOfA_Seats * pricePerA_Seat +
                    numberOfB_Seats * pricePerB_Seat +
                    numberOfC_Seats * pricePerC_Seat;
```

Write this program, using only one class, the main class of the program.

Question 8

Redo Exercise 7 by using a Seat class. An instance of the Seat class keeps track of the ticket price for a given type of seat (A, B, or C).