

# **Intelligent Online Math Tutorial**

## **User Manual**

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# **Index**

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- 1. Introduction**
- 2. Login**
- 3. Choosing Problem Type**
- 4. Choosing the Mode**
- 5. Learning Mode**
  - 5.1 Start Over**
- 6. Solving Mode**
  - 6.1 Schematic Knowledge**
  - 6.2 Semantic Knowledge**
  - 6.3 Formula**
  - 6.4 Image**
- 7. Learning Profile**
  - 7.1 Problem Solving Progress**
  - 7.2 Missing Concepts**
  - 7.3 Misconceptions**
  - 7.4 Learned Concepts**
  - 7.5 Learning Profile Of Mensuration Domain**
  - 7.6 Activity**
- 8. Logout**

## 1. Introduction

This tutorial is an Intelligent Online Math tutorial based on semantic-web technology. It gives provision for the user to understand and solve problems in Mathematics by providing feedback based on the actions of the user. It also tracks the user's actions and performance in order to judge the user's competency level in terms of understanding the concepts behind the problems.

## 2. Login

The Login page provides a brief description about the Math tutor and allows the user to enter his registered username and password. On clicking the submit button, the user is redirected to the "Choosing Problem Type" page. In case wrong authentication details are provided the user is redirected to the same page.

**Intelligent Tutor for Math Word Problems**

**Information About Intelligent Tutor**

This is an intelligent tutoring system for teaching word problem solving. To use this student needs to register by filling a form for collecting basic information. After receiving the login information through e-mail, student can start using it. After login student's learning home page will be opened where student can find table of contents from which student can select type of problem to learn or practice and select one problem of the same type from the problem database.

After the selection of the problem student can start solving the problem directly by using a tool named input editor which is available in a separate tab. If needed student can see a sample problem. If student does not know how to solve the problem and wants help then student can click on the tab 'Need Help?' and get help from the machine tutor. This system tracks student's interaction and builds student's learning profile. Student's learning profile contains a) Type of problems student have learned b) Concepts which student know very well c) Concepts which student have not understood.

The tool input editor contains mathematical symbols, alphabets for variables, various mathematical operations and various shapes for drawing rough diagram needed for diagrammatic representation of the problem. If student wants to know key terms or concepts which are used in the problem then student can see it by clicking on the key concepts. After solving one problem student can select another problem of the same type for practice if needed. Student can also see schematic knowledge structure of the word problem if needed.

**Login**

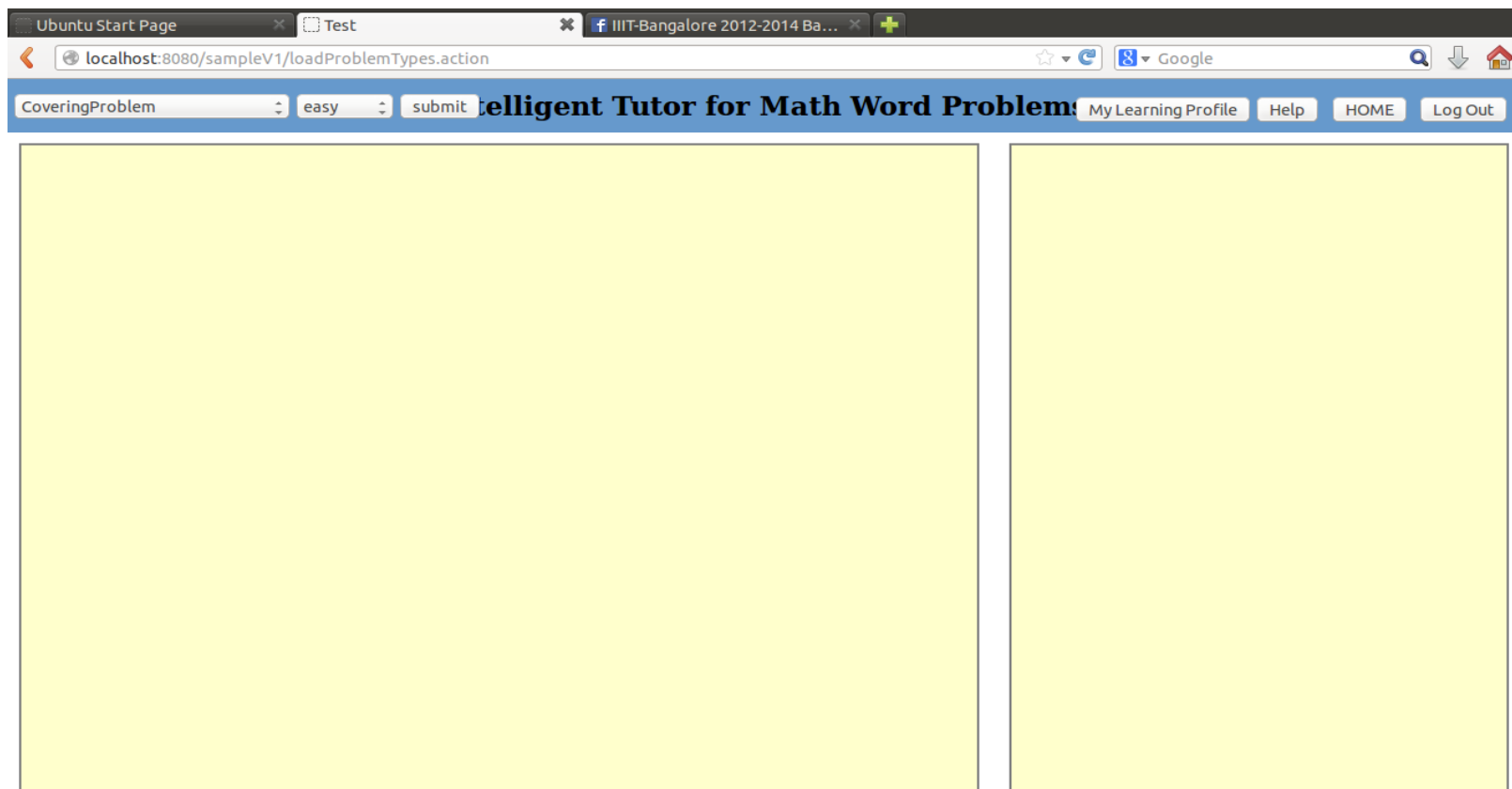
UserName

Password

Fig. 1 Login page

### 3. Choosing Problem Type

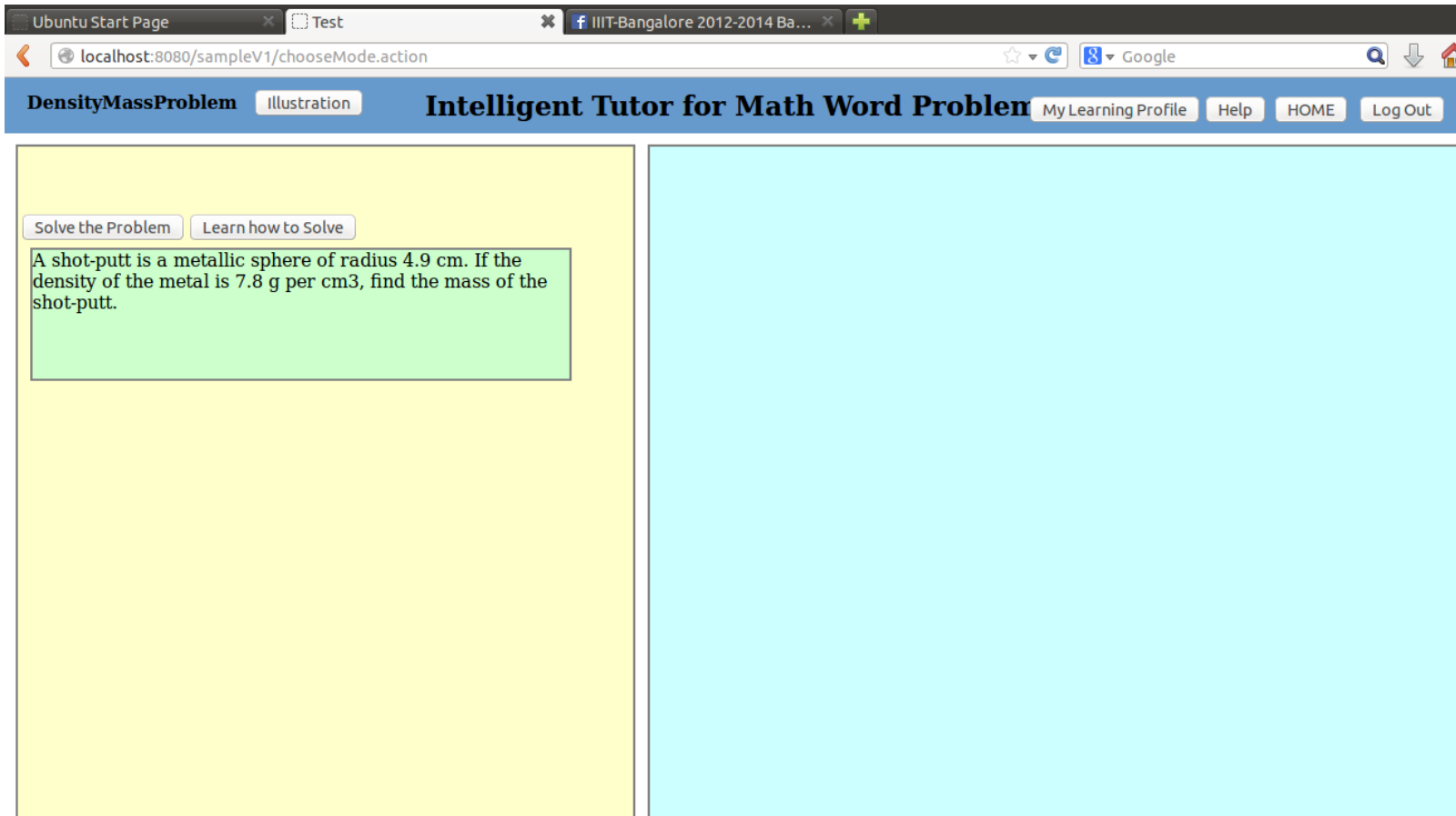
This page lets the user pick the category of problems he wants to work on. This selection includes choosing the type of problem and the level of difficulty as shown in the snapshot(s) below. Once the submit button is pressed, the “Choosing the Mode” page is obtained with the problem statement belonging to the selected problem type.



**Fig. 2 Choosing Problem Type**

#### 4. Choosing the Mode

On this page, the problem type which was chosen in the previous page is displayed on the top left and the problem statement is given. Two buttons are provided for the user to choose the mode he intends to work on. Learning Mode helps the user to understand the given problem



**Fig. 3 Choose Mode**

by answering a set of questions in a step by step manner. The feedback provided for each answer selected by the user aids the user in correcting his mistakes and gaining better knowledge of the problem concepts. Solving mode on the other hand, gives provision for the user himself to enter the solution steps for the given problem and arrive at the answer. Here too, feedback is provided for each and every line statement that the user enters.

“HOME” button is used to go back to the Choosing Problem Type page.

#### 5. Learning Mode

On this page, the problem statement is displayed on the left half of the screen and the right

half contains the question and the corresponding answer choices. The user has to pick an answer based on his level of understanding of the given problem. On clicking the submit button, if correct answer has been selected by the user then the feedback “Correct! You can proceed for the next question” is displayed and the next question and its answer choices get loaded with the problem statement remaining the same. The question and the corresponding correct answer gets added to the Questions Learned Till Now box. If the user has picked a wrong answer, the corresponding feedback gets displayed and the same page with the same question gets loaded again.

Once the user answers all the questions correctly, he is automatically directed to the Solving Mode of the same problem. The user can also choose to go to the solving mode page in the middle of the learning mode by using the button “Solve the Problem”. In case the user switches back to learning mode while performing solving mode, he is allowed to continue from the point that he had stopped without having to redo from the beginning.

The screenshot shows a web browser window with the URL `localhost:8080/sampleV1/loadQuestions.action`. The page title is "DensityMassProblem" and the main heading is "Intelligent Tutor for Math Word Problem". There are navigation links: "My Learning Profile", "Help", "HOME", and "Log Out".

The interface is divided into two main panels. The left panel contains a "Solve the Problem" button and a "Start over" button. Below them is a text box with the problem statement: "A shot-putt is a metallic sphere of radius 4.9 cm. If the density of the metal is 7.8 g per cm<sup>3</sup>, find the mass of the shot-putt."

The right panel contains a blue box with instructions: "Use the following question-answer session to learn how to approach the given problem! At some places you can select multiple choices. What is asked to find in the given problem?". Below this is a dropdown menu with the text "Metal.DensityGmPerCuCm" and a "submit" button.

At the bottom of the right panel is a section titled "Questions Learned Till Now" with a large empty box below it.

Fig. 4 Learning Mode

### 5.1. Start Over

While proceeding with the learning mode of a problem, if a user wants to redo the learning mode of the same problem from the beginning, he can use the start over button. Clicking this button takes him to the first question of the same problem and allows him to redo it.

## 6. Solving Mode

While learning mode checks the level of understanding of a problem by asking questions and giving answer choices, solving mode enables him to find the solution for the problem on his own. The page for Solving Mode is shown below. The user should enter the given data in the text box under “Given” label in this format: Object.ParameterUnit = Value Unit

For example: WoodenBox.LengthCm = 80 Cm

If the entered given statement is in the correct format and also matches with the actual data given in the problem, then it is printed in the text area below the text box.

Similarly the user has to fill the text box under the “To Find” label in the following format:

Object.Parameter = ?

For example: SquareSheets.Number = ?

For entering the steps in the Solution text box, user has to follow this format:  
Object.ParameterUnit = Formula Unit

or

Object.ParameterUnit = Substituted\_numerical\_values\_for\_a\_formula Unit

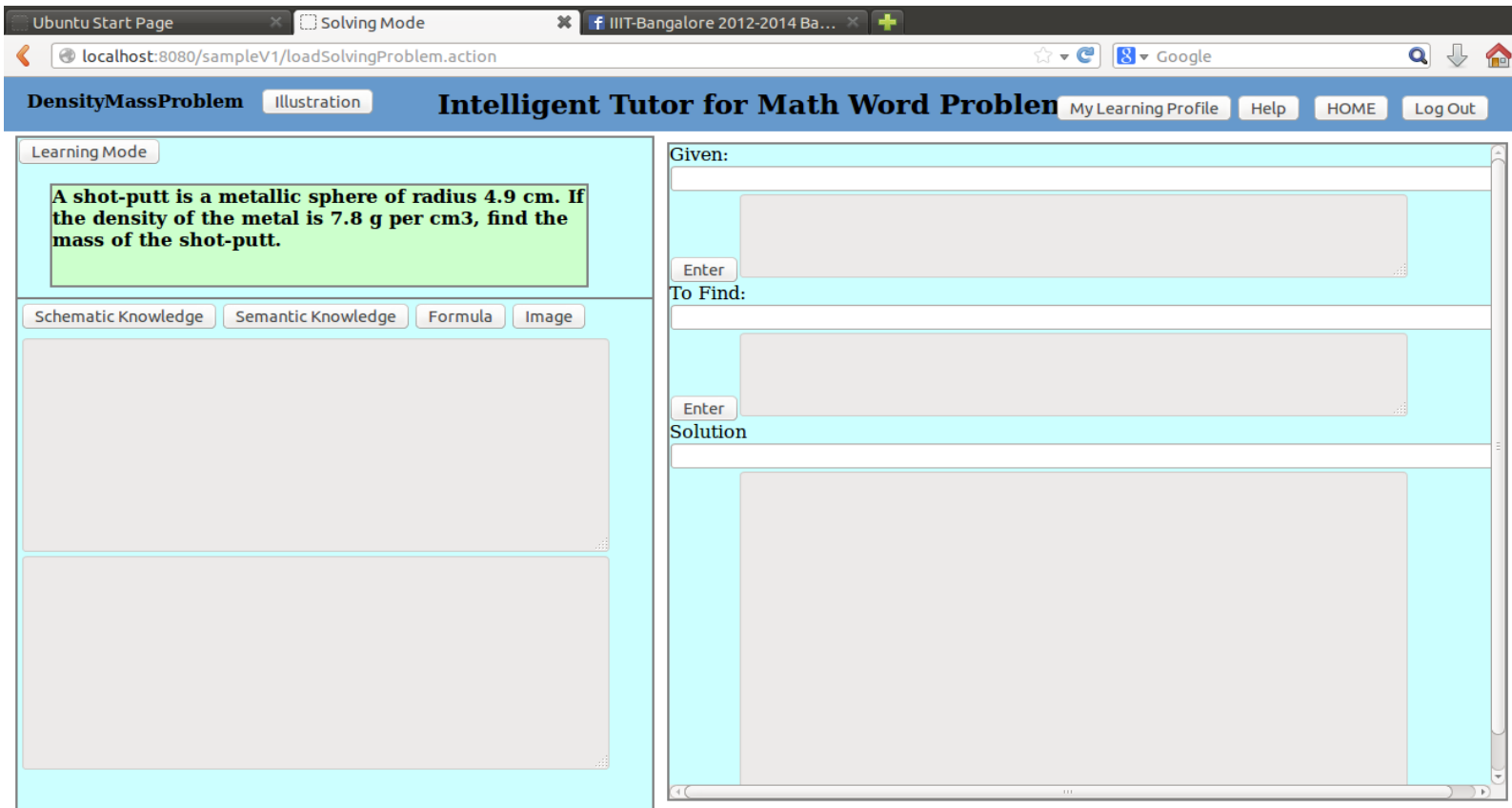
For example:

SquareSheet.AreaSqCm = (SquareSheet.Side)\*(SquareSheet.Side)

SqCm SquareSheet.AreaSqCm = (40\*40) SqCm

WoodenBox.TSASqCm = (2\*((80\*40)+(40\*20)+(20\*80)) SqCm

It is to be noted that there should not be any space between the expression for the formula or the substitution of numerical values for the formula. Also only parentheses are allowed for sequencing of operations in a formula expression. Symbols like [], {}, or <> are not allowed for this purpose. The well-formedness of the entered statement and the correctness of the statement according to the problem are checked and then printed into the Solution text area. In case it is wrong, corresponding feedback is provided to the user. If the user enters all the steps correctly and completes the problem, a “Well Done Problem is successfully Completed” message is displayed to the user. Then the user can use the “HOME” button to work on another problem of the same or of different problem type.



**Fig. 5 Solving Mode**

### 6.1 Schematic Knowledge

Clicking the “Schematic Knowledge” button displays the schematic structure of the problem in terms of the objects used in the problem and their parameters like area, volume etc.

For example:

Has\_Dimension\_Of\_Object\_

With\_Density

Has\_Object\_With\_Density



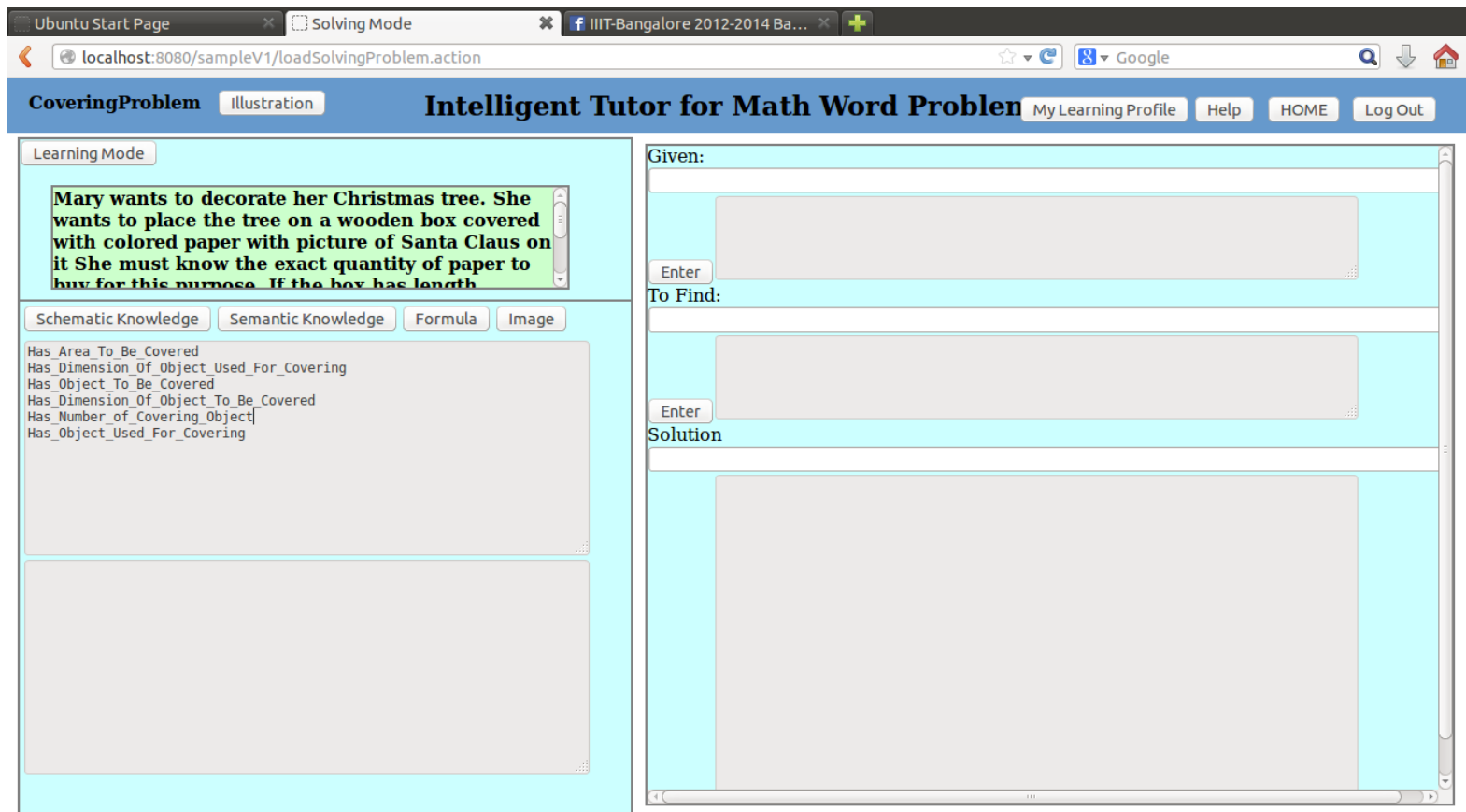


Fig. 6 Schematic Knowledge loaded

## 6.2 Semantic Knowledge

Semantic Knowledge button is used to obtain further details about the problem schema. The schematic structure along with the actual name of the object referred to by the schematic structure is displayed.

For example:

Has\_Object\_To\_Be\_Covered : WoodenBox(Cuboid)

Has\_Object\_To\_Be\_Covered is part of the problem's schematic structure. The above example denotes that WoodenBox is the object to be covered and it is an instance of the shape cuboid as per the problem statement given.

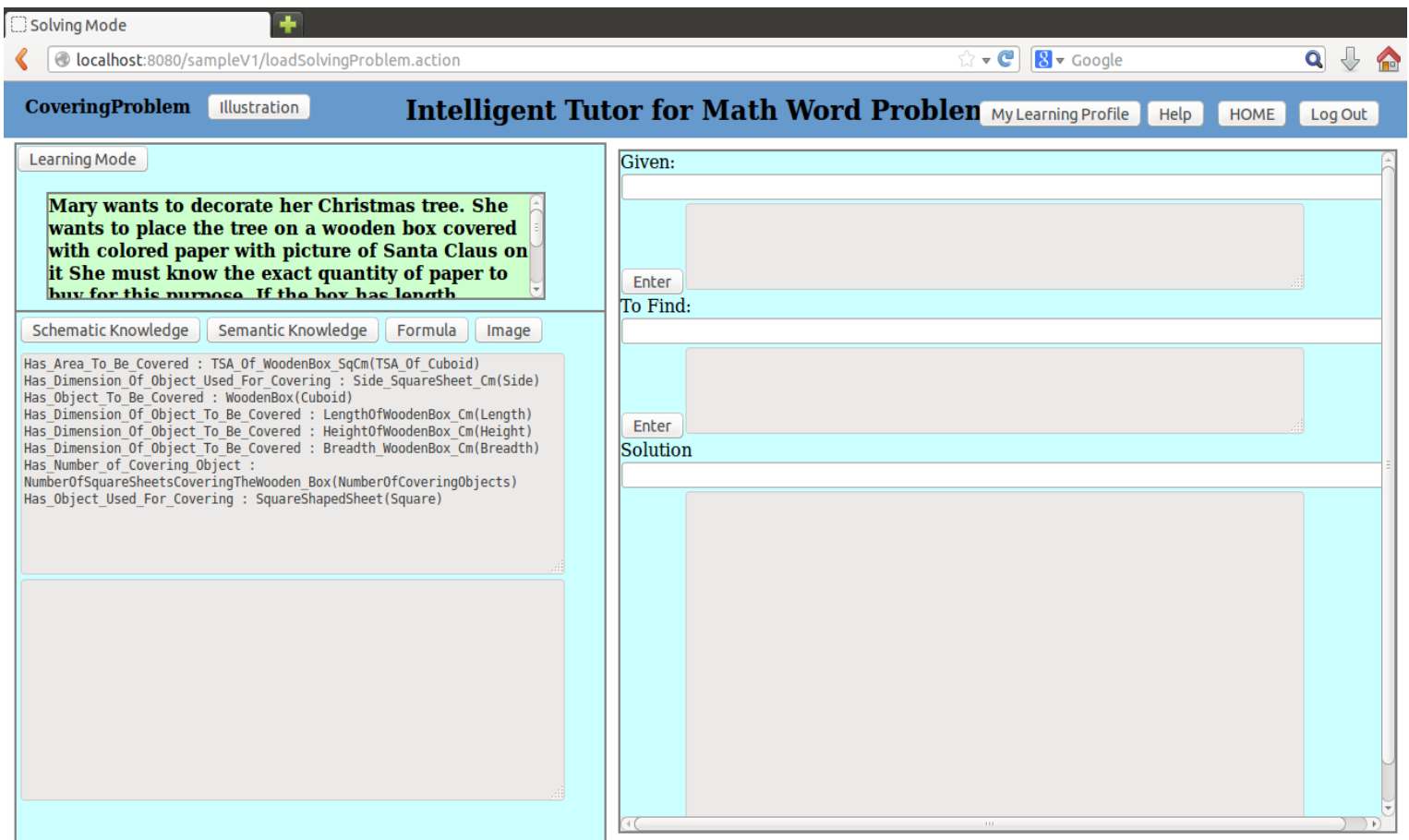
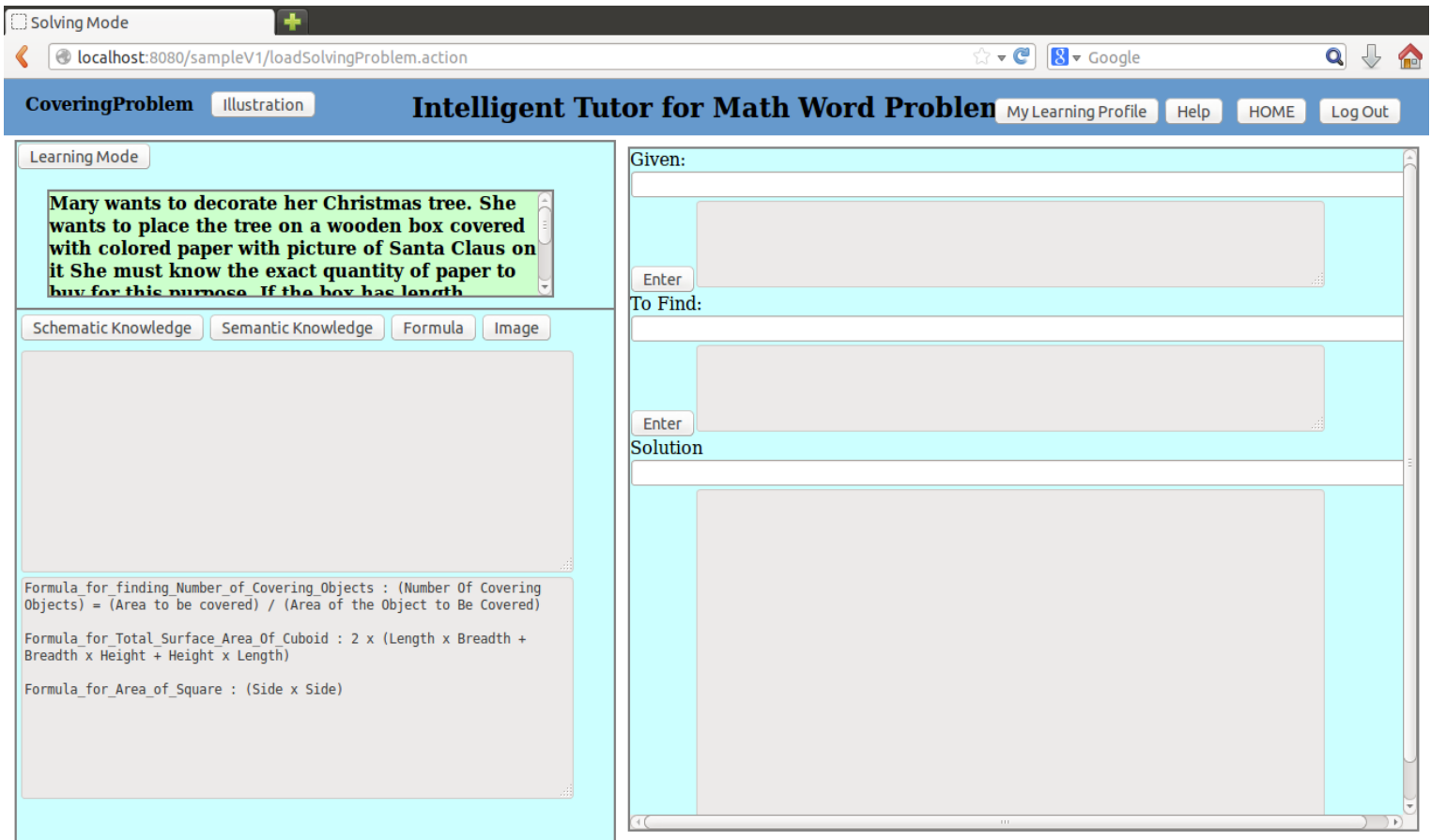


Fig. 7 Semantic Knowledge loaded

## 6.3 Formula

When the user is doubtful about certain formulas and needs to refer to them as a hint in order to proceed with the problem, he can use the Formula button. The formula specific to the problem are shown.



**Fig. 8 Solving Mode page with Formulae loaded**

## 6.4 Image

On clicking the Image button the diagrammatic representation of the problem is displayed.

Solving Mode

localhost:8080/samplev1/loadSolvingProblem.action

Google

CoveringProblem

Illustration

Intelligent Tutor for Math Word Problem

My Learning Profile

Help

HOME

Log Out

Learning Mode

Mary wants to decorate her Christmas tree. She wants to place the tree on a wooden box covered with colored paper with picture of Santa Claus on it She must know the exact quantity of paper to buy for this purpose. If the box has length

Schematic Knowledge

Semantic Knowledge

Formula

Image

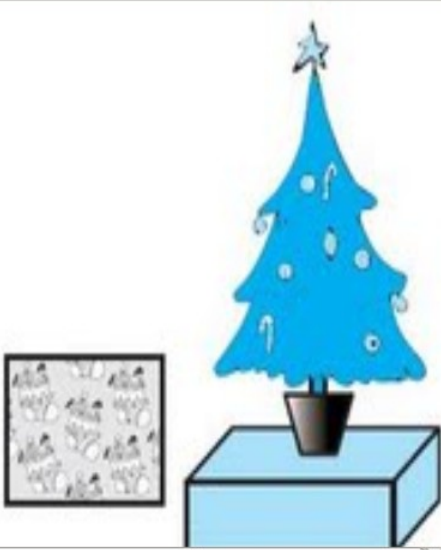


Diagram illustrating the problem setup: A Christmas tree is placed on a wooden box. The box is covered with colored paper featuring a picture of Santa Claus. The tree is decorated with lights and ornaments.

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Fc

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Given:

Enter

To Find:

Enter

Solution

Fig 9. Diagramatic representation of the problem

## 7. Learning Profile

The learning profile is used to track the overall activity done by the user on the system. It keeps track of the progress the user has made, the misconceptions that he had while solving, time taken to learn and solve the problems, concepts learned and so on.

### 7.1 Problem Solving Progress

Problem solving progress is in general for all problem types in which you can see how many problems of each level you have solved for each problem type and the percentage of its correctness. Also, it combines all percentage of correctness of all the three levels and shows overall percentage of correctness. This correctness is calculated based on the list of tasks you complete correctly while solving a problem correctly.

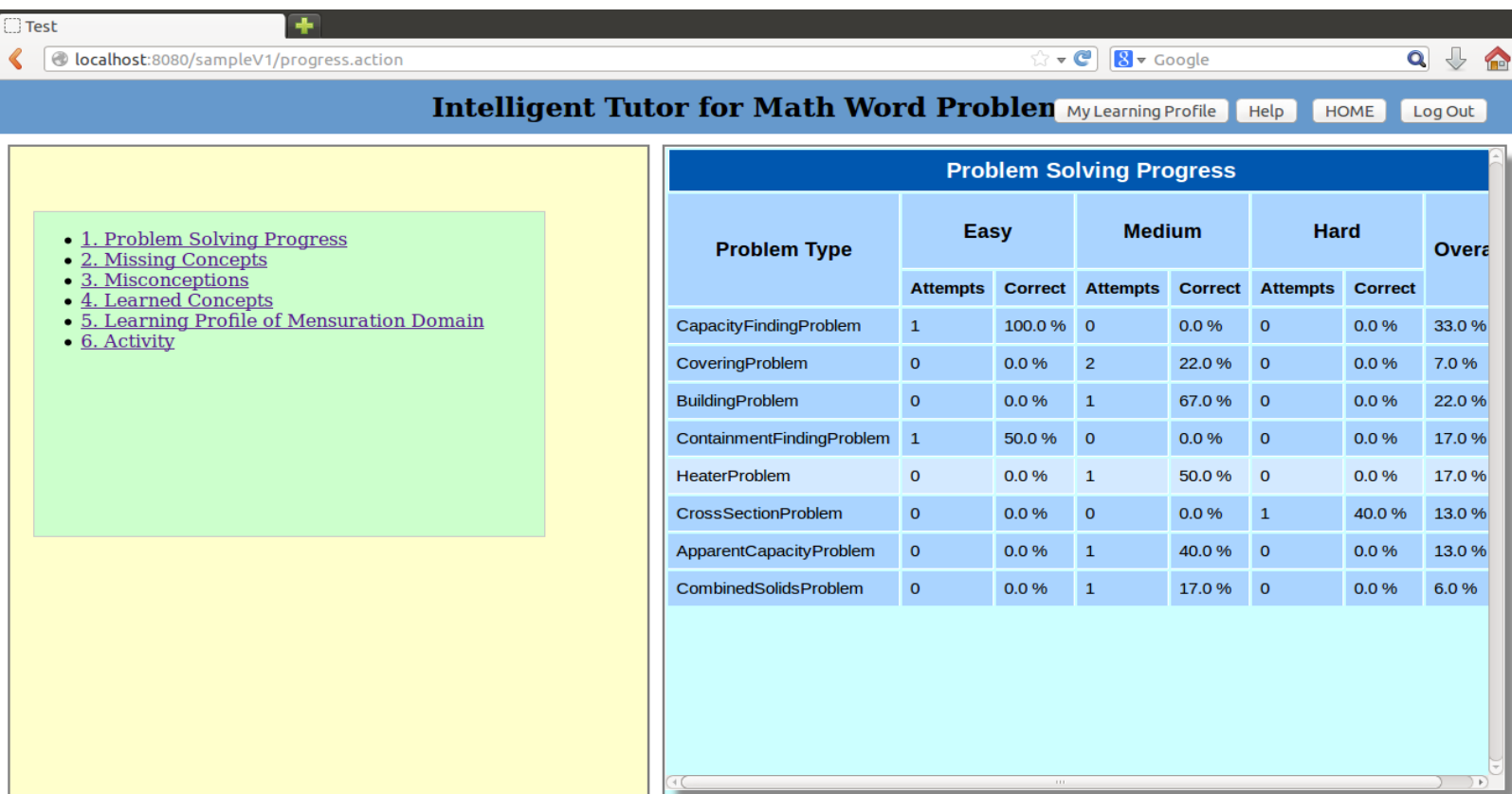


Fig 10. Problem Solving Progress

## 7.2 Missing Concepts and Misconceptions

Misconceptions and Missing Concepts are captured from your Learning mode interaction and solving mode interaction. These are captured commonly for all problems. The information displayed shows the percentage of resolving and remedial feedback for the same. If the percentage is more means you are progressing towards removing the misconception and the missing concept which is captured during the interaction.

The screenshot displays a web application titled "Intelligent Tutor for Math Word Problem". The interface is divided into two main sections. On the left, a green box contains a list of navigation links: "1. Problem Solving Progress", "2. Missing Concepts", "3. Misconceptions", "4. Learned Concepts", "5. Learning Profile of Mensuration Domain", and "6. Activity". On the right, a table titled "Missing Concepts Captured" lists five concepts with their respective resolution percentages and remedial feedback.

Missing Concept	Percentage Resolved	Remedial Feedback
Finding_TSA_Of_Thick_and_Hollow_Cylinder	50.0 %	Please refer to the formula of TSA of thick and hollow cylinder.
Identification_of_Diameter_of_RCCyl	50.0 %	Study dimensions of right circular cylinder.
Finding_Radius_From_Diameter	43.0 %	Radius is half the diameter.
Finding_Total_CoveringCost_when_cost_of_CoveringObject_is_Known	0.0 %	(Total cost of covering) = (Cost of covering) * (Area to be covered)
Finding_LSA_of_RCCyl	33.0 %	Study finding LSA of right circular

Fig 11. Missing Concepts

### 7.3 Learned Concepts

Learned concepts displays the information of concepts you have learned for particular problem type in a tabular form where list of concepts and the number of times you have learned that concept are displayed. With the displayed learned concept you can see in the brackets the schematic connection of that particular problem type. Also, the same is showed by using 3D Bar charts

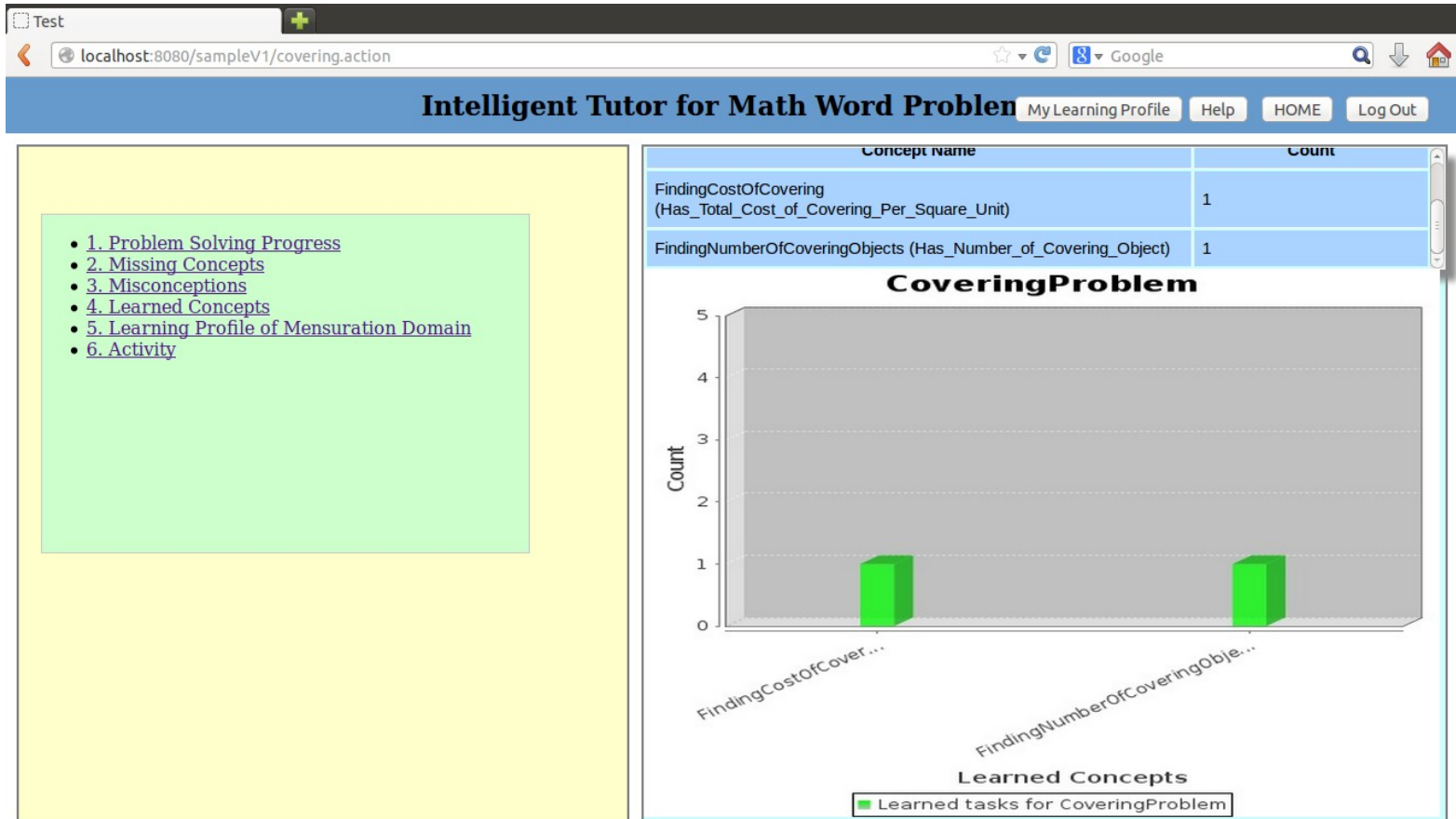


Fig 12. Learned Concepts

### 7.4 Learning Profile Of Mensuration Domain

Learning profile of mensuration domain shows information about the mensuration problem types you have learned for each shape. For example it displays percentage of TSA problems learned from each shape, percentage of LSA problems learned for each shape, percentage of SA with Less Faces problems learned for each shape and percentage of volume problems learned for each shape.

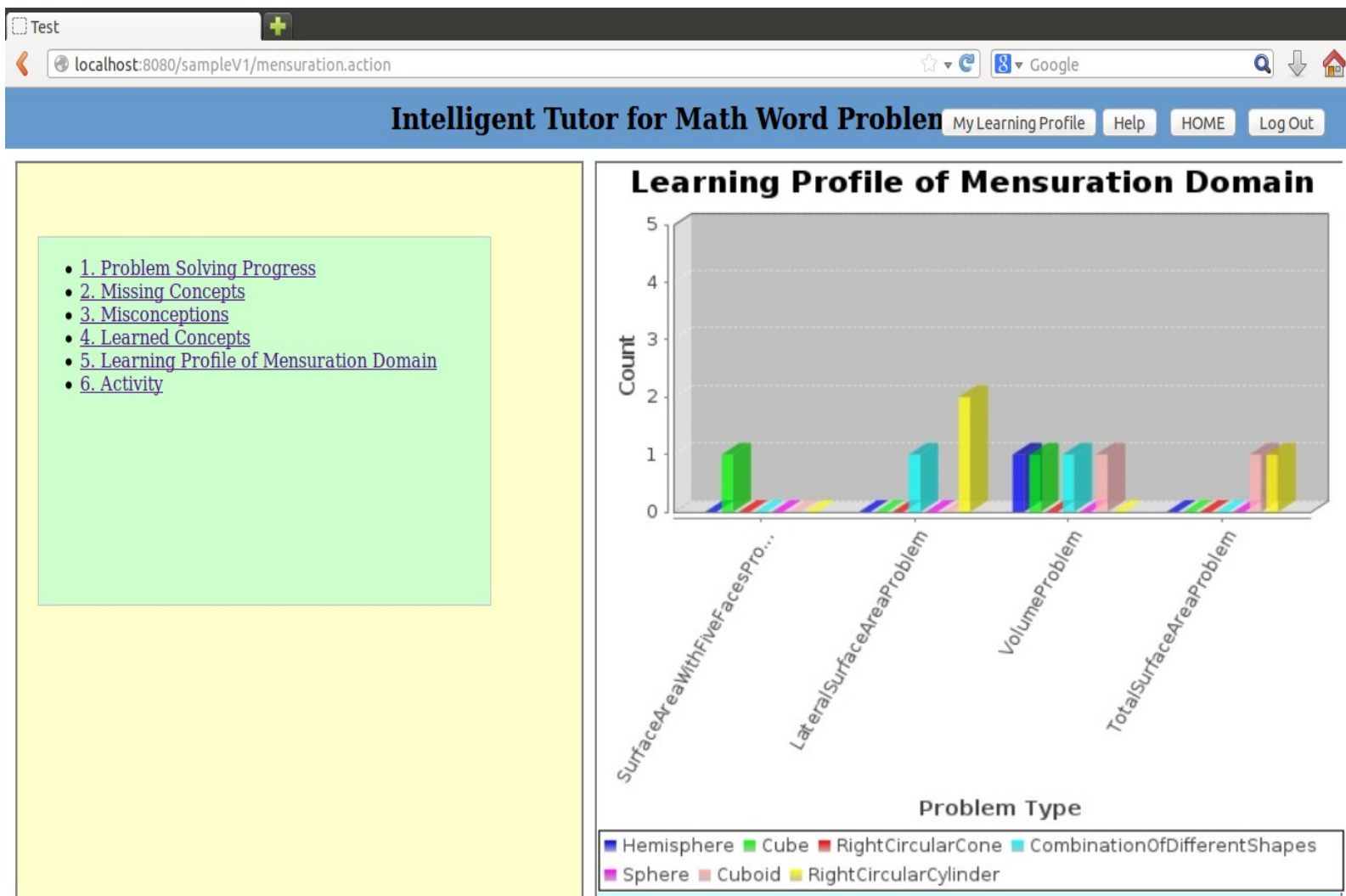


Fig 13 : Learned Concepts Of Mensuration Domain

## 7.5 Activity

Activity shows that how much time (in seconds) you have spent on Learning Mode and Solving Mode for various problem types.



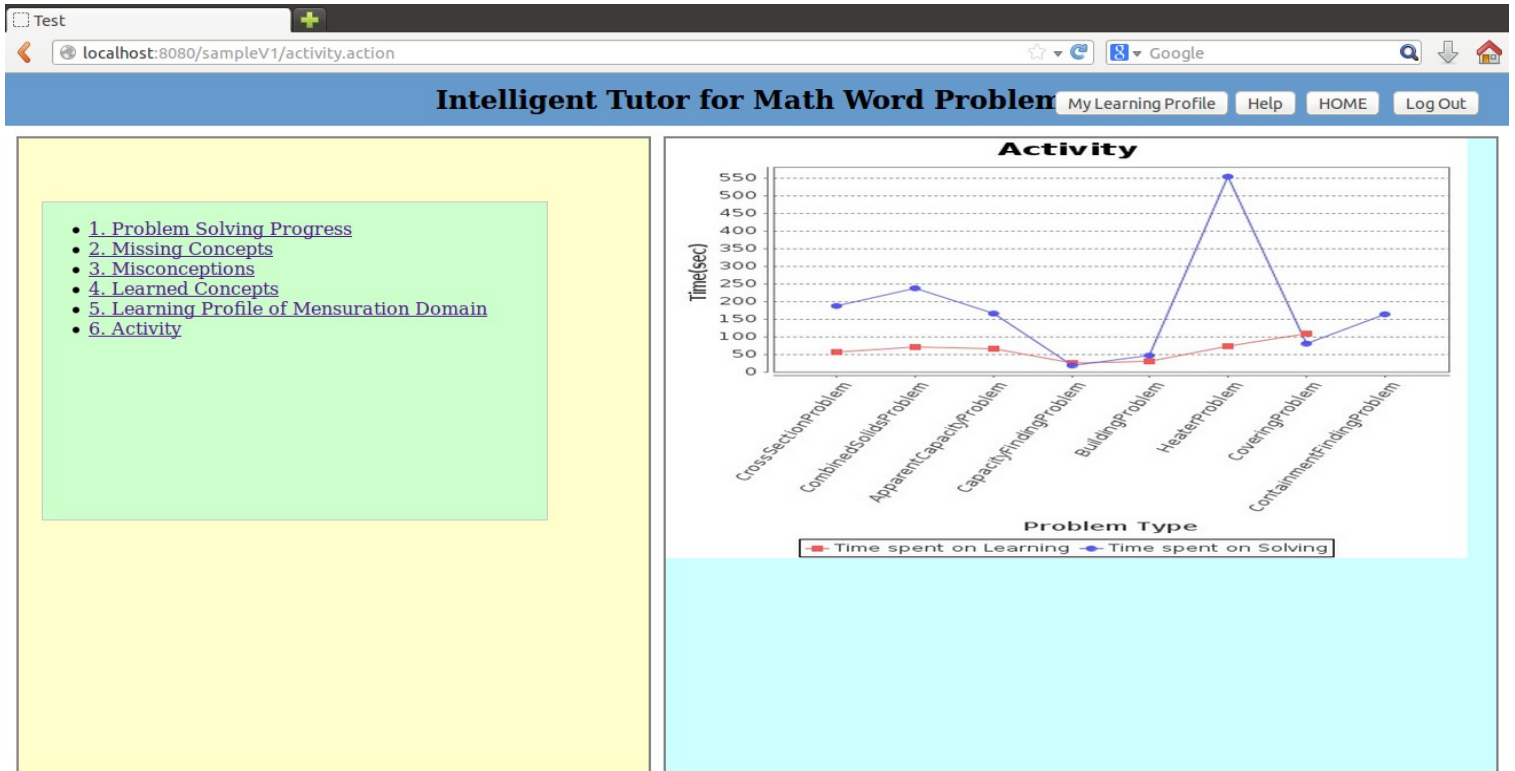


Fig 14: Activity

## 8. Logout

Logout button ends the user session and takes the user back to the login page.