CHAPTER 4

METHODOLOGY

4.0. INTRODUCTION

This chapter describes the methodology adopted in the study. The study analyzed the effectiveness of Web Based Instruction on the various scientific process skills namely reporting, interpretation, reasoning and problem solving skills among university entrants. The content of the Web Based Instruction package prepared was based on the syllabus prescribed by the university where the study was conducted. Links were provided in each chapter for more information on the topic being discussed in each. This enables students and the teachers to delve deeper into the subject during instruction.

In contrast to Computer Assisted Instruction, which has a tutorial program ensures the mastery of a topic; the Web Based Instruction used in the study aims at providing larger amounts of information and develops scientific skills through investigating about the topic by the students themselves.

4.1. EXPERIMENTAL DESIGN

Quasi Experimental method was used for the study. To assess the effectiveness of Web Based Instruction on the scientific skills of higher secondary students, the students were administered the Web Based Instruction Package. A pre-test post-test two group design was used.
The sample for the experimental study comprised of 228 students from Princess Nora Bint Abdul Rahman University, Riyadh, KSA (Experimental group – 114, Control Group - 114). These students are of the age group 16 -17 and are technically the first year university students, called the Preparatory Year. The investigator is a preparatory year teacher in the University. The Preparatory year course is a bridging course where the concepts taught until the 12th grade in school in Arabic are all introduced in English, which will then be continued as the medium of instruction in the university.

After gaining permission from the university, samples were selected based on the distribution category followed by the university in each class. The university divides the students evenly based on their levels and grades in their previous classes in school level. 20 students were allotted in each class and hence the investigator selected 114 groups as the control group and experimental group respectively. The extra students in the groups were randomly elimination method. Consequently, a class for two hours every day during the course of the semester was scheduled. The students were observed for a semester, comprising of 120 days, and were graded based on their midterm examination, quizzes conducted in the class, their self study materials (projects) and the practical laboratory works. The achievements of the Experimental And Control Group were compared.

Data was collected during the course of the semester by analyzing their class work, practical, short quizzes given in class and the project work done by the students. In addition, the criterion referenced test, was prepared by the investigator in consultation, consent and approval of the experts from the university as well as the supervising teacher. The web
based instruction material was presented to the students based on the prescribed course content which is attached in Appendix 1.

The various skills evaluated were

1. Reasoning skill (based on the content delivered in the syllabus prescribed).
2. Problem solving skill (based on the problem sums in the syllabus prescribed).
3. Interpretative skill (based on their project work and the syllabus prescribed).
4. Reporting skill (based on their project work).

More weightage was given to the Reasoning and Problem solving skill from their class work, quizzes, homework and classroom evaluation. Reporting and interpretation skill was evaluated mainly from their Practical sessions, practical examination and the project work prepared by them.

4.2. METHOD ADOPTED

Web Based Instruction Package is a package based on information technology, which is developed by the investigator with the help of the supervising teacher. The package was developed by php html (version 8), javascript (version 1.8.5) and jquery (version 2.0) software. This package available in the website, www.pypp4phy.com, is supported by the website www.edmodo.com and the Magic Class console. The contents in the package are in accordance with the syllabus prescribed by the university. A total of 9 units are prescribed for the preparatory year students in physics. All these 9 topics are consolidated in the website. The Theory portion in detail is available in the link THEORY,
practical part is available under the link PRACTICAL, animated videos of various concepts and definitions under VIDEOS, worksheets, under WORKSHEETS, and a link to www.edmodo.com. This website provides an option for the students to reuse the material by enabling downloading and printing of the content if needed.

In addition, a link for the purpose of playing and creating videos related to the important concepts and definitions in the syllabus, www.goanimate.com, was also employed. There are various templates for videos like classroom setting, office gossipers, anime, jungle warfare and the like. Any template according to the topic to be delivered can be chosen.
Fig. 4.1. Home Page of www.pypp4phy.com
Fig. 4.2. Video from www.goanimate.com
I. Magic Class:

Magic class console (Magic Class version v.40) is a software enabling two way interaction between the teacher and the students. This enables easy content delivery in the classroom setting - the CALL (Computer Assisted Language Learning) LAB. Even though meant for language learning, Magic Class console can enable easy delivery of instruction and communication to each student on their respective computers. There are various options available in the Magic class Console like, self study mode, exam mode, teaching mode and the like. Depending on the need, the teacher can make use of any during instruction. On the individual level, the laboratory is open for remedial work, enrichment study, make-up work, and exam preparation. Even though CALL LABs are used for Language learning, the investigator during the course made good use of the same with the Magic Class Console for teaching physics, especially when online quizzes were to be administered and derivations of various equations in the course were to be discussed. Using the chat rooms in the Magic Class programs in the CALL LAB, the students could individually chat with the teacher to clarify their doubts in the topic of discussion. Teacher can define the number of chat rooms, and also the topic of each chat room. Students are able to enter all the chat rooms based on topic anytime. In each chat room, students can have their own conversation. Teacher can monitor or enter any chat room. This gave the students access to the software in class according to their own pace individually. Magic class program used by the teacher also enables the teacher to give exams to the students for a fixed time limit.
Fig. 4.3. Home page of Magic Class

Fig. 4.4. Students Logged on to the Magic class Console

Fig. 4.5. Modes of use in Magic Class
Fig. 4.6. Setting Questions in Magic Class Console

Fig. 4.7. Answer key Window in Magic Class Console

Fig. 4.8. Students Accessing the Internet
Be it a single question or a whole exam, the teacher sends links to the students computers, students solve the problems and at the end of time, teacher stops the program. On doing this, the teacher gets all the files on her computer form each student in the folder already created by the teacher and selected to be used. Teacher then opens each file and discusses the problems of each student individually. This way, students learn their mistakes and others can see the possible mistakes that they could have made. This enables remedial instruction.

I. www.edmodo.com:

This is a social networking site, solely meant for educational purpose. Educational institutions can use this, with the help of which, the investigator interacts with the students even outside the university campus. This enables the investigator to hand in assignments, alerts, quizzes on defined dates and enable sharing of files. The platform in the www.edmodo.com is similar to that of a www.facebook.com page where the user creates an account to login to the site. In the same way, the instructor creates an account, uploads the content she needs to deliver, and then creates a group. A unique code is allotted for each group. The instructor reveals the code for each group and the students login to the site using the unique code with their username and the password as the code. Hence, it is ensured that only those group members can access the related information. The investigator locks the group once all the students have joined in. In this way, folders can be shared, assignments created and the classroom discussion can be kept ongoing 24X 7. Furthermore, parents can also keep a track of their ward’s progress using a unique code and joining the group and also communicate with the investigator.
Fig. 4.9. www.edmodo.com homepage
4.3. UNITS COVERED:

Discussed below are a few of the contents covered in the theoretical and practical areas during the course of the semester.

I. THEORY

Unit I:

There are 23 topics in unit 1. For instance, in the first unit, following the link “What is Physics?”, leads to a small definition of physics and the introduction to the term Physics. To delve deeper, 6 other links are provided along with the link “Useful links”, that leads to the next page. These useful links can be used by the student if necessary during the course of instruction individually.
Fig. 4.10. Window for the introduction of the topic “Physics” in www.pypp4phy.com

What is physics?

• Physics is the science that based on measurements of physical quantities.

• Physics deals with the laws that govern the operation of the whole world.
  So, how to get these measurements?

• We measure each physical quantity in its own units.

• The unit is a unique name we assign to measures of that quantity. For example the meter (m) is the unit of length.
Unit II: Newton’s Laws of Motion:

Following the link for the Newton’s law of Universal Gravitation, it leads the student into the formula and its derivation can be found in the main lecture among theory or in the useful links provided.

Fig. 4.11. Window displaying the topic “Law of Gravitation” in www.pypp4phy.com
Fig. 4.12. Window displaying “The effect of distance on force of gravity” in www.pypp4phy.com.
Unit III: Linear Momentum

These were some of the topics prepared by the investigator for the website.

Fig. 4.13. Window displaying the derivation of the formula for Time period of a pendulum in www.pypp4phy.com
Fig. 4.14. Window displaying the formula and calculation of the time period of a pendulum in www.pypp4phy.com
II. PRACTICAL

In the experiments conducted, the students are expected to prepare a report based on the experiment conducted. Based on the first chapter Measurements, the experiment chosen is “Measurements using Vernier Caliper and Micrometer”. Here, the student has to clearly make a report stating the aims, objectives, procedure and methodology, tools used, and the formula used.

Tabulation for data collection also needs to be prepared by the student. Where the units and conversion of units, finding the least count of the vernier and micrometer has to be specified clearly.

The procedure and methodology needs to be elaborated in detail before submission to the teacher for evaluation.

In experiments involving graphs like “Hooke’s Law”, “Boyle’s Law”, and “Simple Pendulum”, the learner interprets data (eg. Slope of the graph, whether the relation is linear or non-linear, the relationship between the variables whether it is directly or indirectly proportional to each other and the like) to find the final result of the experiment. For example, in the experiment “Hooke’s Law” after the student collects data as follows:
The student makes a graph of Force Vs. Displacement and from the nature of the graph, interprets the linear direct relation between the two variables. The student then
reasons the cause of direct proportionality and uses the data in the graph to find the spring constant of the spring.

In the same way, in “Boyle’s Law “Experiment, the student after data collection based on the following table,

![Apparatus for Boyle’s Law Experiment](image)

**Fig. 4.16. Apparatus for Boyle’s Law Experiment**

**Table 4.3 - \( \Delta P \) Vs. h (height)**

<table>
<thead>
<tr>
<th>( \Delta P ) (hPa)</th>
<th>h (cm)</th>
<th>h (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
draws a graph between Pressure and volume to interpret the relation. In addition, also interprets the meaning of $\Delta P$ as small change in pressure, $h$ as the height of the mercury column and the like.

Thus, while instruction, the theoretical part is shown as an animation with the intention of making it easier for them to understand the real concept of the experiment. This is done so that the students gets a clear picture of the theoretical aspect, interpret and assess reasons and can then be incorporated into the reporting process while doing the experiment and hence solving the problem statement of the experiment.

4.4. MODE OF CONTENT DELIVERY

The control and experimental group students were selected as mentioned earlier. Each day, during the course of the semester, comprising of 120 days, the instructor delivered two hours of lecture to both the groups for two hours. The control group was given the traditional method of instruction and the experimental group was instructed through the website (www.pypp4phy.com) prepared by the investigator, and magic class console was used as the medium for this. The students in the experimental group were always in constant contact with the teacher through the www.edmodo.com even outside the premises of the campus. The experimental group had a complete online instruction. The investigator used the internet facilities and the content uploaded in the website for this purpose. The students in the control group had contact with the teacher only within the classroom.
The instructor introduces the lesson Measurements, elicits the important terms in the chapter providing various examples. As an introduction, teacher puts in a video of the measurement concepts – measurements, basic units or fundamental units, derived units, significant figures and problem solving. After the students get a brief idea about what’s going to happen in the discussion following, teacher elicits various concepts and terms from the students using the magic class console where the students answer the teacher. In this way, the teacher can easily see how many students answered the question, who answered correctly and who answered wrong. Terms and concepts in the chapter are elicited in this way. This is followed by instruction from the content prepared by the teacher in accordance with the syllabus. For further discussion, extra links and references are made use of.

New terms and concepts are introduced, animations and examples are shown to make the concept clear to the students in this way. Investigator then puts in a few questions on the Magic Class Console – like:

i) The total mechanical energy of a 10 Kg ball resting on top of a building with height 20 m is ____________________

In the first question, in addition to solving the problem,

- The student reasons how and why in finding the total Mechanical Energy, the Kinetic Energy is Zero.
- Solves the problem using the information given. Moreover, the student interprets the information given and uses it in the correct way.
ii) The mass of an object is 400 Kg, then the maximum static friction acting on the tires given that $\mu_s = 0.50$ and $g=10 \text{ m/s}^2$ is: ____________________

Hence assessing their problem solving and reasoning skills. Here,

- The learner interprets what static friction is,
- The significance of $\mu_s$, the coefficient of static friction
- Puts in the correct formula to solve the problem
- Finds the value of static friction.

The Value of Normal Force is not given directly. The learner has to identify and interpret that mass multiplied by the gravitational constant “g” gives the normal force.

Students could ask a question to the teacher using the option raise hand in the Magic Class Console if required. The teacher gets the notice of that in her computer based on which she can cater to the individual needs of the students.

Yet another example from the Unit IX – Waves, during instruction is – the teacher keys in the following question:

iii) A man is standing 5m from a loudspeaker, with a sound intensity of $5.2 \times 10^{-5} \text{ W/m}^2$.

a) What’s the intensity level of sound for the man, given that $I_0 = 1.0 \times 10^{-12} \text{ W/m}^2$?

What’s the total power emitted by the speaker?
And from Units V & VI:

iv) Water flows in a horizontal tube. The difference in pressure of water between the points A and B is 250 N/m², where the areas of cross sections are 4 m² and 2 m² respectively.

a) Calculate the ratio of velocities using the equation of continuity.

b) Find the velocity of water flow through the tube using Bernoulli’s equation. (the density of water = 1000 Kg/m³)

In all these three questions, the student interprets the information given and gives reasons while solving the problem.

The investigator selects the “Exam” icon from the list. Here, the teacher browses the files and folders and gives the path where all the files from students are to be saved. Teacher then types in the above question and presses the ‘start’ icon. All the students get the question on their screen. Teacher gives them a fixed time to solve the question. When time is up, teacher presses the ‘stop’ icon. All the files and the work done in them gets saved into the folder created by the teacher initially on the teachers computer. This process is repeated for a series of questions.

The students can also speak to the teacher using the Single Speak or Multi Speak option available. The single speak facility available allows the student to speak to the teacher and all other students in the same session. The teacher can click on the student icon with raised hands. The student can then speak up. In the same way the multi speak application allows more than one student to speak enabling a discussion.
Teacher can also assist the students in opening the same webpage by keying in the web address to the “URL” icon in the application. This is in case the teacher wants the student to go into the www.edmodo.com web site or any other during the time of instruction. The teacher can also give the URL of the video created by her in the same whereby students can get to see the same. In addition, the student can choose a website to browse during the free study session.

Monitoring students is also possible using the capture screen application. The screens of the target students will be captured in snapshot from time to time and sent to the teacher PC. Teacher can set the path of saving the file as well as the maximum number of snapshots and the interval. Teacher can review the saved files from time to time to monitor the progress of the students. In addition, the short cut key manager application prohibits the students from using the short cut keys provided by the windows platform, for example Cntrl+Alt+Del, Alt+F4, and the like. The students will therefore not be escaping from the class with these short cut keys. This computer mediated communication program thus allows synchronous-online chat, asynchronous email, discussion forums, message boards etc.

I. PROJECTS:

Further to the chapter covered, students were asked to suggest a few projects and prepare a report, model if necessary based on the same. The above example shows the suggestions put forward by the students under different category for the preparation of the project, thus depicting their interpretation and reporting skills. This was followed in each of
the units covered during the course of the syllabus. The lists of projects put forward by students is attached in appendix 1 (page 174).

**Table- 4.4 Suggested Projects**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Unit and Type</th>
<th>Suggested Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inventions</td>
<td>Musical Glasses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green house</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sound proofing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Swinging Pendulums</td>
</tr>
<tr>
<td>2</td>
<td>Environment</td>
<td>Ozone depletion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Global warming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harmful effects of communication devices</td>
</tr>
<tr>
<td>3</td>
<td>Electronic learning</td>
<td>Touch the scientists</td>
</tr>
<tr>
<td>4</td>
<td>Society</td>
<td>Non-Smokers smoking.</td>
</tr>
<tr>
<td>5</td>
<td>Making educational films</td>
<td>Transverse and Longitudinal Waves</td>
</tr>
<tr>
<td>7</td>
<td>Preparing booklets and reports</td>
<td>Interference</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standing Waves</td>
</tr>
<tr>
<td>8</td>
<td>Distance learning</td>
<td>knowledge transfer between universities on uses of Doppler Effect</td>
</tr>
<tr>
<td>9</td>
<td>Student Seminar/workshops</td>
<td>Radar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sonar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infra-red imaging</td>
</tr>
</tbody>
</table>

A list of the projects suggested from the other units are attached in the Appendix 2, (page 179).
I. WORKSHEETS:

The link for worksheets leads the student to the worksheets available in the pdf format which can be downloaded and printed.

Fig. 4.17. Window displaying worksheet

4.5. EXPERIMENTAL VARIABLES

1. Dependant Variables
   a. Reporting Skill
   b. Interpretation Skill
   c. Interpretative Skill
   d. Problem Solving Skill

2. Independent Variable
   a. Web Based Instruction Package
4.6. SELECTION OF ITEMS IN TESTS

Test of Achievement was constructed and standardized by the investigator under the guidance of the supervising teacher and the scrutiny and consent of the experts from the university (Appendix 6, Appendix 10). The topics were selected from syllabus prescribed by the university and based on the review of literature from Fundamentals of Physics (Walker, 2008). The construction and standardization procedure are discussed below:

4.6.i. Planning of the Test

The final achievement test consisted of 20 objective type questions, 8 true or false questions, and 4 short answer type questions which included the problem sums, for the final examination; and, 12 objective type questions, 6 true or false and 1 problem to be solved. Then the investigator set the time schedule for answering. The investigator decided to prepare the test items in accordance with the Blueprint. The major steps in the preparation of Achievement test are as follows.

4.6.ii. Try Out

The investigator tried out the test on a sample of 60 students.

4.6. iii. Item Analysis

Item analysis helps to detect the strength and weakness of the test and to find out the suitability of each item. After a thorough analysis of the prescribed
curriculum and the text book (walker	extsuperscript{77}, 2008), sufficiently large numbers of questions were prepared. These were discussed with experts and rectifications based on their recommendations were made. The accepted items were selected and printed out for the tests. Difficulty Index and Discriminating Power were determined as per normal procedure. Items having high degree of Discriminating Power and Difficulty Index have been selected. Details of the Item analysis are given in the (Appendix 4 – Final Examination and Appendix 8- Mid Term Examination)

4.6.iv. Selection of items

The selection of the test items was based on the values of difficulty index and discriminating power, thus the items selected for the test, in which the Difficulty Index of items lies between 0.4 and 0.6 the Discriminating Power which is greater or equal to 0.30.

4.6.v. Reliability

Reliability of the test refers to the degree of consisting with which it measures what is intended to measure. Reliability of the scale was found by test-retest method on a sample of 60 students. To find out the reliability of the scale the investigator re-administered after 3 weeks time. The two sets of the scores are correlated by using the Pearson’s Product Moment Coefficient of Correlation to obtain the reliability of the test. The reliability coefficient obtained was 0.84(N=60). This suggests that the test is reasonably reliable.
4.6.vi. Validity

Content validity involves essentially the systematic examination of the content. Content validity has been taken care of by comparing with the prescribed curriculum and consultation with experts. Questions were framed using easy, comprehensive, readable sentences. This indicates good construct validity of tests.

4.6.vii. Preparation of Blue print

A blue print gives the details of the design in concrete terms. The investigator prepared the Blue print as a three dimensioned chart which indicate the distribution of questions, objective wise, content wise, and form wise. The Achievement test for both midterm and final examinations were constructed as per the details in the blue print presented in the table. In both the midterm examination and the final examination, item analysis (Garret^{24},1979) was done, and appropriate questions were selected.
Table 4.5 – Blue Print Final Examination

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Unit</th>
<th>Multiple Choice Questions (MCQ)</th>
<th>True/False</th>
<th>Short Answer (SA)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Measurements &amp; Newton’s Laws of Motion</td>
<td>1(1)</td>
<td>1(1)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Momentum &amp; Oscillation</td>
<td>1(1)</td>
<td>1(1)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Energy</td>
<td>1(1)</td>
<td>1 (2.5)</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>4</td>
<td>Fluids I&amp;II</td>
<td>3 (1)</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Heat</td>
<td>5 (1)</td>
<td>1(1)</td>
<td></td>
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</tr>
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<td>6</td>
<td>Waves</td>
<td>7 (1)</td>
<td>1(1)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Images I &amp;II</td>
<td>4 (1)</td>
<td>3(1)</td>
<td>1(5.5)</td>
<td>12.5</td>
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</table>

**BLUE PRINT**                      **TOTAL**  **35**
## Table 4.6 - Blue Print – Mid Term Examination

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Unit</th>
<th>Multiple Choice Questions (MCQ)</th>
<th>Objective (True/False)</th>
<th>Short Answer (SA)</th>
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<tr>
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<td>Measurements &amp; Newton’s Laws of Motion</td>
<td>6(1)</td>
<td>1(1)</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Friction &amp; Newton’s Law of Gravitation</td>
<td>2(1)</td>
<td>1(1)</td>
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<td>3</td>
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<tr>
<td>3</td>
<td>Momentum &amp; Oscillation</td>
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<td>4</td>
<td>Energy</td>
<td>1(1)</td>
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<tr>
<td>5</td>
<td>Fluids I</td>
<td>1(1)</td>
<td>1(1)</td>
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<td>6</td>
<td>Fluids II</td>
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<tr>
<td></td>
<td><strong>BLUE PRINT</strong></td>
<td><strong>TOTAL</strong></td>
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<td><strong>20</strong></td>
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</table>
4.7. TOOLS USED

Criterion referenced test

4.8. MATERIALS DEVELOPED

1. Web Based Instruction Package

2. Project Work

4.9. STATISTICAL TECHNIQUES USED

The means of pre-test and post test, means of the gain scores and the total effectiveness of the various skills evaluated in the study were calculated. ANOVA and ANCOVA were made use of for the same. SPSS version 18 aided the investigator in the statistical analysis.