CHAPTER 3

PROBLEM STATEMENT AND RESEARCH METHODOLOGY

This chapter describes the problem definition, objectives and research methodology adapted in this research work. It is categorized into five sections. The first section provides a brief description of the problem definition. The second section presents the objectives of this research work. The third section explains the research methodology. The fourth section is about the procedure for gathering the data. The fifth section summarizes the chapter.

3.1 PROBLEM DEFINITION

In higher education environments the students require more support during the learning process in the form of feedback and guidance about how to improve learning. In order to identify the slow learning students in the early stages, formative assessments will be more useful. It provides feedback on their learning and the marks will not be considered for final grade thus encourage and guide the students towards better learning. Though CMs are proved to be effective as instructional, learning and assessment tool, many challenges and difficulties have been reported. The major issues related to the usage of CMs are; the time consumption for creating the maps and evaluating them. From the literature study, it was found untapped research problems exist when attempt to integrate game theory with CMs using the Information and Communication Technologies (ICTs). Hence, the main problem identified
with respect to this area of research is that the need for developing innovative tools that utilize the CMs using ICTs with features like flexibility, easy to use, quick and more interactive.

Further, the existing assessment methods such as multiple choice questions, quizzes, assignments etc., were found time consuming and with a poor or seldom feedback mechanism. Also they are given less importance as they fail to create interest among the students and motivate them. This is also considered as one of the important challenges that needed to be addressed. The above issues stress the need for developing innovative assessment approaches that attract students to actively take part in assessment processes.

3.2 OBJECTIVES

In this thesis, two novel assessment methods were tailored with gaming principles for online formative knowledge assessment. The objectives of this research constitute the following:

3.2.1 Main Objectives

The main objectives of this work is to develop novel formative knowledge assessment tools using concept maps and game theory and to determine whether the newly suggested assessment methods will enhance the enthusiasm of the students to learn and help educators to assess.

3.2.2 Specific Objectives

In order to achieve the above main objectives, it is essential to achieve the following specific objectives:
• To develop an architectural design for Online Assessment Management System (OAMS) which would facilitate the CM based assessment process using ICTs.

• To develop two Online Formative Knowledge Assessment (OFKA) methods based on the architectural design using game theory. (to be called as OFKA).

• To test the methods in line with the assessment processes and study their impact among the students.

• Evaluate and analyze the proposed OFKA methods.

• To investigate the perceived usefulness of the methods and students’ willingness to use the proposed assessment methods and the assistance rendered to the educators.

3.3 RESEARCH METHODOLOGY

The research work commenced with an exhaustive survey on the formative knowledge assessment using CMs and computer games. From the literature survey, it was identified that the formative knowledge assessment provided in the form of games has great potential for further research. Hence, an online formative knowledge assessment system by name Online Assessment Management System (OAMS) has been designed and developed. OAMS has been tailored as a concept map game using two novel methods namely Collapsed Concept Map Game (CCMG) and Concept Tree Game (CTG) that involve concept map and gaming procedures. As an outcome, the CCMG and CTG methods for assessing the students’ knowledge were designed, implemented and evaluated. An experimental research was carried out in order to evaluate the proposed methods.
Major data gathering techniques utilized for this work were the CCMG and CTG methods, Class Test (CT) and survey questionnaires. A thorough analysis was made on the survey data to measure the impact of the methods in terms of usefulness of OAMS and willingness to use OAMS further. The data collected were analyzed statistically using Statistical Package for the Social Sciences (SPSS) version 16.0 for Windows. The statistical analysis techniques such as Cronbach’s alpha test, Wilcoxon Signed-Rank test and Paired Samples t-Test were involved in the analysis.

Participants for this study were chosen using purposive sampling technique (Patton 1990). A total of 230 students from three undergraduate and two post graduate classes took part in the study.

3.3.1 Research Methods

This research focuses on collaboration of a quantitative method and a follow-up survey method. Firstly, this research work utilizes OAMS as a platform to test both the CCMG and CTG methods as OFKA. Secondly, it uses a survey questionnaire to obtain the views of the students on the proposed OFKA. The OAMS is used to collect numerical data to investigate students’ performance on the chosen courses. The usage of survey questionnaires is to collect qualitative data to determine students’ views on the usefulness of the proposed methods.

3.3.2 Participants

In a research work like this, choosing the participants (samples) has to be given importance. There exist two types of sampling methods, namely (i) probability sample and (ii) non-probability or purposive sample. Probability sampling techniques are to enhance inference quality. Purposive
sampling techniques are to confirm generalizability. For this research work, Purposive sampling technique was employed to select the samples.

The number of participants selected for the study was 230. The students were selected through the purposive sampling technique. The details of the participants are illustrated in Table 3.1. These students are selected from specific undergraduate (UG) programmes such as B.E./B.Tech* and a Post Graduate (PG) programme namely, Master of Computer Applications (MCA) of a private institution of higher education in the territory. The subjects chosen for the study are Electronic Commerce (III MCA group and IT group) and Software Engineering (II MCA group and III CSE group). For the Biotechnology group, a course by the name Environmental Science & Engineering was chosen. The courses considered for this work are three-credit courses. The MCA students are from different streams in the undergraduate level.

Table 3.1 Purposive sample based on Branches and Courses

<table>
<thead>
<tr>
<th>Branch(s)</th>
<th>No. of Students</th>
<th>Name of the Group</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.Tech (IT)</td>
<td>66</td>
<td>Group A</td>
<td>Electronic Commerce</td>
</tr>
<tr>
<td>B.E. (CSE)</td>
<td>66</td>
<td>Group B</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>II nd MCA</td>
<td>37</td>
<td>Group C</td>
<td>Electronic Commerce</td>
</tr>
<tr>
<td>III rd MCA</td>
<td>33</td>
<td>Group D</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>B.Tech (Biotech)</td>
<td>28</td>
<td>Group E</td>
<td>Environmental Science &amp; Engineering</td>
</tr>
</tbody>
</table>

* B.E. – Bachelor of Engineering; B.Tech. – Bachelor of Technology
The students admitted to the UG programs are basically from a 10+2 pattern of school education in the territory. All the students are possessed with computer operational knowledge as they are all underwent a computer fundamental course during their first year of the course.

Typically, the students had to attend four face-to-face classes per week for every course. Each class lasted for 50 minutes. At the end of every week they had to take the assessment (Class Test) for the topics covered in that week concerned.

3.4 MATERIALS

The major data collection techniques used in this research work are the experiments of CCMG and CTG and a survey questionnaire for each method. Details of these techniques are described in the following subsections.

3.4.1 Online Assessment Management System (OAMS)

The OAMS is an online application that involves CM and gaming principles with an aim to assist the educators and students towards effective learning in their course. OAMS is developed to perform OFKA using CM based CCMG and CTG methods as assessment games. This type of assessment can be served as an investigator on the students’ understanding in order to keep their learning on the right track. In addition, the user friendly interfaces of OAMS provide easy to use services for creating and taking the assessment. This helps to reduce the time consumed in creating the map. A detailed discussion on the development and features of OAMS is presented in Chapter 4.
After its construction, OAMS was experimented with a group of students selected for the assessments. The analyses of the participants’ marks in the assessments were analyzed to ensure the reliability. The Cronbach’s alpha was calculated to see the reliability coefficient of assessment methods. The proposed OFKA methods are used to assess the students’ level of learning. The marks along with the analysis are used to assist the educators and students towards performing better learning. Hence, this kind of assessment does not need very high reliability coefficients. A reliability coefficient of 0.50 to 0.65 may be sufficient (Rudner & Schafer 2001).

Further, the data collected through the experiments were analyzed using the Wilcoxon signed-rank test and Paired t-test for comparing the performance of the students in the proposed OFKA methods and Class Test.

Wilcoxon signed-rank test is a non parametric statistical analysis tool that compares the related samples. This test was developed to compare repeated measures of a same sample under two different conditions which is called repeated-measure design. In this work a repeated-measures design was used such that a student’s performance using class test and proposed OFKA methods (CCMG and CTG) is investigated using paired sample analysis. The goal of repeated-measures design is to determine whether a student’s performance is changed significantly across conditions.

An alternate to the Wilcoxon signed-rank test is the Paired Samples t-Test which is a parametric statistical analysis tool that compares the related samples. This test compares the measure of a same student’s score in two different formative assessments. This test investigates the difference of mean values for significant change.
3.4.1.1 How to use OAMS

To access the OAMS, each student was required to register with the system. The educators are authorized to add the students to the system and register them with the courses chosen for the assessment. Further, the educators are allowed to create the assessments by adding the details like topic for the week, instructions, start date and end date and then create a concept map for the assessment. An email will be sent to each student registered for that course along with the announcement details. The students then can log on to the systems by providing the user id and password. If accepted, the students are allowed to visit the user’s home page where they are allowed to perform the following actions; view profile, update profile and view tests (where the announcements of the assessments are listed). As mentioned earlier, the announcement contains the topic, description, instruction, start date and end date. Then the students can choose to launch test option which will take them to the assessment game environment. As the concepts and relations play a vital role in the proposed assessment methods, they are randomized each time when the game is played by a student to avoid or reduce cheating.

3.4.2 Survey Questionnaire

The survey questionnaire aims to collect data regarding students’ views toward the use of the CCMG and CTG through OAMS in their courses. Survey as a research instrument, is considered to be the most appropriate for measuring different viewpoints of participants (Johnson & Christensen 2004). The survey questions are defined as either open-ended or close ended questions. Balnaves & Caputi (2001) had claimed that the questionnaire is suitable for the analysis of a large group of participants. The answers to the questionnaire are presented in the form of the Likert scales to obtain the views or responses of the participants.
3.4.2.1 Development of the survey questionnaire

The students using the OAMS were administered the survey questionnaire at the end of both assessments. The questionnaires are prepared as post-questionnaires, which were designed in the format of Likert scales. The questionnaires were constructed by the researcher which included question items to obtain the opinions about the proposed OFKA assessments. The content in both questionnaires was not identical. The questionnaire for CCMG method consisted of 6 closed-ended items (Appendix 1) which contained question items relevant to investigate the students’ perceptions of the usefulness of the CCMG method and usefulness of the feedback that was provided by the system. The questionnaire was written in plain English.

The CCMG survey questionnaire was constructed to have six items by following 5 point Likert scale in order to obtain the views of students on the aspects like the usefulness of the approach, willingness to use further, the impact of the approach and usefulness of the feedback provided and few other relevant parameters. The items were provided with following options; Strongly Agree (5), Agree (4), Neither Agree Nor Disagree (3), Disagree (2) and Strongly Disagree (1).

The CTG survey questionnaire (Appendix 2) was constructed to have ten items by following 5 point Likert scale in order to obtain the views of students on the aspects like the usefulness of the approach, willingness to use further, the impact of the approach and usefulness of the feedback provided and few other relevant parameters. The items were provided with following options; Strongly Agree (5), Agree (4), Neither Agree Nor Disagree (3), Disagree (2) and Strongly Disagree (1).

The respondents to the CCMG and CTG survey questionnaires were the purposive sample (students) selected from different disciplines of
study (N = 230). Among the 230 students, 160 students were belonging to three undergraduate programmes and 70 students were belonging to post graduate programmes. It was anticipated that the students’ view toward the use of the OAMS (use of both CCMG and CTG) as OFKA would motivate positively towards active participation. The data obtained from both questionnaires were used to identify and compare the students’ view on the usefulness of the methods and feedback provided by the system.

3.4.2.2 Survey administration

The questionnaires were distributed at the end of each assessment during the semester to the students of each branch who participated in this research work. The questionnaire was administered for the improvement of assessment and feedback. The students’ views were analyzed using SPSS (version 16.0 for Windows). The reliability coefficient for the survey data was calculated for survey data. The Cronbach’s alpha of the data calculated on the survey data for the CCMG was 0.699 and CTG was 0.713. The alpha values confirmed the reliability of the data.

3.4.2.3 Return rates

With reference to the return or response rates for the survey questionnaire, it is recommended (Babbie, 1986) that “a 50 percent response rate for a questionnaire is adequate, 60 % is good, and 70 % is very good”. In this research work, the response to the survey was made compulsory for both the OFKA methods were 100% which is a strong rate.

3.5 RESEARCH PROCEDURE

The following procedure shown in Figure 3.1 was followed for data collection. The research work is carried out in the host institution where the
researcher is currently working. The institution is a self financing Engineering Education institution offering courses on various engineering disciplines. The students selected for the research work were introduced with concept mapping and CMs. They were given adequate training to create CMs using the CmapEditor developed as part of this work. Then the students were introduced with the OAMS. All the functionalities of OAMS were explained to the students and students were allowed to explore and experience the functionalities of OAMS.

The quantitative data collection was carried out in two stages: the Class Test, the OFKA assessment (see Figure 3.1). During the research period, the students attended the regular conduct classes and class test as part of the regular teaching learning activities. The first stage was designed to have two phases; phase 1 was used to conduct the Class Test for the selected students. Then after a week, the proposed OFKA, the CCMG method was experimented with the same students with a different topic followed by a survey. Similarly phase 2 was used for testing of CTG method. The collected data i.e. the test marks along with the survey results are used for further analysis.

In this work, same participants were involved in the experiments of proposed methods. The data collected i.e. the Class Tests, CCMG and CTG and survey results were considered for statistical analyses. The comparison of Class Test marks with proposed method’s marks will give an understanding of the learning achievements of the students. Further, the survey results will indicate the level of acceptance and usefulness of the proposed methods as OFKA methods.
3.6 CHAPTER SUMMARY

This chapter has brought out the problem definition that is attempted in this research work. The objectives of the research have been highlighted. The research methodology to be followed is also presented. The general framework and basic building blocks of the proposed Online Assessment Management System (OAMS) are presented in the next chapter.