CHAPTER 1

INTRODUCTION

Knowledge Assessment (KA) is the process of measuring the knowledge of an individual or a group (will be referred as student/s hereafter) in order to take academic decisions. KA involves the assessment methods like written tests or final examinations, including oral examinations, assignments and projects to assess the level of knowledge acquired. In recent years, educators associated formal KA with the use of various question patterns such as multiple choice questions, short questions and several other forms. With the advent of highly competitive techniques and tools, there are more opportunities to introduce varieties during such assessment methods than in the past. The major issue with the KA is that there is no chance to improve the learning process of the students through the examination. This demands new methodologies that could help the students to learn and perform better during the assessment processes.

Recent years evidenced the advantage of using formative knowledge assessment (FKA). FKA is an act of measuring the knowledge of students in stages thus helps the educator to get an insight into the learning took place among the students (Black & Wiliam 1998). Currently, FKA is being done using ICT such as WWW and custom tools across the world. Today a fleet of innovative assessments techniques like short answer questions, quiz, game and oral presentations are available with facilities to receive immediate feedback.
Even though, there are plenty of methods available for FKA, Concept Map (CM) is considered as one of the promising FKA tool which deals with the organization of students’ knowledge. CM is also known as a visual knowledge representation technique which is proposed by John D Novak (Novak & Canas 2006). CM is used as a tool for organizing and representing knowledge (Novak & Gowin 1984). A CM represent knowledge in the form of a node - arc kind of diagram or like a graph in which the labeled nodes represent concepts of a knowledge domain and arcs showing relations between pairs of concepts.

Recent literature study revealed that there exist research avenues for studies that involve CM and the idea of computer games in the process of knowledge assessment. Assessment Game is a buzz term that represents a game based activity integrated with assessment processes. Hence, this research work proposed to integrate the gaming principles and game theory (GT) with the CM for formative knowledge assessment in an online environment. To achieve this, two game based knowledge assessment approaches have been proposed, developed and experimented. First approach is called as Collapsed Concept Map Game (CCMG) and the second is called Concept Tree Game (CTG) which is based on extensive game theory and CM.

In summary, the challenges that are faced by HEIs motivated this research work. This work attempts to provide solutions by introducing novel FKA methods using the CMs and GT. The following sections provide overview of the principles of assessment, categories of assessment, issues pertaining to the assessment, concept maps game theory especially extensive game theory and the needs for online formative knowledge assessment.
1.1 PRINCIPLES OF ASSESSMENT

In an educational set up or domain, the term assessment is referred to the process of collection of academic information, review and use of the collected information to improve teaching and learning. Assessment focuses on student's level of understanding obtained, their ability in demonstrating concepts, ability to apply knowledge acquired and so on. A Wikipedia web article that quotes the Academic Exchange Quarterly (2013) which defines assessment as follows:

"Studies of a theoretical or empirical nature addressing the assessment of learner aptitude and preparation, motivation and learning styles, learning outcomes in achievement and satisfaction in different educational contexts are all welcome, as are studies addressing issues of measurable standards and benchmarks".

Assessment is used as an integral part of teaching process. It determines whether the goals of education are being met or not. Assessment is used to take decisions about grades or scores, advancement, lesson plan and instructional needs and curriculum design. The assessment should be valid, reliable, fair, purposeful, timely, efficient and manageable. When assessment works better in an educational setup, it achieves the following:

- Helps educators to define standards
- Evaluates progress of students
- Helps the students and teachers in self-evaluation
1.2 CATEGORIES OF ASSESSMENT

Assessment is categorized into four different types, namely; Diagnostic, Formative, Summative and Authentic assessment which is depicted in Figure 1.1.

![Figure 1.1 Types of Assessment](image)

1.2.1 Diagnostic Assessment

Diagnostic assessments (DA) are carried out by the educators to evaluate their students’ learning through tests and measurements. The results from the tests give educators an opportunity to decide on needs to alter lesson plan or curriculum. The assessments give educators an idea of what students should work on to improve their learning and to obtain the course outcomes that are set for learning of that course.

Generally the DA is described as an informal assessment approach that helps the educators to gain knowledge on the current level of achievement of students. The tests are commonly conducted at the beginning of each course and/or before starting new topic to gauge the prior knowledge of the students, thus allowing the restructuring of lesson plan in terms of time allotment on each topic. Sometimes they may also be referred to as "pre-assessments" in that they are given before any final examination to gain insights about any needs for learning on the part of students.
The advantages of DA are that the educators are able to evaluate their student's progress very well at the beginning itself as it helps them to plan better and helps to know what students do and do not know. Disadvantages of DA are that unwarranted labels may be put on students, the information may be used incorrectly and students may have to spend more time preparing for and taking tests than learning.

1.2.2 Formative Assessment

Formative Assessment (FA) is used as an integral part of teaching and learning process. FA is conducted periodically when the course is being taught to gauge the level of understanding or learning obtained by the students. Black and Wiliam (1998) define Formative Assessment (FA) as "all those activities undertaken by teachers, and/or by students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged". Similarly, Cowie and Bell (1999) define FA as "the process used by teachers and students to recognize and respond to student learning in order to enhance that learning, during the learning". Nicol and Macfarlane (2006) states FA as follows; "formative assessment aids learning by generating feedback information that is of benefit to students and to teachers. Feedback on performance, in class or on assignments, enables students to restructure their understanding/skills and build more powerful ideas and capabilities".

It is to be noted that the FA does not have any impact on the final mark or grade awarded to the course or subject; instead it helps the students to learn by providing feedback. As the FA tasks are practice activities embedded in the lesson, educators can use the assessment information to stick with the lesson plan or to change the lesson plan. Formative assessments provide educators with immediate feedback to meet students' learning needs. Some of
The examples of formative assessment include quiz, oral discussions, short question-answer and homework.

The FA is more beneficial to educators as it helps them to determine level of knowledge acquired by the students and to what degree. So, they can decide on necessary modifications or major changes in the lesson plan that they need to make. On the other side, FA is benefits the students by motivating them to learn better. It helps the students to assess themselves and make them to realize on their level of learning. Further, FA assists the students by providing feedback on their performance in the assessment.

### 1.2.3 Summative Assessment

Summative assessment (SA) demonstrates the degree of a student’s success in meeting the assessment criteria. SA is used to gauge the learning outcomes of a course or a subject. SA is generally conducted at the end of the course or subject, which contributes to the final mark given for the course. SA is used to perform a final assessment on the course learning. However, validity and reliability are important for summative assessment as this has no look back or remedial concerns.

### 1.2.4 Authentic Assessment

According to a Wikipedia web article (2013) the main goal of the authentic assessment (AA) is to check whether a student’s knowledge can be applied outside the classroom. Authentic assessment tends to focus on contextualized tasks, enabling students to demonstrate their skills to solve a real time problem. This is also regarded as performance assessment. Applying particular knowledge and role playing are few examples of authentic assessment. According to Ormiston (2011), "Authentic learning mirrors the tasks and problem solving that are required in the reality outside of school".
1.3 CHALLENGES OF ASSESSMENT

Success of assessment depends on the extent of participation by the students in all phases of learning. It also depends on whether there is institutional support for integrating formative knowledge assessment in the community of practice, and not just tolerance for individual teacher’s innovative practice. Some practical challenges for the institution are:

- To establish clear frameworks and guidelines for formative assessment
- To be clear about organizational details and procedures, including procedures when students fail
- Grading practices and how to deal with reliability and validity issues
- How to develop an interpretative community for assessing portfolios?

For teachers

- How to balance control and freedom in the assessment process?
- How to integrate process and product in the assessment?
- How to involve students in assessments?
- How to promote self assessment?
- How to utilize the particular potential in the digital medium?

For students

- Written and oral communication skills
- Collaboration skills and peer review skills
- Time Management
- Development of Strategies
- New roles in the learning and assessment process
1.4 FORMATIVE ASSESSMENT

The growth of the World Wide Web opens doors for many web based applications for educational purposes. Today there are plenty of e-learning web sites offering online courses. It is also noted that there are good number of efficient course management practices incorporated through familiar learning management systems (LMS). For example Moodle is one of the proven LMS and it is available as open source software.

Today, in a fast moving world, educators and students hardly find time to meet, interact and to carry out the academic activities comfortably outside the classrooms. As mentioned above, FA is a process of gauging the understanding of the students in stages during the course that is being taught. This supports both the students and educators for an effective learning (Figure 1.2).

![Concept Map about Formative Assessment](image)

**Figure 1.2 A Concept Map about Formative Assessment**
Developing powerful FKA tools that support online assessment of the conceptual understanding of the students has become a need of the day. Hence, the interactive learning systems were introduced in order to fulfil this gap. This research tries to add a novel formative assessment tool to the fleet of learning assessment tools available.

1.4.1 Issues in Formative Assessment

In any educational setup, assessment plays a vital role in imparting quality education. As the assessment is important, it is inevitable that the procedures to practice assessment activities are of greatest importance. One will accept that assessment is not an easy task as it involves many procedures that measure the learning of a student. Assessment is being practiced manually in most of the higher educational institutions across the globe. But the advents of ICT into education help the educators to use online or automated assessment tools to certain degree of possibility. The following are the few issues identified above in terms of institution, educator and students;

**For Institutions**

- To establish clear frameworks and guidelines
- Dealing with grading practices
- Dealing with issues related to reliability and validity

**For teachers**

- How to motivate students towards formative assessment?
- How to utilize the particular potential in the digital medium?
For students

- Collaboration skills and peer review skills
- Time management
- The feedback

These issues are considered for further research for concentrating towards solutions that are to be identified, designed, developed and tested.

1.5 OVERVIEW OF CONCEPT MAP

Concept Map (CM) was first proposed by Joseph D Novak in late 1970s. A CM is popularly known as a knowledge visualization tool used for organizing and representing knowledge. CMs are widely used in educational setups to help students to understand concepts and their relationships with other concepts. Generally, a CM reflects the learner's understanding or learning about the domain of knowledge and the relationships between concepts. Further, a CM is a pictorial representation tool in which labeled nodes represent concepts or ideas or events and labeled links that connect nodes represent the relationships among them. As there is no universally accepted formal representation, concepts are included in the enclosed circles or boxes of some type in the concept maps.

Novak's (Novak & Gowin 1984) work is based on the cognitive theories of David Ausubel known as assimilation theory (Ausubel 1968), who stressed the importance of prior knowledge to learn new concepts by stating the following quote: "The most important single factor influencing learning is what the learner already knows. Ascertain this and teach accordingly." Novak defines concepts as a “perceived regularity in events or objects, or record of events or objects, designated by a label".
According to Novak, concept maps usually follow a hierarchical structure and also many researchers reported the use of other forms like spider form, flowchart form and system form for concept maps. A concept map of CM is presented in Figure 1.3. Concept mapping is a classroom technique that can aid in the exploration of the type and organization of the students’ prior knowledge, and allows them to visualize what they have learned after a learning lesson or an activity. There are numerous research works carried out and floated in the journals on the roles of concept map as instructional and evaluation tool.

Figure 1.3 A Concept Map about Concept Map (Source www.ihmc.us)
Proved to be effective for meaningful learning, CMs are widely used as an aid in various educational activities such as teaching, learning (self and collaborative) and assessment. More recently CMs have been used as an assessment tool in the classroom as well as in e-learning for assessment. Many researchers reported that CMs are effective in assessment (Novak & Canas 2006).

As mentioned earlier, CMs have been widely used in traditional classrooms, e-learning as their usage in higher education is a relatively new phenomenon and has the potential to assess students’ conceptual knowledge of course that is being taught. Educators get an insight of learning when students submit their concept maps and as a result, a feedback in regard to the understanding and learning of the students can be obtained based on the performance by the students. CMs can be used as a way to capture and evaluate students' learning and knowledge acquisition in a specific topic. The CMs created by the students illustrate their understanding of the important concepts of the topic that they learned. This provides the educator with a simple way to evaluate and plan for further proceedings.

CMs are widely used in various fields including education. The uses include the following; knowledge elicitation, knowledge retention, knowledge modeling, knowledge transfer. Hence, CMs are recommended as a tool to perform knowledge assessment and have been widely used for both formative and summative assessment tasks. More recently many researchers reported the usage of CMs in the classroom as well as online formative assessment tasks (Buldu & Buldu 2010).

1.5.1 Concept Maps in Assessment

CMs can be effectively used as a knowledge assessment tool for identification of valid patterns and misunderstandings in students’ cognitive
structures (Novak & Canas 2006). Since the introduction of CMs, there has been great amount of efforts reflected in through research in concept mapping and its applications to various tasks of education. Many researchers have used CMs in the class room activities like teaching, learning and assessment. In addition to their application for representing knowledge, concept maps have been used in various ways including evaluation of learners’ performance and to identify misunderstandings. Recent years evidenced many research reports on the usage of concept maps. Many researchers developed computer based CM tools that were tailored with teaching and learning assessment procedures (both formative and summative).

Jonassen (1996) states that CM is a constructivist-based mind tool, "a way of using a computer application program to engage learners in constructive, higher-order, critical thinking about the subjects they are studying". CMs are also used to evaluate the learning in laboratory settings (Warner & Brian 2010). The following are the advantages of CMs:

- CMs can be used in any stage of the learning process
- CMs can be used also for any type of knowledge assessment
- Regular usage of CMs provides valuable information both for the student and for the teacher.
- CMs reveal the whole organization of knowledge (understanding of concepts and their links with other concepts) instead of memorization of contents
- CMs allow evaluation of higher order levels of cognitive development.
1.6 OVERVIEW OF GAME THEORY

Game Theory is known as a study of how gaming or game playing strategies can be used for real time applications. The theory has its origin to 1940s during which Von Neumann and Moreganstern developed it. The theory is based on the works done by Von Neumann who is called the father of game theory and Borel earlier to 1940s (Von Neumann & Morgenstern 1944). Game Theory is also called as ‘Interactive Decision Theory’ (Aumann 2008). Game Theory can be regarded as a multi-agent decision problem in which many people contending for limited rewards and payoffs. They have to make certain moves on which their payoff depends. The players have to follow certain rules while making their moves. Each player is supposed to behave rationally.

1.6.1 Categories of Game Theory

Game Theory can be classified in two branches (Wikipedia 2013)

1. **Non co-operative game theory**: In this case the players work independently without assuming anything about what other players are doing.

2. **Co-operative game theory**: Here players may co-operate with one another.

Game Theory has found its application in the fields of economics, evolutionary biology, sociology, political science and share markets, etc., and it is also found in various applications of Computer Science domain.

Among the handy number of game theories classified under the above branches, extensive game theory form is more suitable for our study as it applies a tree structure. The extensive game form (Sergiu 1992) is used to
formalize games with a time sequencing of moves and played on trees. The extensive form can be used to formalize games with a time sequencing of moves. Games are played on trees as follows;

1. Each vertex (or node) represents a point of choice for a player.
2. The player is specified by a number listed by the vertex.
3. The lines out of the vertex represent a possible action for that player.
4. The payoffs are specified at the bottom of the tree.

Figure 1.4 An example of extensive form game

In the game pictured above (Figure 1.4), a game of two players is presented. Player I moves first and chooses either D or C. Player II sees player I's move and then chooses D or C either in node 2 or node 3. Suppose that, if player I chooses D and then player II chooses D, then player I gets 2 and player II gets 2, else if I chooses D and II chooses C from node 2 then I gets 4 and II gets 0.
1.7 NEED FOR THE PROPOSED RESEARCH WORK

Knowledge Assessment (KA) is a very important activity in an educational setup as it reveals the amount knowledge acquired by the students. The Higher Educational Institutions (HEIs) assess the knowledge of the students using unit tests which have been conducted on a monthly basis. The main disadvantage of these tests is that they assist the educators only to identify the slow learners. Educators found it difficult to take the remedial actions to support the students learning beyond these assessments. This is mainly because of time and availability. For students the existing KA processes do not provide any chance for correction or remedial action during learning. For any assessment the feedback and remedial actions are of importance as they assist the students towards better learning. In addition to this, the assessment tests require considerable amount of time from educators to prepare tests and to evaluate the answers. Above all, the educators and students seldom find time to meet to have a face to face discussion on the course contents. Hence, the HEIs have realized the needs of introducing new assessment methodology that could assist the educators and students towards a better learning. In this regard, introducing formative assessment would be a solution for this issue. Formative assessment could measure the understanding level of the students periodically. Thus it aids the educators to know the level of learning took place among the students and students will be able to know where they stand with respect to learning of the subject is concerned.

As the present FKA are paper based tests and are frequent. The same difficulties mentioned above are experienced by the educators and students. Another problem of student participation has become an added issue to the fleet of existing challenges of FKA. These challenges call for a solution and this research work is focused on devising such a system to support FKA.
Concept Maps (CMs) are widely used for formative assessment in the classrooms. As they are used to reflect or visualize the knowledge of a person, they found best suitable for measuring the knowledge of the students. Due to the limitations of manual practice, many CM software tools are being used for formative assessment processes. CMs flexible nature is considered to be promising in developing new FKA methodology. Further, the advancements in ICT have motivated the researchers to integrate CM with latest technologies of ICT.

1.8 CHAPTER SUMMARY

An overview about assessment, concept map and game theory were presented in this chapter. The literature survey conducted for this research work is presented in the next chapter.