CHAPTER 2

LITERATURE SURVEY

The literature survey has been carried out to explore the previous works reported in the relevant areas namely:

- Formative Assessment in Higher Education Environments
- Concept Maps in Knowledge Assessment
- Game Based Learning
- Game Theory in Knowledge Assessment

2.1 FORMATIVE ASSESSMENT IN HIGHER EDUCATION ENVIRONMENT

Formative Assessment (FA) is the process of measuring the knowledge of the students' in stages in order to get an insight into their progress in learning. Black & Wiliam (1998) defined 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". According to a report from the OECD (2005), Formative assessment has been shown to be highly effective in raising the level of student attainment, increasing equity of student outcomes and improving students' ability to learn. Palloff & Pratt (2008) mentioned that the formative assessments could assist the instructors to help the students learn better by providing them with a more interactive, more self-directed and
learner focused nature of learning. FA also provided educators with information to adjust their teaching as necessary to ensure a better performance for students.

Well defined and implemented FAs are relatively easy and provide a feedback on learning effectiveness. FAs can be used at any time, intermingled with more formal feedback styles such as traditional summative and graded assessments. Formative assessments can include everything from short hand-written papers, one minute test, exit slips, assignments, multiple choice questions, classroom quizzes and online quizzes.

In higher education institutions (HEI) the above FA techniques are widely practiced by the educators. Class tests are a form short time exams which is normally a paper-pen based activity conducted by the educators to better understand the students’ level of learning on the topics. Generally, Class Tests demand more time and effort of the educators. Educators find it difficult to conduct frequent FA in the classrooms and also this requires more time to evaluate the answer scripts. Further, analyzing the performance needs more effort and time. These aforementioned problems necessitate the development of innovative solutions for formative assessments.

2.2 CONCEPT MAPS IN KNOWLEDGE ASSESSMENT

Nowadays, most of the educators rely on assessments to gauge the learning took place among the students. Therefore assessments discovering essential information from the assessment data sources become very important for an effective learning for the students as well as educators.

CMs are used as a teaching tool in various levels of educational institutions to better connect the relationships between concepts. These CMs will also help the students to map the new knowledge with previous
knowledge and hence support meaningful learning of the concepts rather than memorizing concepts. Novak & Gowin (1984) first used CMs to assess the understanding level and knowledge structure of school students belonging to primary classes.

A detailed literature study carried out by Canas et al (2003) quoted many research works that described the use of CMs with respect to Applications in Educational Settings and other domains as well. The report covered the CM based developments in various domains/fields from 1995 to 2003. A Large number of articles had been considered and surveyed to give summary about the applications of CM in various domains including education as a major domain of interest. The report presents a broad understanding of the usage and applications of CM in various processes of education domain. Applications of CM with respect to education domain include learning, measuring of the level of understanding, to identify misconceptions, to explore conceptual change of the learners, for collaborative learning, to organize and present knowledge and for a course or curriculum development. Contemporary research indicated that CM had a positive effect on student achievement.

2.2.1 Concept Map as Instructional Tool

One of the major uses of CM is that it has been used as a teaching tool, thus encouraging teachers to use it as a knowledge visualization tool for teaching. CM is also regarded as meaningful-mode for learning patterns. Canas et al (2003) presents an overview and in depth understanding on the usage and applications of CM in various processes of education domain. Applications of CM from teaching to role in curriculum development were discussed with evidences. Further CMs can also be used for notes taking, summarizing important key concepts and relationships in the classroom environments.
CMs are being used as a tool for course instructional design as advance organizers which provide an initial conceptual frame for subsequent information and learning for an effective course delivery. Large numbers of researchers have been using CMs in various processes of teaching as well as the learning process. Also many others had used and experimented CMs for teaching Mathematics, Sportive Techniques, Science (Kharatmal & Nagarjuna 2009), Biology and Chemistry (Canas et al 2003; Omer Beydogan & Gursel Bayindir 2010; Schaal 2010; Faily et al 2012 ; Schaal et al 2010) for meaningful learning.

Further, CMs are also found effective in collaborative learning. De Livere Bruno et al (2010) analyzed the way in which university-level students perceive IHMC CmapTools in a remote learning context. Canas et al (2010) used LiveMappers, a learning environment that supports collaborative concept map-based projects among schools.

Gul Takdemir & Nergiz Ercil Cagiltayet (2010) used CMs to introduce course curriculum in engineering education institutions. Debopriyo Roy (2010) argued for the importance of using specific kinds of concept maps, such as ladders in a technical writing class offered for computer science majors.

### 2.2.2 Concept Map as Assessment Tool

CM is widely used as an assessment tool both in the traditional classroom environment and e-learning environment in the recent years. It has been regarded from the literature survey that the CM as an assessment tool reflects its unique strength among its varied uses, thus it encourages students to use meaningful-mode learning pattern. Ayala et al (2008) argued that embedding the formative assessment along with the core curriculum itself would help the teachers and students to get more benefits.
CMs are being used as a tool for instructional, assessment, curriculum design and other teaching learning activities. The following sections explore the role of CM as an assessment tool in the classrooms and e-learning contexts.

2.2.2.1 Concept map as assessment tool in classrooms

Since the inception, CMs have been widely used as an instructional tool for teaching subjects like science, chemistry, mathematics, grammar and others in the school level. This has been evidenced by a large number of researchers’ works published so far. On the other hand, apart from being used as a teaching tool, CMs have been used as an assessment tool in order to evaluate the prior knowledge and to enrich the same by acquiring new knowledge. In fact, the main purpose behind the inception of CM was to analyze how a new knowledge is accumulated with the existing knowledge of the elementary level school children (Novak & Canas 2006).

There has been a significant amount of growth in the studies that were carried out based on CM as Assessment tool in the classroom environment. As evidenced CMs have been used measure the structure of declarative knowledge in the form of multiple-choice, short-answer and concept maps provide valid evidence (Berlanga et al 2011). CMs have been used to measure the change took place in knowledge structure and to measure the sensitivity of pre-and post-instruction in the undergraduate Marketing Principles course (Von Der Heidt & Spriggs 2011), to measure the understanding of the learners (Ingec 2009; Meagher 2009). CMs have been used for measuring the student satisfaction in the classroom as part of the assessment process (De Lievre Bruno et al 2010). Buldu & Buldu (2010) used CMs in the classroom as an assessment tool for measuring the student satisfaction. Canas et al (2003) also reviewed articles on the applications of
the CMs in various other domains like government settings, business and knowledge management.

2.2.2.2 Concept map as online assessment tool

The introduction of web based software tools for concept mapping opened the avenues for researchers to focus on the usage CMs in e-learning. The CMs have been widely used by many researchers in the e-learning context. Gouli et al (2004) contributed a handy number of works that reported the use of web-based CM as an assessment tool for the students. They presented COMPASS, a web-based concept map assessment tool, which aimed at providing support to assessment as well as learning online. CMs were used to gauge the knowledge level of the students focusing on the propositions in the maps created, in various assessment tasks during the process of learning, to support individualized and collaborative learning and assessment (Koc 2012; Canas et al 2010; Hoeft et al 2000) and to obtain automated feedback to support reflection in concept mapping (Hwang et al 2011). CMs also used in mobile devices to assess the knowledge of the students (Hung et al 2012).

Anohina et al (2007) used CMs for adaptive knowledge assessment. They focused on using pre-built CMs in the adaptive assessment which had adopted 5 patterns for assessment purpose. The advantage reported was that the learner had the opportunity to present with tasks appropriate to their knowledge level. Further they argued that CMs could be successful when used as a core of adaptive assessment systems.

Oboko and Neoga (2011) used the adaptive scaffolds in the form of concept maps in web-based e-learning systems that played the role of instructor cum learner guide. The learner was made to create concept maps from prior knowledge to represent his understanding of a domain. The
concept map had taken into account the knowledge of the learner on that topic by integrated evaluation, and then used it to adapt to the next level. The scaffolding and the adaptation was implemented using production rules.

Cho et al (2012) attempted to improve concept mapping via an integration of the concept mapping procedure with self-explanation in order to improve the efficacy of training. They investigated whether the concept mapping can be further improved by incorporating self-explanation activities by controlling the total training time.

Schwartz & Dylan Arena (2009) argued that increasing abilities to make good learning choices would be one among the 21st century skills. ‘Learning Choices’ is a dynamic construct that suits the realization that people will need to continue to learn and adapt. They proposed a choice based assessment method, in which dethrone knowledge was used as the primary construct of assessment.

Hwang et al (2011) investigated an instant assessment and remediation approach to find how that approach could significantly improve the learning achievement and learning attitude of students. The study used a concept map-oriented mobile learning system with an instant feedback mechanism is provided. The experimental results reported that that the provision of proper assessment tools helped students make reflections and engage in higher-order thinking in the field. Also a comparison with traditional in-the-field learning and immediate assessment and feedback mechanism was carried out.

De Livere Bruno et al (2010) analyzed the way in which university-level students perceive IHMC CmapTools in a remote learning context. The activity was done remotely and in collaboration to conceptualize the main features of a course in the human sciences. They used the CmapTools as an
aid for structuring learning material. They argued that this activity of structuring the material is pertinent in terms of the conceptualization activities that they asked students to perform in lab exercises for a university course.

CMs have been suggested for computer based knowledge assessment as a self-assessment tool (Anohina & Naumeca 2012). This work suggests the importance of identifying the concept mapping tasks to be addressed during the computerized knowledge self-assessment. The result, a taxonomy of concept mapping was presented and with explanation.

Grundspenkis (2011) presented the analysis of questionnaires focusing on CMs as an assessment tool and mentioned that the feedback obtained from the students reveal the necessity of developing rubrics for evaluation of maps in the intelligent knowledge assessment system (IKAS).

Berlanga et al (2011) presented the theoretical considerations, design and requirements of a tool that can provide formative feedback on learner’s textual assignments using CM. The tool enables the users to know their position in the field of interest by comparing different reference models that are generated semi automatically.

Zak & Munson (2008) used CMs to assess K–8 pre-service teachers’ understanding of basic ecological concepts. It was reported that CM was a useful tool for providing insight into the understanding of learners. The teachers organized, associated, and described the relationships among 16 basic ecological concepts used during the assessment. The findings revealed the general understanding of the topics and patterns of omissions of select concepts were also reflected.
2.3 GAME BASED LEARNING

Game Based Learning (GBL) has been practiced by educators to provide fun and excitement based learning environment by modern education educators. Educators have been using computer games and video games in teaching learning processes for many years mainly focusing to create an interesting learning amongst students. Research reported by Rosas et al (2003) showed that integrating games in learning processes in the classroom can be beneficial for academic achievement, motivation. Sharples (2000) argues that teaching methods based on educational games are not only attractive to schoolchildren, but can also be beneficial for university students. However, research on usage of game concepts and game development in higher education is not unique, for example works reported in (Baker 2003, Natvig et al 2004; Navarro & Hoek 2004; Burguillo 2012) tried different game concepts. In the present media age, educational domain demands reforms in order to support more open and flexible on-demand learning with the help of technologies. Game Based Learning can be regarded one such reform. Computer games and video games have become very popular nowadays. Games play an important role in the culture of people especially youngsters. Nowadays, games are played everywhere in devices like Laptops, Smart Phones, Game Consoles, Televisions boxes and other digital devices.

3-D technology based games are have been reportedly used in the teaching and learning process. (Cheng et al 2013) reported their work which discusses the development of a 3D game based learning system which utilized 3-D virtual reality scenario mapped to the learning contents. They investigated the learning achievement of the students. The 3-D virtual quiz game was used in formative assessment (Weng et al 2011). The design of the 3D quiz game (QuizMASter) and the use of QuizMASter as formative assessment with adaptive testing and feedback were discussed.
Digital games have been proposed as an innovative method (Joiner et al. 2012) in teaching and learning. Technologies have been widely tried in teaching and learning. Spires et al. (2008) involved video, entitled ‘Having Our Say’ designed and produced by Lodge McCammon of North Carolina State University. They also provided an overview of research that is being conducted at on game based learning environments and emphasizes the potential of game play. Many research studies have been conducted to study the effectiveness of GBL in schools (Cheng et al. 2013).

Learning games have been widely used for special children’s education (Safia Doumani 2013). Students with Attention Deficit Hyperactivity Disorder (ADHD) struggle to pay attention and control their impulses in class which provokes frustration in teachers. Current research shows that students with ADHD respond well to game-based learning activities.

To foster collaborative learning game and game design activities have been used in the classroom (Reynolds et al. 2013). It was reported that the method demanded the understanding of how students learn to collaborate in the learning environment that can effectively support knowledge sharing in education. Exploratory research results revealed that students in self-organizing game design teams experienced certain challenges and innovative solutions while few indicated meta-knowledge development and socialization gains. A summary of research works considered to explore GBL is presented in Table 2.1.
Table 2.1 Summary of research works on GBL

<table>
<thead>
<tr>
<th>Author(s) &amp; Year</th>
<th>Type of Game</th>
<th>Technology</th>
<th>Application to Teaching / Learning</th>
<th>If Subject specific name of the subject</th>
<th>Level of Application (Graduate/School/others)</th>
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<tbody>
<tr>
<td>Chung-Ho Su</td>
<td>Role based Digital Game</td>
<td>3D Virtual Reality</td>
<td>Game Based Learning</td>
<td>Software Engineering</td>
<td>Graduate</td>
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<td>Ching-Hsue Cheng</td>
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<td>2013</td>
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<tr>
<td>Hiller A.</td>
<td>Multi User Virtual Environment</td>
<td>Video Game - Crystal Island</td>
<td>Game Based Learning</td>
<td>General</td>
<td>K-12</td>
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<tr>
<td>Spires, John K. Lee, James Lester</td>
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<td>2008</td>
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<tr>
<td>Safia Doumani</td>
<td>Video Game Repository</td>
<td>Web Based repository for games</td>
<td>General</td>
<td>School /Graduate</td>
<td></td>
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<tr>
<td>2013</td>
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<tr>
<td>Martin M.</td>
<td>Quiz Game</td>
<td>Intelligent Agents</td>
<td>Assessment</td>
<td>General</td>
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<td>Weng, Ireti Fakinlede, Fuhua Lin, Timothy K. Shih, Maiga Chang</td>
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<td>2011</td>
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<td>Yuh-Ming Cheng, Sheng-Huang Kuo, Shi-Jer Lou, Ru-Chu Shih</td>
<td>Online Games</td>
<td>Open source game engines</td>
<td>General</td>
<td>School</td>
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<td>2012</td>
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<td>Author(s) &amp; Year</td>
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<tr>
<td>Cheng, YM., Lou, SJ., Kuo, SH, &amp; Shih, RC. 2013</td>
<td>Online Games</td>
<td>DGBL</td>
<td>Environmental Science</td>
<td>School</td>
<td></td>
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<tr>
<td>Takaoka, R., Shimokawa, M., &amp; Okamoto, T. 2012</td>
<td>Online Games</td>
<td>GBL</td>
<td>Mathematics</td>
<td>School</td>
<td></td>
</tr>
<tr>
<td>Joiner, R., Drew, B., Darling, J., &amp; Huang, Y. 2012</td>
<td>Learning Game</td>
<td>STEM Race Academy</td>
<td>GBL</td>
<td>Engineering Courses</td>
<td>University</td>
</tr>
<tr>
<td>Chee, Y, S, Mehrotra, S and Liu, Q 2013</td>
<td>Statecraft X game</td>
<td>Apple iPhones (Mobile Technology)</td>
<td>GBL</td>
<td>Citizenship Education</td>
<td>Secondary School</td>
</tr>
</tbody>
</table>

There were few studies about the online GBL that focuses on the provision of an effective learning platform in terms of competitiveness (Cheng et al 2012), collaboration, socialization, improvement in performance, learning skills (Kim et al 2009), and motivation. According to Takaoka et al (2012) elements such as “pleasure” and “fun” incorporated in the game to improve a learner's motivation. Subject specific games have been developed in the field of learning environments. GBL is used by Kim et al (2012) to explore the effectiveness of a game-based mobile learning model for children.
Chee’s (2013) Statecraft X game-based learning program designed with dialogic pedagogy in the context of citizenship education. The Statecraft X game, played on Apple iPhones, provides students with a first person experience of governance by allowing them to take on the role of governors and thus to enact governance. The study results indicated that students of the intervention class outperformed the control class students.

Wu & Wang (2012) argued that, by introducing games in higher education educators can access teaching aids that promote active students, provide alternative teaching methods to improve variation, enable social learning through multiplayer learning games, and motivate students to work harder on projects and exercises. Hence, the adaptation of games in higher education is inevitable in the 21st century, as the world is moving towards intelligent tutoring, digital classrooms, e-learning and many other online courses.

2.4 **GAME THEORY IN KNOWLEDGE ASSESSMENT**

Game Theory (GT) has been used in many disciplines by researchers to demonstrate decision making and to develop strategies. Game theories have been applied in economics, business, and computer games. This survey reveals that game theory has not yet been used in education until now more effectively. Few researchers have used Game Theories in the teaching process as an example or to demonstrate the decision making process. Competition-based Learning (Katherine et al 2009) is a new arena in which game theories are used in learning and assessment processes. A framework for using Game Theory tournaments as a base to implement Competition-based Learning (CnBL) was reported. There is an untapped potential for research that includes the GT for educational process from teaching to assessment. The researchers have to look for possibilities of adopting GT for
various educational processes and identify suitable game theory principles or to develop new theories.

2.5 FINDINGS

From the literature study, it has been evidenced that CMs are widely used in the traditional teaching and learning process in order to assess the knowledge structure of the students. Reports considered for this study reveal that CM has been used as an effective tool both for teaching - learning as well as assessment. Further the articles published very recently revealed that more researchers have been using CM in e-learning and m-learning environments effectively by integrating it with intelligent and semantic computing techniques. The following are the gist of the findings;

1. CMs have been widely used in both classrooms, e-learning as well as m-learning environments effectively.

2. Adaptive e-learning is the focused area which is evident from the majority of the research articles considered for this study.

3. This study also found that potential research problems exist in the context of usage of CM in mobile learning processes such as tools and methods that take CM to the recent mobile devices like notebook, tablet, smart phones etc.,

4. Research on the impact of CM among the students in the context of cognitive processes that taken place, perceived usefulness and effectiveness were also found during this study.

5. Few works have reported that the CMs can be used for choice-based learning.
This study also reviewed research works pertain to knowledge assessment in GBL environments. It is revealed that the GBL environments utilized both computer and video games for educational processes. The expected outcomes are being achieved in GBL as it involves game into teaching and learning process. The students show interest in GBL rather than the traditional learning environments. However, this demands efforts and special technology setups to create games and also regarded as a difficult task as there is no standard procedure to develop games for knowledge assessment.

Further, this study also investigated the role of GTs in the higher education. This survey reveals that game theory has not yet been used in education until now more effectively. Few researchers have used Game Theories in the teaching process as an example or to demonstrate the decision making process. There is an untapped potential for research that includes the GT for educational processes from teaching till assessment. The researchers have to look for possibilities of adopting GT for various educational processes and identify suitable game theory principles or to develop new theories.

Hence, it is essential to develop a new assessment methodology that could enhance the students’ understanding and educators’ assessment processes.

2.6 CHAPTER SUMMARY

This literature survey was carried out to explore the basic ideas behind knowledge assessment processes, role of concept maps and game theories in knowledge assessment. Selected papers from the period 2009-2012 have been considered and the findings from this study were also presented. As far as CMs are concerned, this study conveys the following; (a) As CM is more flexible in nature, there is a scope for integration with new and novel assessment approaches of learning environment. (b) As an emerging tool with
different roles in a learning environment, CM has a huge opportunity for new research avenues as stated below;

1. Integrating the innovative and new ideas that make the process of concept mapping an interesting process can be focused to enable the 21st century educators and learners use new techniques

2. Potential research avenues are possible in the area of intelligent concept mapping systems in the fields of e-learning and m-learning with respect to observing the user behavior, identifying their choices and interests etc.

3. New schemes to assess the knowledge of the learners (both formative and summative assessments) may be another area of interest where a lot of research issues can be addressed

4. Mobile learning - New CM based techniques for m-teaching and m-learning is the need of the hour as new powerful and handy mobile devices like smart phones, i-phones and tablets have started attracting people and will gain their popularity and existence with students in the very near future.

5. More rigorous works towards the usage of CM with open ended research issues like formalizing the mapping processes would be another potential area for future directions.

6. Further attempts can be made to integrate game theory approaches in the game-based learning environments.

This study also reviewed research works pertain to knowledge assessment in GBL environments. It is revealed that the GBL environments utilized both computer and video games for educational processes. Further,
this study also investigated the role of GTs in the higher education. This survey reveals that there is an untapped potential for research that includes the GT for educational processes from teaching till assessment.

The objectives of the research and the research methodologies adapted are presented in the next chapter.