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STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

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APPENDIX/ANNEXURE

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A MODEL FOR ORGANIZING, MEASURING, ANALYZING STUDENTS' KNOWLEDGE AND PERFORMANCE

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ABSTRACT

Present work tries to offer a new view on the current, vastly discussed and successfully engaged concept of a Data Warehouse. This view presents it in the light of Knowledge Management that includes knowledge sharing and knowledge reuse. i.e., a Data Warehouse can serve as a storage medium for keeping the business memory, or at least involving certain varieties of data. It helps to get new knowledge by presenting well integrated data to analysis tools and then becomes an important part of Executive Information Systems or Decision Support Systems. Sharing and reuse of relevant knowledge during project could prove significant benefits. Data Warehouse by storing, managing and sharing data contributes to the growth of knowledge and may show the way to improve the institution's quality and success. Data mining can be used for the purpose of discovering new knowledge from large databases. New knowledge may be further managed by the applications of knowledge sharing and reuse. Data mining as a new technology allows the user to access or process large amount of information generated mainly from large databases using its latest database technologies. Thus the present work relates Data Warehousing and Data Mining to Knowledge Discovery and Knowledge Management including knowledge sharing and knowledge reuse. The intention is to apply this problem to the higher education sector and compare their results to diagnose pros and cons.

KEYWORDS

Achievement Measure, Course Objectives, Performance Analysis, Students' Assignments.

1. INTRODUCTION

The suitability in systems of education requires detailed reports about students' performance to take appropriate actions. A well developed set of information regarding students' knowledge and their performances, helps to make a diagnosis with fair accuracy what the student knows and how much a student knows, in order to conclude what a student does not know i.e., a student's learning gaps. The set of information regarding students' knowledge and their performances obtained through an assessment process of their several assignments specify, with reasonable precision, whether the courses selected were appropriate for them or not. And if not, the areas for improvement have to be identified for its remedy, in case students decide to go ahead with their study in that field. This work proposes a model for organizing, measuring, analyzing students' knowledge and performance in systems of education with the help of certain Data Mining tools.

There could be various Assignments to assess students' knowledge in a particular area of knowledge. The general knowledge area is very vast, but an assignment is designed to measure the knowledge only in a particular area of knowledge. Assignment is a tool designed to observe student's behavior and produce data that can be used to draw reasonable conclusion about what students know. Assignments serve a vital role in providing information to help students, teachers, parents, administrators, and policy makers to take decisions [7].

Assignments are very powerful educational tools for encouraging effectual study in the field of education. These Assignments provide specific information about students' strengths and weaknesses with their study. Educators can use information from these Assignments after its evaluation, to adjust their instructions to meet students' requirements. Students can also use this information to decide which skills and knowledge they need to learn further or to be improved upon or for their higher studies.

Black and William [3] specified that classroom-based formative Assignments can positively affect learning when the Assignments are properly used. According to them and to their research, students study better when they get advice on what they can do to improve on particular qualities of their work along with a feedback about their work. Based on research of Black and William, the Assessment Reform Group [5] holds that successful study occurs when students understand the goals they are aiming at and when they get control on their proper study, and when they have the enough abilities to do self-assessment tasks.

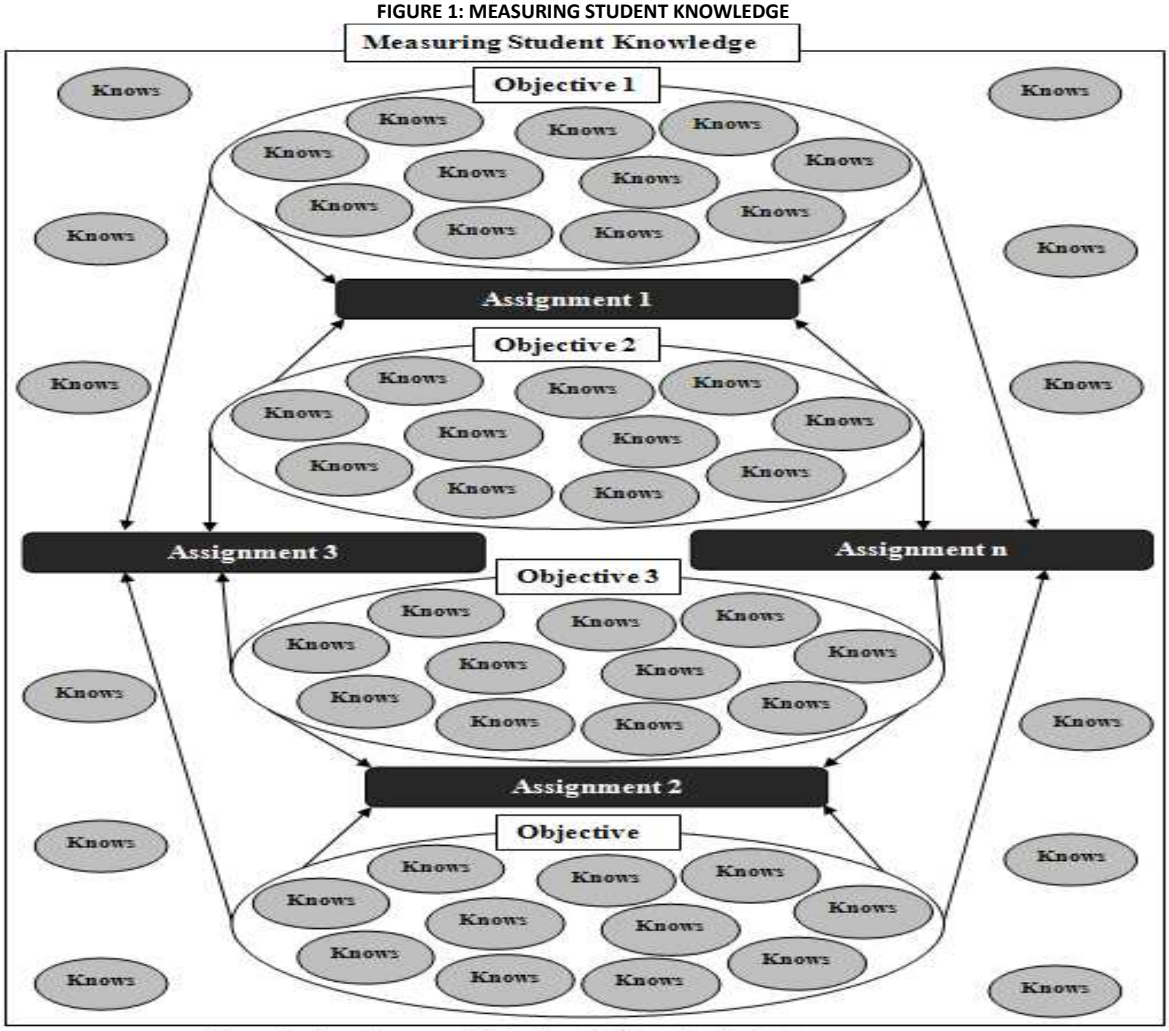
The continuous assessments of various Assignments that aim to identify difficulties and to improve the learning, instead of simply classifying the students, can provide data for increasing the personalization of the learning through the flexibility of systems. Status Measures are important in many Assignment situations, but in educational setting it is also important to track and monitor student change over time [7]. Pimentel and Omar [28] developed a model for continuous assessments of the study to detect possible learning gaps, by monitoring student's Knowledge Acquisition Level in each item of the knowledge area. The model also supports the monitoring and developing the process of acquiring knowledge to allow the student controlling his own study through a process of self-regulation, which consists of self-reinforcement, self-evaluation and self-monitoring [29].

The process of data collection creates great amount of data involves automatic procedures for analysis to acquire new knowledge for further action [29]. This paper suggests another model for organizing, measuring, analyzing students' knowledge and performance in systems of higher education with the help of certain Data Mining tools. Following descriptions in the next few sections contain a discussion on knowledge organization using specialized group of concepts associated with its objectives and presents some ideas on data mining and its application in higher education sector. It demonstrates the proposed model for organizing, measuring, analyzing students' knowledge and performance.

2. KNOWLEDGE ORGANIZATION AND ITS MEASUREMENTS

The outermost rectangle in the below given figure corresponds to the whole knowledge area and the ellipses in the figure represent the student current knowledge i.e., what the student knows. The student will possibly have a bad performance if an Assignment is designed mainly from "knowledge absence" portion of the knowledge area. But the student will possibly have a good performance if an Assignment is designed mainly from that part of knowledge area where the student possesses a certain level of knowledge. It is always better to have assignments designed to give emphasis on identifying students' learning gaps. The instructions can be adjusted based on the outcome of an assignment.

FIGURE 1: MEASURING STUDENT KNOWLEDGE

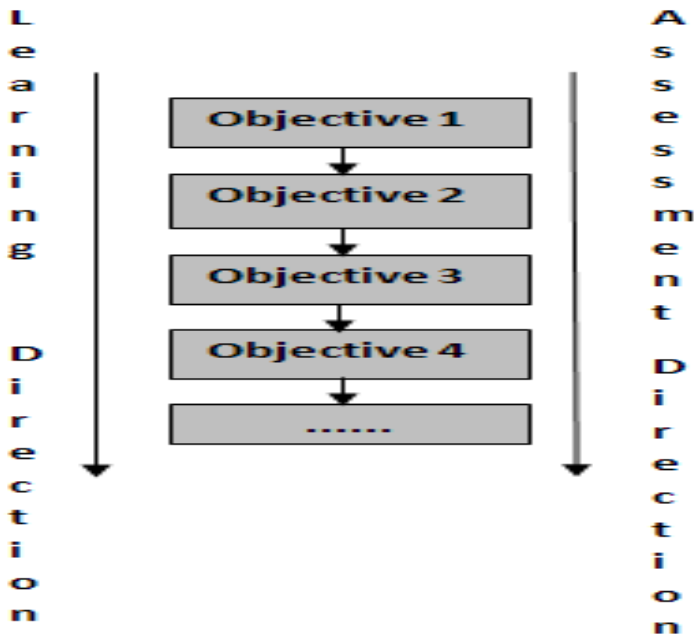


Knowledge Area and Students' Knowledge Measure

The knowledge or expertise has to be encoded and represented in such a way it supports reasoning that resembles the human problem-solving process within the teaching domain and in Intelligent Tutoring Systems (ITS) the domain module contains the knowledge of the specific domain to be taught [36] [37].

Robert Gagne [12] has proposed instructional prescriptions designed to facilitate learning in the various categories of learned capabilities that he has identified. According to Gagne, if instruction is organized hierarchically, learning some of the skills can be facilitated, so that prerequisite courses and objectives are learned in proper order. Hierarchical learning maps can also help the students and educators to prioritize or schedule their learning activities based on objectives for a course. Moreover, the hierarchical learning maps can guide assignments that assess different objectives of a course in the direction as shown in the figure below.

FIGURE 2: HIERARCHICAL ASSESSMENT AND LEARNING DIRECTIONS

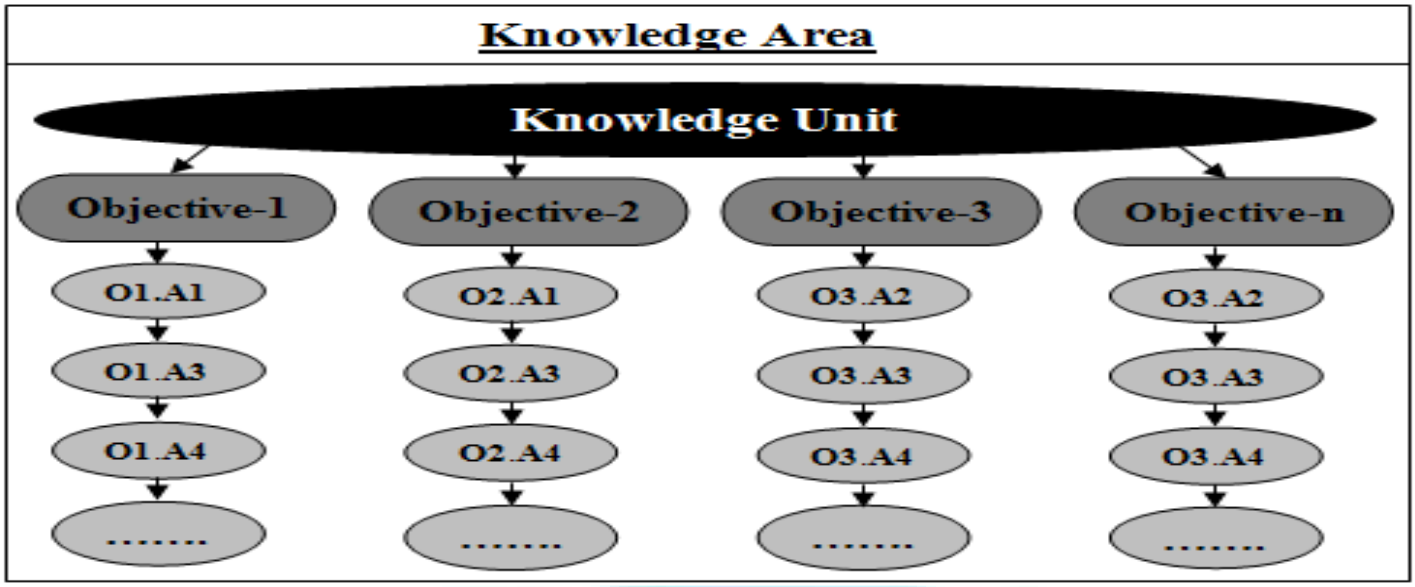


The continuous learning assessment process of different assignments in a course allows to have a better understanding of the students' knowledge in a particular course (current student knowledge), in order to guide the instruction in that area of the course. The phrase "current student knowledge" means that what someone knows is always changing.

The knowledge representation in a knowledge area allows ontology knowledge units with many objectives and its measurements in a hierarchical way, through interconnections between the objectives and its measurements. The word ontology means a specialized type of knowledge that consists of definitions or descriptions of special kinds of things and it is frequently mystified with knowledge base. This corresponds roughly to Gruber's definition, which is: "a specification of a conceptualization: the objects and relations that exist for an agent" [13] [14].

The following figure shows an architecture of the Knowledge Unit with the hierarchical organization of the objectives and its various related assignments for a course. A course may have many objectives (n number of objectives: O1, O2, O3… On) and it could be measured using several assignments (A1, A2, A3… An).

FIGURE 3: KNOWLEDGE UNIT



According Self J. [31], a detailed student model preferably contains information about previous student knowledge prior to the application of educational system, like the student's interests, objectives, preferences, progress and all other information related to student. In addition to the Knowledge Unit of the knowledge organization, other important points are the Objective Units and Marks Units, i.e., the units to organize the way students' performances will be updated.

Brusilovsky [6] considered Student Knowledge Model as a part of the main model which symbolizes a manifestation of the student's mental state and level of knowledge and abilities in terms of a particular course and its output. The Assessments Unit could be configured with measurements from various assignments of the course. The process of acquiring knowledge from various such Assignments is done by its accumulation and dynamic updation in the Objectives Unit and Marks Unit. After organizing the Knowledge Area, Assignments can be created in order to refer objective items from the Knowledge Unit. The Assignment grading will show the measurement for each objective item in detail, and its accumulation in the Objectives Unit and Marks Units, making it possible to show the students' main learning gaps, i.e., it identifies in which course objective, the student displays better or worse performance.

3. DATA MINING IN HIGHER EDUCATION SECTOR

Data mining can be used for the purpose of discovering new knowledge from databases. Data mining as a new technology allows the user to access or process large amount of information extracted mainly from large databases using its latest database technologies. The process of data mining uses its techniques to create automatic tools to investigate and then to generate new information from large databases. The generated new knowledge is then offered with the help of certain rules using different variables and then presented as a model. Data mining is used to predict new data, based on a set of rules or models extracted from databases. Data mining uses its techniques and powerful tools to describe database in a summarized way by capturing its important properties. Due to their multidisciplinary application, a multitude of data mining techniques have been studied, applied and proposed in a variety of different fields and visual data mining can be considered a data mining process enriched by visualization methods [29] [10]. Some works that apply Data Mining techniques in education concentrate on the data gathered during student interaction with communication tools: chat, forum and e-mail [31].

Data mining is applied on students 'performance-data' obtained from several of his Assignments (for example, Test 1 [A1], Test 2 [A2], Take-home-assignment [A3] and Final Examination [A4]). The main idea is to prepare the data collected from all of his assignments related with different objectives of a course and relate them by using their hierarchical organization of study, in order to discover new knowledge about students learning by using data mining tools.

Assessments Unit of the Relational Model presents data from the database that contains Assignment data showing students' performance in various assignments stored in relational database model. Students' knowledge is measured based on the different objectives of the course using different assignments and the findings are recorded using a relational database.

FIGURE 4: TABLE OF RELATIONAL ASSESSMENT UNIT

Relational Model for Assessments Unit

Student ID	Assignment ID	Objective ID	Performance
1001	A1	O1	10
1001	A1	O2	08
1001	A2	O3	08
1001	A2	O4	10
1001	A3	O1	02
1001	A3	O2	02
1001	A3	O3	03
1001	A3	O4	02
1001	A4	O1	12
1001	A4	O2	13
1001	A4	O3	10
1001	A4	O4	10
...	...	...	...
1002	A1	O1	10
1002	A1	O2	09
...	...	...	...

This data from the relational model is then summarized to get another data for a multidimensional model of Objectives Unit, as shown in the table below. It shows students' summarized performance in different objectives that were measured previously using various assignments.

FIGURE 5: TABLE OF MULTIDIMENSIONAL OBJECTIVE UNIT

Multidimensional Model for Objectives Unit

Student ID	O1	O2	O3	…	On
1001	24	23	21	…	22
1002	20	25	20	…	20
…	…	…	…	…	…
…	…	…	…	…	…

Each objective (O1 for example) can be measured in several Assignments. The Knowledge Acquisition Level indicates the student knowledge level in a specific objective item of the knowledge area and it could be computed using appropriate formula. For example, the knowledge acquisition level for the objective O1 can be calculated from three assignments (A1, A3, and A4) as 10 + 2 + 12 = 24 getting by adding all separate marks obtained in all different assignments testing that particular objective of the course. Another way of calculation is computing the arithmetic average of the percentages of marks obtained in various assignments of the course testing that objective.

In the multidimensional table of the Objectives Unit, the knowledge acquisition level for each objective (O1, O2,…,On) is displayed. This data corresponds to the objective evaluated (each respective line of the table in relational model) and the measures correspond to respective knowledge acquisition level for the objectives. (The objectives are all specified clearly and distributed to the students normally at the beginning of the course's training along with the syllabus for that course.)

Marks obtained in various assignments during the continuous evaluation process are summarized in Marks Unit as shown in the given table below. This is same as the summation of marks obtained in all the objectives for that course. (For example O1+O2+O3+O4=24+23+21+22=90) The student with ID: 1001 scored 90 marks and the grade 'A-' is awarded to that student according to the assessment criteria for the marks. (Assessment criteria are also specified in the syllabus of the course.)

FIGURE 6: TABLE OF MULTIDIMENSIONAL MARKS UNIT

Multidimensional Model for Marks Unit

Student ID	Marks	Grade
1001	90	A-
1002	85	B+
1003	96	A
…	…	…

Apply visual data mining tools along with other data mining techniques like clusterization, segmentation, classification and association on the data for knowledge discovery. Historical data must be kept and utilized for new knowledge discovery for a continuous assessment learning model. The conclusion based on historical data helps the teachers to see what qualities and problems their students face and who their students are. An improvement in education is possible by the implementation of a program of such data and analysis.

A model for organizing, measuring, analyzing students' knowledge and performance with the help of data mining is discussed next.

4. A MODEL FOR ORGANIZING, MEASURING, ANALYZING STUDENTS' KNOWLEDGE AND PERFORMANCE

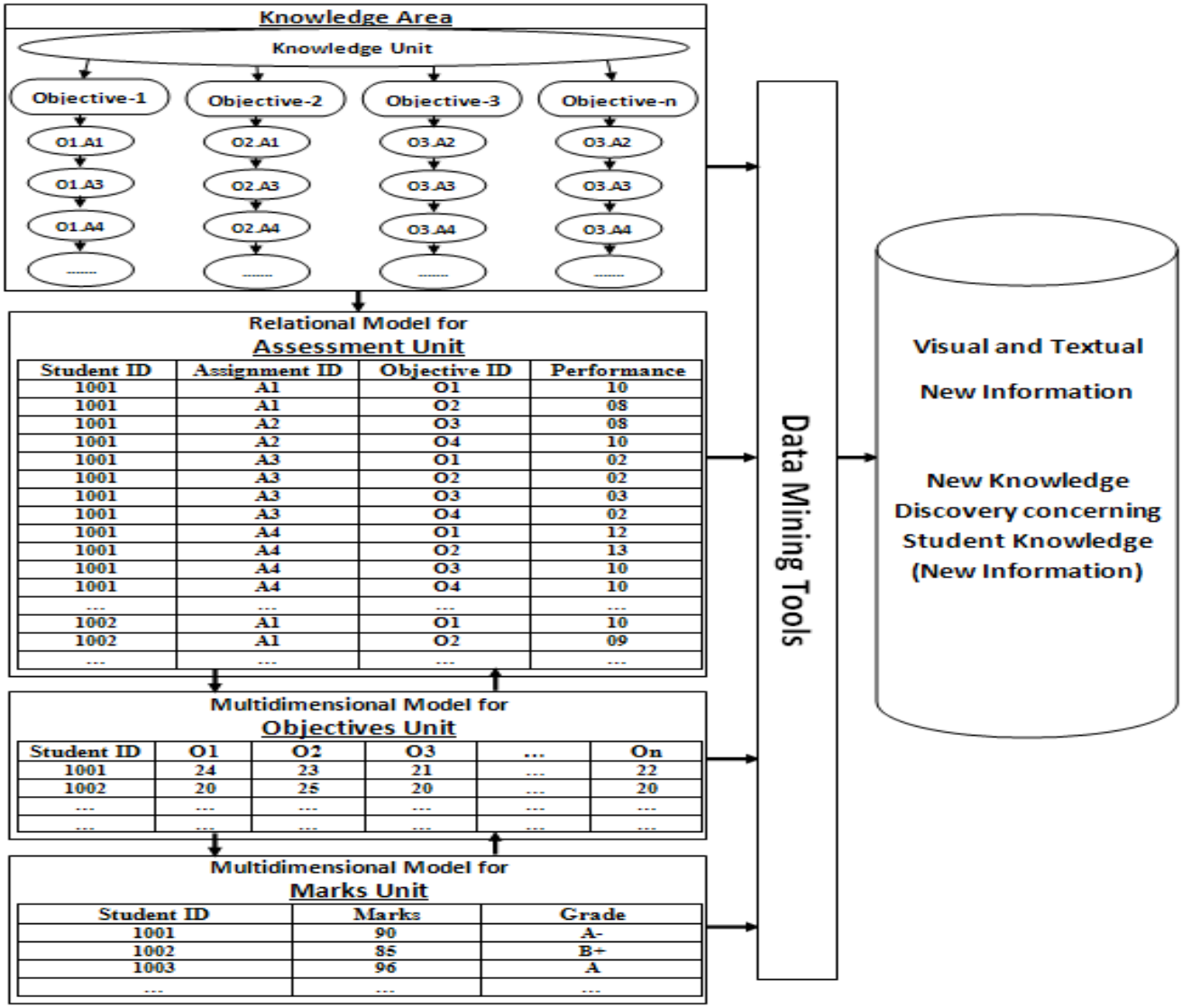
It is very important to find out continuously what the student knows by measuring their performance and knowledge. Keep this information in a database for its investigation, so that the new knowledge can be used for improvement of teaching by instructors as well as for improved understanding and study by students. This work proposes a model for knowledge organization, measurement and analysis based on ontology knowledge area, and with the help of data mining techniques; the model makes discovery of new information from the data collected with the several assignments.

This model is based on knowledge organization representing the learning hierarchies, uses ontology knowledge area with different objectives and its measurements using several assignments. Each problem or question in an Assignment must be associated with an objective of the course and the objective must be clearly indicated for each question specifying very clearly which objective is tested with that question.

It is possible to establish a knowledge measure for each ontology objective item specified in the model. The establishment of knowledge measure in each objective item will allow the selection of more adjusted evaluations to the students' knowledge acquisition levels and it might trigger an adjusted guidance in accordance with the student learning gaps due to students' learning necessities.

FIGURE 7

Model Architecture for Organizing, Measuring, Analyzing Students' Knowledge and Performance

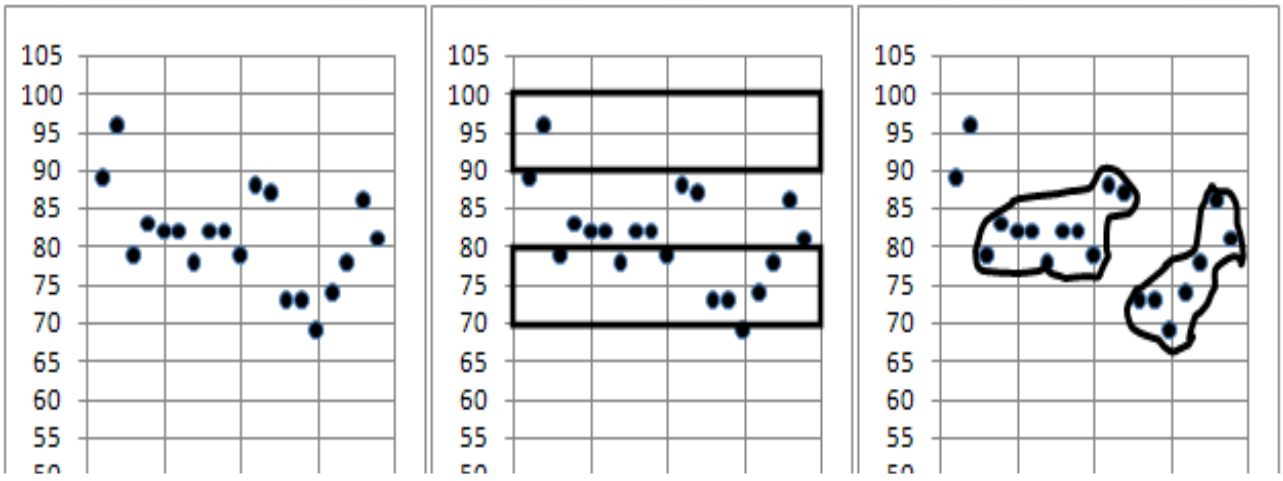


Based on knowledge organization using Knowledge Unit and the current student knowledge calculated in the Objectives Unit and Marks Unit, the proposal is to apply data mining techniques for new knowledge discovery concerned with students' knowledge to get new information regarding them. The use of visual tools will help in the new knowledge reading and its interpretation.

Successful knowledge management (including knowledge sharing and reuse) needs to integrate data bases, information systems, and knowledge based systems. These kinds of systems can be connected based on the Data Ware-house of the architecture shown in the figure above. It provides an extensive basis of integrated data. This data can be presented and utilized via proper knowledge management; knowledge sharing and knowledge reuse activities with the help of data discovery or related tools.

Knowledge-based support for decision-making is becoming a key element of a Higher Educational setting. Traditional data warehouses with the combinations of knowledge management environments and its related tools may influence Higher Educational decision-makers. The knowledge oriented model together with a collection of services, can be used to manage and encourage knowledge activities within the Higher education sector, through the data mining and data warehousing techniques.

FIGURE 8: VISUAL DATA MINING



5. CONCLUSION

The continuous learning assessment process aims to find out the learning gaps to improve the training, can create a huge amount of data. The collected data need to be recorded and analyzed so as to provide new and necessary information concerning the current student knowledge level and measure how much they know about the course and evaluate it to take decisions to improve the situation.

The model for organizing, measuring, analyzing students' knowledge and performance in systems of education with the help of Data Mining tools generates new information from the collected assessment data automatically. The model is based on knowledge organization using ontology of course objectives that represents the learning hierarchies and it makes possible to establish the knowledge acquisition level in each objective item of the knowledge area. The model helps to organize, measure, analyze students' knowledge and performance and thus used to improve both students' as well as teachers' performances.

The model for organizing, measuring, analyzing students' knowledge and performance must be tested with some data mining techniques on the real data and implement the model after its validation.

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