MINISTRY OF EDUCATION AND SCIENCE OF REPUBLIC OF KAZAKHSTAN

SULEYMAN DEMIREL UNIVERSITY

ENGINEERING FACULTY

Department of Computer Engineering

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RAUAN SYZDYKOV

Development of an Exam application using Adaptive Learning algorithms

6M070400– «Computing systems and software» speciality

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«Accepted for defense»
responsible director of department
d.t.s professor Amirgaliyev E. N.

«11» 06 2013 year

Director of department
for postgraduate education
Ph.s.c. Aydogdu S.

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Master dissertation

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Master student _____ RAUAN SYZDYKOV
(signature) (name-surname)

Supervisor
_____ PhD.Assoc.Prof. Özcan ASİLKAN
(signature) (position, name-surname)

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ABSTRACT

Web-based exams are becoming increasingly popular in the last years; however, most of the exams developed using static exam content, so that students access to the same content irrespective of different learning backgrounds, learning styles, knowledge levels and abilities. It's a challenge to develop advanced Web-based exam application that can offer both adaptivity and intelligence. This study presents a novel approach to design an exam application which includes major adaptive features. The student, domain and exam content are separately designed to support adaptive learning. Application tracks students' answers during the exam phase. The results are analyzed according to the Item Response Theory (IRT) in order to calculate students' abilities. The student model is updated based on exam results.

The updated student model is used to generate learning style and knowledge level of each learner.

ТҮЙІНДЕМЕ

Веб оқыту жүйелерінің көбісі статикалық мазмұнын қолданып өңделгеніне қарамастан, соңғы жылдары одан да көп танымал болды. Әр түрлі үйрену стильдеріне, білім дәрежесіне және қабілеттеріне қарамастан оқушыларға мазмұны бірдей білім берілуде. Бұл жұмыс, маңызды бейімделген ерекшеліктерді қамтитын бір алдын ала шолуды ұсынады. Оқушы, орта және бейімделген модель бейімделген үйренуді қолдау үшін бөлек құрастырылған.

РЕЗЮМЕ

Веб-обучающие системы становятся популярными в последние годы, несмотря на то что многие из систем разработаны с использованием статистического контента. Они разработаны так, что ученики имеют доступ к одному и тому же контенту, независимо от того что у каждого разный стиль изучения, уровень знаний и возможностей. Эта работа представляет собой предварительный обзор системы адаптивного обучения, который включает в себя основные адаптивные модели. Ученик, сфера и адаптационная модель конструированы отдельно чтобы поддерживать адаптивное обучение

CONTENTS

LIST OF ABBREVIATIONS

IRT	Item Response Theory
CAT	Computerized Adaptive Testing
1PL	One-Parameter Logistic
2PL	Two-Parameter Logistic
3PL	Three-Parameter Logistic
Q1	Question 1
Q2	Question 2
DSS	Decision Support System
S1	Student 1
S2	Student 2
UI	User Interface

1 INTRODUCTION

The importance of personalized education has recently been agreed by most web-based instruction researchers [1]. Today it is very difficult for teacher to determine the optimal learning strategy for every student in a class. And even if a teacher is able to determine all the strategies, it is even more difficult to apply all multiple teaching strategies in a classroom. Today's development of searching technology provides learners a new way to break of the traditional educational models "one size fits all" approach. It makes it possible to "customize down to the individual" and hence for effective personalized and creative learning [2-3].

The aim of adaptive learning is to provide suitable information to the right student at the right time. An adaptive learning system is able to keep track of usage and to accommodate content automatically for each of the learners, for the best learning result. An adaptive system is supported by a student model, which is built from a student's goals, preferences, and knowledge. Then the student model is used to adapt the interaction mode of the learning system according to the student's needs [4-6].

In existing exam systems, same exam content is delivered to different students. However, an exam questions for one learner is not necessarily for another. Preferences, ability and educational levels of students are varied. The complexity of existing exam applications is in selecting exam contents and sequences appropriate to particular students. Currently, there are few systems that suggest to students appropriate exam contents and sequences based on student's characteristics and analysis of previous exam results. In this study, we present an innovative exam application using adaptive learning algorithms capable of suggesting students appropriate exam contents and sequences by analyzing user's profile model in an adaptive engine. Personalization and adaptation are achieved by designing appropriate domain, student and content models separately to increase flexibility of the exam system. The user profile data are collected via a registration process for student's characteristics and continuously updated from the results of tests throughout the process. The system also uses Item Response Theory (IRT) [7-8]. for calculating student's abilities in order to be more accurate [9].

2 BACKGROUND OVERVIEW

2.1 "One size doesn't fits all" aproach

All efforts at major education reform over the last few decades have been compromised by the failure to recognize this obsolescence. School districts have accepted demands for higher teacher preparation standards, additional Advanced Placement classes, and a greater focus on the "core" subjects of math, science, English, and history. But more radical changes – such as replacing teachers with technology, using a global labor pool, or hiring a lower-paid staff – face much fiercer opposition. This has led reformers, for all their good intentions, to simply add more rules and regulations over existing ones. The result is an accumulation of claims on institutional time and resources which make for an increasingly resentful bureaucracy and schools that have become unmanageable.

The same can be said about the often-furious conflict over pedagogical practices. From the start, there should have been more discussion about what style of teaching or curriculum fits the needs of particular students, rather than the establishment of a one-size-fits-all model. Instead, we have seen wave after wave of disappointment, as some promising changes have been over applied and not worked as advertised. Which, in turn, paves the way for the next over applied fad, creating another cycle of failure and disillusionment [15].

No one would ever say that all students are the same. Certainly no teacher or parent would tell you that. Yet in schools, we often treat students as if they were, even though all those faces look so different. We sometimes out them through the same hoops, even though we know it isn't making a difference for all of them. Experiences, as well as the research we now have about the human brain, tells us that students are different, that they learn differently and have different likes, preferences, and needs.

Yet of years we have planned "The Exam" and made it to all, knowing that we were losing some and dropping others because the exam level is not necessary for all students. Still we expect students to adjust to the exam when the exam should really be adjusted to the students. Adjustments should be based on the sound knowledge of the student. This includes what they know already, can do, like, need, or prefer [14].

3 LITERATURE REVIEW

3.1 What is adaptive learning?

The term "adaptive" is associated with a quite range of diverse system characteristics and capabilities in the e-Learning industry, thus making it is necessary to qualify the qualities one attributes to a system when using the term. A learning environment considered adaptive if it is capable of: monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge on its users and the subject matter at hand, to dynamically facilitate the learning process. The preceding informal definition should differentiate the concept of adaptivity from those of tailorability / configurability, flexibility / extensibility, or the mere support for intelligently mapping between available media / formats and the characteristics of access devices. Please note that in several places in this paper, the term "adaptation" is used as a synonym for "adaptivity" [11].

Adaptations in learning environment are based on well-organized models and processes. A lot of information is needed in adaptive exam systems to represent domain knowledge and to model the student learning behavior. And it can be divided into three models: a domain model, a student model, and an adaptive model.

3.1.1 Domain Model

A domain model contains questions of exam content to support adaptive course delivery. The domain model acts as a data repository that consists of topics, contents, questions or nodes, and navigation links related to the design structure of the represented data. However, the domain model may also contain student information relevant to the learning activity, such as workflows, participants, and roles. There are two important parts of the domain model: exam content and the delivery system. The delivery system should be able to support all content types and be adaptable to different requirements of exam content. The most important aspect of the domain model is the relationship between the exam elements – the navigation links between questions – which are used to decide upon adaptations. The domain model focuses on designing a hypermedia structure that is appropriate for use needs and characteristics. This model designs the structure of hypermedia content to protect users from such obstacles as the "lost in space" problem when they enter each node. These content structures make it convenient for students to see the questions they can answer [10].

3.1.2 Student Model

The main component of adaptive exam system is a student model. It is sometimes referred to as a learning model. It contains all student information, for example, their domain knowledge, behavior, learning level, and other information. The student model not only collects general user information, but also maintains a live user account within the system [11]. Domain-specific information and domain-independent information are two major groups of information collected in the student

models, based on the relationships with the particular subject. The domain-specific information model is referred to as the student knowledge model. It is describes the student's knowledge level, their understanding of domain knowledge or curriculum elements, the errors that the students made, the student's knowledge development process, records of learning behaviors, records of evaluation or assessment, and so forth. The domain-independent information is information about the skills of students, so it is based on their behavior. It may include learning goals (to evaluate the learner's achievements), cognitive capabilities such as inductive reasoning skill and associative learning skill, motivational states that drive the learners, background and experience, and preferences [10].

3.1.3 Adaptive Model

An adaptive model incorporates the adaptive theory of an adaptive exam system by combining the domain model with the student model. The process of adaptive modeling starts with selecting representative nodes by analyzing the student needs from the student model. Nodes can be classified into different types of knowledge: basic knowledge, including knowledge of definitions, formulas, and other matter; procedural knowledge, addressing relations among steps; and conceptual knowledge, referring to relations between concepts that draw details into a bigger picture [12]. Each kind of knowledge requires different strategies, so nodes will be presented to students in different fashions [12]. The next step is to make a decision about which objects from which nodes should be represented, so that they can be used by students until they are finished with that node. The last step is to repeat the process until each node is completely selected.

3.2 COMPUTERIZED ADAPTIVE TESTING (CAT)

CAT successively selects questions so as to maximize the precision of the exam based on what is known about the examinee from previous questions [16]. From the examinee's perspective, the difficulty of the exam seems to tailor itself to his or her level of ability. For example, if an examinee performs well on an item of intermediate difficulty, he will then be presented with a more difficult question. Or, if he performed poorly, he would be presented with a simpler question. Compared to static multiple choice tests that nearly everyone has experienced, with a fixed set of items administered to all examinees, computer-adaptive tests require fewer test items to arrive at equally accurate scores [16].

The basic computer-adaptive testing method is an iterative algorithm with the following steps:

1) The pool of available items is searched for the optimal item, based on the current estimate of the examinee's ability

2) The chosen item is presented to the examinee, who then answers it correctly or incorrectly

3) The ability estimate is updated, based upon all prior answers

4) Steps 1-3 are repeated until a termination criterion is met [17].

Nothing is known about the examinee prior to the administration of the first item, so the algorithm is generally started by selecting an item of medium-easy, difficulty as the first item.

As the result of adaptive administration, different examinees receive quite different tests [18]. The psychometric technology that allows equitable scores to be computed across different sets of items is Item Response Theory (IRT). IRT is also the preferred methodology for selecting optimal items which are typically selected on the basis of information rather than difficulty [17].

3.2.1 Advantages

Adaptive tests can provide uniformly precise scores for most test-takers [17]. In contrast, standard fixed tests almost always provide the best precision for test-takers of medium ability and increasingly poorer precision for test-takers with more extreme test scores.

An adaptive test can typically be shortened by 50% and still maintain a higher level of precision than a fixed version [16]. This translates into time savings for the test-taker. Test-takers do not waste their time attempting items that are too hard or trivially easy. Additionally, the testing organization benefits from the time savings; the cost of examinee seat time is substantially reduced. However, because the development of CAT involves much more expense than a standard fixed-form test, a large population is necessary for CAT testing program to be financially fruitful.

Like any computer-based test, adaptive tests may show results immediately after testing.

Adaptive testing, depending on the item selection algorithm, may reduce exposure of some items because examinees typically receive different sets of items

rather than the whole population being administered a single set. However, it may increase the exposure of others [17].

3.2.2 CAT components

There are five technical components in building a CAT [16]. This list does not include practical issues, such as item pretesting or live field release.

1) Calibrated item pool
2) Starting point or entry level
3) Item selection algorithm
4) Scoring procedure
5) Termination criterion

3.2.2.1 Calibrated Item Pool

A pool of items must be available for the CAT to choose from [16]. The pool must be calibrated with a psychometric model, which is used as a basis for the remaining four components. Typically, IRT is employed as the psychometric model [16]. One reason IRT is popular is because it places persons and items on the same metric, which is helpful for issues in item selection.

3.2.2.2 Starting Point

In CAT, items are selected based on the examinee's performance up to a given point in the test. However, the CAT is obviously not able to make any specific estimate of examinee ability when no items have been administered. So some other initial estimate of examinee ability is necessary. If some previous information regarding the examinee is known, it can be used, [16]. but often the CAT just assumes that the examinee is of average ability – hence the first item often being of medium difficulty.

3.2.2.3 Item Selection Algorithm

As mentioned previously, IRT places examinees and items on the same metric. Therefore, if the CAT has an estimate of examinee ability, it is able to select an item that is most appropriate for that estimate [19]. Technically, this is done by selecting the item with the greatest information at that point [16]. Information is a function of the discrimination parameter of the item, as well as the conditional variance and pseudo guessing parameter.

3.2.2.4 Scoring Procedure

After an item is administered, the CAT updates its estimate of the examinee's ability level. If the examinee answered the item correctly, the CAT will likely estimate their ability to be somewhat higher, and vice versa. This is done by using the item response function from IRT to obtain a likelihood function of the examinee's ability. Two methods for this are called maximum likelihood estimation and Bayesian estimation. The latter assumes an a priori distribution of examinee ability, and has two commonly used estimators: expectation a posteriori and maximum a posteriori.

Maximum likelihood is equivalent to a Bayes maximum a posteriori estimate if a uniform (f(x)=1) prior is assumed [19]. Maximum likelihood is asymptotically unbiased, but cannot provide a theta estimate for a nonmixed response vector, in which case a Bayesian method may have to be used temporarily [16].

3.2.2.5 Termination Criterion

The CAT algorithm is designed to repeatedly administer items and update the estimate of examinee ability. This will continue until the item pool is exhausted unless a termination criterion is incorporated into the CAT. Often, the test is terminated when the examinee's standard error of measurement falls below a certain user-specified value, hence the statement above that an advantage is that examinee scores will be uniformly precise or "equiprecise" [16]. Other termination criteria exist for different purposes of the test, such as if the test is designed only to determine if the examinee should "Pass" or "Fail" the test, rather than obtaining a precise estimate of their ability [16, 20].

3.3 E-ASSESSMENT

In its broadest sense, e-assessment is the use of information technology for any assessment-related activity. This definition embraces a wide range of student activity ranging from the use of a word processor to on-screen testing. Due to its obvious similarity to e-learning, the term e-assessment is becoming widely used as a generic term to describe the use of computers within the assessment process. Specific types of e-assessment include computerized adaptive testing and computerized classification testing.

E-assessment can be used to assess cognitive and practical abilities. Cognitive abilities are assessed using e-testing software, while practical abilities are assessed using e-portfolios or simulation software.

3.3.1 Components

An e-testing system designed to focus on lower level associations comprises two components: 1) an assessment engine; and 2) an item bank. An assessment engine comprises the hardware and software required to create and deliver a test. Most e-testing engines run on standard hardware so the key characteristic is the software's functionality. There is a wide range of software packages. The software does not include the questions themselves; these are provided by an item bank. Once created, the engine uses the item bank to generate a test. Traditional paper-and-pencil testing is similar, but the test is pulled from the bank at only one time, when it is sent to publishing.

The creation of the item bank is more costly and time consuming than the installation and configuration of the assessment engine. This is due to the fact that assessment engines can be bought "off the shelf" whereas an item bank must be developed for each specific application.

An e-assessment system designed to focus on more sophisticated forms of knowledge requires some sort of interactive activity and a system for inviting

students to reason or solve problems around that activity. One influential program of research is known as Evidence Centered Design, or ECD. ECD involves the use of Bayesian Inference Nets to create a sophisticated model of student cognition, and a set of activities or problems that students work on that allow the system to estimate the individuals understanding of the particular domain.

3.3.2 Advantages

E-assessment is becoming widely used. It has many advantages over traditional (paper-based) assessment. The advantages include:

lower long-term costs

instant feedback to students

greater flexibility with respect to location and timing

improved reliability (machine marking is much more reliable than human marking)

improved impartiality (machine marking does not 'know' the students so does not favour nor make allowances for minor errors)

greater storage efficiency - tens of thousands of answer scripts can be stored on a server compared to the physical space required for paper scripts

enhanced question styles which incorporate interactivity and multimedia.

There are also disadvantages. E-assessment systems are expensive to establish and not suitable for every type of assessment (such as extended response questions). The main expense is not technical; it is the cost of producing high quality assessment items - although that cost is identical when using paper-based assessment.

The best examples follow a Formative Assessment structure and are called "Online Formative Assessment". This involves making an initial formative assessment by sifting out the incorrect answers. The author/teacher will then explain what the pupil should have done with each question. It will then give the pupil at least one practice at each slight variation of sifted out questions. This is the formative learning stage. The next stage is to make a Summative Assessment by a new set of questions only covering the topics previously taught. Some will take this even further and repeat the cycle such as BOFA Online 11 plus papers which is aimed at the eleven plus exam set

3.3.3 E-assessment standards

In order to create a mechanism for the sharing of high quality assessment items, global standards have emerged. The IMS Question and Test Interoperability specification (QTI) provides a common format for describing and distributing question items across disparate systems.

3.3.4 Hand-held student response systems

An area of E-assessment that has seen extensive growth in recent years is the use of hand held student response devices (often referred to as clickers or voting devices). These allow a teacher to carry out whole-group assessments, polls and surveys quickly and easily. They use either radio or infra red to communicate with a central

hub that is usually attached to a computer. In many school classrooms these devices may also be used in combination with an interactive whiteboard.

3.3.5 Note on terminology

Various terms are used to describe the use of a computer for assessment purposes. These include:

Computer-Assisted Assessment or Computer-Aided Assessment (CAA)
Computer-Mediated Assessment (CMA)
Computer-Based Assessment (CBA)
online assessment.

Although these terms are commonly used interchangeably, they have distinct meanings.

Computer Assisted/Mediated Assessment refers to any application of computers within the assessment process; the role of the computer may be extrinsic or intrinsic. It is, therefore, a synonym for e-assessment which also describes a wide range of computer-related activities. Within this definition the computer often plays no part in the actual assessment of responses but merely facilitates the capture and transfer of responses between candidate and human assessor.

Computer-Based Assessment refers to assessment which is built around the use of a computer; the use of a computer is always intrinsic to this type of assessment. This can relate to assessment of IT practical skills or more commonly the on screen presentation of knowledge tests. The defining factor is that the computer is marking or assessing the responses provided from candidates. It can be performed on an equivalent electronic device such as a cell phone or PDA. CBA systems enable educators and trainers to author, schedule, deliver, and report on surveys, quizzes, tests and exams [28]. They may be a stand-alone system or a part of a virtual learning environment, possibly accessed via the World Wide Web.

Online assessment refers to assessment activity which requires the use of the internet. In reality, few high stakes assessment sessions are actually conducted online in real-time, but the transfer of data prior to and after the assessment session is conducted via the internet. There are many examples of practice and diagnostic tests being run real time over the internet.

3.4 E-LEARNING

E-learning refers to the use of electronic media and information and communication technologies (ICT) in education. E-learning is broadly inclusive of all forms of educational technology in learning and teaching. E-learning is inclusive of, and is broadly synonymous with multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer-based training (CBT), computer-assisted instruction or computer-aided instruction (CAI), internet-based training (IBT), web-based training (WBT), online education, virtual education, virtual learning environments (VLE) (which are also called learning platforms), m-learning, and digital educational collaboration. These alternative names emphasize a particular aspect, component or delivery method.

E-learning includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, satellite TV, CD-ROM, and computer-based learning, as well as local intranet/extranet and web-based learning. Information and communication systems, whether free-standing or based on either local networks or the Internet in networked learning, underly many e-learning processes [29].

E-learning can occur in or out of the classroom. It can be self-paced, asynchronous learning or may be instructor-led, synchronous learning. E-learning is suited to distance learning and flexible learning, but it can also be used in conjunction with face-to-face teaching, in which case the term blended learning is commonly used.

It is commonly thought that new technologies make a big difference in education [30]. Many proponents of e-learning believe that everyone must be equipped with basic knowledge of technology, as well as use it as a vehicle for reaching educational goals.

3.4.1 Overview

E-learning refers to the use of technology in learning and education. There are several aspects to describing the intellectual and technical development of e-learning, which can be categorized into discrete areas. These are addressed in turn in the sections of this article:

e-learning as an educational approach or tool that supports traditional subjects;

e-learning as a technological medium that assists in the communication of knowledge, and its development and exchange;

e-learning itself as an educational subject; such courses may be called "Computer Studies" or "Information and Communication Technology (ICT)";

e-learning administrative tools such as education management information systems (EMIS).

3.4.2 Background

E-learning is a broadly inclusive term that describes educational technology that electronically or technologically supports learning and teaching. Bernard Luskin, a pioneer of e-learning, advocates that the "e" should be interpreted to mean "exciting, energetic, enthusiastic, emotional, extended, excellent, and educational" in addition to "electronic." This broad interpretation focuses on new applications and developments, and also brings learning and media psychology into consideration [31]. Parks suggested that the "e" should refer to "everything, everyone, engaging, easy" [32].

Depending on whether a particular aspect, component or delivery method is given emphasis, a wide array of similar or overlapping terms has been used. As such, e-learning encompasses multimedia learning, technology-enhanced learning (TEL), computer-based training (CBT), computer-assisted instruction (CAI), internet-based training (IBT), web-based training (WBT), online education, virtual education, virtual learning environments (VLE) which are also called learning platforms, m-learning, digital educational collaboration, distributed learning, computer-mediated communication, cyber-learning, and multi-modal instruction. Every one of these

numerous terms has had its advocates, who point up particular potential distinctions. In practice, as technology has advanced, the particular "narrowly defined" aspect that was initially emphasized has blended into "e-learning." As an example, "virtual learning" in a narrowly-defined semantic sense implies entering the environmental simulation within a virtual world [33-34]. for example in treating PTSD [35-36]. In practice, a "virtual education course" refers to any instructional course in which all, or at least a significant portion, is delivered by the Internet. "Virtual" is used in that broader way to describe a course that not taught in a classroom face-to-face but through a substitute mode that can conceptually be associated "virtually" with classroom teaching, which means that people do not have to go to the physical classroom to learn. Accordingly, virtual education refers to a form of distance learning in which course content is delivered by various methods such as course management applications, multimedia resources, and videoconferencing. Students and instructors communicate via these technologies [37].

The worldwide e-learning industry is economically significant, and was estimated in 2000 to be over $48 billion according to conservative estimates [38]. Developments in internet and multimedia technologies are the basic enabler of e-learning, with consulting, content, technologies, services and support being identified as the five key sectors of the e-learning industry [39]. Information and communication technologies (ICT) are used extensively by young people [40].

E-learning expenditures differ within and between countries. Finland, Norway, Belgium and Korea appear to have comparatively effective programs [41].

3.4.3 History

In 1960, the University of Illinois initiated a classroom system based in linked computer terminals where students could access informational resources on a particular course while listening to the lectures that were recorded via some form of remotely device like television or audio device [42].

In the early 1960s, Stanford University psychology professors Patrick Suppes and Richard C. Atkinson experimented with using computers to teach math and reading to young children in elementary schools in East Palo Alto, California. Stanford's Education Program for Gifted Youth is descended from those early experiments. In 1963, Bernard Luskin installed the first computer in a community college for instruction, working with Stanford and others, developed computer assisted instruction. Luskin completed his landmark UCLA dissertation working with the Rand Corporation in analyzing obstacles to computer assisted instruction in 1970.

Educational institutions began to take advantage of the new medium by offering distance learning courses using computer networking for information.

Early e-learning systems, based on Computer-Based Learning/Training often attempted to replicate autocratic teaching styles whereby the role of the e-learning system was assumed to be for transferring knowledge, as opposed to systems developed later based on Computer Supported Collaborative Learning (CSCL), which encouraged the shared development of knowledge.

Computer-based learning made up many early e-learning courses such as those developed by Murray Turoff and Starr Roxanne Hiltz in the 1970s and 80s at the New Jersey Institute of Technology [43]. and the ones developed at the University of Guelph in Canada [44]. By mid 1980's, accessing course content become possible at many college libraries.

Cassandra B. Whyte researched about the ever increasing role that computers would play in higher education. This evolution, to include computer-supported collaborative learning, in addition to data management, has been realized. The type of computers has changed over the years from cumbersome, slow devices taking up much space in the classroom, home, and office to laptops and handheld devices that are more portable in form and size and this minimalization of technology devices will continue [45].

The Open University in Britain[44]. and the University of British Columbia (where Web CT, now incorporated into Blackboard Inc. was first developed) began a revolution of using the Internet to deliver learning [46]. making heavy use of web-based training and online distance learning and online discussion between students [47]. Practitioners such as Harasim (1995)[48]. put heavy emphasis on the use of learning networks.

With the advent of World Wide Web in the 1990s, teachers embarked on the method using emerging technologies to employ multi-object oriented sites, which are text-based online virtual reality system, to create course websites along with simple sets instructions for its students [49]. As the Internet becomes popularized, correspondence schools like University of Phoenix became highly interested with the virtual education, setting up a name for itself in 1980 [50].

In 1993, Graziadei described an online computer-delivered lecture, tutorial and assessment project using electronic mail. By 1994, the first online high school had been founded. In 1997, Graziadei described criteria for evaluating products and developing technology-based courses include being portable, replicable, scalable, and affordable, and having a high probability of long-term cost-effectiveness [51].

By 1994, CALCampus presented its first online curriculum as Internet becoming more accessible through major telecommunications networks. CALCampus is where concepts of online-based school first originated, this allowed to progress real-time classroom instructions and Quantum Link classrooms [52]. With the drastic shift of Internetfunctionality, multimedia began introducing new schemes of communication; through the invention of webcams, educators can simply record lessons live and upload them on the website page. Now, there are currently wide varieties of online education that are reachable for colleges, universities and K-12 students. In fact, the National Center for Education Statistics estimate the number of K-12 students enrolled in online distance learning programs increased by 65 percent from 2002 to 2005. This form of high learning allowed for greater flexibility by easing the communication between teacher and student, now teachers received quick lecture feedbacks from their students. The idea of Virtual Education soon became popular and many institutions began following the new norm in the education history.

The emergence of e-learning is arguably one of the most powerful tools available to the growing need for education. The need to improve access to education opportunities allowed students who desire to pursue their education but are constricted due to the distance of the institution to achieve education through "virtual connection" newly available to them. Online education is rapidly increasing and becoming as a viable alternative for traditional classrooms. According to a 2008 study conducted by the U.S Department of Education, back in 2006-2007 academic year, about 66% of postsecondary public and private schools began participating in student financial aid programs offered some distance learning courses, record shows only 77% of enrollment in for-credit courses being for those with an online component [53]. In 2008, the Council of Europe passed a statement endorsing e-learning's potential to drive equality and education improvements across the EU [54].

Recent studies show that the effectiveness of online instruction is considered equal to that of face-to-face classroom instructions but not as effective as the combination of face-to-face and online methods [53].

3.4.4 Educational Aproach

The extent to which e-learning assists or replaces other learning and teaching approaches is variable, ranging on a continuum from none to fully online distance learning [54-55]. A variety of descriptive terms have been employed (somewhat inconsistently) to categorize the extent to which technology is used. For example, 'hybrid learning' or 'blended learning' may refer to classroom aids and laptops, or may refer to approaches in which traditional classroom time is reduced but not eliminated, and is replaced with some online learning [56-58]. 'Distributed learning' may describe either the e-learning component of a hybrid approach, or fully online distance learning environments [54]. Another scheme described the level of technological support as 'web enhanced', 'web supplemented' and 'web dependent'.

3.4.4.1 Synchronous and Asynchronous

E-learning may either be synchronous or asynchronous. Synchronous learning occurs in real-time, with all participants interacting at the same time, while asynchronous learning is self-paced and allows participants to engage in the exchange of ideas or information without the dependency of other participants involvement at the same time.

Synchronous learning involves the exchange of ideas and information with one or more participants during the same period of time. A face-to-face discussion is an example of synchronous communications. In e-learning environments, examples of synchronous communications include online real-time live teacher instruction and feedback, Skype conversations, or chat rooms or virtual classrooms where everyone is online and working collaboratively at the same time.

Asynchronous learning may use technologies such as email, blogs, wikis, and discussion boards, as well as web-supported textbooks [59]. hypertext documents, audio[60]. video courses, and social networking using web 2.0. At the professional educational level, training may include virtual operating rooms [61]. Asynchronous learning is particularly beneficial for students who have health problems or have child

care responsibilities and regularly leaving the home to attend lectures is difficult. They have the opportunity to complete their work in a low stress environment and within a more flexible timeframe [62]. In asynchronous online courses, students proceed at their own pace. If they need to listen to a lecture a second time, or think about a question for awhile, they may do so without fearing that they will hold back the rest of the class. Through online courses, students can earn their diplomas more quickly, or repeat failed courses without the embarrassment of being in a class with younger students. Students also have access to an incredible variety of enrichment courses in online learning, and can participate in college courses, internships, sports, or work and still graduate with their class.

Both the asynchronous and synchronous methods rely heavily on self-motivation, self-discipline, and the ability to communicate in writing effectively [63].

3.4.4.2 Linear learning

Computer-based learning or training (CBT) refers to self-paced learning activities delivered on a computer or handheld device such as a tablet or smartphone. CBT often delivers content via CD-ROM, and typically presents content in a linear fashion, much like reading an online book or manual. For this reason, CBT is often used to teach static processes, such as using software or completing mathematical equations. Computer-based training is conceptually similar to web-based training (WBT), the primary difference being that WBTs are delivered via Internet using a web browser.

Assessing learning in a CBT is often by assessments that can be easily scored by a computer such as multiple choice questions, drag-and-drop, radio button, simulation or other interactive means. Assessments are easily scored and recorded via online software, providing immediate end-user feedback and completion status. Users are often able to print completion records in the form of certificates.

CBTs provide learning stimulus beyond traditional learning methodology from textbook, manual, or classroom-based instruction. For example, CBTs offer user-friendly solutions for satisfying continuing education requirements. Instead of limiting students to attending courses or reading printed manuals, students are able to acquire knowledge and skills through methods that are much more conducive to individual learning preferences. For example, CBTs offer visual learning benefits through animation or video, not typically offered by any other means.

CBTs can be a good alternative to printed learning materials since rich media, including videos or animations, can easily be embedded to enhance the learning.

However, CBTs pose some learning challenges. Typically the creation of effective CBTs requires enormous resources. The software for developing CBTs (such as Flash or Adobe Director) is often more complex than a subject matter expert or teacher is able to use. In addition, the lack of human interaction can limit both the type of content that can be presented as well as the type of assessment that can be performed. Many learning organizations are beginning to use smaller CBT/WBT activities as part of a broader online learning program which may include online discussion or other interactive elements.

such as Second Life [74]. This phenomenon has also been referred to as Long Tail Learning[75].

E-learning 2.0, in contrast to e-learning systems not based on CSCL, assumes that knowledge (as meaning and understanding) is socially constructed. Learning takes place through conversations about content and grounded interaction about problems and actions. Advocates of social learning claim that one of the best ways to learn something is to teach it to others [76].

In addition to virtual classroom environments, social networks have become an important part of E-learning 2.0. Social networks have been used to foster online learning communities around subjects as diverse as test preparation and language education [77]. Mobile Assisted Language Learning (MALL) is the use of handheld computers or cell phones to assist in language learning. Traditional educators may not promote social networking unless they are communicating with their own colleagues [78].

3.4.5 Technology

Various technologies are used to facilitate e-learning. Most e-learning uses combinations of these techniques, including blogs, collaborative software, ePortfolios, and virtual classrooms.

3.4.5.1 Audio

The radio has been around for a long time and has been used in educational classrooms. Recent technologies have allowed classroom teachers to stream audio over the internet. There are also webcasts and podcasts available over the internet for students and teachers to download. For example, iTunes has various podcasts available on a variety of subjects that can be downloaded for free.

3.4.5.2 Video

Videos allow teachers to reach students who are visual learners and tend to learn best by seeing the material rather than hearing or reading about it. Teachers can access video clips through the internet instead of relying on DVDs or VHS tapes. Websites like YouTube are used by many teachers. Teachers can use messaging programs such as Skype, Adobe Connect, or webcams, to interact with guest speakers and other experts. Interactive video games are being integrated in the curriculum at both K-12 and higher education institutions.

Research on the use of video in lessons is preliminary, but early results show an increased retention and better results when video is used in a lesson. Creating a systematic video development method holds promise for creating video models that positively impact student learning [79].

3.4.5.3 Computers, tablets and mobile devices

Computers and tablets allow students and teachers access to websites and other programs, such as Microsoft Word, PowerPoint, PDF files, and images. Many mobile devices support m-learning.

3.4.5.4 Blogging

Blogs allow students and teachers to post their thoughts, ideas, and comments on a website. Blogging allows students and instructors to share their thoughts and comments on the thoughts of others which could create an interactive learning environment [80].

3.4.5.5 Webcams

The development of webcams and webcasting has facilitated the creation of virtual classrooms and virtual learning environments. Virtual classrooms supported by such technology are becoming more and more popular, especially since they are contributing as a main solution to solving problems with travel expenses. Virtual classrooms with such technology also provide the benefits of being easy to set up [81].

3.4.5.6 Whiteboards

Interactive whiteboards ("smartboards") allow teachers and students to write on the touch screen, so learning becomes interactive and engaging.

3.4.5.7 Screencasting

Screencasting is a recent trend in e-learning. There are many screencasting tools available that allow users to share their screens directly from their browser and make the video available online so that the viewers can stream the video directly [82]. The advantage of such tools is that it gives the presenter the ability to show his ideas and flow of thoughts rather than simply explain them, which may be more confusing when delivered via simple text instructions. With the combination of video and audio, the expert can mimic the one-on-one experience of the classroom and deliver clear, complete instructions. From the learner's point of view this provides the ability to pause and rewind and gives the learners the advantage of moving at their own pace, something a classroom cannot always offer.

3.4.5.8 Combining technology

Along with the terms learning technology, instructional technology, the term educational technology refers to the use of technology in learning in a much broader sense than the computer-based training or Computer Aided Instruction of the 1980s. It is also broader than the terms Online Learning or Online Education which generally refer to purely web-based learning. In cases where mobile technologies are used, the term M-learning has become more common. E-learning, however, also has implications beyond just the technology and refers to the actual learning that takes place using these systems.

In higher education especially, the increasing tendency is to create a virtual learning environment (VLE) (which is sometimes combined with a Management Information System (MIS) to create a Managed Learning Environment) in which all aspects of a course are handled through a consistent user interface standard throughout the institution. A growing number of physical universities, as well as newer online-only colleges, have begun to offer a select set of academic degree and certificate programs via the Internet at a wide range of levels and in a wide range of disciplines. While some programs require students to attend some campus classes or orientations, many are delivered completely online. In addition, several universities offer online student support services, such as online advising and registration, e-counseling, online textbook purchases, student governments and student newspapers.

E-learning can also refer to educational websites such as those offering learning scenarios, worksheets and interactive exercises for children. The term is also used extensively in the business sector where it generally refers to cost-effective online training.

3.4.5.9 Virtual classroom

Virtual Learning Environments (VLE), also known as learning platforms, utilize virtual classrooms and meetings which often use a mix of communication technologies. One example of web conferencing software that enables students and instructors to communicate with each other via webcam, microphone, and real-time chatting in a group setting, is Adobe Connect, which is sometimes used for meetings and presentations [83]. Participants in a virtual classroom can also use icons called emoticons to communicate feelings and responses to questions or statements. Students are able to 'write on the board' and even share their desktop, when given rights by the teacher. Other communication technologies available in a virtual classroom include text notes, microphone rights, and breakout sessions. Breakout sessions allow the participants to work collaboratively in a small group setting to accomplish a task as well as allow the teacher to have private conversations with his or her students.

The virtual classroom also provides the opportunity for students to receive direct instruction from a qualified teacher in an interactive environment. Students have direct and immediate access to their instructor for instant feedback and direction. The virtual classroom also provides a structured schedule of classes, which can be helpful for students who may find the freedom of asynchronous learning to be overwhelming. In addition, the virtual classroom provides a social learning environment that replicates the traditional "brick and mortar" classroom. Most virtual classroom applications provide a recording feature. Each class is recorded and stored on a server, which allows for instant playback of any class over the course of the school year. This can be extremely useful for students to review material and concepts for an upcoming exam. This also provides students with the opportunity to watch any class that they may have missed, so that they do not fall behind. It also gives parents the ability to monitor any classroom to ensure that they are satisfied with the education their child is receiving.

3.4.5.10 Administrative tools

Learning management system

A learning management system (LMS) is software used for delivering, tracking and managing training and education; for example, tracking attendance, time on task, and student progress. Educators can post announcements, grade assignments, check on course activity, and participate in class discussions. Students can submit their work, read and respond to discussion questions, and take quizzes [80]. An LMS may allow teachers, administrators, students, and permitted additional parties (such as parents if appropriate) to track various metrics. LMSs range from systems for managing training/educational records to software for distributing courses over the Internet and offering features for online collaboration. The creation and maintenance of comprehensive learning content requires substantial initial and ongoing investments of human labor. Effective translation into other languages and cultural contexts requires even more investment by knowledgeable personnel [84].

Two widely used internet-based learning management systems tools for e-learning are Blackboard Inc. and Moodle.

Blackboard Inc. has over 20 million users daily. Offering six different platforms: Blackboard Learn, Blackboard Collaborate, Blackboard Mobile, Blackboard Connect, Blackboard Transact, and Blackboard Analytics; Blackboard's tools allow educators to decide whether their program will be blended or fully online, asynchronous or synchronous. Blackboard can be used for K-12 education, Higher Education, Business, and Government collaboration [85].

Moodle is an Open Source Course Management System. It is free to download and provides blended learning opportunities as well as platforms for distance learning courses. The Moodle website has many tutorials for creating a program or becoming a Moodle student [86].

Learning content management system

A learning content management system (LCMS) is software for author content (courses, reusable content objects). An LCMS may be solely dedicated to producing and publishing content that is hosted on an LMS, or it can host the content itself. The Aviation Industry Computer-Based Training Committee (AICC) specification provides support for content that is hosted separately from the LMS.

A recent trend in LCMSs is to address this issue through crowd-sourcing

Computer-aided assessment

Computer-aided assessment (also but less commonly referred to as e-assessment), ranging from automated multiple-choice tests to more sophisticated systems is becoming increasingly common. With some systems, feedback can be geared towards a student's specific mistakes or the computer can navigate the student through a series of questions adapting to what the student appears to have learned or not learned.

The best examples follow a formative Assessment structure and are called "Online Formative Assessment". This involves making an initial formative assessment by sifting out the incorrect answers. The author of the assessment/teacher will then explain what the pupil should have done with each question. It will then give the pupil at least one practice at each slight variation of sifted out questions. This is the formative learning stage. The next stage is to make a summative assessment by a new set of questions only covering the topics previously taught.

Learning design is the type of activity enabled by software that supports sequences of activities that can be both adaptive and collaborative. The IMS Learning Design specification is intended as a standard format for learning designs, and IMS LD Level A is supported in LAMS V2.elearning has been replacing the traditional settings due to its cost effectiveness.

Electronic performance support systems (EPSS)

An electronic performance support system (EPSS) refers to a "computer-based system that improves worker productivity by providing on-the-job access to integrated information, advice, and learning experiences" [88].

3.4.6 Content

Content is a core component of e-learning and includes issues such as pedagogy and learning object re-use.

3.4.6.1 Pedagogical elements

Pedagogical elements are defined as structures or units of educational material. They are the educational content that is to be delivered. These units are independent of format, meaning that although the unit may delivered in various ways, the pedagogical structures themselves are not the textbook, web page, video conference, Podcast, lesson, assignment, multiple choice question, quiz, discussion group or a case study, all of which are possible methods of delivery.

3.4.6.2 Pedagogical approaches

Various pedagogical perspectives or learning theories may be considered in designing and interacting with e-learning programs. E-learning theory examines these approaches, including social-constructivist, one application of which was One Laptop Per Child [89]. Laurillard's conversational model[90]. including Gilly Salmon's five-stage model [91]. and cognitive [92]. emotional [93]. behavioral [94]. and contextual perspectives [95]. In 'mode neutral' learning online and classroom learners can coexist within one learning environment, encouraging interconnectivity [96]. Self-regulated learning refers to several concepts that play major roles in e-learning. Learning courses should provide opportunities to practice these strategies and skills. Self-regulation and structured supervision both enhance e-learning [97].

3.4.6.3 Learning object standards

Much effort has been put into the technical reuse of electronically based teaching materials and in particular creating or re-using learning objects. These are self-contained units that are properly tagged with keywords, or other metadata, and often stored in an XML file format. Creating a course requires putting together a sequence of learning objects. There are both proprietary and open, non-commercial and commercial, peer-reviewed repositories of learning objects such as the Merlot repository.

Sharable Content Object Reference Model (SCORM) is a collection of standards and specifications that applies to certain web-based e-learning. Other specifications such as Schools Framework allow for the transporting of learning objects, or for categorizing metadata (LOM). These standards themselves are early in the maturity process with the oldest being 8 years old. They are also relatively vertical specific: SIF is primarily pK-12, LOM is primarily Corp, Military and Higher Ed, and SCORM is primarily Military and Corp with some Higher Ed. PESC- the Post-Secondary Education Standards Council- is also making headway in developing standards and learning objects for the Higher Ed space, while SIF is beginning to seriously turn towards Instructional and Curriculum learning objects.

In the US pK12 space there are a host of content standards that are critical as well- the NCES data standards are a prime example. Each state government's content standards and achievement benchmarks are critical metadata for linking e-learning objects in that space.

An excellent example of e-learning that relates to knowledge management and reusability is Navy E-Learning, which is available to Active Duty, Retired, or Disable Military members. This on-line tool provides certificate courses to enrich the user in various subjects related to military training and civilian skill sets. The e-learning system not only provides learning objectives, but also evaluates the progress of the student and credit can be earned toward higher learning institutions. The Internet allows for learning to be directed at one's current objectives [98]. This reuse is an excellent example of knowledge retention and the cyclical process of knowledge transfer and use of data and records.

3.4.7 Applications

3.4.7.1 Preschool

Various forms of electronic media are a feature of preschool life [99]. Although parents report a positive experience, the impact of such use has not been systematically assessed [100].

The age when a given child might start using a particular technology such as a cellphone or computer might depend on matching a technological resource to the recipient's developmental capabilities, such as the age-anticipated stages labeled by Swiss psychologist, Jean Piaget [100]. Parameters, such as age-appropriateness, coherence with sought-after values, and concurrent entertainment and educational aspects, have been suggested for chosing media [101].

3.4.7.2 K–12

E-learning is utilized by public K–12 schools in the United States as well as private schools. Some e-learning environments take place in a traditional classroom, others allow students to attend classes from home or other locations. There are several states that are utilizing cyber and virtual school platforms for e-learning across the country that continue to increase. Virtual school enables students to log into synchronous learning or asynchronous learning courses anywhere there is an internet connection. Technology kits are usually provided that include computers, printers, and reimbursement for home internet use. Students are to use technology for school use only and must meet weekly work submission requirements. Teachers employed by K–12 online public cyber schools must be certified teachers in the state they are teaching in. Cyber schools allow for students to maintain their own pacing and progress, course selection, and provide the flexibility for students to create their own schedule.

E-learning is increasingly being utilized by students who may not want to go to traditional brick and mortar schools due to severe allergies or other medical issues, fear of school violence and school bullying and students whose parents would like to homeschool but do not feel qualified [102]. Cyber schools create a safe haven for students to receive a quality education while almost completely avoiding these common problems. Cyber charter schools also often are not limited by location, income level or class size in the way brick and mortar charter schools are [103].

National private schools are also available online. These provide the benefits of e-learning to students in states where charter cyber schools are not available. They also may allow students greater flexibility and exemption from state testing.

Virtual education in K-12 schooling often refers to cyber schools, and in higher education to virtual universities. Virtual schools are "cybercharter schools"[104]. with innovative administrative models and course delivery technology [104].

3.4.7.3 Higher education

In the United States, e-learning has become a predominant form of post-secondary education. Enrollments for fully online learning increased by an average of 12–14 percent annually between 2004–2009, compared with an average of approximately 2 per cent increase per year in enrollments overall [105-106]. In 2006, 3.5 million students participated in on-line learning at higher education institutions in the United States [107]. Almost a quarter of all students in post-secondary education were taking fully online courses in 2008 [105]. In 2009, 44 percent of post-secondary students in the USA were taking some or all of their courses online, this figure is projected to rise to 81 percent by 2014 [108]. During the fall 2011 term, 6.7 million students enrolled in at least one online course [109]. Over two-thirds of chief academic officers believe that online learning is critical for their institution [110]. The Sloan report, based on a poll of academic leaders, indicated that students are as satisfied with on-line classes as with traditional ones.

Although a large proportion of for-profit higher education institutions now offer online classes, only about half of private, non-profit schools do so. Private institutions

may become more involved with on-line presentations as the costs decrease. Properly trained staff must also be hired to work with students online. These staff members need to understand the content area, and also be highly trained in the use of the computer and Internet. Online education is rapidly increasing, and online doctoral programs have even developed at leading research universities [111].

Although massively-open online courses (MOOCs) may have limitations that preclude them from fully replacing college education [112]. such programs have significantly expanded. MIT, Stanford and Princeton University offer classes to a global audience, but not for college credit [113]. University-level programs, like edX founded by Massachusetts Institute of Technology and Harvard University, offer wide range of disciplines at no charge. Private organizations also offer classes, such as Udacity, with free computer science classes, and Khan Academy, with over 3,900 free micro-lectures available via YouTube.

Coursera, an online-enrollment platform, is now offering education for millions of people around the world. A certification is consigned by Coursera for students who are able to complete an adequate performance in the course. Free online courses are administered by the website- fields like computer science, medicine, networks and social sciences are accessibly offered to pursuing students. The lectures are recorded into series of short videos discussing different topics and assignments in a weekly basis.

This virtual curriculum complement the curriculum taught in the traditional education setting by providing equality for all students, despite disability, and geographical location and socioeconomic status.

3.4.7.4 Corporate and professional

E-learning has now been adopted and used by various companies to inform and educate both their employees and customers. Companies with large and spread out distribution chains use it to educate their sales staff about the latest product developments without the need of organizing physical onsite courses. Compliance has also been a big field of growth with banks using it to keep their staff's CPD levels up. Other areas of growth include staff development, where employees can learn valuable workplace skills.

3.4.8 Advantages and disadvantages

Key advantages of e-learning include:

Improved open access to education, including access to full degree programs[114].

Better integration for non-full-time students, particularly in continuing education [114].

Improved interactions between students and instructors [115].

Provision of tools to enable students to independently solve problems [115].

Acquisition of technological skills through practice with tools and computers.

Key disadvantages of e-learning, that have been found to make learning less effective than traditional class room settings, include:

Potential distractions that hinder true learning,

Ease of cheating [citation needed].

Bias towards tech-savvy students over non-technical students,

Teachers' lack of knowledge and experience to manage virtual teacher-student interaction [116].

Lack of social interaction between teacher and students.

Lack of direct and immediate feedback from teachers.

Asynchronic communication hinders fast exchange of question.

Danger of procrastination.

4 ITEM RESPONSE THEORY (IRT)

Imagine for a second that you're teaching a math remediation course full of fourth graders. You've just administered a test with 10 questions. Of those 10 questions, two questions are trivial, two are incredibly hard, and the rest are equally difficult. Now imagine that two of your students take this test and answer nine of the 10 questions correctly. The first student answers an easy question incorrectly, while the second answers a hard question incorrectly. How would you try to identify the student with higher ability?

Under a traditional grading approach, you would assign both students a score of 90 of 100, grant both of them an A, and move on to the next test. This approach illustrates a key problem with measuring student ability via testing instruments: test questions do not have uniform characteristics. So how can we measure student ability while accounting for differences in questions?

Item response theory (IRT) attempts to model student ability using questions level performance instead of aggregate test level performance. Instead of assuming all questions contribute equally to our understanding of a student's abilities, IRT provides a more nuanced view on the information each question provides about a student. What kind of features can a question have? Here are some examples.

First, think back to an exam you have previously taken. Sometimes you breeze through the first section, work through a second section of questions, then battle with a final section until the exam ends. In the traditional grading paradigm described earlier, a correct answer on the first section would count just as much as a correct answer on the final section, despite the fact that the first section is easier that the last. Similarly, a student demonstrates greater ability as she answers harder questions correctly; the traditional grading scheme, however, completely ignores each question's difficulty when grading students.

The one-parameter logistic (1PL) IRT model attempts to address this by allowing each question to have an independent difficulty variable. It models the probability of a correct answer using the following logistic function:

$$p(x_j = 1|\theta_i, \beta_j) = \frac{e^{(\theta_i - \beta_j)}}{1+e^{(\theta_i - \beta_j)}} \qquad (1)$$

where j represents the question of interest, theta is the current students ability, and beta is item j's difficulty. The function is also known as the item response function. We can examine its plot (with different values of beta) below in Fig. 1.

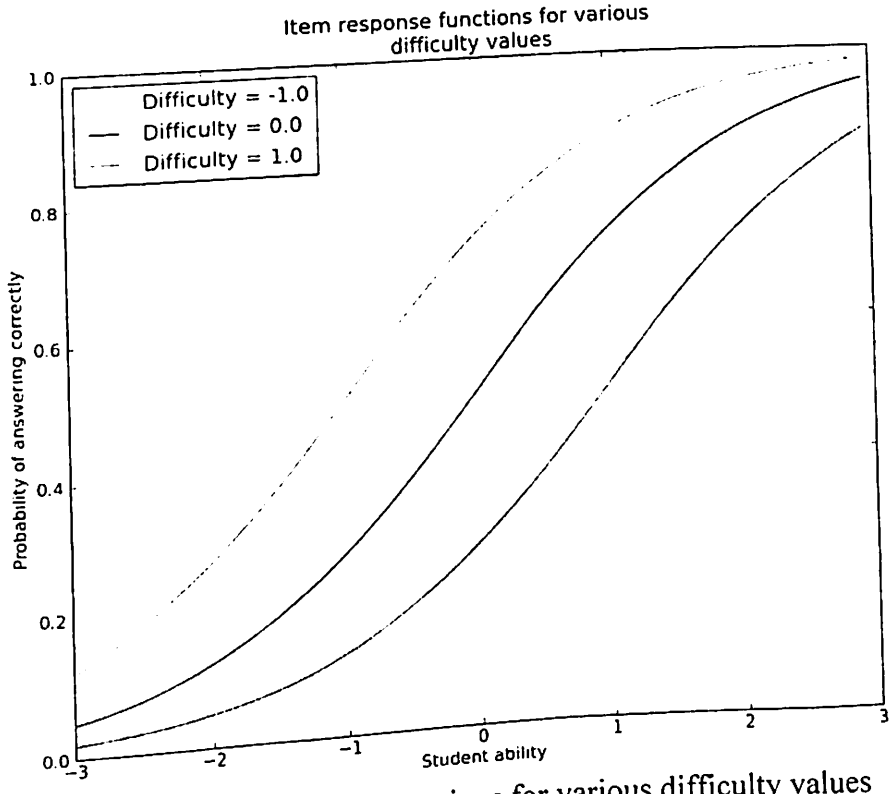

Figure 1 - Item response functions for various difficulty values

to confirm a couple of things:

1)For a given ability level, the probability of correct answer increases as item difficulty decreases. It follows that, between two questions, the question with a lower beta value is easier.

2)Similarity, for a given question difficulty level, the probability of correct answer increases as student ability increases. In fact, the curves displayed above take a sigmoidal form, thus implying that the probability of a correct answer increases monotonically as student ability increases.

Now consider using the 1PL model to analyze test responses provided by a group of students. If one student answers one question, we can only draw information about that student's ability from the first question. Now imagine a second student answers the same question as well as a second question, as illustrated below in Fig. 2.

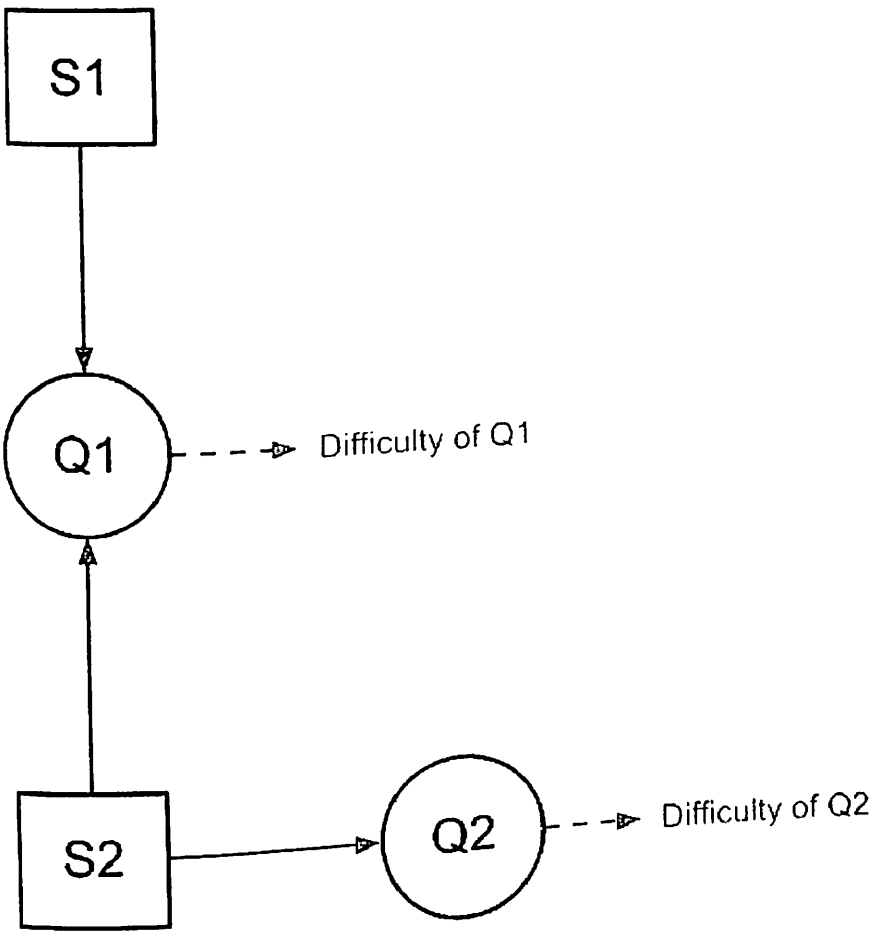

Figure 2 - 1PL model to analyze test responses provided by a group of students

We immediately have the following additional information about both students and both test questions:

1) We now know more about student 2's ability relative to student 1 based on student 2's answer to the first question. For example, if student 1 answered correctly and student 2 answered incorrectly we know that student 1's ability is greater than student 2's ability.

2) We also know more about the first question's difficulty after student 2 answered the second question. Continuing the example from above, if student 2 answers the second question correctly, we know that Q1 likely has a higher difficulty that Q2 does.

3) Most importantly, however, we now know more about the first student. Continuing the example even further, we know that Q1 is more difficult that initially expected. Student 1 answered the first question correctly, suggesting that student 1 has greater ability that we initially estimated.

Considering the fact those students of all ability levels might have the same probability of correctly answering a poorly-written question. When discussing IRT models, we say that these questions have a low discrimination value, since they do not discriminate between students of high- or low-ability. Ideally, a good question will maximally separate students into two groups: those with the ability to answer correctly, and those without.

This gets at an important point about test questions: some questions do a better job than others of distinguishing between students of similar abilities. The two-parameter logistic (2PL) IRT model incorporates this idea by attempting to model each item's level of discrimination between high- and low-ability students. This can be expressed as a simple tweak to the 1PL:

$$p(x_j = 1|\theta, \beta_j, \alpha_j) = \frac{e^{\alpha_j(\theta-\beta_j)}}{1+e^{\alpha_j(\theta-\beta_j)}} \quad (2)$$

How does the addition of alpha, item discrimination parameter, affect our model? As above, we can take a look at the item response function while changing alpha a bit in Fig. 3:

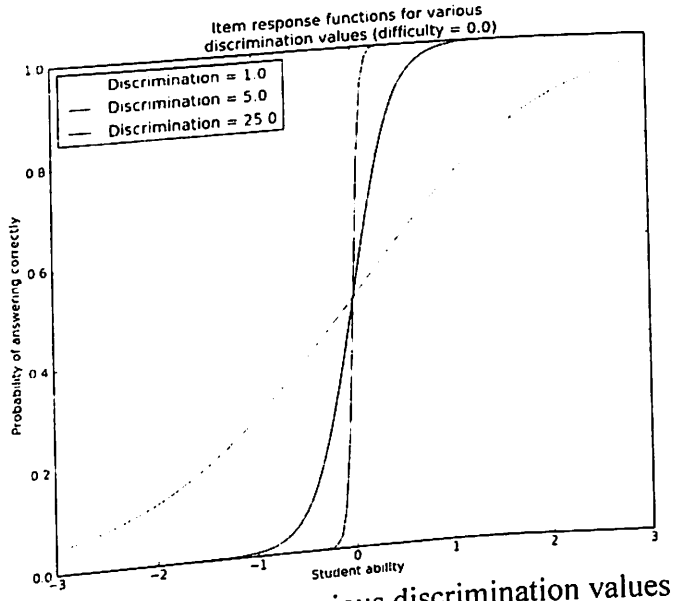

Figure 3 - Item response functions for various discrimination values (difficulty = 0.0)

As previously stated, items with high discrimination values can distinguish between students of similar ability. If we're attempting to compare students with abilities near zero, a higher discrimination sharply decreases the probability that a student with ability <0 will answer correctly, and increases the probability that a student with ability >0 will answer correctly.

We can even go a step further here, and state that an adaptive test could use a bank of high-discrimination questions of varying difficulty to optimally identify a student's abilities. As a student answers each of these high-discrimination questions, we could choose a harder question if the student answers correctly. In fact, one could even identify the student's exact ability level via binary search, if the student is willing to work through a test bank an infinite number of high-discrimination questions with varying difficulty.

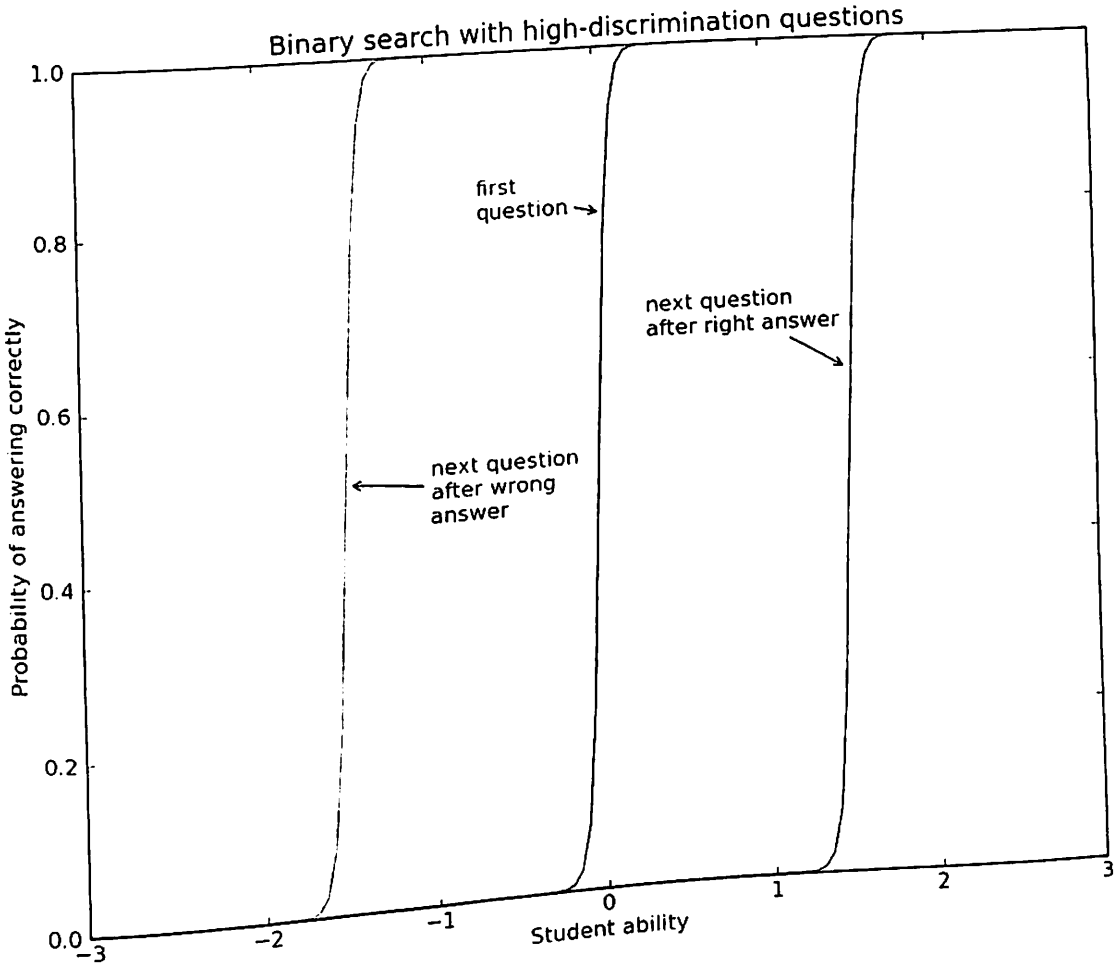

Figure 4 - Binary search with high-discrimination questions

Of course, the above scenario is not completely true to reality. Sometimes students will identify the correct answer by simply guessing. Additionally, students can increase their odds of guessing a question correctly by ignoring answers that are obviously wrong. We can thus model each question's "guess-ability" with the three-parameter logistic (3PL) IRT model. The 3PL's item response function looks like this:

$$p(x_j = 1|\theta, \delta_j, \propto_j, x_j) = x_j + (1 - x_j)\frac{e^{\propto_j(\theta-\delta_j)}}{1+e^{\propto_j(\theta-\delta_j)}} \quad (3)$$

where chi represents the item's "pseudoguess" value. Chi not considered a pure guessing value, since students can use some strategy or knowledge to eliminate bad guesses. Thus, while a "pure guess" would be the reciprocal of the number of options, those odds may increase if the student manages to eliminate an answer.

As before, let's take a look at how the pseudoguess parameter affects the item response function curve in Fig. 5:

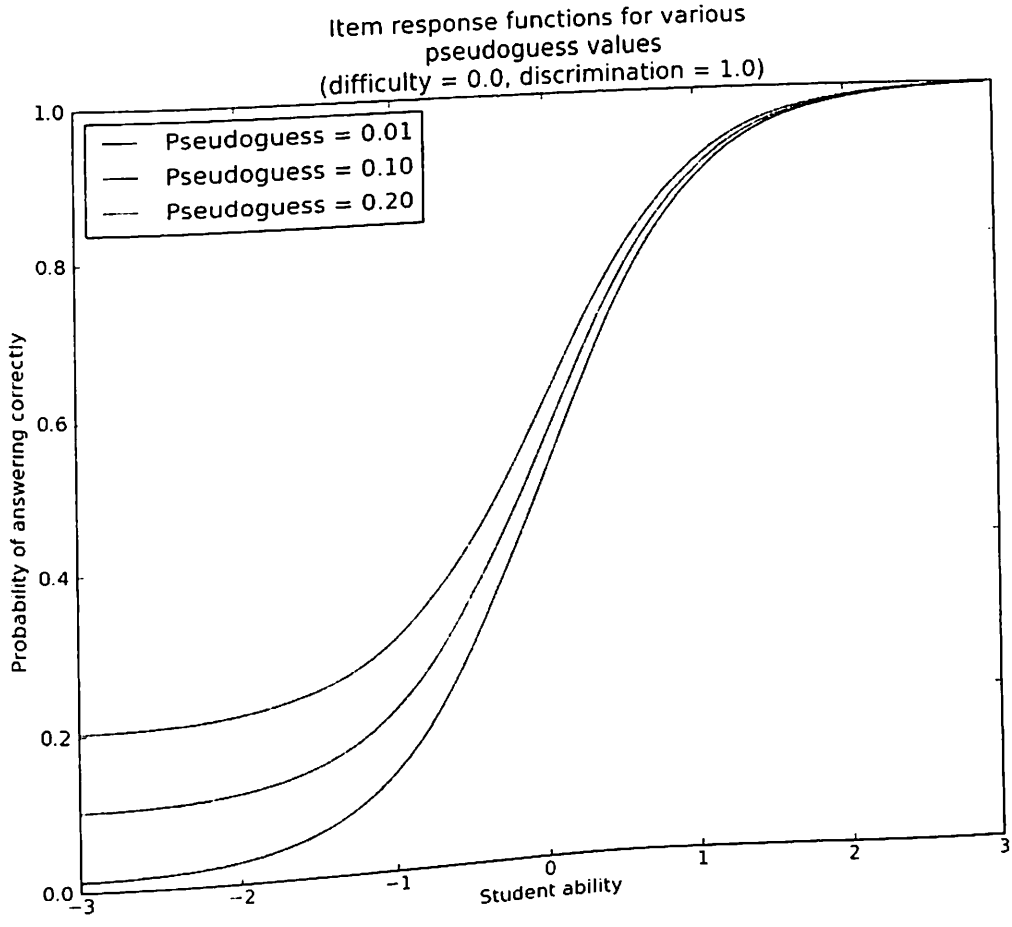

Figure 5 - Item response functions for various pseudoguess values (difficulty = 0.0, discrimination = 1.0)

Note that students of low ability now have a higher probability of guessing the question's answer. This is also clear from the 3PL's item response function. Note that there are few general concerns in the IRT literature regarding the 3PL, especially regarding whether an item's "guessability" is instead a part of a student's "testing wisdom," which arguably represents some kind of student ability [21-23].

5 SYSTEM STRUCTURE

In this section we comprehensively describe the architecture of our adaptive exam system DSS (Decision Support System) and demonstrate the individual components needed to implement our approach. The proposed architecture is depicted in Fig. 6.

The structure of the system consists of six components: User Interface, Courseware manager, Content Mediator, User Mediator and Adaptive Engine. The user interface deals with the student's registration, login process. It also takes student's responses from the test items and transfers them into the Adaptive Engine. The courseware manager allows the instructors to update the test repository through their related mediator. The different mediators are responsible for handling requests for interacting with the repository to retrieve and update the information. The Adaptive Engine, at the heart of our architecture is responsible for suggesting adaptive learning paths according to student's characteristics and the result of tests in previous steps of assignment process.

The structure of adaptive engine is shown in Fig. 7. Considering that our architecture is comprehensive, the proposed engine does not contain the strategies and knowledge for a particular learning domain, this is entirely ontology driven. However, it consists of six components, Activity Unit, Test Unit, Learning Result Analyzer, IRT Analyzer, Course Structure Constructor and Decision Support System.

The learning result analyzer analyzes the activities and test result from the activity unit and test unit and transfers the result to the DSS. According to Item Response Theory student's response to test is analyzed by the IRT Analyzer to obtain the student's level [24]. The Course Structure Constructor performs the process of constructing the annotated course structure by using link annotations and link hiding to offer adaptive navigational support techniques [25]. which helps the student in navigate the domain space. Links to topics with different educational status are marked differently. This Constructor gets student's level of knowledge from student's model and course structure from domain model to construct proposed annotated course structure. The main part of Adaptive Engine is the Decision Support System. It obtains knowledge about students, exam content information and course structure through related mediators. Subsequently, it classifies this information, analyzed previous exam activities, analyzed test result to generate the best learning path is presented to the learner via the UI. The DSS supports adaptivity from two aspects: Firstly, it provide different presentation and level of the exam content for student's with different characteristics [26].; Secondly, it suggests adaptive learning paths according to analyzed previous exam activities and analyzed test results.

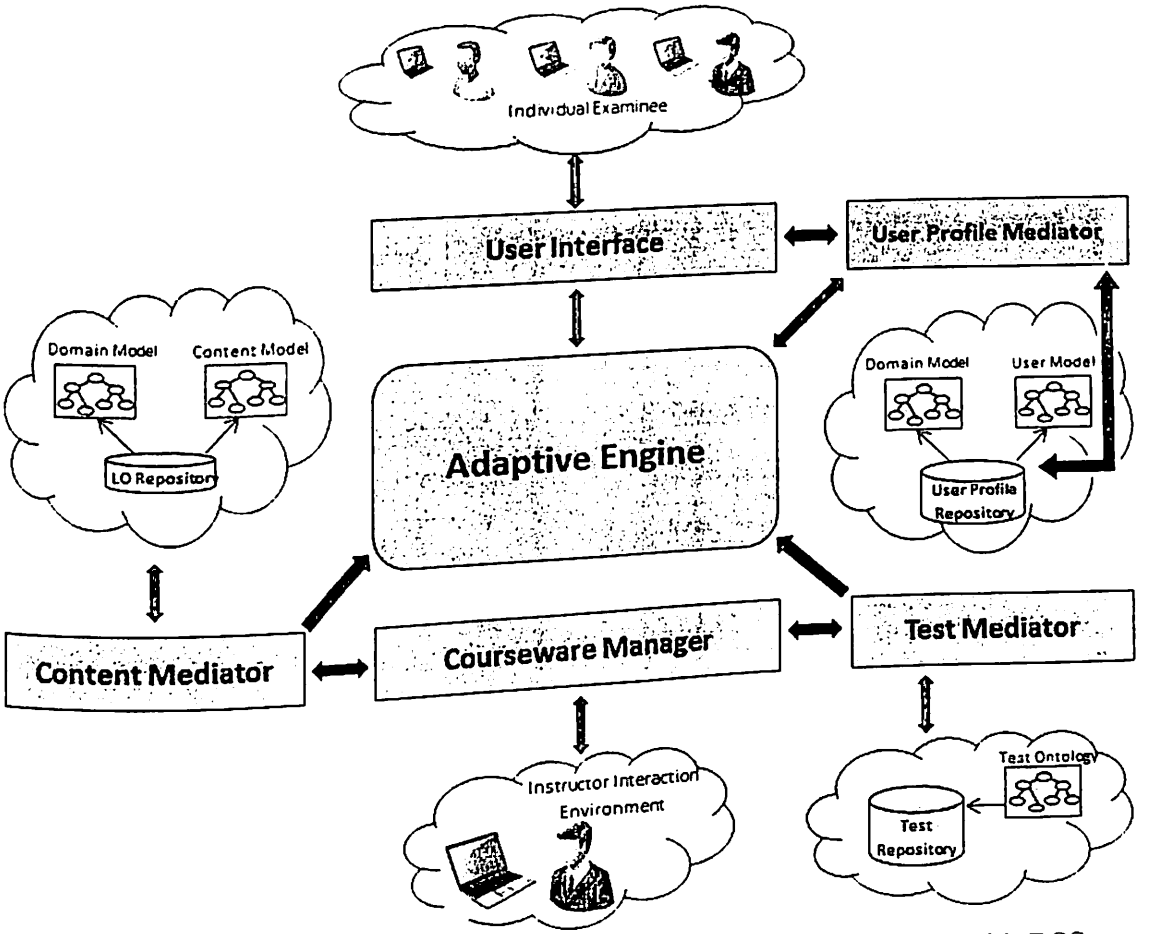

Figure 6 - The Architecture of Adaptive Exam Application with DSS

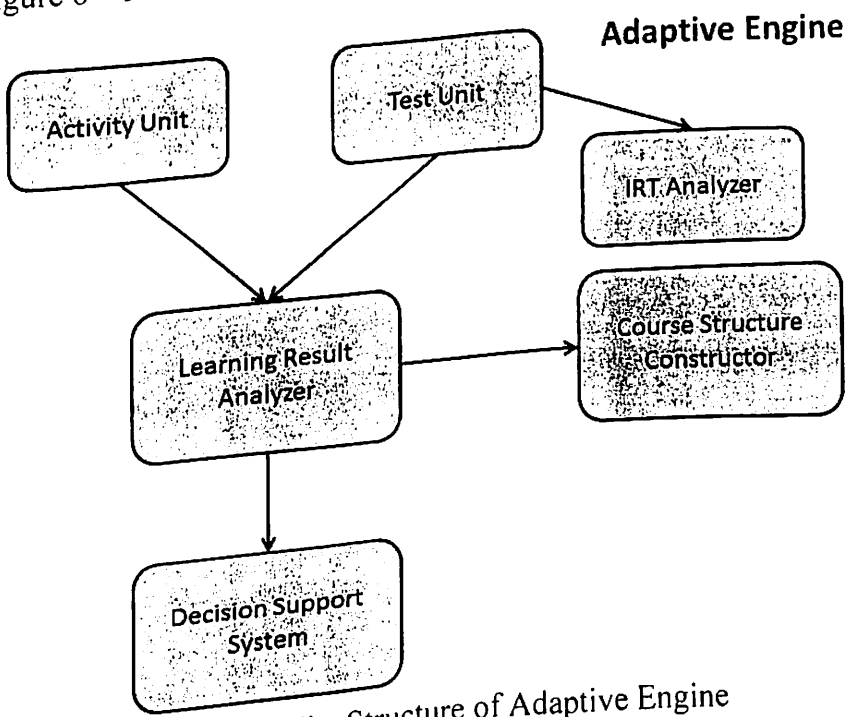

Figure 7 - The Structure of Adaptive Engine

6 SINIP.KZ

"Сыныпп" is an enhanced exam web based application quizzes. Among dozens of useful features we can name the following:

– the possibility to add audio and video to quiz questions;

– extensive feedback options (quiz feedback; feedback for correct/incorrect answers (during the quiz or at the end); feedback for each answer option);

– 9 question types + boilerplate;

– Question Pool that allows organizing questions by categories and reusing them for different quizzes;

– the possibility to select how many random questions will be added to the quiz from any category of the question pool;

– each question of the quiz may belong to a certain question category;

– the possibility to export the selected quiz or all of them; or import previously saved quizzes;

– the possibility to move or copy questions to other quizzes/question pool; copy quizzes or move them to another category;

– the possibility to set any number of attempts for each question;

– the possibility to set score points for answering each question, answer option, or combination of both;

– the possibility to set a time limit for passing a quiz or a time limit before a user can take the quiz again;

– the possibility to use one of the existing templates for the quizzes or edit CSS;

– the possibility to manage menu items with the created quizzes in the menu manager;

– language files in .ini format to translate the FE and BE interface to your own language;

– the possibility to manage access levels for quiz;

– the possibility to email results to admin, quiz author or to the email specified by a user;

– the possibility to create and upload unique certificates for the quizzes;

– dynamically generated custom reports for an administrator and for the users;

– the possibility to create Learning Paths to sequence the learning program;

– redirection after exam to another page or to the different pages depending on user score;

– manual payments mode and automatic mode that works with Virtue Mart;

– track statistics from the admin section as well as show quiz statistics to users on your site;

– enhanced Skip Question option;

6.1 Quiz Categories

This section includes all categories created for quizzes.

Categories are a very convenient way of managing large number of quizzes. You can not only use them for the user interface area, but also create a Category menu there.

To create a quiz category, do the following:

Go to Quizzes > Quiz Categories:

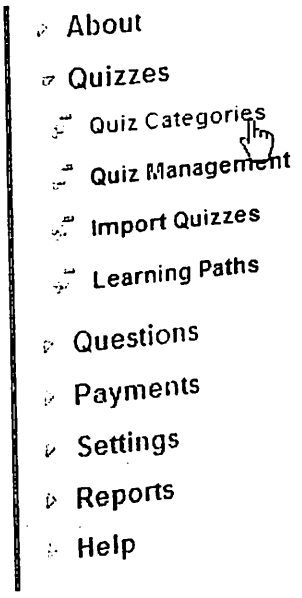

Figure 8 - Quiz Categories menu

Click New ().

In the open form, complete the following information:

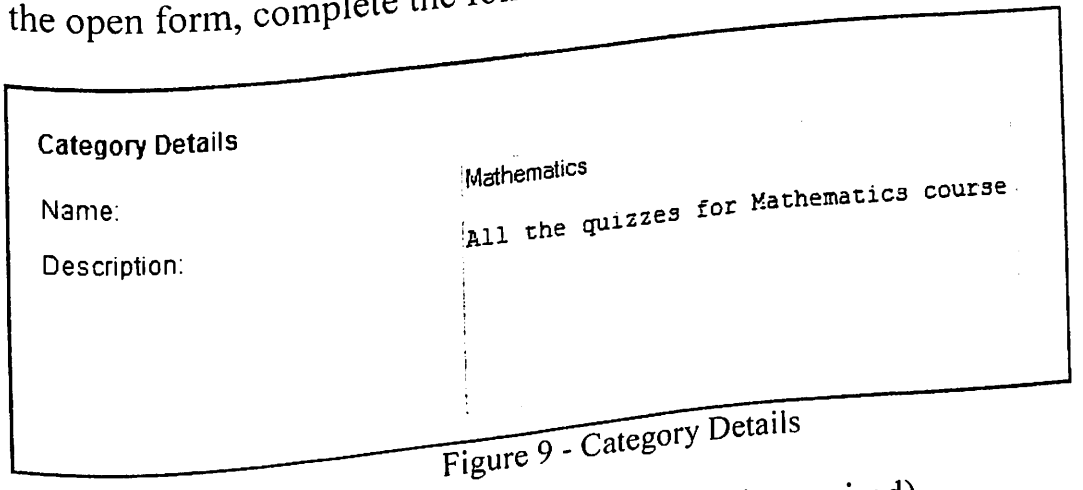

Figure 9 - Category Details

Name - type the title for this category (this field is required).

Description - type the description for this category.

Click Save () to save the changes and stay on this page OR click Save&Close () to save the changes and be redirected to the categories list.

6.2 Quiz Management

This section contains all quizzes created by administrator on the Back-end (BE).

Quiz is one of the most popular ways of checking the knowledge. It's widely spread for the education purposes, fun and games, as well as for any other possible reasons you can imagine. "Сынып" offers an easy way to create quizzes with the variety of different settings.

In this section you can create quizzes and manage the settings of the existing ones.

To create a quiz, do the following:

Go to Quizzes > Quiz Management:

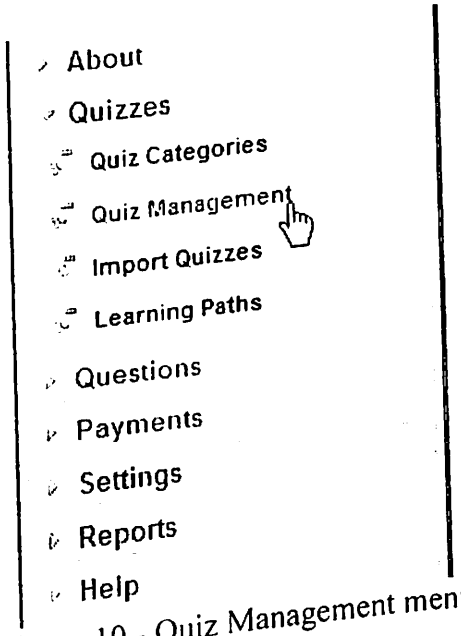

Figure 10 - Quiz Management menu

Click New ( ).

In the open form, complete the needed information for the following tabs:

Quiz Details

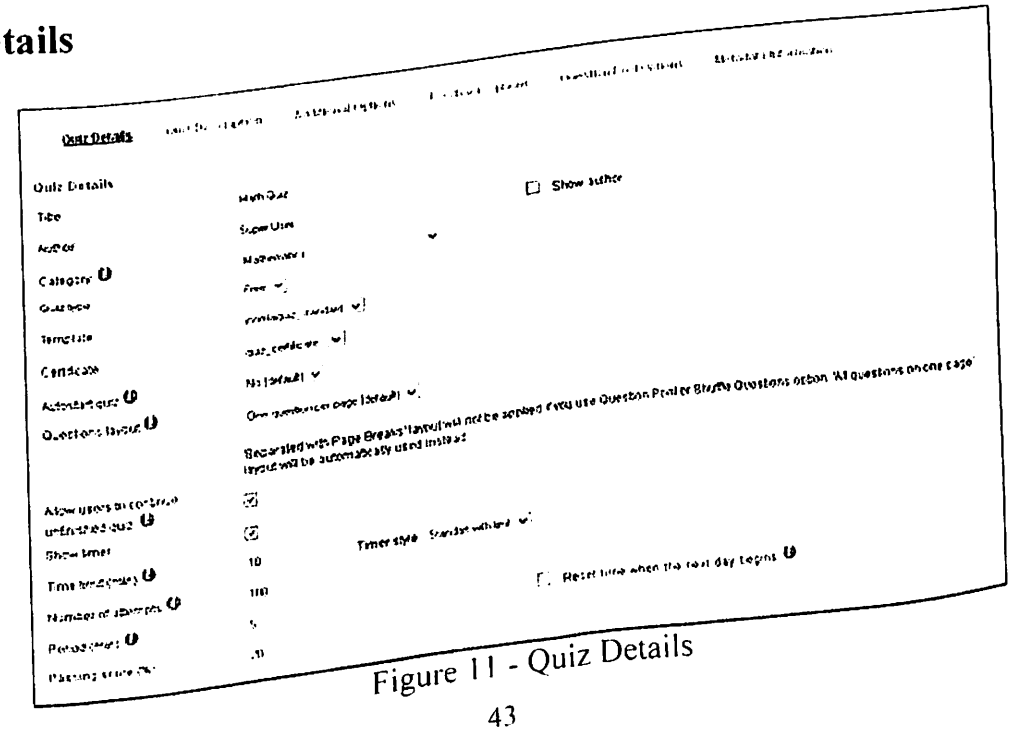

Figure 11 - Quiz Details

– Title - type the unique name for your new quiz.

– Author - type in the authors name you want to be displayed on the quiz; by default the name of the authorized user is inserted.

– Show Author - select the check box to show the quiz author name to the users; it is hidden by default.

– Category - from the drop-down list of the earlier created categories, select the needed one.

– Quiz Type - from the drop-down list, select the quiz type:

Free - the quiz does not require any payment.

Paid - The quiz is only available when added to the quiz product and the user paid for it.

– Template - from the drop-down list, select the template you want to use.

– Certificate - from the drop-down list of the earlier created certificates, select the needed one.

– Autostart quiz - from the drop-down list, select one of the following:

Yes - If you want to skip the quiz description on FE and take the users directly to the first question.

No (default) - If you want to display the quiz description for the users before they can see the first question. Make sure you added the description for that quiz in the Quiz Description section.

– Questions Layout - from the drop-down list, select the option to control the number of questions on the page:

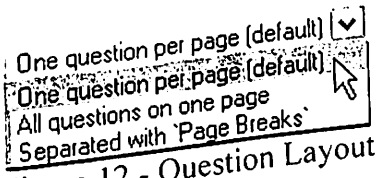

Figure 12 - Question Layout

– One question per page (default) - one question per page will be displayed.

– All questions on one page - all questions will be displayed on one page.

– Separated with 'Page Breaks' - the questions will be grouped on the pages according to the added page breaks.

– Allow user to continue unfinished quiz - select the check box to allow the user to leave the unfinished quiz and return to it later.

– Show timer - select the check box to display the timer; you can set the needed timer style.

– Time limit (min) - specify the time the user has to finish this quiz. The timer will start when the user clicks the Start button; the quiz description will not be timed.

– Timer style - from the drop-down list, select one of the following options:

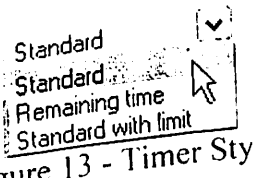

Figure 13 - Timer Style

- Standard - Shows time spent on the quiz:
- Remaining time - Shows time left till the end of the quiz, time is counting down:
- Standard with limit - Shows time spent on the quiz and the total time the user has:

– Number of attempts - define how many times the user can take this quiz. Empty field means the unlimited number of attempts.

– The period (min) - set the period (in minutes), within which the user cannot do more than the specified number of attempts.

– Passing score (%) - specify the minimum percentage the user must score to pass the quiz.

Quiz Description

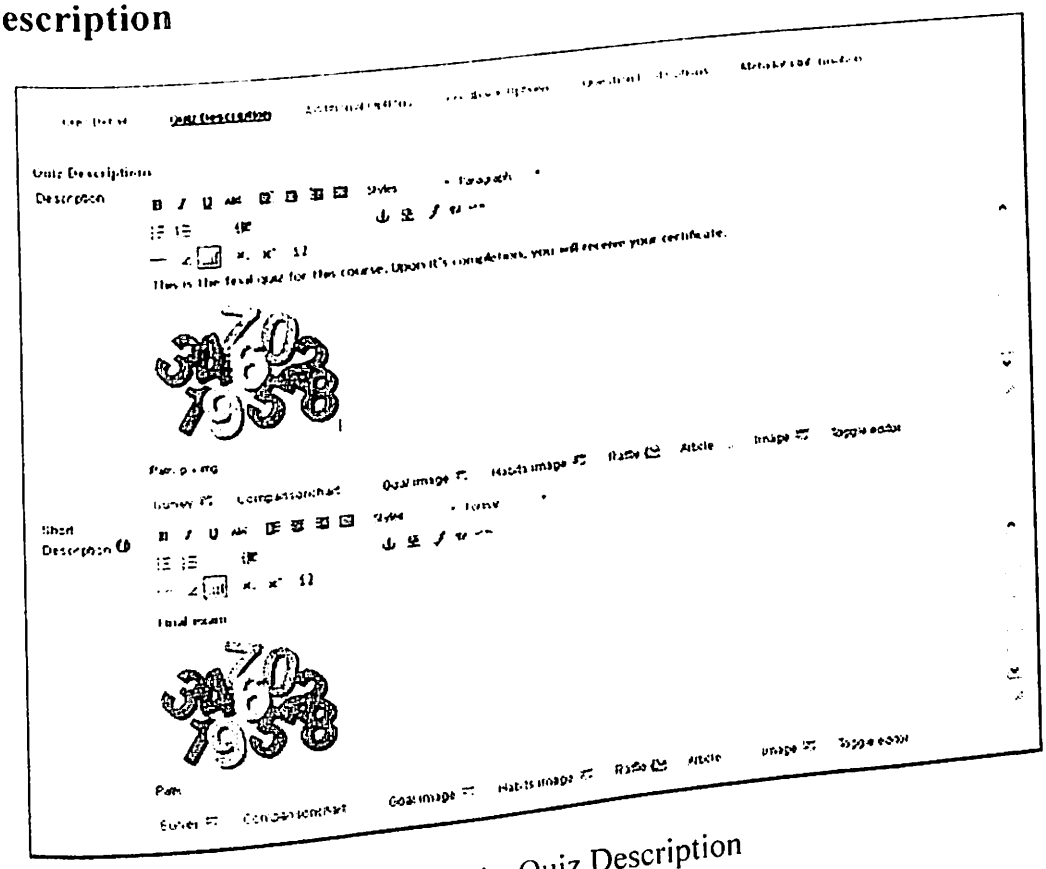

Figure 14 - Quiz Description

– First Page Description - type the description you want to display for users before they can click the Start button. You can apply the needed formatting to the text and insert the images.

– Short Description - type the description you want to display for this quiz on the Front-end when it is added to the Category list, Quiz Package or Learning Path. Example:

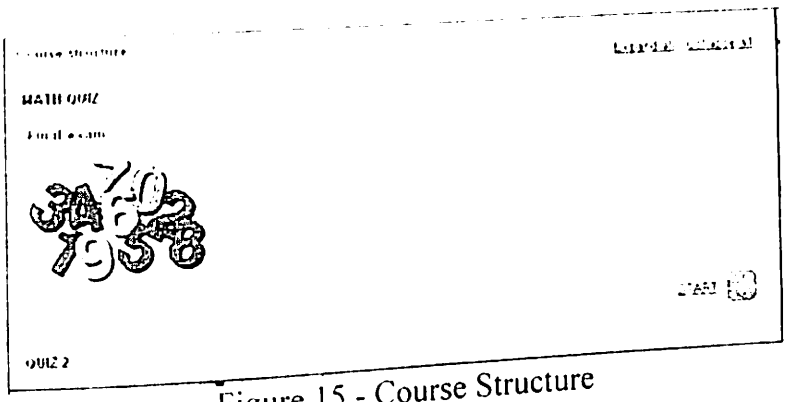

Figure 15 - Course Structure

Additional Options

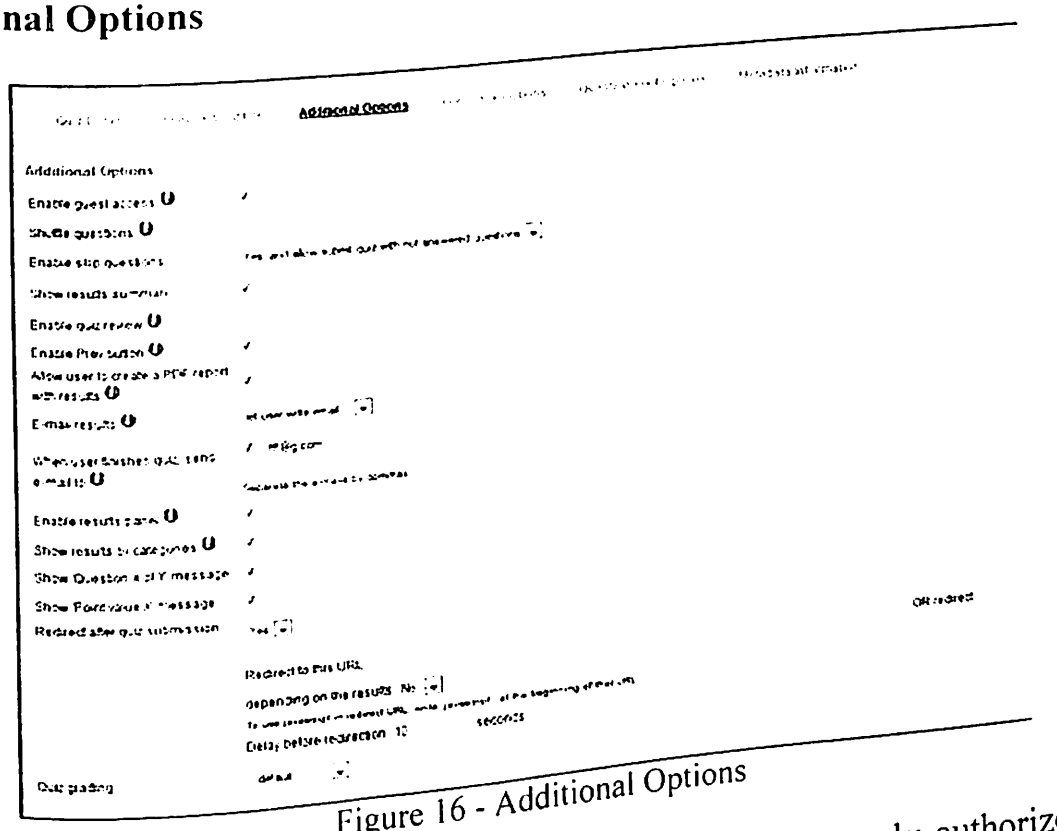

Figure 16 - Additional Options

– Enable guest access - select the check box to allow not only authorized, but anonymous users to take the quiz.

– Shuffle questions - select the check box to load the questions in the random order every time the user makes a new attempt to take the quiz.

– Enable skip questions - from the drop-down list, select in what way you want the option to work:

Note - You can only use the One question per page layout if you plan to use skipping questions.

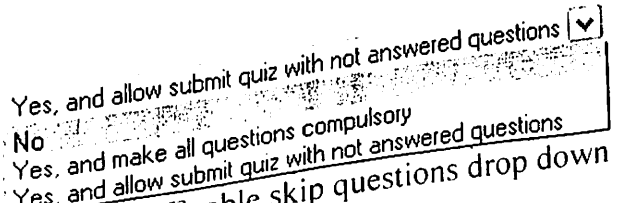

Figure 17 - Enable skip questions drop down

– No - All the questions are obligatory and need to be answered in the order they appear.

– Yes, and make all questions compulsory - All the questions are obligatory, but they can be left out using the Skip ( ) button. When the user reached the last question, the skipped questions will be shown again and need to be answered.

– Yes, and allow submit quiz with not answered questions - The quiz can be finished even when the user skipped some questions and didn't provide an answer for them. To return to the skipped questions, use the navigation buttons or Results panel.

– Show results summary - select the check box to display the results for the user at the end of the quiz.

– Enable quiz review - select the check box to display the Review link at the end of the quiz, so the user could go through the questions again and review the answers he provided.

– Enable Prev button - select the check box to display the navigation buttons ( ) and allow the user to move through the questions.

– Allow user to create a PDF report with results - select the check box to display the PDF Report ( ) link for the user at the end of the quiz and on the results menu.

– E-mail results - from the drop-down list, select how the e-mail is sent when the user clicks the E-mail ( ) link shown to the user on the results page:

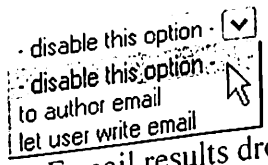

Figure 18 - E-mail results drop-down

- To author's e-mail - The quiz author will receive the detailed report for each quiz attempt.
- Let user write e-mail - After clicking the E-mail ( ) link, the empty field appears where the user can write an e-mail to receive a short summary of this attempt.

– When user finishes quiz, send e-mail to - type the e-mail addresses you want the results of each attempt to be sent to; use a comma to separate e-mails. This email will include only a short summary of the quiz attempt, but not the detailed results on every question.

– Enable results panel - select the check box to display the Results panel when taking the quiz. The user can click its link any time and view all the quiz questions as well as whether the answer is correct or not for the already answered questions.

– Show results by categories - select the check box to display the score points received for each question category.

– Show 'Question X of Y' message - select the check box to display the message saying how many questions there are in this quiz and how many the user has already answered.

– Show 'Point value X' message - select the check box to display the point value the user can receive for the correct answer to every question.

– Redirect after quiz submission - from the drop-down list, select Yes to redirect the user to some other page on your site instead of showing the last page with the results. The redirection can go in 2 ways:

- Redirect to URL - type the URL- address of any page of your site:

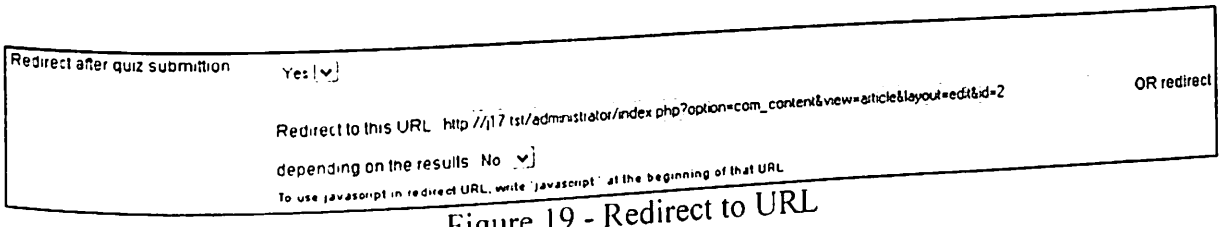

Figure 19 - Redirect to URL

- Redirect depending on the results - select Yes to redirect the users to different pages depending on how well they have done on the test. This option must be used together with the By score received feedback option.

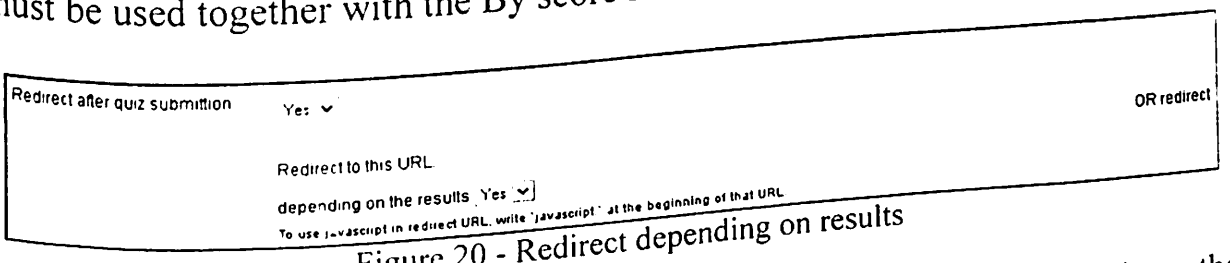

Figure 20 - Redirect depending on results

– Delay before redirection - type in the number of seconds for how long the redirection will be postponed after the user submits the quiz. In this case the user will be able to see the results for this specified time and only after that be redirected.

– Quiz grading - from the drop-down list, select what data the user will see on the Results menu if several attempts are made:

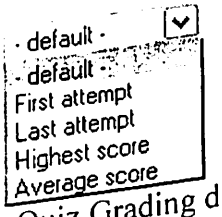

Figure 21 - Quiz Grading drop-down

- default -- The user will see the list of all attempts and can view the details for all the passed ones.
- First attempt - The user will only see one result link to the first attempt results score.
- Last attempt - The user will only see one result link to the last attempt results score.
- Highest score - The user will only see one result link to the attempt with the best results score.
- Average score - The user will only see one result link; the average score for all attempts will be calculated and the details on every question will be shown from the last attempt.

Feedback Options

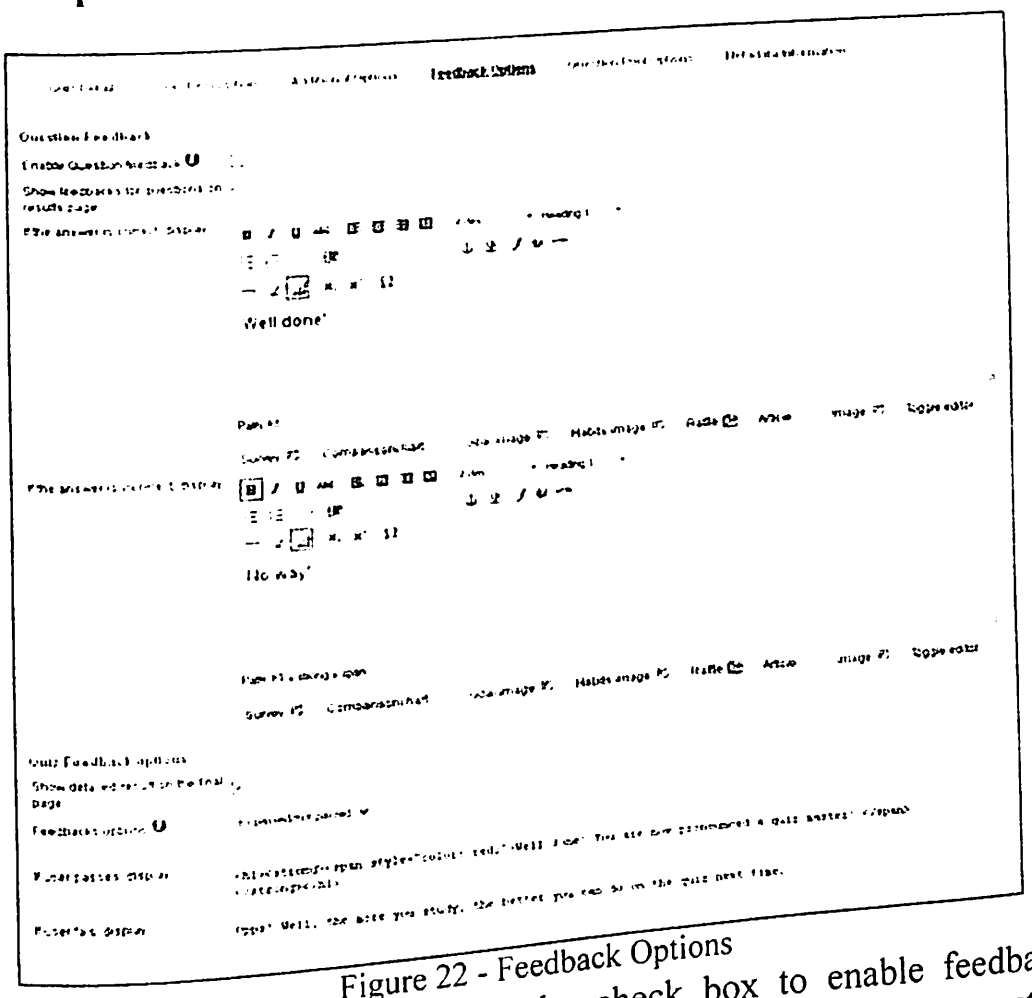

Figure 22 - Feedback Options

– Enable Question feedback - select the check box to enable feedbacks for questions in the quiz. It will be shown to users after they answer the question and click Next.

– Show feedbacks for questions on results page - select this option to show the question feedbacks on the Results page and not during the quiz. This option allows you to write long and descriptive feedbacks.

Note: To use this option, you must have the Show detailed result on the final page option enabled first.

– If the answer is correct, display/If the answer is incorrect, display - Create the feedback messages for the correct and incorrect answers. These messages will be shown for all the questions in the quiz, unless you disable them for some questions or provide different feedbacks in the settings of those questions.

– Show detailed result on the final page - select the check box if you want the last page of the quiz to display not only the short summary of the attempt, but the details on every question.

– Feedbacks options - from the drop-down list, select one of the following options:

- By passed/not passed - Show different feedback messages depending whether the user passed the quiz or not. Type in the messages text below, otherwise the default text will be used.

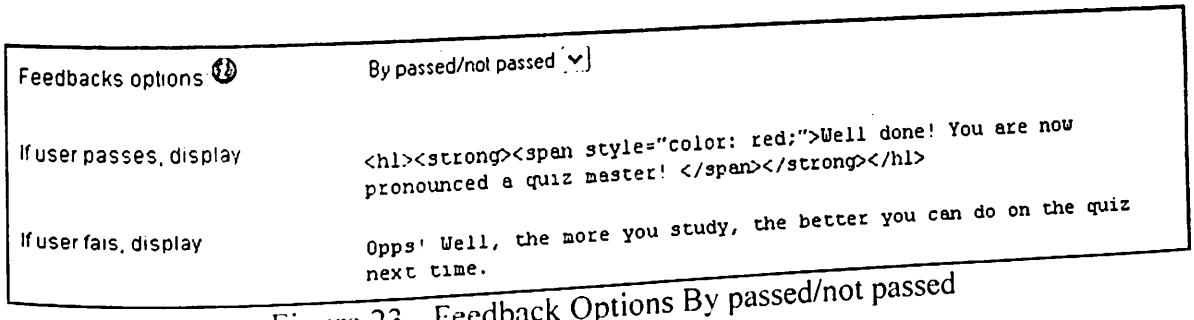

Figure 23 - Feedback Options By passed/not passed

- By score received - Show different feedback messages depending on the score the user gets. This option can be used together with the Redirect depending on the results option: enable this option, and then instead of the message text, type in the link to any article on your site:

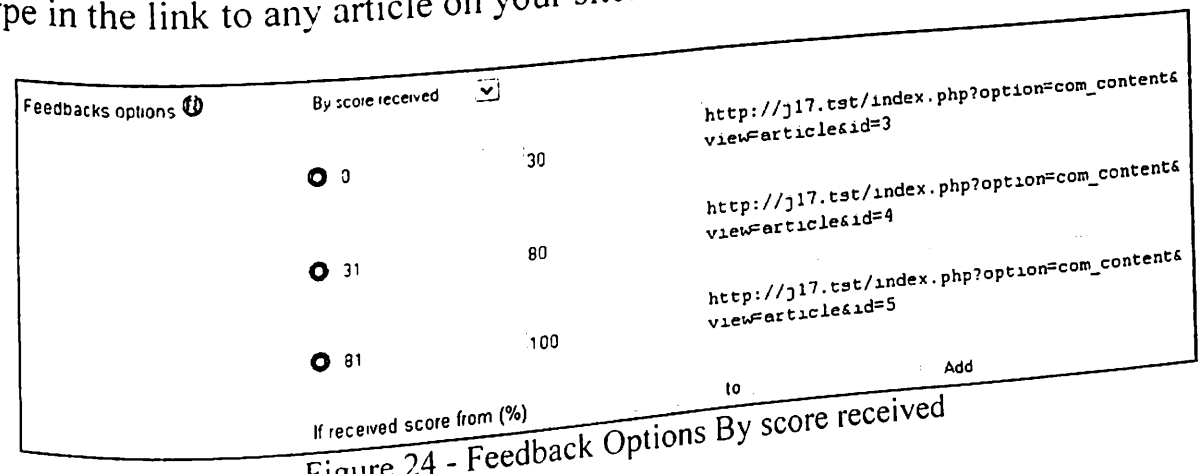

Figure 24 - Feedback Options By score received

Question Pool Options

Question Pool contains the questions that can be assigned to any quiz and used repeatedly without the need to recreate them every time. You can either use only the questions from the Pool for the quiz, or use them both at the same time.

Note: The points for the question from the Pool will be added to the points you have for the regular quiz questions.

– Do not use - by default the Pool is disabled for the quiz. Only the questions belonging to that quiz will be used.

– Random questions - enable the option to have a certain number of questions to be taken from the Pool for every quiz attempt; type the number of that questions.

– By categories - You can set how many random questions will be taken from the particular category. That will allow you to use only the questions from one or several categories needed at the time.

– Choose Head Category - From the drop-down list you can select the main category and then set the number of questions to be taken from each subcategory. For details, see Question Categories.

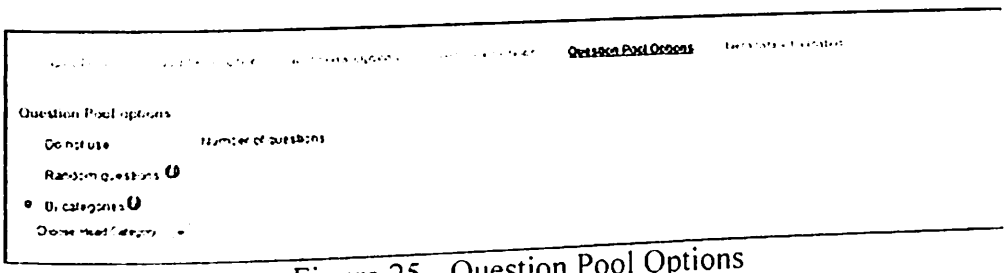

Figure 25 - Question Pool Options

Metadata Information

Metadata can increase the search quality of your quiz. In this section you can enter the specific metadata for the quiz that will replace metadata you set for your site.

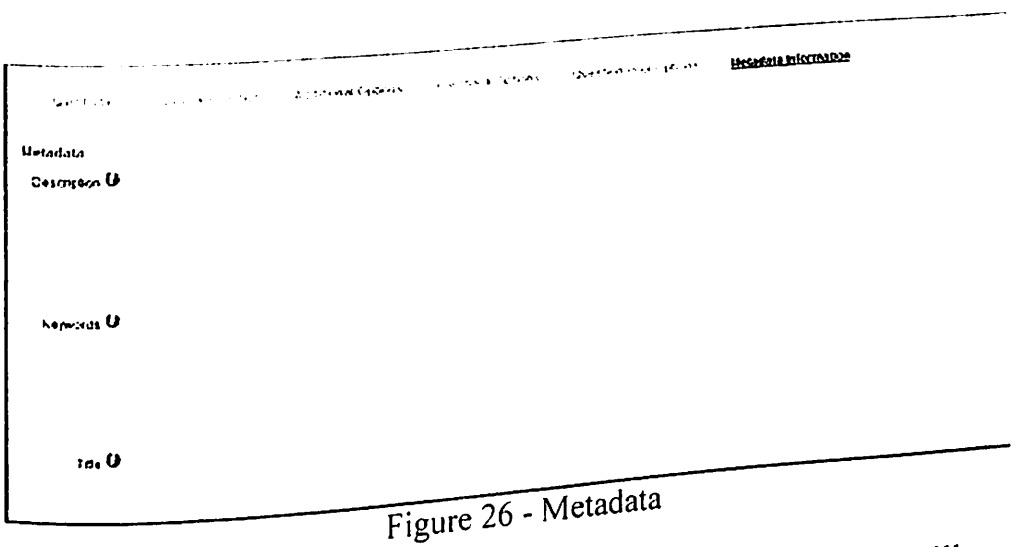

Figure 26 - Metadata

Title metadata will be used in addition to the site metadata and will replace the name of the Web-page for this quiz.

Click Save () to save the changes and stay on this page OR click Save&Close () to save the changes and be redirected to the categories list.

6.3 Import Quizzes

This section helps to move your quizzes to other sites without the need to recreate them every time. All the questions and settings are imported automatically. You can import only the quizzes you have exported via Quiz component.

To import the quizzes, do the following:

Go to Quizzes > Import Quizzes:

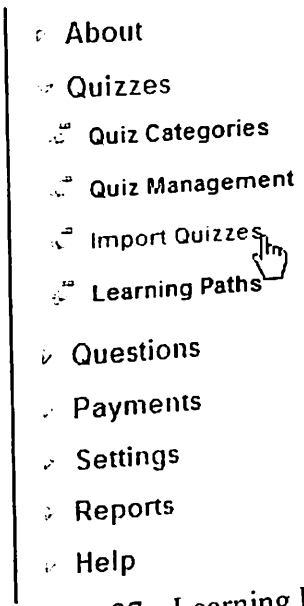

Figure 27 - Learning Paths menu

Click Browse and select the archive with the quizzes from your local machine:

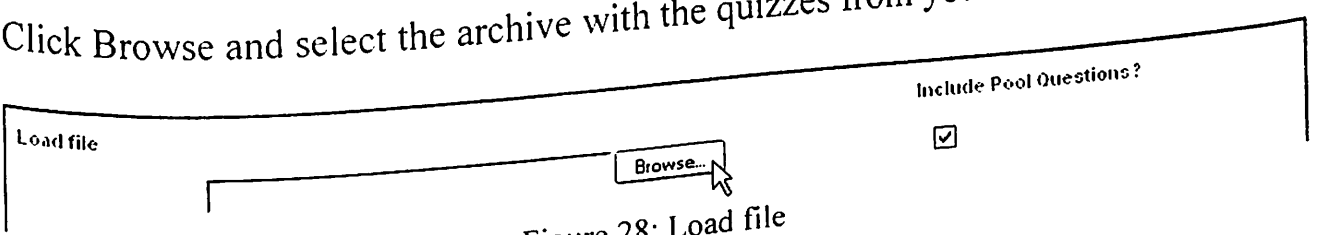

Figure 28: Load file

Select the Include Pool Questions? check box if you want to import the questions from the pool together with the general quiz questions.

Click Import (). After processing, you are redirected to the quizzes list and see the new quizzes in it.

6.4 Question Categories

This section includes all categories created for questions.
Categories are a very convenient way of managing large number of questions.
To create a question category, do the following:
1. Go to Questions > Question Categories:

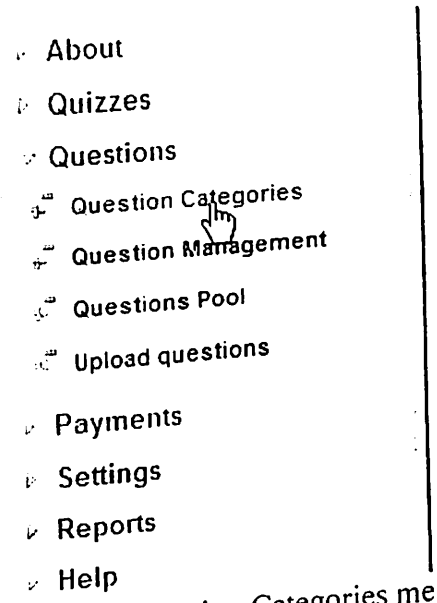

Figure 29 - Question Categories menu

2. Click New ( ).
3. In the open form, complete the following information:

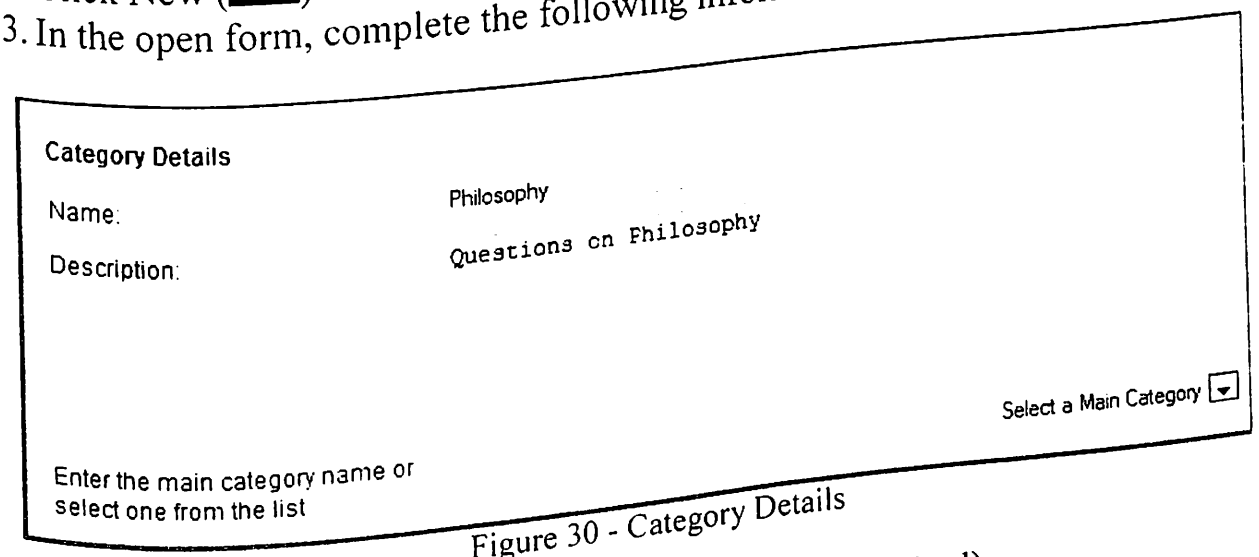

Figure 30 - Category Details

- Name - type the title for this category (this field is required).
- Description - type the description for this category.

4. Click Save ( ) to save the changes and stay on this page OR click Save&Close ( ) to save the changes and be redirected to the categories list.

6.5 Question Management

Question is one of the most popular ways of checking the knowledge. It's widely spread for the education purposes, fun and games, as well as for any other possible reasons you can imagine. "Сынып" offers an easy way to create different types of questions with the variety of personal settings.

In this section you can create new questions and manage the settings of the existing ones.

To create a question, do the following:

1. Go to Questions > Question Management:

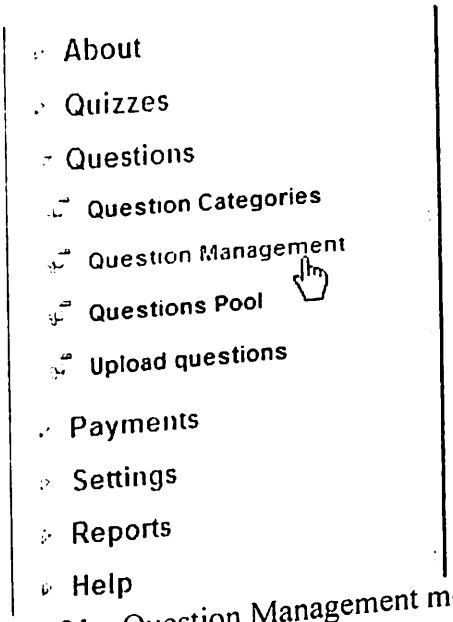

Figure 31 - Question Management menu

2. Click New ( ).
3. In the open form, select the needed question type and click Next ( ).
4. Complete the needed information:

Multiple Choice

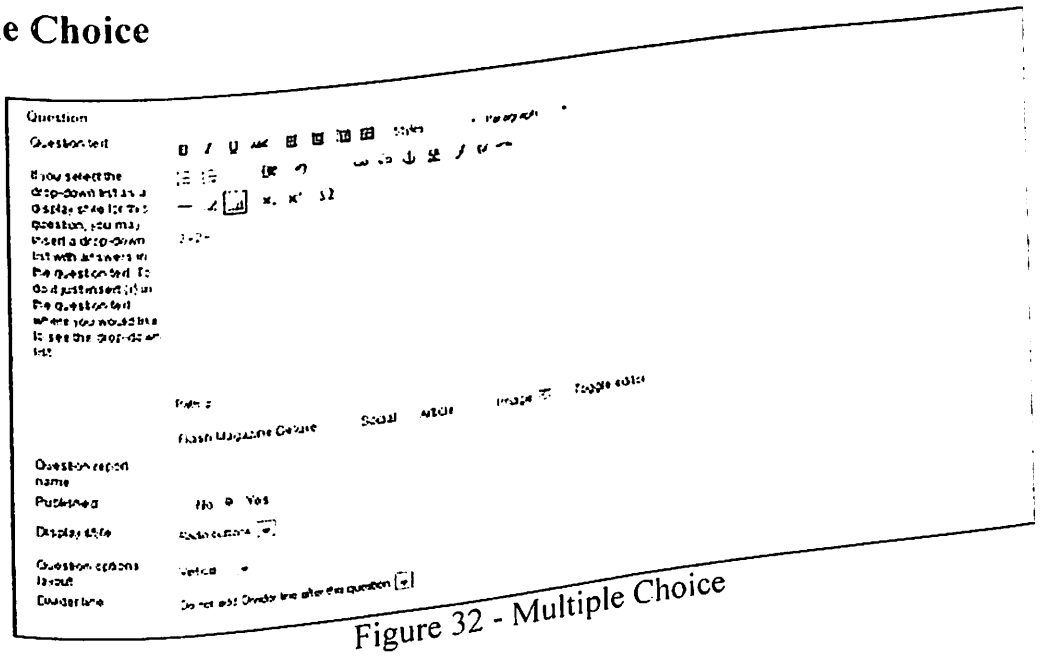

Figure 32 - Multiple Choice

- Question Text - type the question information here.
- Question report name - specify the name for this question. This name will be displayed before the question text in the Reports section.
- Published - specify the publishing status for this question.
- Display style - specify the display layout for this question: radio buttons or drop-down list.
- Question options layout - specify the display layout for the question options: vertical or horizontal.
- Divider Line - specify whether to add a divider line after this question.

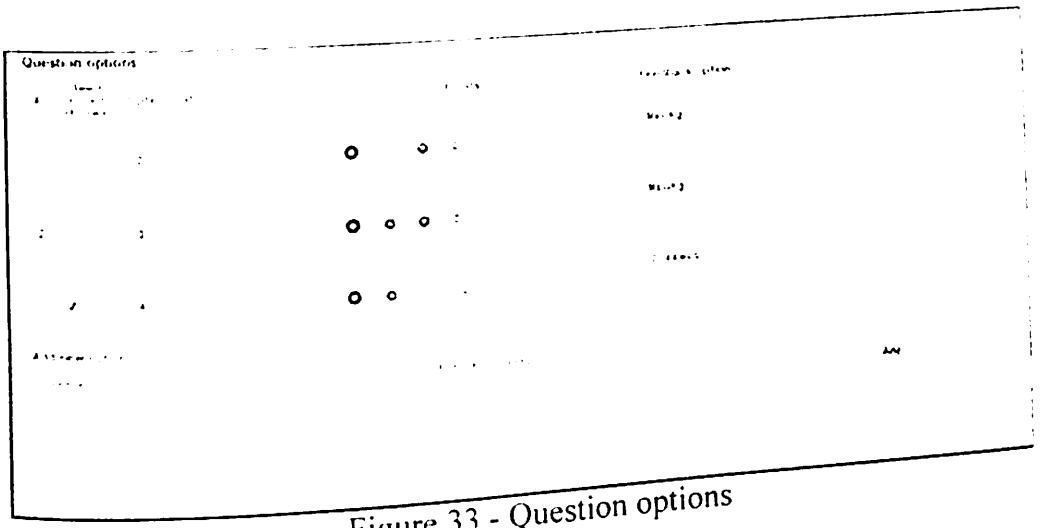

Figure 33 - Question options

- Question options - specify the question answers data:
  - Option Text - specify the answer for this question.
  - Option points - specify the points for an answer.
  - Feedback option (message) - type the text message following the answer.
  - Select correct choice - select the check box next to the correct answer.

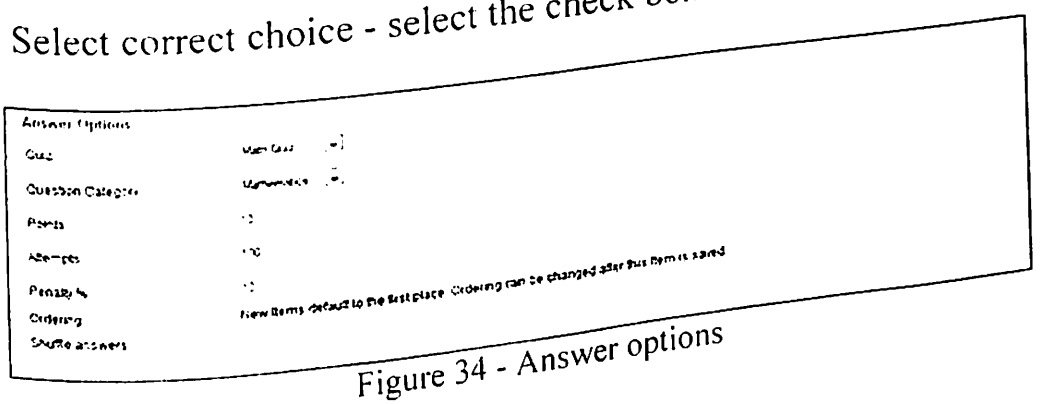

Figure 34 - Answer options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.
- Shuffle answers - select the check box to disorder the answers.

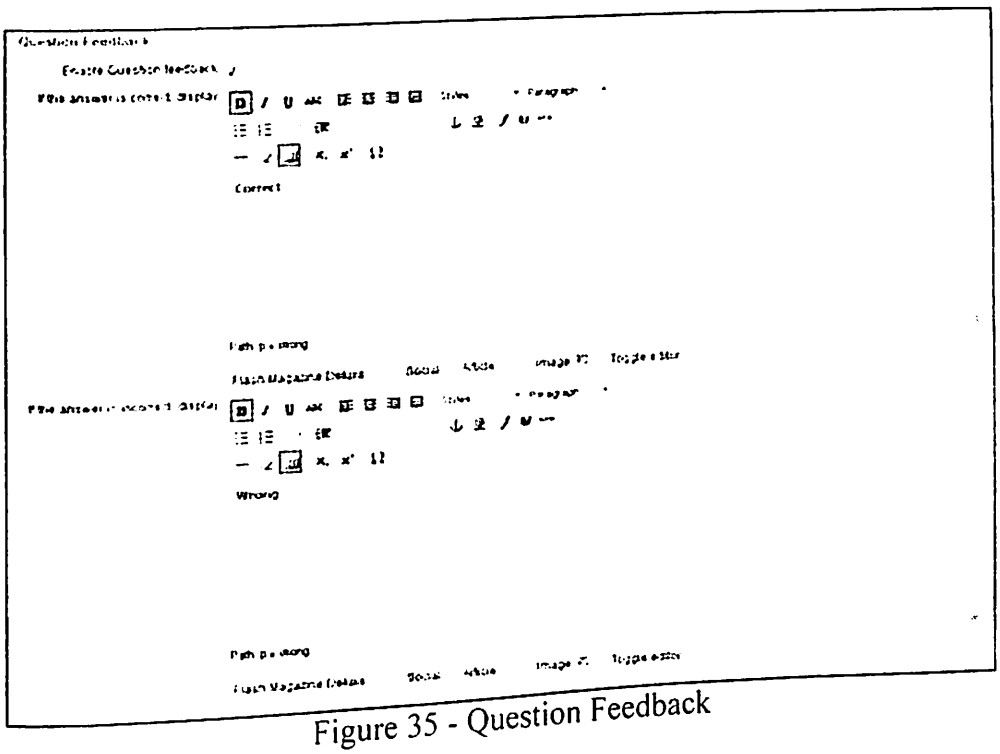

Figure 35 - Question Feedback

– Select the check box to enable Question feedback feature and specify the notification texts.

True/False

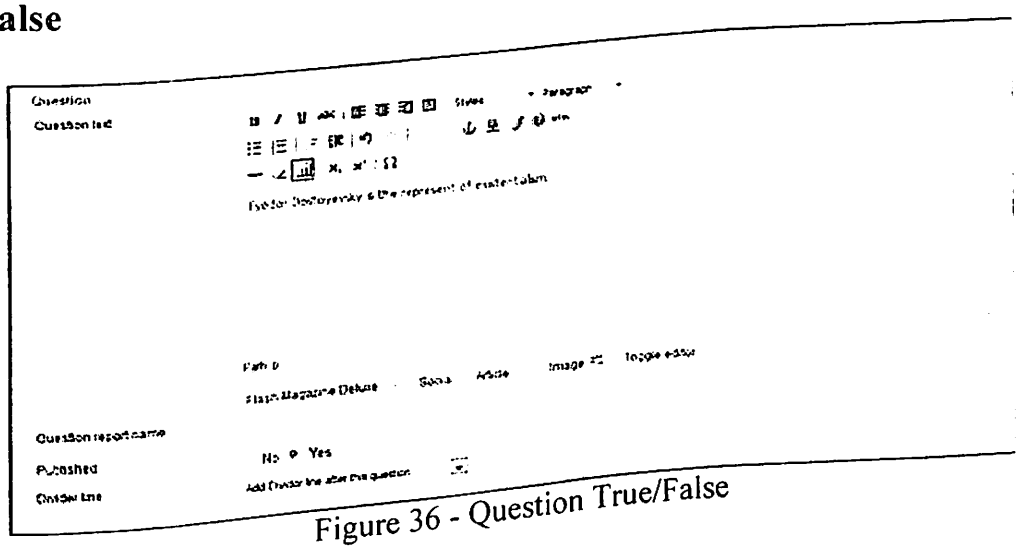

Figure 36 - Question True/False

– Question Text - type the question information here.
– Question report name - specify the name for this question. This name will be displayed before the question text in the Reports section.
– Published - specify the publishing status for this question.
– Divider Line - specify whether to add a divider line after this question.

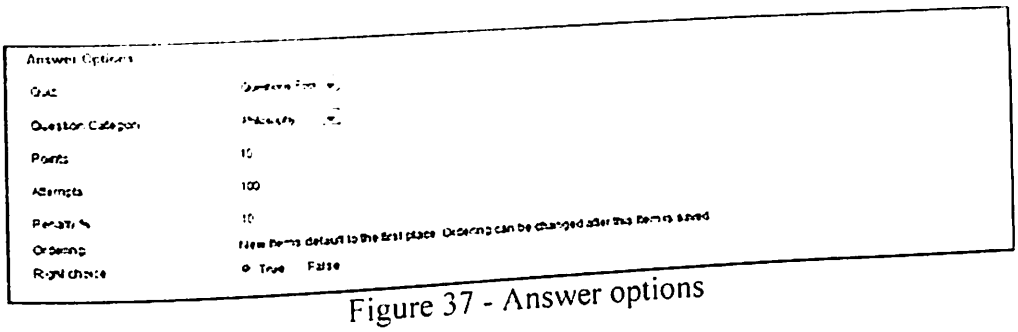

Figure 37 - Answer options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.
- Right Choice - specify whether the question text is true or false.

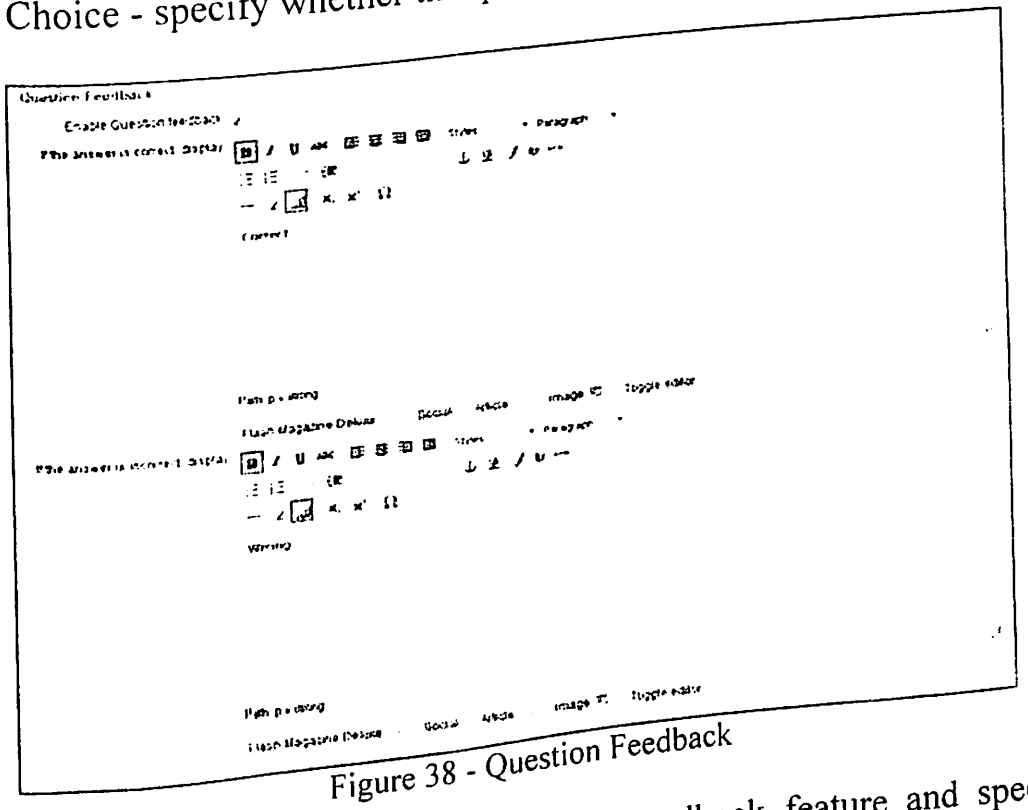

Figure 38 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Matching Drop-Down

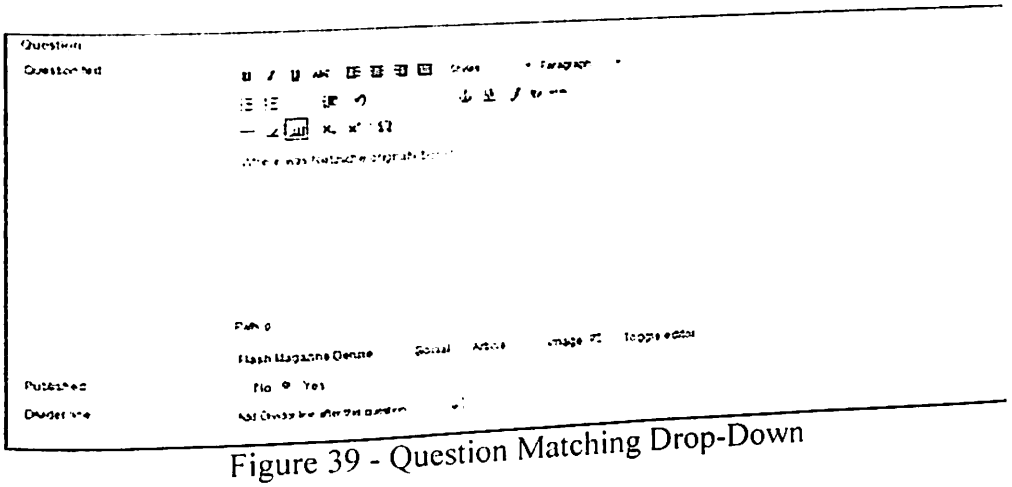

Figure 39 - Question Matching Drop-Down

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.

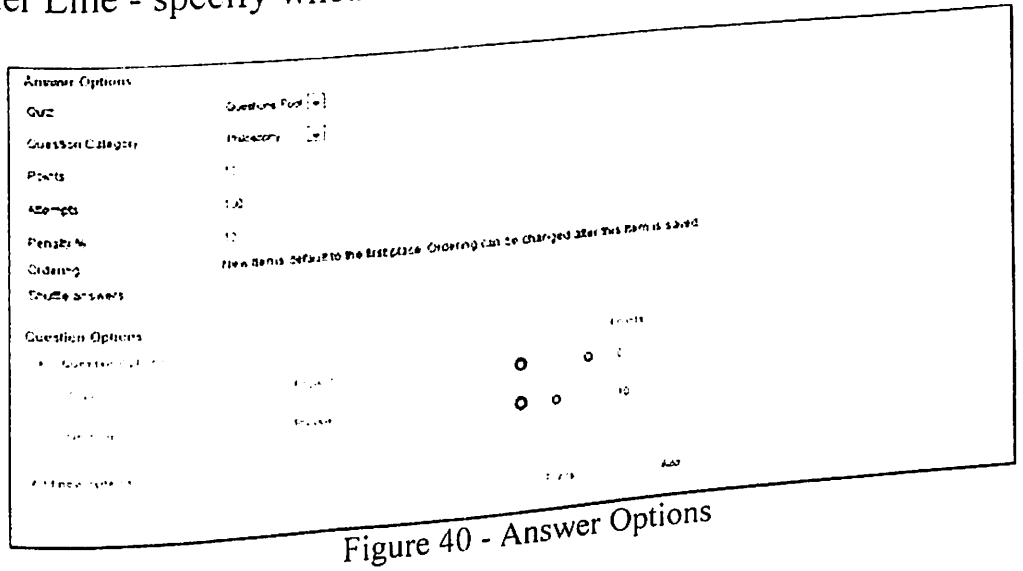

Figure 40 - Answer Options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.
- Shuffle answers - select the check box to disorder the answers.
- Question options - specify the question answers data:
  - Option Text - specify an answer for this question.
  - Option points - specify the points for an answer.

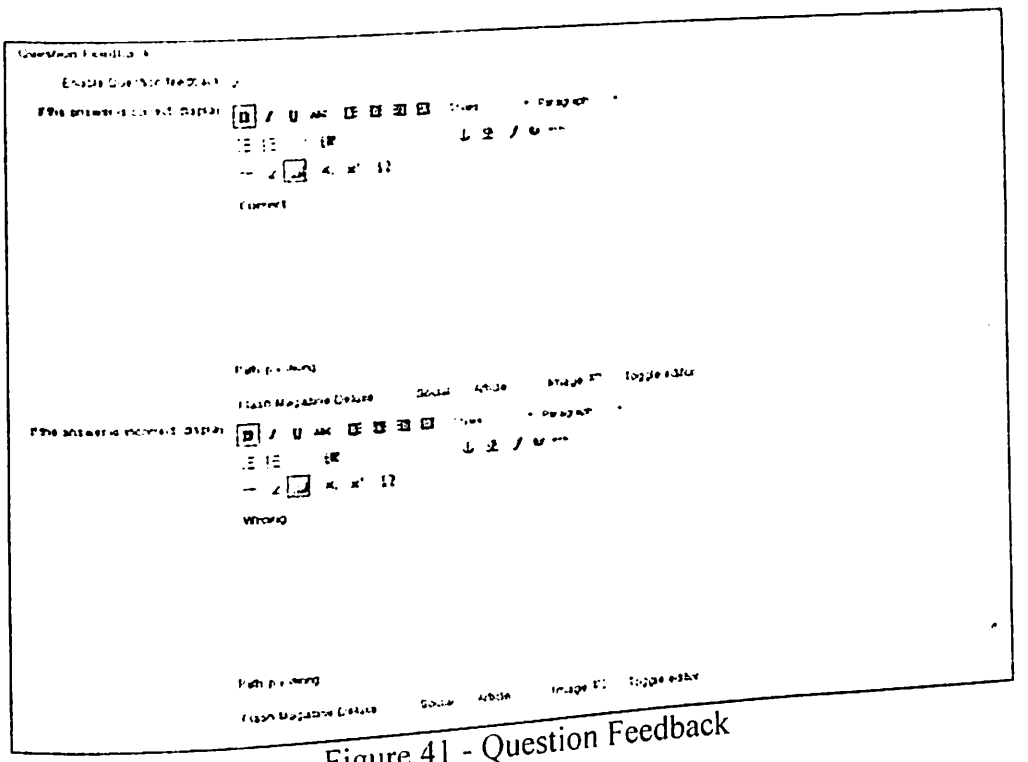

Figure 41 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Hotspot

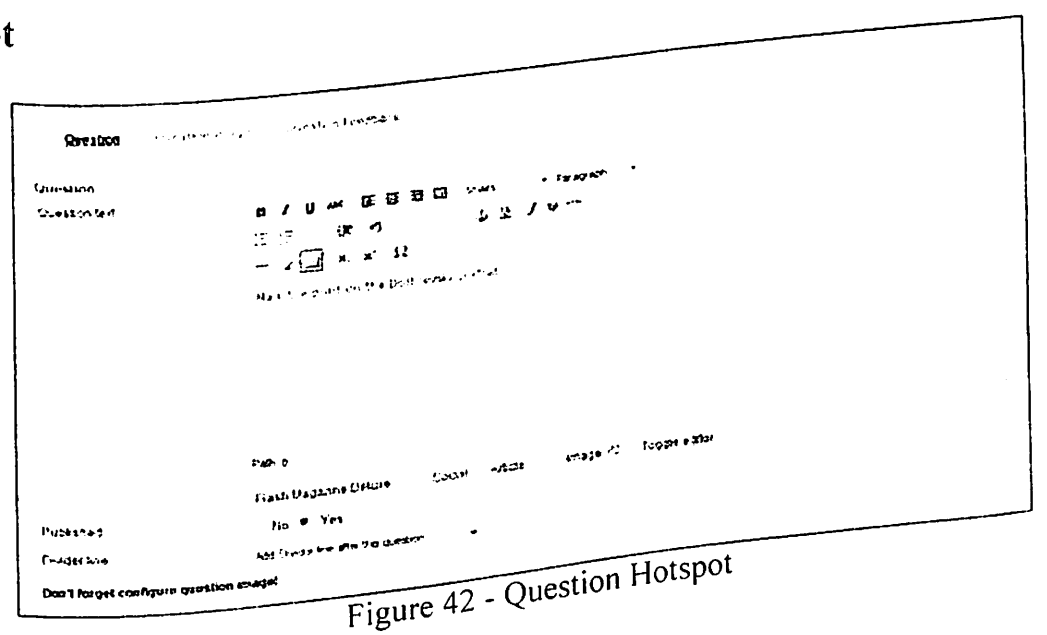

Figure 42 - Question Hotspot

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.

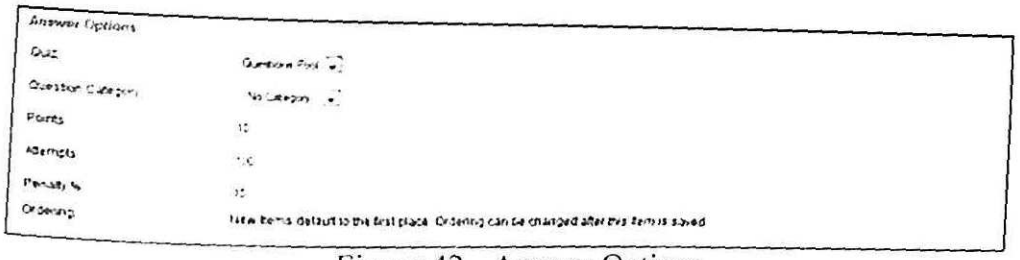

Figure 42 - Answer Options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.

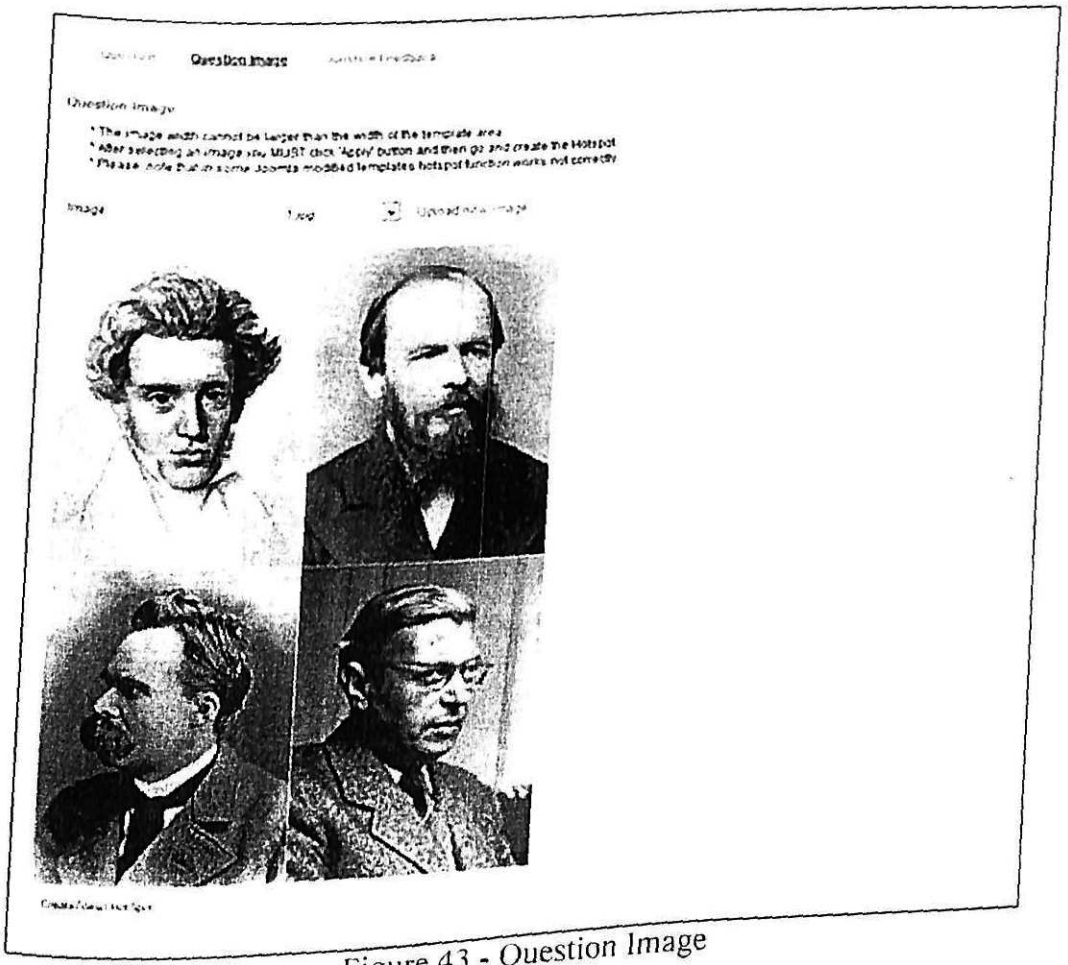

Figure 43 - Question Image

- If the answer is correct, display/If the answer is incorrect, display - Create the feedback messages for the correct and incorrect answers. These messages will be shown for all the questions in the quiz, unless you disable them for some questions or provide different feedbacks in the settings of those questions.
- Image - choose the image for this question. You can either use already existing images or upload new image.
- Create (View) HotSpot - mark the point to set the area for the right answer.

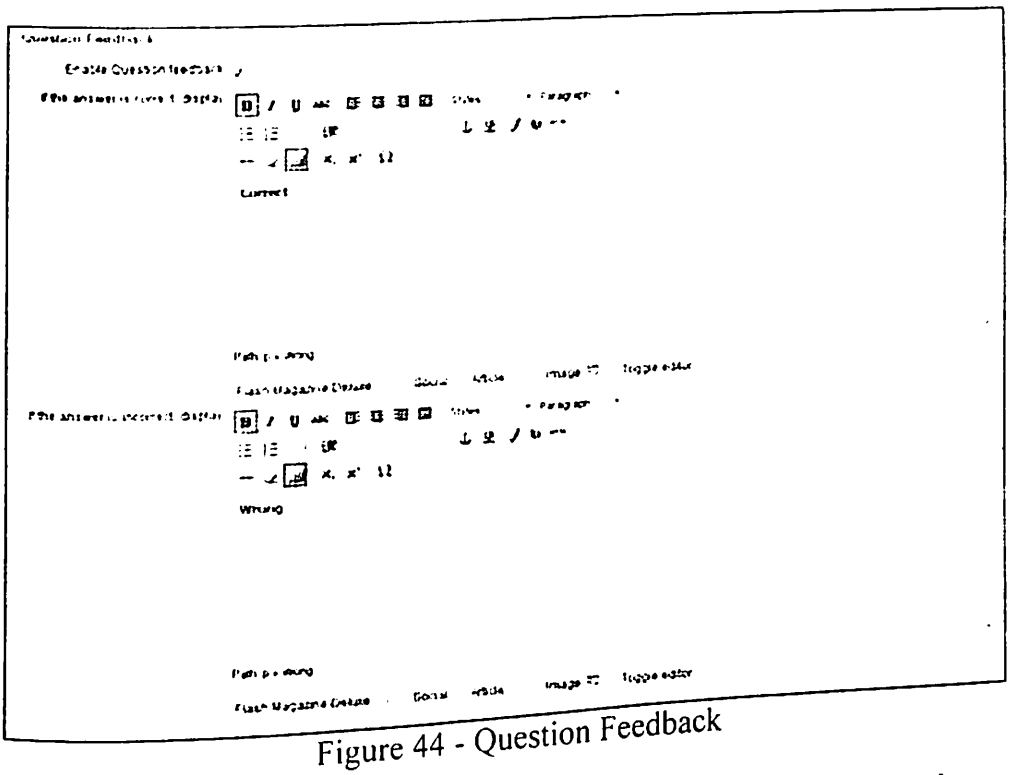

Figure 44 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Boilerplate

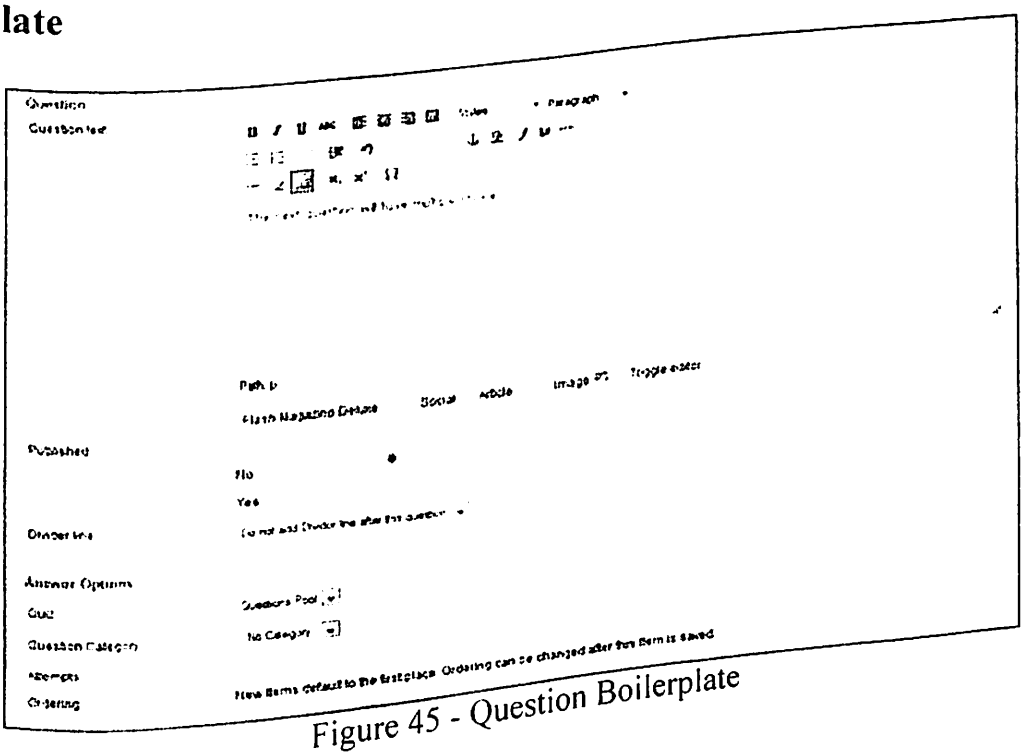

Figure 45 - Question Boilerplate

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.
- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Attempts - limit the number of attempts for passing this question.

- Ordering - specify the ordering options after saving this question.

Multiple Response

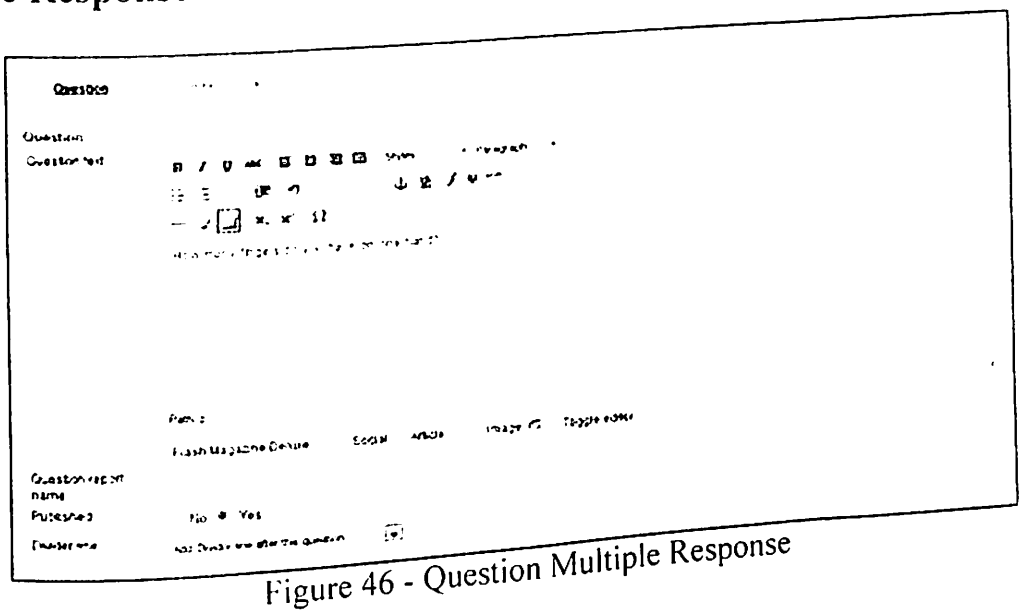

Figure 46 - Question Multiple Response

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.
- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.
- Shuffle answers - select the check box to disorder the answers.
- Partial Score - when this option is enabled, a user can only choose one correct answer (instead of choosing all correct answers) to pass the question.

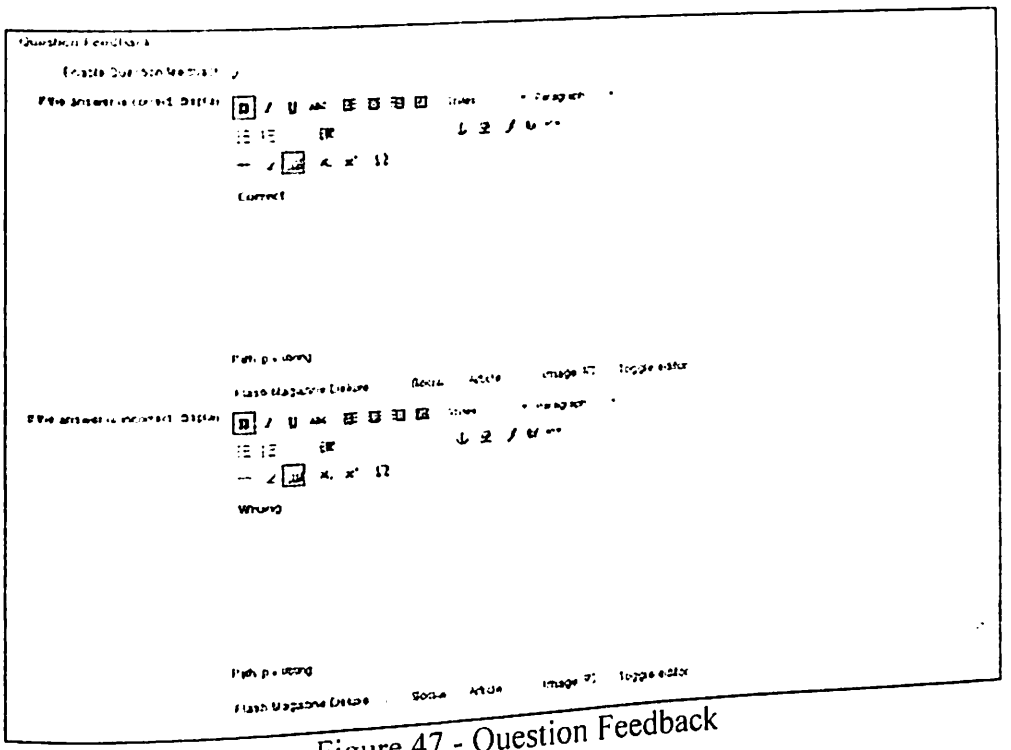

Figure 47 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Matching Drag&Drop

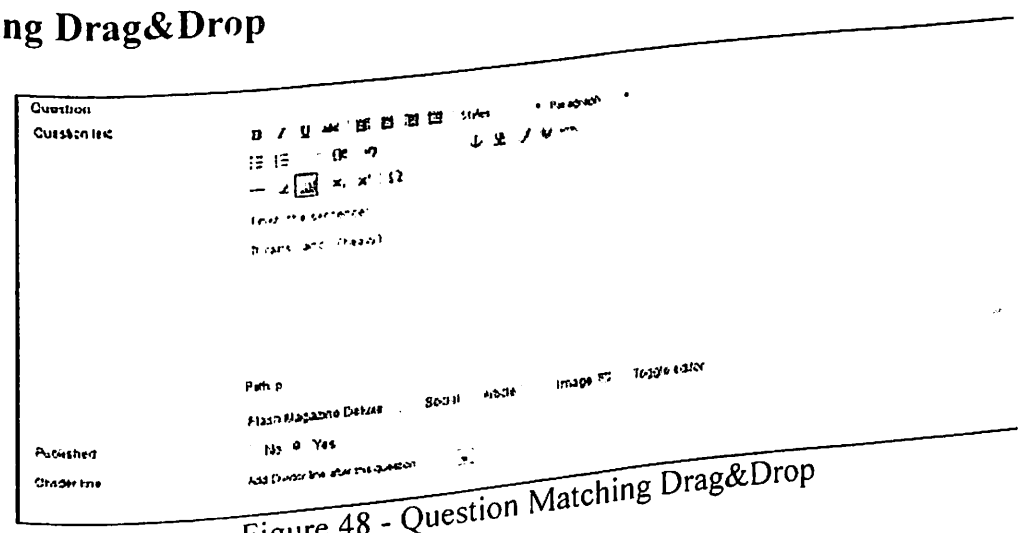

Figure 48 - Question Matching Drag&Drop

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.

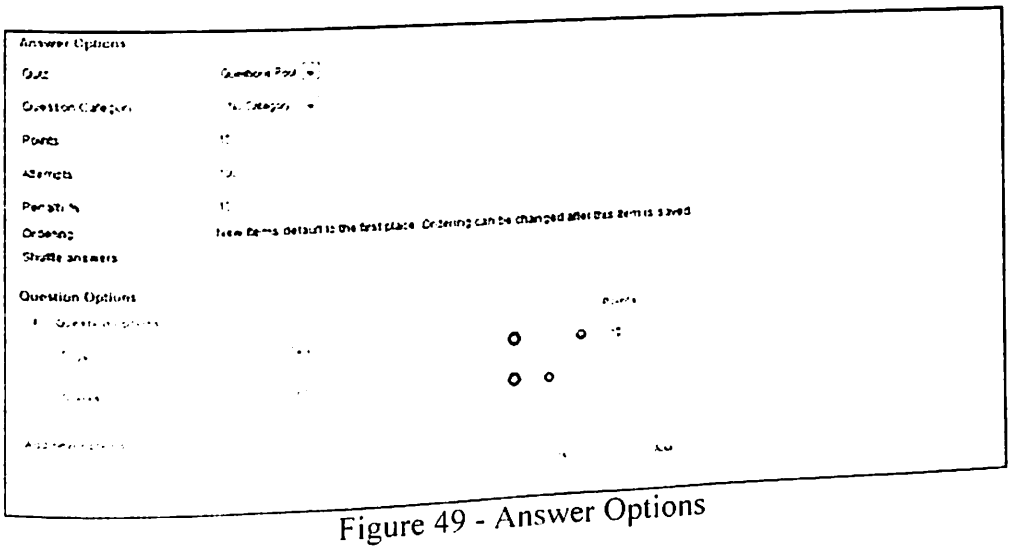

Figure 49 - Answer Options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.
- Question options - specify the question answers data:
  - Option Variants - specify an answer for this question.
  - Option points - specify the points for an answer.

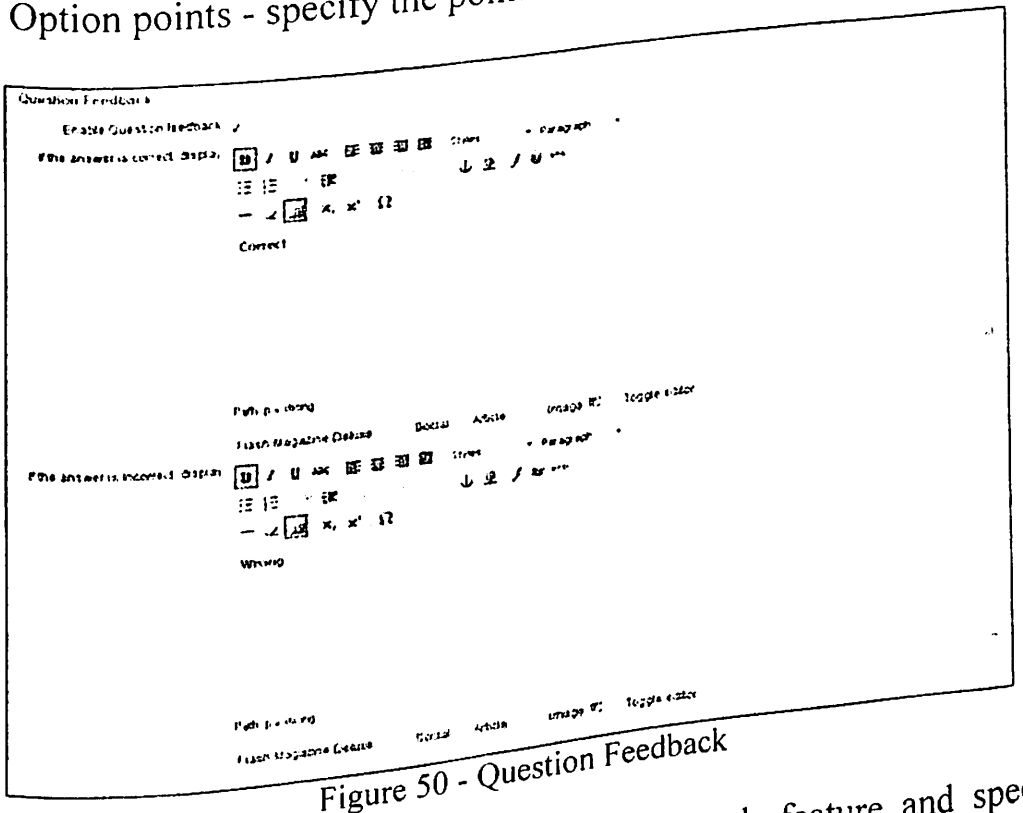

Figure 50 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Fill in the blank

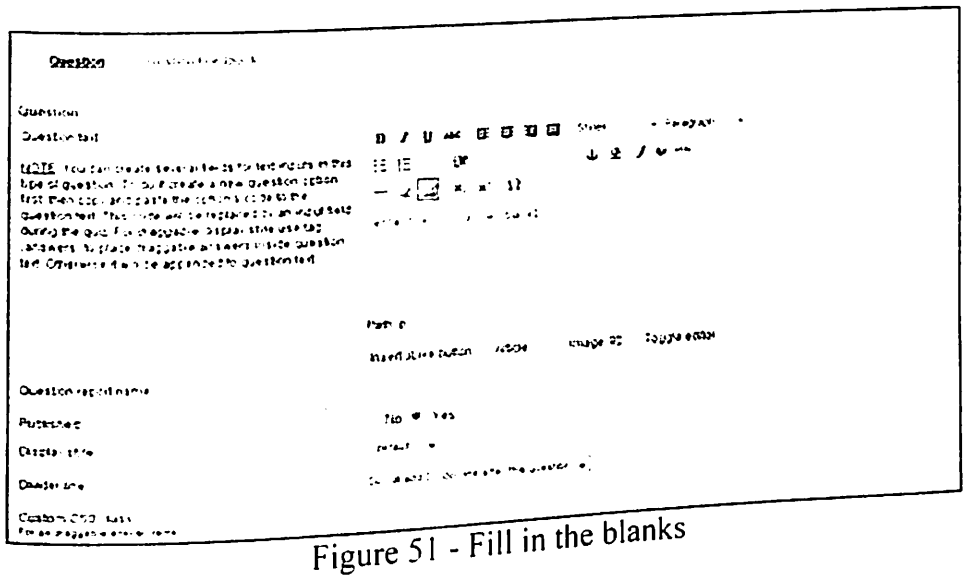

Figure 51 - Fill in the blanks

- Question Text - type the question information here.
- Question report name - specify the name for this question. This name will be displayed before the question text in the Reports section.
- Published - specify the publishing status for this question.
- Display style - specify whether the display layout for this question should be draggable.
- Divider Line - specify whether to add a divider line after this question.
- Custom CSS class - specify the css class for all draggable answer items.

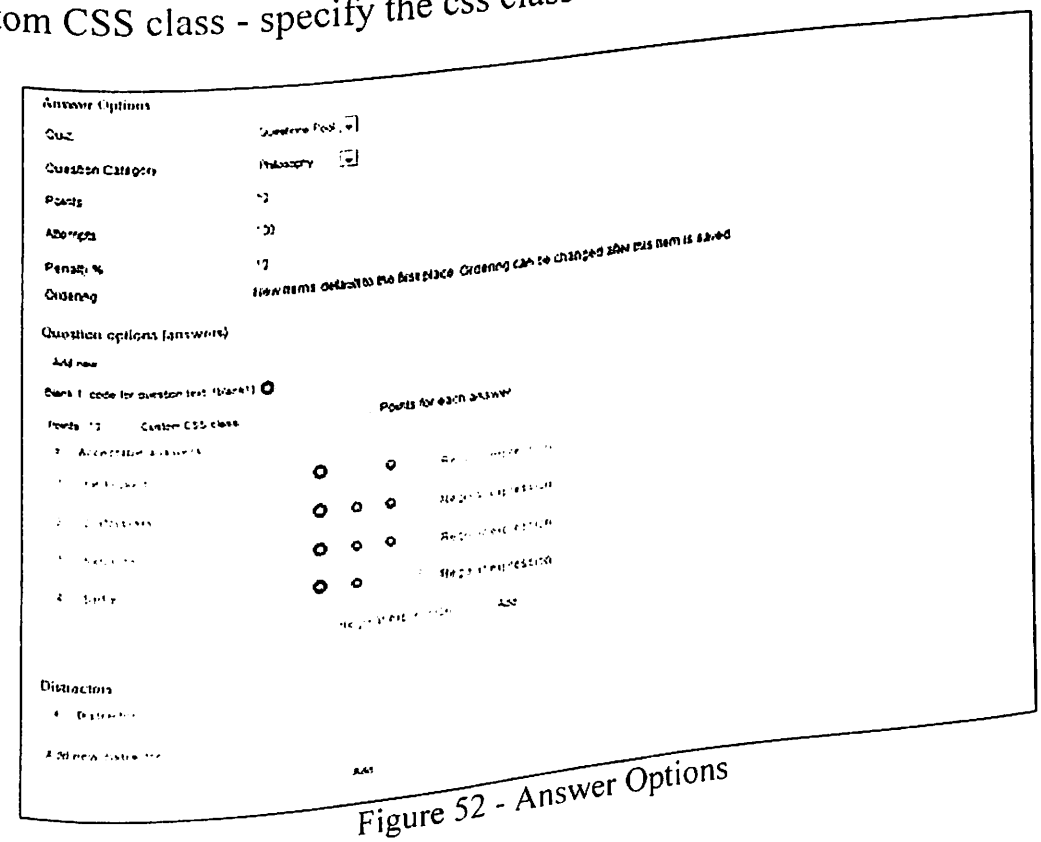

Figure 52 - Answer Options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.

- Points - specify the points for passing this question.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.
- Question options - specify the question answers data:
  - Option Variants - specify an answer for this question.
  - Option points - specify the points for an answer.
- Right Choice - specify whether the question text is true or false.
- Distractors - add distractors if needed.

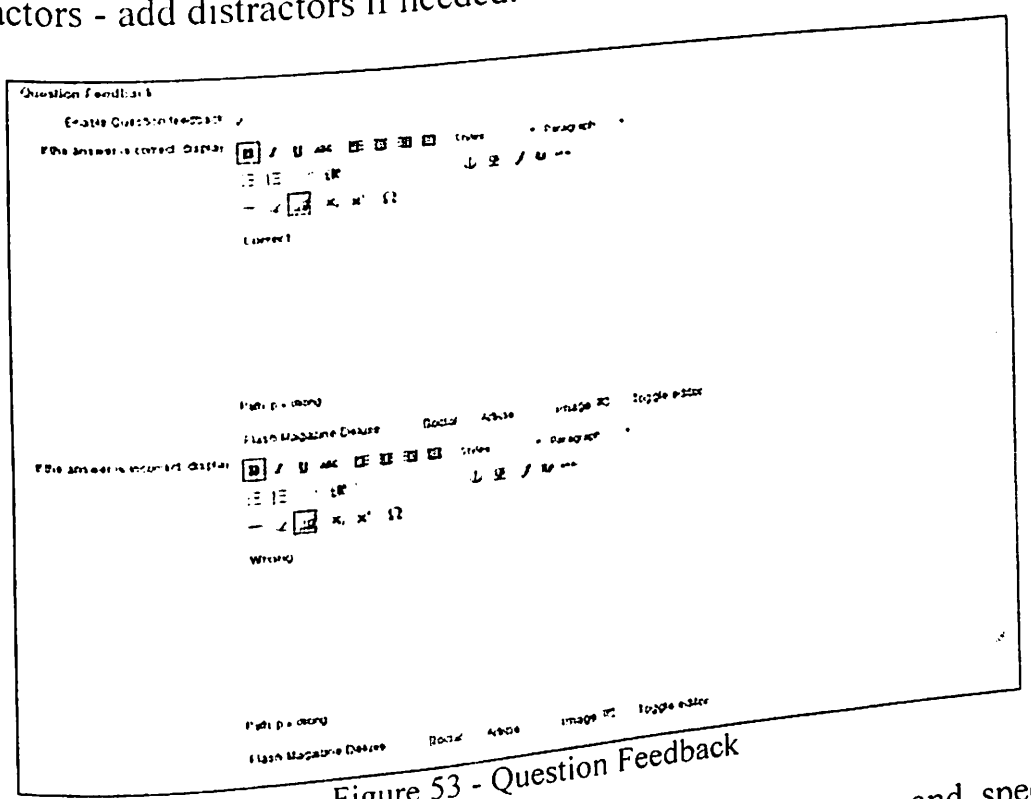

Figure 53 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Surveys

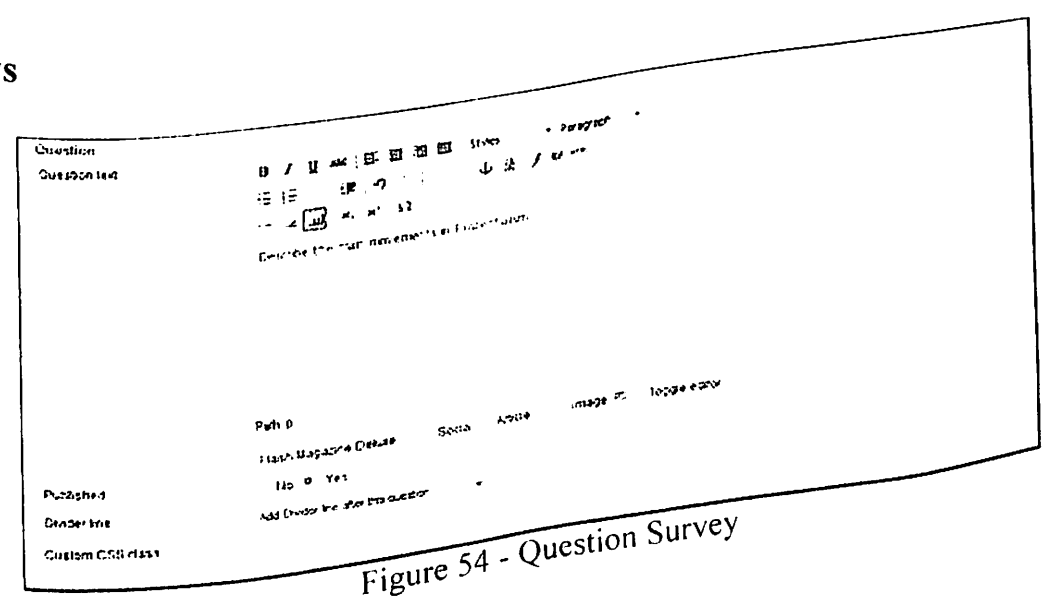

Figure 54 - Question Survey

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.
- Custom CSS class - specify the css class for all draggable answer items.

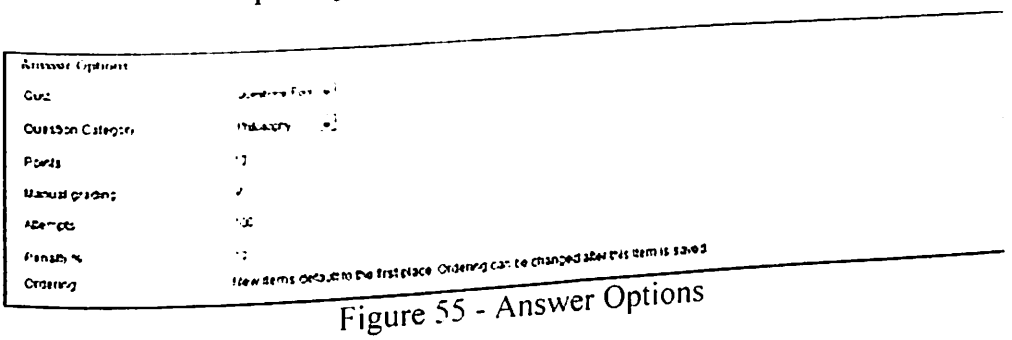

Figure 55 - Answer Options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.
- Manual grading - select the check box to allow the manual grading for this survey.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.

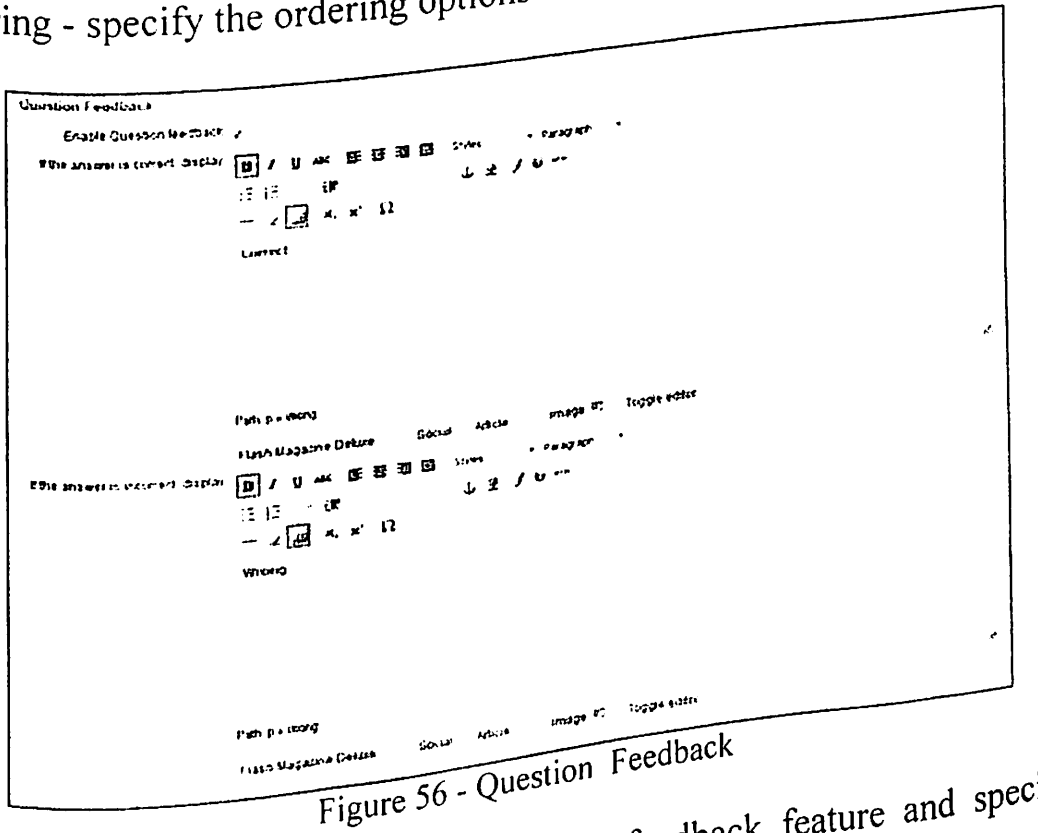

Figure 56 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

Multiple question

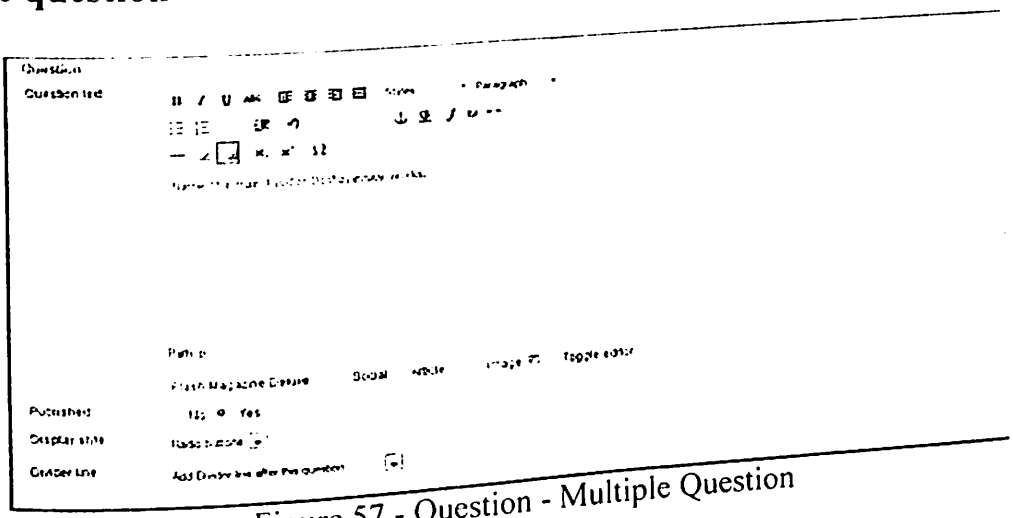

Figure 57 - Question - Multiple Question

- Question Text - type the question information here.
- Published - specify the publishing status for this question.
- Divider Line - specify whether to add a divider line after this question.
- Custom CSS class - specify the css class for all draggable answer items.

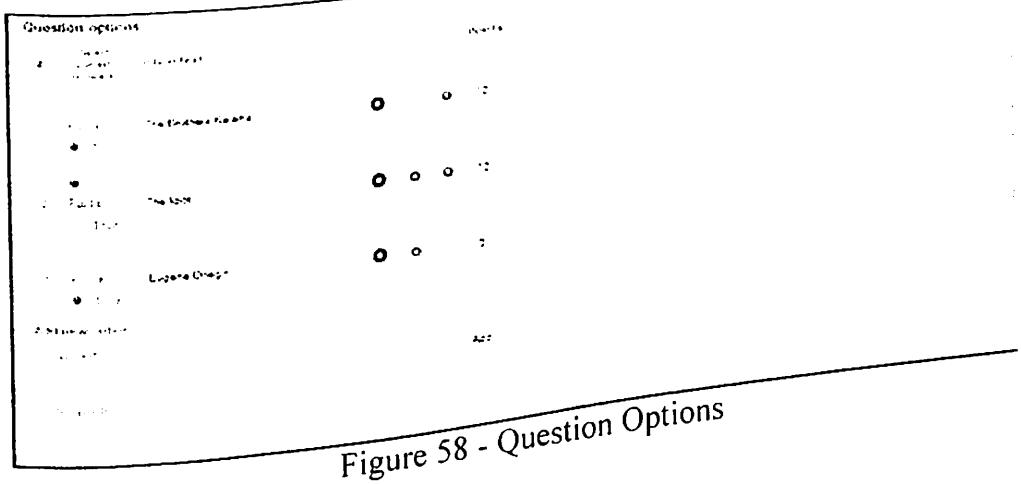

Figure 58 - Question Options

- Quiz - specify the quiz for this question to be put.
- Question category - specify the category for this question.
- Points - specify the points for passing this question.

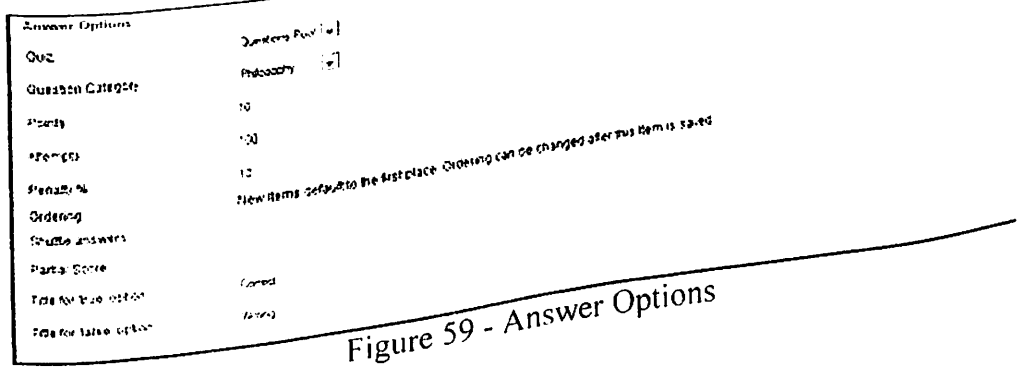

Figure 59 - Answer Options

- Manual grading - check the box to allow the manual grading for this survey.
- Attempts - limit the number of attempts for passing this question.
- Penalty % - specify the penalty points (in percents) for every repeated attempt.
- Ordering - specify the ordering options after saving this question.

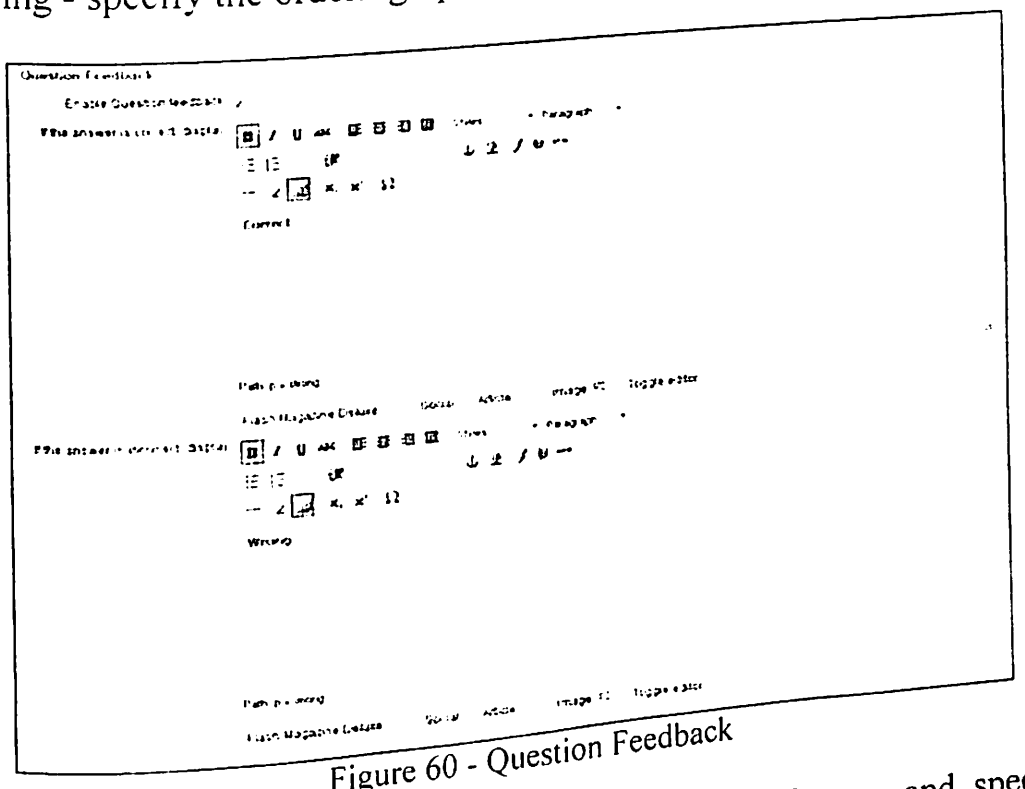

Figure 60 - Question Feedback

- Select the check box to enable Question feedback feature and specify the notification texts.

5. Click Save () to save the changes and stay on this page OR click Save&Close () to save the changes and be redirected to the questions list.

6.6 Question Pool

Question Pool contains all questions that are not assigned to any particular quiz.

This section allows you to create questions and then include them in any quiz. Hereby, you do not need to create one and the same question every time you want to assign it to a number of your quizzes.

To create a question in the Questions Pool section, go to Questions > Questions Pool and repeat all the steps described in the Question Management section.

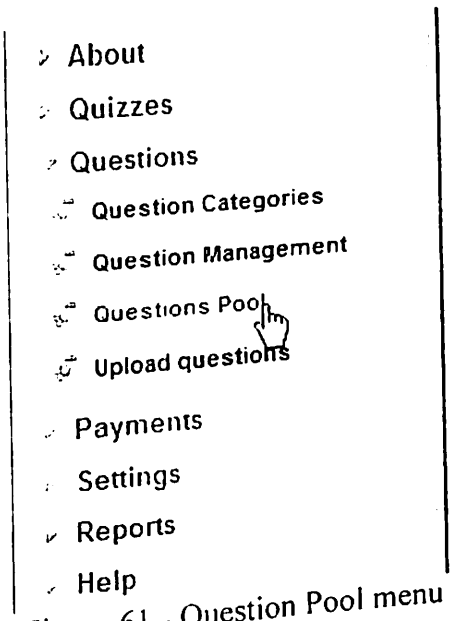

Figure 61 - Question Pool menu

6.7 Upload Questions

In this section you can upload .csv files containing questions, adding them either to Questions Pool or assign them to a Quiz from the drop-down list.

Note: You can upload only Multiple Choice AND Multiple Response Questions.

To upload a question, do the following:

1. Go to Questions > Upload questions:

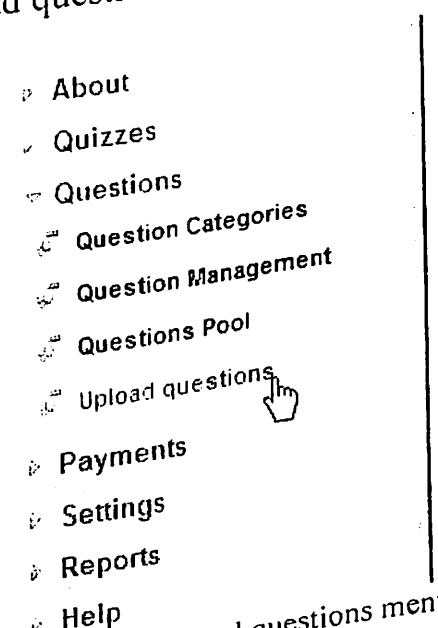

Figure 62 - Upload questions menu

2. Select a .csv file containing questions and click Upload ( ).

The questions appear in the specified section:

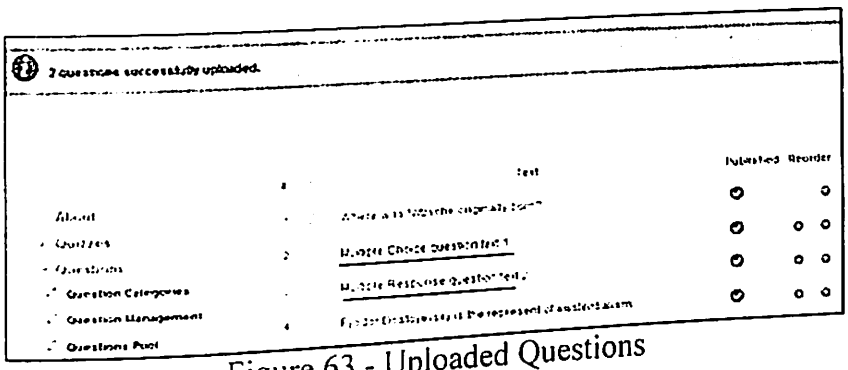

Figure 63 - Uploaded Questions

7 CONCLUSION

Utilizing traditional web-based systems to support learning is one useful approach in education. The problem with this approach is that, during on-line testing, a massive amount of exam questions presented will make students feel frustrated and dissatisfied. The problem of personalization in eLearning remains the focus of attention of many researchers nowadays. Various attempts have been undertaken but only some of the solutions are practically useful for teaching. Sophisticated web-based Adaptive Hypermedia systems as well as Intelligent Tutorial systems are often oriented on one type of task, for instance quizzes or assessments, and therefore cannot be used for other purposes [27].

A dynamic assessment is very important in the learning process. It is a part of understanding of progress. We believe that it would be very useful to develop an adaptive exam system that will be effective, efficient, and engaging learning experiences, which will meet the needs of the individual learners. For that reason, we realized this preliminary study of adaptive learning or in order to develop an exam application in the near future.

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