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QSIA – a Web-based environment for learning, assessing and knowledge sharing in communities

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Abstract

This paper describes a Web-based and distributed system named QSIA that serves as an environment for learning, assessing and knowledge sharing. QSIA – Questions Sharing and Interactive Assignments – offers a unified infrastructure for developing, collecting, managing and sharing of knowledge items. QSIA enhances collaboration in authoring via online recommendations and generates communities of teachers and learners. At the same time, QSIA fosters individual learning and might promote high-order thinking skills among its users. QSIA's community, conceptual architecture, structure overview and implementations are discussed.

Keywords: Architectures for educational technology systems; Learning communities; Interdisciplinary projects; Interactive learning environments

1. Introduction

One of the earliest contexts of use of computers in teaching and learning was the online test (Rafaeli & Tractinsky, 1991). Computerized administration of tests is attractive for a variety of substantive, convenience, efficiency, aesthetic and pedagogic reasons (Rafaeli & Tractinsky, 1989).

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Online testing has traditionally been a very centralized, closely guarded and tightly controlled enterprise. Modern online assessment systems offer considerable scope for innovations in testing and assessment as well as a significant improvement of the process for all its stakeholders, including teachers, students and administrators (McDonald, 2002).

In the following, we describe the construction and use of an innovative online system that attempts to pull together several disparate strands. This is an Internet-based assessment system that harnesses the potential of communities to both teaching and learning purposes. We will show how communities of learners, recommender systems as well as the generation and assessment of knowledge items can be managed in a sharing environment.

Online systems that support education have originally been about teacher-to-student communication (Dori, Barak, & Adir, 2003; Gal-Ezer & Lupo, 2002; Light, Nesbitt, Light, & White, 2000; Rafaeli & Ravid, 1997) or student-to-student communication (Guzdial & Turns, 2000; Light et al., 2000). These two modes are the topology inherited from the traditional classroom, and were naturally emulated in first generation online systems. Second generation online systems can be based on innovations in the direction and control of communication flow. Web-based learning systems can now aim not just at delivering content from teacher-to-student, they can go beyond student-to-student communication to teacher-to-teacher as well as student- and teacher-to-the-future avenues. Along these lines of thought, new systems that allow teachers to share lesson plans are gaining prominence (Nachmias, Mioduser, Oren, & Ram, 2000; Pear & Crone-Todd, 2002; Sheremetov & Arenas, 2002).

This project is about implementing network-based online assessment in an entirely new perspective. We investigate the design and use of a network-based system for online assessment and learning that emphasizes the sharing, community potential of the network in what, heretofore, was considered mostly an individual task.

QSIA is acronym for Questions Sharing and Interactive Assignments but also an eponym for "question" in ancient Hebrew. QSIA is designed to share the authoring of test items, their contents and psychometric accumulated history, as well as the process of constructing assignments and tests. The system runs the administration of assignments and tests under a variety of contexts: online as well as offline, proctored as well as individual, with or without time limits, open or closed book, etc. Straightforward contributions to the item database and assignments templates within any learning domain are only the first tier. Provision of recommendations for items and assignments is a second level of communication. Actual use of the system in a learning capacity enriches the collected history and available logs. Thus, this system is designed to learn, not just teach.

The basic idea of sharing, which is the essence of QSIA, also stands behind its technology. The system is based on a set of six principles: Open strands, Flexibility, Privacy, Open source, Ease of use and Multi-community. The system uses an open source application server, Apache Tomcat and an open source database, MySQL, which are based on a Linux system. The infrastructure is based on Java technology, using JSP and object oriented Java Beans technology.

This paper describes the QSIA online system and its educational goals. QSIA's architecture, structure principles, system overview, applications and current experiments are detailed. Barriers to online assessment and opportunities for future investigations are discussed.

2. Theoretical background

During the past decade, research has been engaged in experimental projects that focus on Web-based learning environments (Dori et al., 2003; Gordin, Gomez, Pea, & Fishman, 1997; Rafaeli & Ravid, 1997). The Internet has already proved to be a supplementary medium for communication, work, trade and learning. Educators in different academic institutes are showing growing interest in Web-based environments for learning, assessing and knowledge sharing.

Learning is influenced by participation in a community (Bruner, 1990; Vygotsky, 1978), learning also involves the use of many resources. In order to sort and select the suitable resource, learners seek guidance and recommendations. Recommender systems are computer systems which seek to guide instructors and students in their choice of relevant resources and knowledge items (Resnick & Varian, 1997). This project focuses on community of learners generated through the implementation of recommender systems and the sharing of knowledge items. These theoretical concepts are defined and discussed in the following paragraphs.

2.1. Communities of learners

Learners construct their knowledge through social interaction with peers, through applying ideas in practice, and through reflection and modification of ideas (Bruner, 1990; Solomon, 1987; Tobin, 1990; Vygotsky, 1978). The notion of communities of learners is gaining much traction in contemporary understanding of work as well (Wenger, 1998).

Computer-Mediated Communication (CMC) is the situation of a large online group working towards a common goal (Sudweeks & Rafaeli, 1996). CMC enables and highlights teamwork and collaboration. Collaboration has become a dominant mode of organizing, conducting work and learning (Eylon, 2000; Gal-Ezer & Lupo, 2002; Jones & Rafaeli, 2000; Sudweeks, McLaughlin, & Rafaeli, 1998; Sudweeks & Rafaeli, 1996).

Online communities are difficult to generate because they have high social and material requirements. Online communities that attempt to engage in long-term participation require access to specialized information, to practitioners, to relevant data and analysis tools (Rafaeli & Ravid, 2001; Sudweeks & Rafaeli, 1996).

One of the aspects of implementing large-scale knowledge items collaborative systems involves the process of seeking and providing experience-based recommendations across users communities.

2.2. Recommender systems

Learning involves a large number of potential educational resources of which only part are relevant, reliable and authoritative. When encountering many resources, people tend to seek recommendations for sorting and selecting the suitable data. Recommendations rely mainly on human-analyzed sources such as reviews, rumors, "word of mouth", surveys, guides, friends and recommendation literature (Resnick & Varian, 1997; Shardanand & Maes, 1995).

Recommender systems are computer systems which seek to guide instructors and students in their choice of relevant resources. Similarity is the most mentioned approach in recommender systems. Recommendation of resources should be motivated either by preference or similarity

(Herlocker, Konstan, & Riedl, 2000; Resnick & Varian, 1997; Shardanand & Maes, 1995). Participants in the recommendation group, referred to as 'neighbors group', share similar preferences.

The core task of a recommender system is to recommend, in a personalized manner, interesting and valuable items and help user make good choices out of a large number of alternatives, without sufficient personal experience or awareness of the alternatives (Oard & Kim, 1998; Resnick & Varian, 1997). This task is implemented by QSIA. One of QSIA sub-tasks is 'matching mates' viewed as the recommender system's capability to make matches between recommenders and those seeking recommendations.

QSIA's epistemology introduces the term 'friends group' instead of 'neighbors group'. This concept is innovative in suggesting that 'neighbors' (like-minded group) are relevant to 'low-risk' recommendation domains such as movies, music or jokes; but 'friends' may be relevant to higher risk domains such as knowledge items, used in learning and assessment.

2.3. Knowledge and knowledge items

Aristotle maintained that Knowledge originates in sense perception. Bloom (1956) describes knowledge as the first in a hierarchy of six levels of cognitive development. Knowledge is defined as understanding or as familiarity gained by experience. 'Knowledge items' can be defined as codified knowledge objects that are the result of inputs to intellectual activities that yield educational, economic or technological value for organizations.

Knowledge items can be scientific or research oriented, they can refer to organizational learning (Linton, Joy, Schaefer, & Charron, 2000) or Usenet messages and Web resources (Bollacker, Lawrence, & Giles, 1999; Goldberg, Nichols, Oki, & Terry, 1992; Konstan, Miller, Malt, Herlocker, Gordon, & Riedl, 1997; Terveen, Hill, Amento, Mcdonald, & Creter, 1997).

QSIA consists of a database of knowledge items. Furthermore, it is an online collaborative system for developing, collecting, managing and sharing of knowledge items. QSIA can be looked upon as an information market, to which knowledge items are brought, in which they are stored, exchanged and consumed.

3. QSIA's conceptual architecture

Our goal was to build a generic data driven system, for the collection, retrieval and use of knowledge items within a knowledge discipline, shared across organizations and beyond boundaries. We designed and built an Internet-based, Java and MySQL fueled online system to deliver this functionality. The QSIA system is based on four conceptual pillars: Knowledge Generation, Knowledge Sharing, Knowledge Assessment and Knowledge Management.

3.1. Knowledge generation

QSIA system enables users to create and edit different knowledge items such as questions or learning tasks. The knowledge items can range from simple low order thinking skill questions that require memorizing or seeking straightforward information, to complex assignments with high order thinking skills that require analysis and synthesis of the learning material. QSIA knowledge items are modular variety of types including multiple-choice questions, matching questions, true/false questions or content items.

QSIA as a Web-tool permits easy accessibility to a variety of knowledge databases that include written text, as well as interactive multimedia such as music, video films, special simulations and virtual tours to museums. It is a multi-lingual system and has been used in English, Hebrew, Arabic and Turkish.

3.2. Knowledge sharing

QSIA focuses on knowledge sharing among participants, while maintaining a secure and private working environment. One of QSIA's sub-tasks is 'matching mates': the capability to make matches among recommenders and those seeking recommendations. Sharing knowledge via QSIA includes three aspects:

Uploading knowledge items. Composing a question and allowing others to use it. QSIA has four different access levels: private (opened only to the owner), personal (opened to a selected set of users), partial (opened only to a selected set of learning groups) or public (opened to everybody). In each of these levels, the user can choose to restrict the access to a specific role (teachers, for example).

Ranking knowledge items. Answering a question and then ranking it on a scale of 1–5, so others could benefit from ones' professional opinion and recommendations.

Receiving recommendations. Looking at the average rank other participants (instructors or students) provided for a certain question. Thus, every user can benefit from the expertise of others. The recommendation system enables instructors and students to get targeted suggestions of knowledge items.

Fig. 1 shows the interface of the recommendation tool where users can search for knowledge items by item text, author name or knowledge area. Users can receive recommendations, rank knowledge items developed by others and see their own recommendations. This ability can be used to rank the questions in a collection provided by the instructors. It can also be used by students to rank peer contributions to the item database.

3.3. Knowledge assessment

QSIA offers new prospects for individual assessment based on computerized follow-up and monitoring of the individual answering path chosen by each student. The QSIA online assessment activities are called assignments and have a number of applications.

QSIA assignments can be seen both as a formal and informal evaluation of the students' knowledge. The formal evaluation is carried out by a quiz given to the students simultaneously but not necessarily in the same place. The informal evaluation is represented by self-tests students' can carry out any time and any place for detecting their difficulties and misunderstanding. Fig. 2 shows the type of feedback students can receive after answering an item as part of a quiz or self-test. This particular item is a part of a set of items used in a Pathology quiz in medical school. The question includes a color slide. After answering it, they are given the correct answer, and information about their response and grading (if applicable).

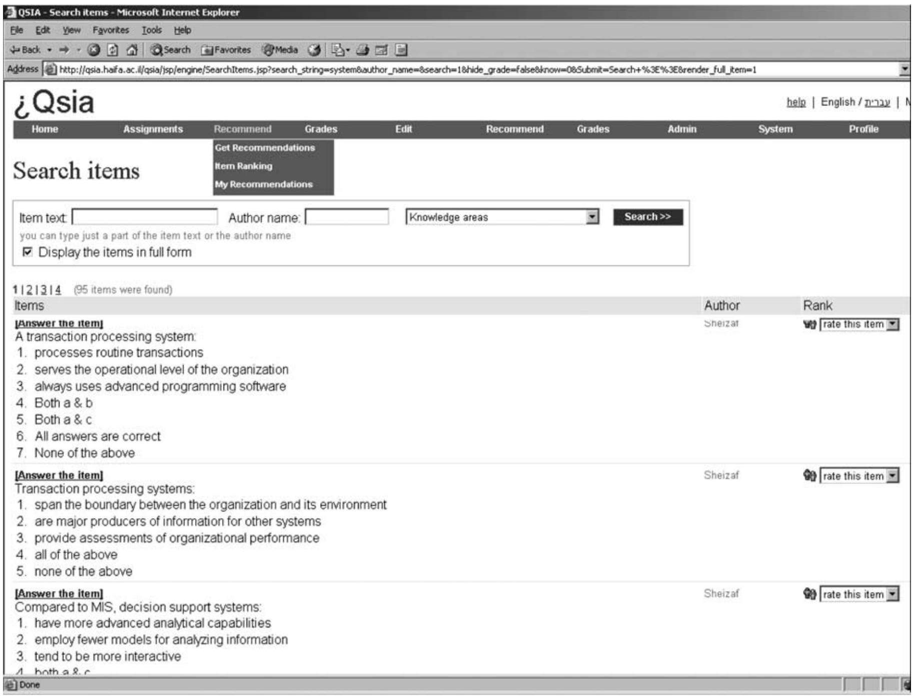

Fig. 1. Knowledge sharing via recommendation.

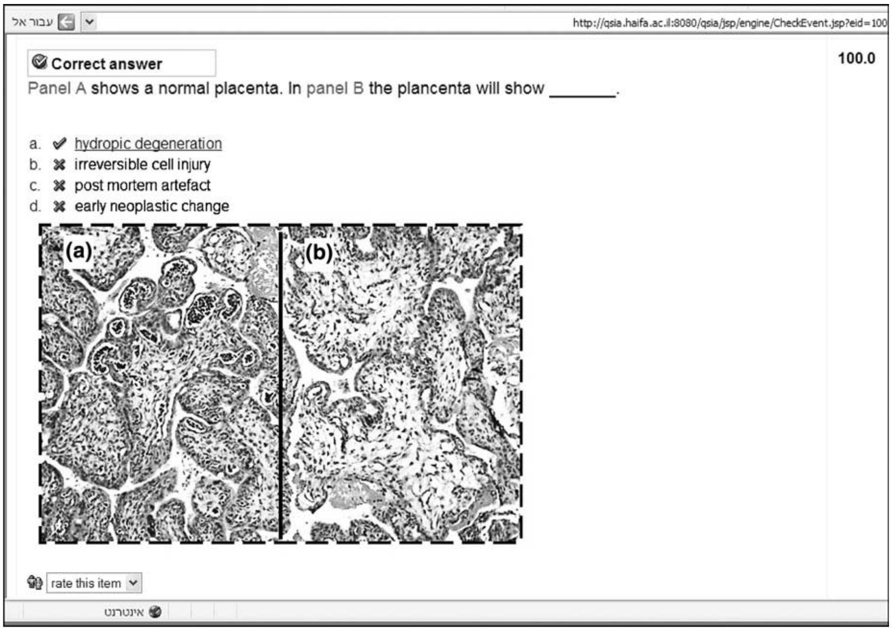

Fig. 2. The feedback students receive after completing a quiz or a self-test.

QSIA assignments can be reviewed by the instructor before distribution to the students. If there are no computer facilities, a hard copy of the assignments can be printed or exported to common word processor formats.

When administered online, the instructor can monitor the progress of the students, according to parameters such as number of questions answered and more. The system allows the instructor to choose between several grading strategies, which may be added dynamically to the system in run-time. Instructors can view and analyze the grades of the students, according to three parameters: students, assignments or knowledge item. Furthermore, the system offers aggregate reports.

3.4. Knowledge management

The educational line of work produces massive learning materials for both instructors and students. After years of learning and teaching, educators possess valuable lectures, working sheets, written projects, exercises, assignments and more. Scholars often have trouble organizing their papers, files and folders. Valuable psychometric history pertaining to items and their quality often gets lost in the shuffle. QSIA helps solve this problem. QSIA allows managing educational content using folders, search facility and editing tools. It enables users to create and manage a set of folders that includes all of the content owned by them. The folders allow users to manage their content's properties using centralized and time-saving methods.

Content such as knowledge items, created by the QSIA user, can be indexed under a certain discipline. The list of personalized knowledge areas can be used afterwards in order to retrieve the contents. The system keeps a list of disciplines or personalized knowledge areas suited for each user. Since QSIA is an online system, users can retrieve their personal educational contents any time and any place providing there is a computer with a connection to the Internet.

4. QSIA's technological architecture

The QSIA four conceptual pillars: Knowledge Generation, Knowledge Sharing, Knowledge Assessment and Knowledge Management are enabled and supported by four subsystems that are presented in Fig. 3.

Each subsystem is responsible for different components and manages different areas of interaction. The subsystems include: Content Management System, Recommendation System, Assessment and Reporting System, and Administration System.

(1) *Content management system* is responsible for managing the Knowledge items, bundles and assignments created by the instructors. The system serves as a content gateway, offering services such as object caching, security policy enforcement and folder management. The knowledge repository is the outcome of this subsystem. It includes knowledge items, bundles and assignments. The external repository includes database of questions, online quizzes and self-tests.

(2) *Recommendation system* is responsible for gathering ranking information from the user, generating the 'friends' group, running the recommendation algorithms and retrieving the recommendations. The recommendations system enables instructors and students to get targeted suggestions of knowledge items. Most recommendation systems use a statistical matching approach, where recommendations are provided based on a probability of similarity. QSIA adds a

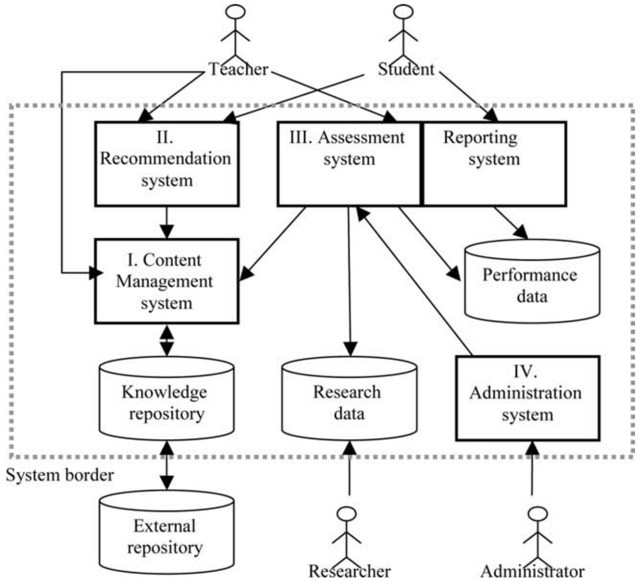

Fig. 3. The QSIA online system internal structure.

social dimension to the recommendation process. One of the QSIA sub-tasks is 'matching mates' viewed as the recommender system's capability to make matches among recommenders and those seeking recommendations, based either on statistical similarity or user choice.

(3) *Assessment and reporting systems* are two subsystems that allow students to perform their assignments, and to learn independently using the database of knowledge items. The heart of the system is the Arena component which allows secure real time testing, as well as online grading using a varied and adjustable set of grading strategies. The system also generates grading reports for learners and instructors. The performance data is one of the Assessment and Reporting subsystems outcomes, it includes a list of the students' grades. The research data is the second outcome and it include a list of the users, the disciplines, the groups and logs.

(4) *Administration system* allows administrators to manage the users in the system, manage disciplines, learning groups and action logs. Hierarchal and secure administration is supported in order to allow various learning organization to use the same system securely.

5. QSIA authorizations

QSIA includes three types of users, with different authorization levels: student, teacher and administrator. Students are allowed to carry out assignments such as quizzes or self-tests and get feedback on their performance. Teachers are authorized to generate knowledge items, create assignments, share knowledge, receive recommendations and more. Administrators are authorized to manage users, groups, disciplines and log files. Each QSIA user can be assigned for more than one authorization. For instance, a student can also have a teacher's authorization and a teacher can also have an administrator's authorization. The three types of authorizations are detailed in the following paragraphs.

5.1. Student authorization

With easy-to-use interfaces that can include interactive learning assignments and knowledge items, students exercise and further develop their learning. QSIA exposes students to a large database of questions and learning assignments composed by their instructors, other instructors and also their fellow students. QSIA allows the students to complete the available assignments in a secure and instructed environment. The system allows the learner to review the given answers before finishing the assignment and warns the student if there are unanswered questions. If the assignment configuration allows it, the system presents detailed feedback after completion of the assignment, including an explanation for correct and mistaken answers. The system offers several measures for preventing students to copy their peers' answers, such as random ordering of questions and answers, login restrictions and more.

The databank of items allows the student to carry out independent learning as well as team learning. Students can work on learning assignments alone, any time and anywhere, search for knowledge items using the search facility or the recommendation system. Students can solve the items independently and get feedback using the explanations given by the instructor. At the same time, students can work in teams and meet for solving problems in a collaborative way. The students can get detailed feedback on their achievements in completed assignments and on solved items.

5.2. Teacher authorization

Using the Webs' technical capabilities such as hyperlinks, photo pictures and different components of multimedia, teachers can compose questions that are interesting as well as cognitively challenging. They can compose questions that require students to, seek information, observe simulations, explore phenomena, analyze data, pose questions and present argumentations. Teachers are authorized to create assignments (quizzes or self-tests), they can do so in an easy three step process. Step one is developing a database of knowledge items. The knowledge items can include questions or learning tasks, differed by subject, theme and level. Each question has a name and is stored in an "item folder".

Step two is creating bundles of questions. Each bundle includes knowledge items of the same subject. The knowledge items collected in a bundle could have been written by the teacher himself or taken from a list of knowledge items in the same subject-matter that other teachers have composed. The bundles are designed to help teachers organize their contents by subject, academic level, classes and so on. Each bundle is given a name and stored in a "bundles folder".

Step three is generating assignments for the students. The assignments can be quizzes or self-tests and include different bundles of the same subject or class. Teachers can create assignments using bundles of knowledge items that can be used repeatedly in different assignments. Teachers can configure the assignments in various ways: determine the exact time and data of the beginning and ending of the assignment; add opening and closing texts; select the number of items per page and more. While items and bundles can be re-used and shared, assignments are usually defined and used only once.

5.3. Administrator authorization

Administrators are authorized to manage the users of the system. Administrators can manage users' personal details, learning group membership and authorization. New users may be added to the system manually by the administrator. The administrator can also generate a template that enables new users to register independently under selected learning groups and by this save the administrator time and work. Learning groups at the QSIA online system are arranged in a hierarchal tree, representing various and dynamic learning organizations such as universities, colleges and schools. Administrators are assigned to selected portions of the tree, and may manage the learning groups.

Administrators are authorized to manage learning disciplines which are also organized in a hierarchal tree. By determining the learning disciplines, the administrators help teachers to organize the knowledge items they have developed and conduct a quick search for new ones. Administrator may define new logs, capturing different events in the system. The events are recorded automatically with the user ID, IP, time and date. The logs may be viewed on screen or downloaded to excel.

Users may be authorized as students, teachers and administrators Fig. 4 presents QSIA's home page interface for a multi-authorized user who logged-in through all three authorization types: student, teacher and administrator. This user can carry out assignments as a student; generate items and manage a library of folders, as a teacher; and administer users, groups and disciplines.

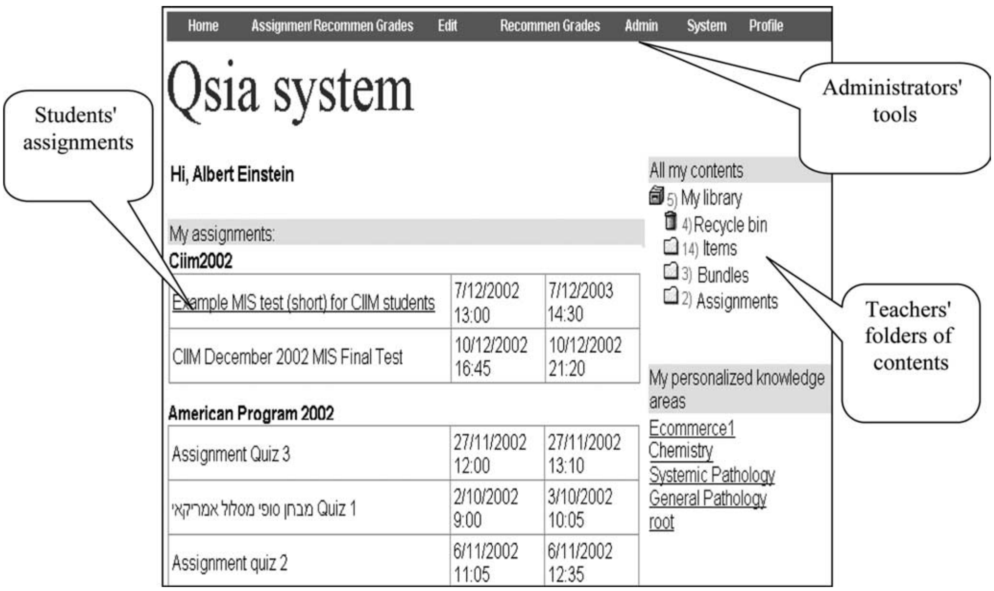

Fig. 4. QSIA's home page interface for a multi-authorized user.

6. QSIA's structural principles

QSIA's structure and functionality are based on a set of principles, determining its construction: Open strands, Flexibility, Privacy, Open source, Ease of use and Multi-community.

6.1. Open standards

The system is built around open and acceptable standards, both in the software engineering aspect and in the functionality aspect. The system is based on Java technology, using JSP as the presentation layer and object oriented Java Beans technology as the business logic layer. These foundations enable the system to operate in any standard operating system and application server environment. The relational MySQL database serves as a data repository for the system. Because of the seamless SQL support, the database could be switched easily to any SQL database.

In order to communicate with an external learning system, and in order to assimilate the system in the world of educational systems, QSIA supports the Question and Test Interoperability (QTI) specification developed by IMS Global Learning Consortium, Inc. (2003). The IMS Question and Test Interoperability Specification provides proposed standard XML language for describing questions and tests. The specification has been produced to allow the interoperability of content within assessment systems.

6.2. Flexibility

The system uses a set of design patterns enabling support for a varied set of item types. These types may include different questions such as multiple choice, matching questions and types that are yet to be defined. The system allows the installation of new question types, without making any change to the system itself. The same method is applied to grading strategies, which determine the grading each student would receive for an assignment.

6.3. Privacy

The open nature of the system obliges a strong protection of the privacy of users who do not want to share their information. The system allows users to configure the sharing level of each of their items, bundles and assignment, at the single object level or at the folder level. Users can keep the object totally private; can open it to a set of learning groups, for different roles (instructor, students) or for a set of specific users. The system ensures that no user would get access to an object, get a recommendation for an object or see an object without the appropriate permission.

6.4. Open source

The basic idea of sharing which initiated QSIA also stands behind its technology. The system is based on open source technology and contributes back to the open source community. The system uses an open source application server (Apache Tomcat), an open source database (MySQL) which are based on an open source operating system (Linux). Some of the software infrastructure built for QSIA is shared with the open source community under the GNU public license.

6.5. Ease of use

The system was designed to have an easy to use interface. The home page interface consists of four parts: a toolbar that includes all the operations the users can perform; a personal library that includes a recycle bin and folders. There are colorful icons that indicate the folders, the recycle bin, the knowledge items, the bundles, the assignments and the editing. Action buttons such as "update knowledge item" or "add file" have red colors so they can easily be detected. These icons and buttons produce an easy and accessible activity while generating an educational question or developing a learning assignment.

6.6. Multi-community

QSIA users, instructors and learners belong to a large array of educational organizations such as universities collages and high schools. The system allows organizations to manage themselves independently by generating users' templates, adding new learning groups (courses or classes) and assigning new disciplines. The QSIA has the ability to generate and facilitate life long learning and communities of practice, by allowing users to share information.

7. QSIA's system overview

QSIA is composed of several technological components. Users can access the QSIA environment by using any HTTP compliant browser. The QSIA Web server handles HTTP requests from Web browsers. Java Application Server is an application container that runs the Java components, including the scriptable Java Server Pages components. QSIA currently uses the open source Jakarta Tomcat server. Java Server Pages hold the presentation layer of the system. Java Beans hold the business logic components that determine the behavior of the system. JDBC communicates between the system and the database. MySQL, a relational database, holds the system's data including the system's content, users' logs and administrative information. Fig. 5 presents the technology components that assemble the QSIA online system.

8. A platform for educational and information systems studies

QSIA was launched in the summer of 2002. Since then it has already been implemented in several universities and high schools in different countries. During its first year of operation, more than 1000 users logged on and about 10,000 knowledge items have been developed, in 94 knowledge areas such as: Business Management, Information Systems, Psychology, Medicine, French and Chemistry. More than 100 assignments (examinations, quizzes and self-tests) were administered in QSIA. Beyond being an online system for developing knowledge items and administrating online examinations QSIA can serve also as a platform for conducting human–computer studies. As of now, several projects are carried out via QSIA for investigating collaborative learning and knowledge sharing. Three of these are described in the following paragraphs.

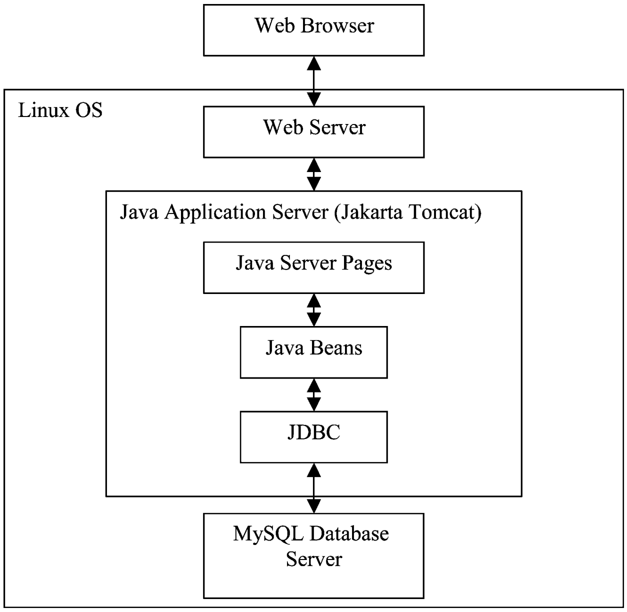

Fig. 5. The technology components that assemble the QSIA online system.

One study is conducted among faculty and teaching assistants who are using QSIA as part of their practice. Interviews were conducted to investigate the instructors' attitudes toward QSIA. Initial findings indicate positive attitudes towards integrating QSIA as part of their teaching and assessing tools. The instructors' feedback is used for making improvements so the system would meet their needs.

A second study is conducted among high school teachers participating in QSIA seminars. This study aims at characterizing in-service teachers' by their approach to learning technology and knowledge sharing. We hope to encourage leading teachers from different high schools to generate communities of practice.

The third research project is conducted among students (Barak & Rafaeli, in press). In this study, Management in Business Administration (MBA) students are required to develop and contribute knowledge items (questions) related to the contents they are being taught. In this question-posing format, students are actively engaged in generating knowledge items and contributing to the systems' database. The students are asked to review their classmates' questions and provide recommendations. This constructivist activity allows students to assimilate and internalize new learning materials. It is, too, an implementation of the sharing construct within online assessment.

The recommendation infrastructure that accompanies QSIA is significant for the research track. QSIA might produce data for answering the following intriguing research questions: How can online recommendations be done best (especially in contexts like tests that are riskier than the usual for recommendation systems)? Who are the appropriate recommenders (do students prefer recommendations from their teachers, their peers, better students, or those to whom they are closer socially)? And how do communities of practice generate (is there a network pattern that emerges among providers and recipients of recommendations)?

We hope that studies via QSIA will contribute to the growing body of knowledge on online learning environments and the use of recommender systems.

9. Barriers to online assessment

QSIA has the potential to introduce significant change in the educational process. With its power to collect and process data, QSIA can be used to mediate instructor–student interactions as well as instructor–instructor interactions. Aspects such as flexibility in time and location, in the way information is represented, and in the way students perform their assignments, provide a new educational tool for assessment and developing high-order thinking activities. On the other hand, some of the particular strengths of this tool also give rise to some affective, security and technical disadvantages.

9.1. Affective barriers

- Computer anxiety and uncertainty in using a computer, especially in a high tension situation such as an exam.
- Instructors or students who are not knowledgeable or comfortable working in a Web-based learning environment might be intimidated or confused.

9.2. Security barriers

- Concern for privacy and security issues in a central and open system.
- Reduction of instructors' control, some students might study alone while others may collaborate with fellow students.

9.3. Technical barriers

- Technology failures such as crashes of the main server and communication problems.
- Insufficient hardware available at the educational institute or at the instructor or students home.
- Generating knowledge items is a time consuming process.

10. Discussion and further investigation

The demand for educational Web-based learning and assessment tools is increasing, particularly when we consider the development of both school- and work-based learning communities (Dori et al., 2003; Gal-Ezer & Lupo, 2002; Rafaeli & Ravid, 2001). Although still in its early stages, the QSIA online assessment system already shows promise. Tests run simultaneously or in a delayed fashion, to groups of many dozens of students concurrently, are comprised of many dozens of items, and of a variety of item-types. The efficiency gains, cooperation potential and positive feedback from the instructors and students who use QSIA and the growing demand for Web-based educational assessment tools suggest the significance of developing such a tool.

Powerful online learning environments have evolved over the past few years for supporting quality learning and communication activities among learners. Systems such as WebCT (Clark, 2002); Blackboard (Yi & Hwang, 2003) and Stellar (Stellar, 2003) are platforms for facilitating course management in different institutes. These systems provides an easy way for instructors to organize class materials for students, handle homework assignments and engage students in discussion using the Web. QSIA on the other hand was designed to reach out and across institutes for promoting collaboration among instructors and knowledge sharing. QSIA has a smaller granularity focus on knowledge items and a process emphasis on sharing across instructors. In fact, in several locations QSIA is integrated into such course-oriented Web-based platforms, serving together different aspects of the same course.

Sudweeks and Rafaeli (1996) discussed the characteristics of CMC. They claim that strangers are able to work together apart. Likewise, QSIA serves as an online platform for instructors to work "together apart" by sharing their knowledge. We propose that QSIA provides instructors with important opportunities to share "craft wisdom" and a professional culture. Web-based knowledge sharing system, which allows instructors and students to exchange information and evaluate peers work, can enhance better teaching and learning (McDonald, 2002).

Future research tied to QSIA and the online sharing of assessment items and tools will follow three tracks: pedagogical, recommendation oriented and studies of communities of practice. First, there are pedagogical implications of large-scale repositories of items, available online alongside classifying and prioritizing data. Education oriented research into the opportunities, advantages and problems of online Web-based testing and construction of shared repositories is already dipping into the data collected by QSIA. The recommendation infrastructure that accompanies QSIA is the target of our second research track. How can online recommendations be done best? Who are the appropriate recommenders? What needs to be done in constructing the recommendation algorithm to improve the use and acceptance of recommendations? Finally, the success of systems and communities of practice like QSIA depends on a deeper understanding of the process, motivations and rewards in sharing information. What are the system-based incentives for people to contribute? How can the design of the item repository and the recommendation engine improve the tendency to contribute?

We believe that the study of these important questions will promote the growing body of knowledge on Web-based environments for learning, assessing and knowledge sharing.

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