

# Impersonation Challenges Associated With E-Assessment of University Students

Jewel Wambui Gathuri    Anthony Luvanda    Samwel Matende    Mr. Sammy Kamundi

Faculty of Information Technology, Kisii University P.O Box 408-40200 Kisii Kenya

\* E-mail of the corresponding author: [jewelwambo@gmail.com](mailto:jewelwambo@gmail.com)

## ABSTRACT

Online examination (E-assessment) is an increasingly important component of online courses, and student authentication is widely seen as one of the major concerns for online examinations. Due to the inherent anonymity of being online, compared to taking an examination in a classroom environment, students may attempt to artificially boost their scores in online examination. This may occur by having another individual take the exam for them, which a typical user/password authentication scheme cannot detect. This research aims to investigate authentication challenges to online examinations, review benefits, constraints of existing authentication traits, and discuss alternative techniques. This will lead to the use of a profile based authentication framework (PBAF) together with user-id and password for the authentication of students during online examinations. The proposed –solution will utilize profile based challenge questions, user-id and password, which will be verified by development of PBAF in a virtual learning environment. The sample size will be obtained from a group of E-learning University students. Descriptive method of research will be used in order to develop better understanding of finding out what is happening, to seek new insight, to ask questions and to assess phenomena in a new light with the use of questionnaires. Data will be analyzed through descriptive statistics where graphs, pie charts, frequency distribution tables and histograms will be used, factor analysis will be employed. Statistical Package for the Social Sciences (SPSS) will also be used as software to analyze data. As a result of this research e-assessment will be deemed more secure in terms of the authentication process.

**Key Words:** Authentication, E-Learning, E-Assessment, Impersonation

## 1.0 Introduction

In today's world, learning capability is judged by means of examinations. Thus, the need of exams today in universities, schools, colleges and even companies for recruitment purposes. The general paper-pen tests/exams are now slowly being replaced by the online internet based testing system. The growth of Internet has largely changed teaching and learning from a conventional class room into an invaluable educational resource accessible remotely from disperse geographical locations, beyond physical boundaries. The online learning environments are likely to be accessible, available, updatable, re-source efficient, usable, economical (Ruiz **et al.**2006) and have been widely adopted by a number of educational institutions in various disciplines.

The Traditional way of examination process used in learning is based on textbooks and face-to-face lectures. Traditional environment can be a physical location (institution) that consists of three elements; lecturers, students, and databases as shown in Figure 1.1. (Kritzinger & Solms, 2006). These elements are grouped in a closed environment such that security threats are minimal. In the optimal case, one can neither attend lectures nor sit for exams on behalf of another, since all students should present their IDs and the proctor is the tutor hence is believed to know the students. Hence this eliminates the chances of impersonation.

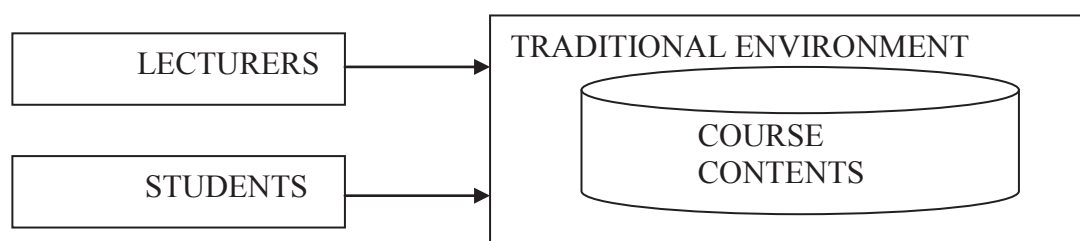


Figure 1.1 Traditional education environment (source: E. Kritzinger, 2006)

Security of online examination is vital to the success of E-learning. Student authentication in online examination has been an active research area and a number of authentication procedures have been evolved over time to ensure secure authentication. Online examinations are reported to be more vulnerable to academic dishonesty and authentication attacks due to lack of physical interaction (Harmon et al.2010).Recent studies indicate that unethical conduct have intensified in online learning due to un-controlled environment for cheating in the online examinations as a result of use of technology and the Internet.

The main advantage of online examination is that it can be conducted for remote candidates and evaluation of answers can be fully automated for questions and other essay type questions can be evaluated manually or through auto-mated system, depending on the nature of the questions and the requirements. Online examinations can be conducted at any time and does not incur higher cost as traditional exam (El-Ghareeb, 2009).

Reliable assessment methods are essential for grading and certifying students and as a basis for selecting appropriate methods and materials. As information and communication technology (ICT) continues to develop, online assessment (e-assessment) offers particular promise for the evaluation of students at a distance. It has also become a topic of discussion that has brought about difference among educationists, for it presents specific problems in relation to academic, social, administrative, technological, and moral issues (Race, 2000).In the flexible context required of open and distance learning, the challenge of reliable student assessment poses significant problems. Fairness to the student, objective testing of knowledge, the capacity of students to respond in electronic mode, and the possibility of online impersonation and cheating, are significant challenges for e-assessment research and practice.

Many researchers have considered the effects of assessment in the curriculum. Barnes (2000) has shown direct causal links between changes in assessment method and classroom practice. Klein **et al.**(2000) indicate that changes in measurement criteria can dramatically, even falsely skew the outcomes of assessment procedures, while (Black & William,2002) have shown that well-designed formative assessment can be associated with major gains in student attainment on a wide range of conventional measures. A major literature review commissioned by the (EPPI Centre, 2002) showed that regular summative assessment can have a negative effect on the performance of low-attaining students, but does little harm to high-attaining students.

In other words, without a reliable mechanism, assessment may not achieve the effects planned and expected by faculty members and institutions. It is therefore important to develop high-quality measurement procedures which ensure the sanctity of the evaluation process. The assessment should reflect core educational goals and achievable rewards for the students (and teachers) which will be of long-term benefit to them and to the global society in which they are expected to work (Ridgway **et al.**2004). As with any approach, it is important to align teaching and learning activities and assessment tasks, particularly where the intention is to encourage deep, rather than superficial approaches. Efficient feedback and interaction between designers, deliverers and assessors of learning outcomes produces a mechanism for continuous improvement.

A profile based authentication technique together with a timing mechanism is proposed to be used in addition to user-id and password technique. There is a lack of enough research about profile based authentication techniques in handling impersonation.

Most of educational institutions have entered the e-learning era within the last decade. They aim at supporting education with modern learning and teaching tools. Therefore E-learning systems as emerging technologies suffer from some limitations, as follows (Sabbah, 2010).These institutions are still reluctant to integrate online examinations as the security implications are difficult and hence turn out expensive in terms of cost. For example biometric authentication needs the acquiring of the finger print scanners for various computers which in the long run is expensive. On the other hand video monitoring requires cameras and large storage of the recordings. As a result they opt to have the e-learning but the exams are done in a classroom setting.

This study suggests in cooperation of a profile based authentication framework with the help of timing mechanism in the authentication process of e-assessment. This framework has minimal costs as no extra hardware is procured by the institutions.

## **2.0 Various approaches of Assessment**

Electronic assessment is presented as an alternative to traditional assessments where the assessment task is delivered and displayed on a computer screen via the internet. A formal definition refers to e-assessment as the

use of ICT for the presentation of assessment activity and the recording of responses (JISC, 2006). Thus, in order to provide an alignment between the teaching, learning and assessment processes, it is essential to employ the use of ICT in assessment (Gipps, 2003). Additionally, Brown *et al.* (1996) suggests that due to paradigm shift in educational technology, it may become unfair to train students online and then use pens for assessments. Adopting electronic assessments in a higher education environment embodies enormous benefits such as, automatic marking, immediate feedback to students, opportunities for lifelong learning and improved access for disabilities or geographically dispersed students. The three types of assessment which may be employed for assessing include: formative, summative and diagnostic assessment.

### **2.0.1 Formative Assessment**

Early work in formative assessment is attributed to leading theorists in education (Black & Wiliam, 2002). Formative implies a process or product which is capable of developing or shaping. Formative assessment is influenced by the need to provide information to students, in a manner that will contribute to the use of their acquired skills. Thus, the aim of formative assessment is to help students' learn something (Rosbottom, 1997). As described by Morgan & O'reilly (1999) traditional formative assessment has commonly taken the form of:

- i. Non-assessable activities and feedback in study materials
- ii. Self-assessment quizzes and tests that help students monitor their own progress
- iii. Feedback from assignments, or from peers, colleagues or mentors
- iv. Dialogue with teachers, tutors and other students
- v. Non-assessable tests that prepare students for formal examinations

Formative assessment takes place while a class is ongoing and it continuously monitors student progress rather than at the endpoint. This type of assessment provides a short term feedback loop which offers insight into the student's strengths and their conceptual errors (Earl, 2003). Thus, the students are presented with opportunities to improve. In another view, Sadler (1989) describes formative assessment as the means to identify the "gap" between a student's current understanding and the desired goal. Hattie & Timperley (2007) suggest that different students will have different "gaps" and the lecturers should design strategies to identify and close these gaps.

### **2.0.2 Summative Assessment**

Summative assessments are administered to record or report an estimate of the student's achievements (Morgan & O'reilly, 1999). Summative assessments are also called high-stakes assessments when used for promotion, placement, certification, and accountability (Rovai, 2000). Thus, reliability is central to summative assessments; since the results may have an enormous impact on students' academic future. For summative purposes, achievement is generally summarized in terms of grades, which aids in the comparison and classification between students. However, summative assessment should be viewed in terms of accountability rather than as a means of classifying students. Therefore, when summative assessments are focused on grading or classification, students are likely to do their best to obtain good marks and look competent in comparison with their peers (Cowie, 2005). In conclusion, the goal of a summative assessment is to provide overall information on the amount and quality of the student learning.

### **2.0.3 Diagnostic Assessment**

Diagnostic assessment has been associated as a testing carried out by educational psychologists for students with learning difficulties. However, in modern education it is used to identify a student's strengths and weakness or prior knowledge and skills in relation to a course program (JISC, 2006). Diagnostic assessment sits between summative and formative assessments and it can be used to diagnose a student's ability at the beginning of a course (Boston, 2002). In formative assessment, an initial diagnosis aids in making decisions about a student's skills whilst as a summative test it serves as a basis for making a decision about a student's suitability for entry to a course (Ecclestone, 1996). Traditionally, diagnostic assessment may take the form of a one-to-one session with a career counsellor; however, in an online mode computerized diagnostic tools replace the physical advisor (kutty *et al.* 2003). The diagnosis may present the lecturer with an overview of the students' ability, which may influence their teaching strategies.

For example, in a work environment, a job applicant may be required to undergo a diagnostic test in order to determine the individual's competency for a job and the extra skills that may be needed. Hence, it is futile for a student to cheat during diagnostic assessments; since the test is aimed at identifying strengths and weakness to aid intellectual growth. Thus, the students' who cheat during a diagnostic assessment may pass the test, feigning competency in the subject area. However, due to the lack of appropriate knowledge, the fraudulent students may have to continue cheating till the end of the course. Therefore, it is important to ensure adequate security during diagnostic assessments to avoid security breaches during high-stake assessments.

Hence in my research summative assessment will be used the mode of examination in cooperated in the profile based authentication framework.

## 2.1 Authentication Schemes

E-Assessment authentication approaches have been categorized into five main schemes, as follows:-

**Proctored-only:** considers traditional in-classroom proctoring the most efficient method. It requires a proctor to monitor the exam-takers during their examinations. Invigilation is the act supervising, monitoring or watching students during a test. In online environments, (Weippl, 2005) amongst others advocate for the use of human invigilators as a good low-technology means of promoting both identity and academic honesty. According to Harrison( 2004), impersonation of one student by another is thought to be unlikely when a test is taken under the eye of an invigilator. Hence, adopting an invigilated test environment is the obvious solution to ensure the correctness of a student taking an online test. Although it is prone to type A threat.

**Uni-modal Biometrics:** These unimodal biometric solutions are commonplace during student login; hence, they are better suited to solve a Type B impersonation threat. Employing unimodal biometric methods to solve a Type C impersonation threat is not practically trivial, as the random authentication of the student will be required for the duration of the test. The random authentication of a student is one feasible approach to solving the Type C impersonation threat; however, it can be perceived as a means of distraction during the test (Levy & Ramim, 2009).

**Bimodal Biometrics:** In their model, the use of the fingerprint scanner statically authenticated a user. Suitable to solve the Type B impersonation threat however, minimizing the Type C threat using the mouse dynamics is unclear. Ahmed & Traore (2007) asserts that, the data capturing process for mouse biometrics requires some considerably time to accomplish. Hence, for an online test the student is delayed until the data acquisition process is completed; this presents a window to perpetrate a Type C impersonation.

**Video Monitoring:** Thus, Ko & Cheng (2004) propose a secure internet examination system based on random video monitoring. A username and password mechanism is adopted which makes the system susceptible to a Type B impersonation threat. Employing video monitoring, suggests that an invigilator/tutor is required to watch the students taking the test live or view the streaming video at any time. In the first option the invigilator /tutor is obligated to seat at the screen for the duration of the test in order to pick out any unusual activity. A disadvantage is that an invigilator may look away or get distracted whilst watching the screen. The second option depicts a more realistic approach to adopting video monitoring in online tests. Thus, a suspicious grade may imply a suspicious identity; hence, the video footage is retrieved. However, watching a set of video sequences to extract anomalous behaviour may become an extra administrative task.

**Biometrics and Webcam Monitoring:** Hernandez **et al.**(2008) an authenticated student is monitored at the beginning of a test whilst the test is terminated when another person is in control. Employing fingerprint recognition is suitable to solve the Type B impersonation threat; however, the use of a webcam to provide dynamic authentication or to control student identity is unclear. Additionally, the security of the suggested model breaks when the student turns the view of the webcam to another.

## 2.2 Drawbacks of Authentication Methods in E-Assessment

Although some of the mentioned authentication approaches are highly reliable, they all have drawbacks when used in summative e-assessment, i.e. e-examination. In addition to the described drawbacks, biometrics approaches are still vulnerable to several risks (Alotaibi, 2010).

Knowledge factors

- i. If the password is freely given away, the password security policy will be cancelled even if strong enough.
- ii. Requested once at login; never trusted for continuous authentication during e-examination.

Ownership factors

- i. If the token is passed to others, the scheme is circumvented.
- ii. Requested once at login; cannot be trusted for continuous authentication throughout e-examination.

Inherence factors

- i. More reliable. But requires special-purpose hardware.
- ii. Unreasonably intrusive, expensive and difficult to implement.
- iii. Not fully trusted, although some approaches repeat authentication continuously throughout e-examination.

- iv. Never trusted in case of getting assistance from others.

### **2.3 Impersonation Threats on User Security**

In e-assessments, the issue of impersonation is considered as a major cause of concern and it is perceived as an even greater risk by the academic community (Kerka, 2000). Weippl (2005) assert that students who want to cheat willingly reveal their login details to another person for the purpose of impersonation. According to Stoner (1996) a student cannot 'accidentally' impersonate another during an online assessment. In traditional (pen and paper) exams, the need to correctly identify a student is well understood and the requirement is to produce a student ID card which includes a photograph. The traditional approach of using a photo ID card and matching it with a student's login details in online environments is generally adopted (Vollans, 2008). This approach provides an added security layer, whereby a human invigilator ensures the correctness of the student taking the test. Based on existing literature, (Wisher et al. 2005) there exists an implicit consideration of impersonation threats in summative e-assessments. In this section the impersonation threats are classified into three types, namely Type A, B and C.

#### **2.3.1 Type A Impersonation Threat**

A connived impersonation is the ability of an invigilator to collude with fraudulent students to allow the fraudulent act. For example, if a student has continually failed a certain test, the tutor/invigilator may respond to human emotions and allow another student to take the online test on behalf of the initial student. This type of impersonation can easily go undetected. A successful connived impersonation reduces the 'equal opportunity' or 'fairness' requirement for all students (Heinrich et al., 2009) and it hinders the integrity of the test.

In addition, there is a possibility of a connived impersonation for monetary purposes. In this situation, the fraudulent students can influence the invigilator to receiving a large sum of money to help perpetrate the act. Irrespective of the motives for a connived impersonation, it is essential to find methods to minimize such threats in a summative E-assessment system.

#### **2.3.2 Type B Impersonation Threat**

This impersonation threat poses the question "is the student really who they say they are?" Impersonation threat occurs when the real student pass his security information to a fraudulent, who use them to answer the exam. Username-Password pairs, for instance, fall in this type. However, strength of authentication method and existence of administrator might reduce this threat. However, the repeated authentication is performed based on the password cached in the browser (Levy et al. 2007). Hence; a method which would increase the difficulty of responses solicited by the security system is required.

#### **2.3.3. Type C Impersonation Threat**

Impersonation threat occurs when the real student just login, letting a fraudulent to continue the exam on his behalf. Non-shareable attributes using biometrics approaches, such as fingerprint authentication fall in this greater security-challenging threat. In an attempt to address this issue, this research shows that E-assessment does not satisfy identity and authentication security goals. Much more is required to ensure that the authenticated student is the expected student and that the correctly authenticated student is taking the online test un-assisted for the duration of the test time. Thus, there is a need for an improved E-assessment system which is sufficient to ensure that only the correct students take an online test for the allocated duration of the test.

### **2.4 Profile Based Authentication**

Profile Based Authentication Framework (PBAF) uses multi modal authentication approach to secure online examination. It comprises of two layers of authentication i.e. user-id and password, and challenge questions. Initially user-id and password can be used to login into the online learning environment to carry out regular learning activities. During the learning process, students are posed profile questions that are used to extend and refine individual student profile. When a student requests to access online examination, the second layer of authentication triggers challenge questions generated from students profile. Profiles questions are used to collect answers in order to built and update student profile. Challenge questions are used to verify student identity.

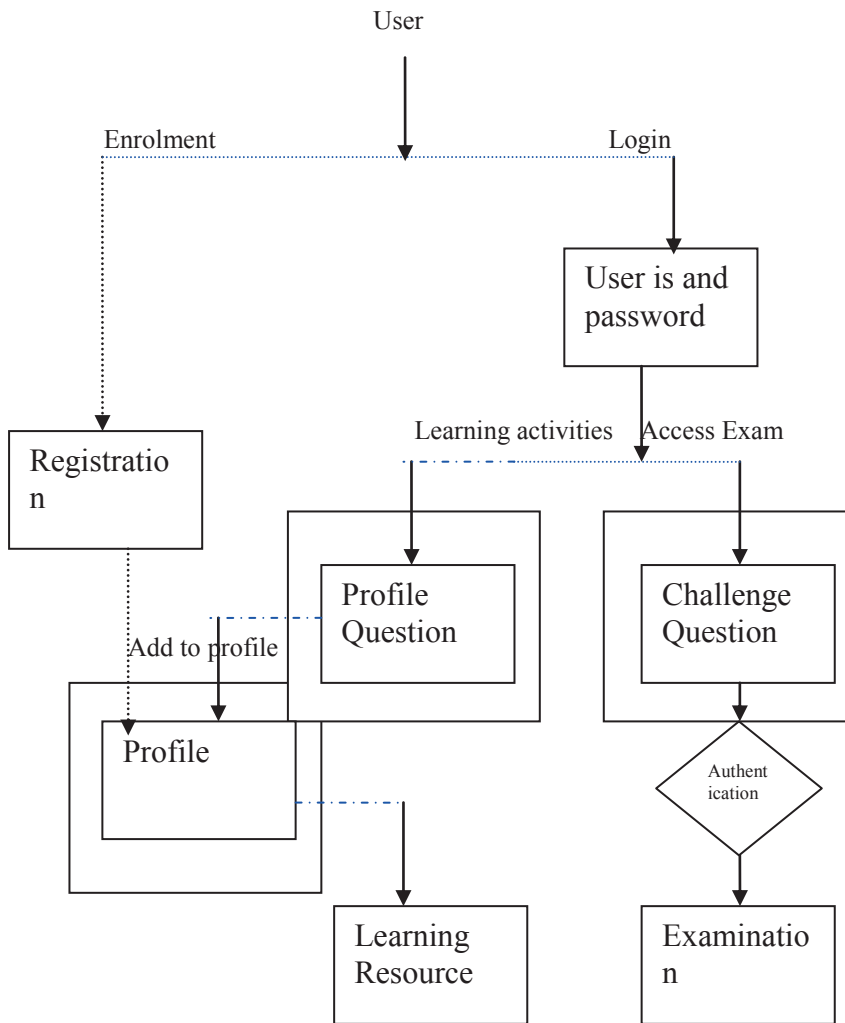


Fig 2.1 Profile Based Authentication Framework (Source:Ullah et al. 2012)

**Key**

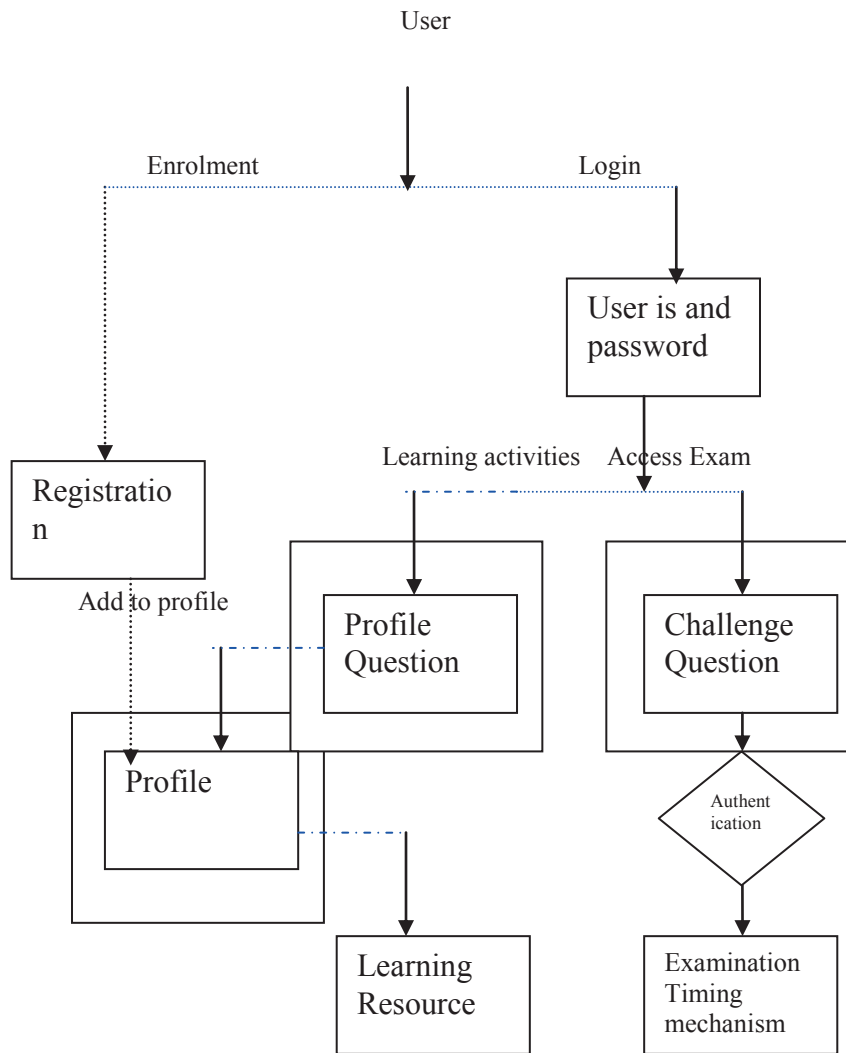
Registration process ..... (dotted line)

Learning Process - - - - - (dashed line)

Assessment Process \_\_\_\_\_ (solid line)

PBAF 





**Fig 2.2 Proposed Profile Based Authentication Framework**

**Key**

Registration process ..... (dotted line)

Learning Process - - - - - (dashed line)

Assessment Process \_\_\_\_\_ (solid line)

PBAF 

## Conclusion

The popularity and growth of online learning has also led to an increased concern about security of online examinations. The threats to online examinations can have a detrimental impact on the credibility of online learning courses that make extensive use of online examinations. Conventional approaches to student authentication are unlikely to be sufficient to counter collusion and malicious attacks to online examinations. This proposal reviewed various authentications traits, their feasibility in the online learning environments, and their strengths to deal with collusion and malicious attacks.

This research proposes PBAF which will use a timing mechanism that locks out students after a predetermined period of time and the findings from the empirical study reported here suggest, that challenge questions based authentication can be an effective technique, if the questions are designed effectively to meet both the usability and security challenges. The collections of answers to profile questions are performed during the learning process hence the student response time, anticipated length of answer, difficulty and clarity of questions shall be considered in the questions design.

## REFERENCES

- Ahmed AAE, Traore (2007) 'A new Biometric Technology based on Mouse Dynamics', IEEE Transactions on Dependable and Secure computing 4(3), pp 165–179.
- Alotaibi, S (2010). "Using biometrics authentication via fingerprint recognition in e-exams in e-learning environment", The 4th Saudi International Conference, The University of Manchester, UK.
- Barnes M., Clarke, D. & Stephens, W. (2000) Assessment as the engine of systemic reform. *Journal of Curriculum Studies* 32 (5), pp. 623-650.
- .Black, P, D. Wiliam (2002). Inside the Black Box. Raising standards through Classroom assessment. *Phi Delta Kappan*. 80(2), pp. 139-148.
- Boston. (2002). The concept of formative assessment. *Practical Assessment research & Evaluation*, 8(9).
- Brown, S, Race, P, &Smith B. (1996). 500 Tips on Assessment, London: Kogan Page. (1996).
- Cooper, D.R., & Schindler, P.S., (2003), *Business Research Methods* 8th edition, McGraw-Hill Companies, Inc. 85
- Cowie. (2005). Pupil commentary on assessment for learning. *Curriculum Journal* 16(2), pp. 137-151.
- Earl. (2003). *Assessment as Learning: Using Classroom Assessment to Maximise Student learning*. Thousand-Oaks, CA: Corwin Press.
- Ecclestone. (1996). How to assess the vocational curriculum, London: RoutledgeElton, L. (2002) *Good assessment practice*.
- El-Ghareeb. (2009). "e-Learning and Management Information Systems, Universities Need Both", *e-Learn Magazine*, September 2009.
- EPPI. (2002). *A systematic Review of the Impact of Summative Assessment and Tests on Students' Motivation for Learning*. University of London: Evidence for Policy & Practice Information & Coordinating Centre
- Gipps G & C. Simpson. (2003). How assessment influences student learning; A Conceptual overview.
- Harrison, G. (2004). Computer-based Assessment Strategies in the Teaching of Databases at hours Degree Level 1'. H. Williams and L. MacKinnon (Eds.): *BNCOD2004, LNCS 3112*, pp. 257–264, 2004, Springer-Verlag Berlin Heidelberg 2004.
- Harmon O. R., Lambrinos J., Buffolino J."Assessment design and cheating risk in onlineinstruction." *Online Journal of Distance Learning Administration*. 2010; 13(3).
- Hattie, T. J. & H. Timperley (2007) the power of feedback. *Review of Educational Research*, 77(1): 81-112.
- Hayes B., Ringwood J., editors. *Authenticating student work in an e-learning programme via speaker recognition*. 3rd International Conference on Signals, Circuits and Systems (SCS) 2009: IEEE.
- Heinrich, , E., Milne, J., & Moore, M. (2009). 'An Investigation into E-Tool Use for Formative Assignment Assessment – Status and Recommendations'.
- Hernandez. J.A., Ortiz, A.O., Andaverde, J.& Burlak, G. (2008). 'Biometrics in Online Assessments: A Study Case in High School Students'.
- JISC. (2006). *Joint Information Systems Committee (2007) Effective Practice with E-Assessment*.
- Klein. S., Hamilton, L., McCaffrey, D. & Stecher, B. (2000). What do test scores in Texas tell us? *Education Policy Analysis Archives* 8 (49)



- Ko. C. C., Cheng, C. D. (2004). 'Secure Internet Examination System Based on Video Monitoring'. *Internet research* 14(1): pp. 48–61.
- Kritzinger. E. & von Solms, S. H. (2006). "E-learning: Incorporating Information Security Governance", *Informing Science: International Journal of an Emerging Trans discipline*, vol. 3, pp. 319-325.
- Kutty. K. Schapira, R&van Ruiswyk, J. (2003). *Kochar's Concise Textbook of Medicine*, 4th edition, Baltimore, MD: Lippincott Williams & Wilkins.
- Levy, Y., Ramim, M. (2007) 'A Theoretical Approach for Biometrics Authentication of E-Exams', *Chais Conference on Instructional Technologies Research*, the Open University of Israel, Banana, Israel.
- Levy, Y., Ramim, M. (2009) 'Initial Development of a Learners' Ratified Acceptance of Multibiometrics Intentions Model (RAMIM)', *Interdisciplinary Journal of E-learning and Learning Objects (IJELLO)*.
- Morgan. C. and O'reilly, M. (1999). *Assessing Open and Distance Learners*. London: Routledge.
- Race, S (2000). *Assessment: A guide for students*. LTSN Generic Centre Assessment Series No 4. York: LTSN.
- Rosbottom. (1997). *Computer managed, open question, open book assessment* pp. 100-102.
- Rosbottom.J, (1997). *Computer managed, open question, open book assessment* pp. 100-102
- Rovai , A. P.. (2000). *Online and traditional assessments*. *The Internet and Higher Education*. 3(3), pp. 141-151.
- Ruiz J. G., Mintzer M. J., Leipzig R. M. (2006). "The impact of e-learning in medical education", *Academic medicine*, 81(3), 207.
- Sabbah.Y, (2010) "Comprehensive Evaluation of e-Learning at Al-Quds Open University", Internal Report OLC-195/2010, Al-Quds Open University (QOU), Open Learning Center (OLC).
- Sadler. R. (1989). *Formative assessment and the design of instructional systems*. *Instructional Science*, 18 (2), pp. 119-144.
- Stoner, G. (1996). 'Implementing Learning Technology' *Learning Technology Dissemination Initiative*.
- Ullah A., Xiao H., Lilley M, (2012) "Profile Based Student Authentication in Online Examination", *InternationalConference on Information Society*.
- Vollans T. (2008). 'The Law School with two Masters?' *Web Journal of Current Legal Issues*.
- Weippl. E. R. (2005). 'In-depth tutorials: Security in e-learning', *e-Learn Magazine*.
- Wisher , R. Curnov, C., Belanich, J. (2005). 'Verifying the Learner in distance learning'.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:  
<http://www.iiste.org>

## CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

**Prospective authors of journals can find the submission instruction on the following page:** <http://www.iiste.org/journals/> All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

## MORE RESOURCES

Book publication information: <http://www.iiste.org/book/>

## IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digital Library, NewJour, Google Scholar

