Electronic Educational Markets from a Total Quality Management perspective

Lampros K Stergioulas [1], Bernd J. Simon[2], Hassan Ahmed[3] and Costas S Xydeas[4]

Abstract ¾ *The concept of an "open" brokerage system for electronic learning resources between institutions of higher education - a so-called electronic educational market - is introduced and its value and feasibility are demonstrated within the paradigm of the EducaNext portal. "Open" in this context means that the brokerage system can deal with highly heterogeneous learning resources, ranging from asynchronous educational material (e.g. case studies, lecture notes, exercises, online tutorials) to educational activities, such as computer-mediated lectures and courses. The main aim of such an endeavour is to develop and validate a scalable exchange model, which embraces offers, enquires, booking and controlled delivery of learning resources. The key innovation is to create and manage an open electronic educational market with a standard way of describing the pedagogical, administrative and technical characteristics of learning resources. Electronic educational markets enable institutions to enrich their curricula with remotely sourced material. The emphasis here is placed on the quality management of electronic educational markets. New theoretical analysis leads to an integrated evaluation concept, which includes:*

• *A reference model of "on-line" evaluation mechanisms aimed to (a) provide the user with useful, up-to-date information on available learning resources and (b) provide a quality assurance dimension to the brokerage service. Evaluation results are fed back to the brokerage system to improve the transparency of the marketplace.*

• *A reference model of "on-line" evaluation mechanisms for platform performance and quality of service, and the use of such mechanisms to continuously monitor and improve the brokerage service. More specifically, these mechanisms will evaluate the performance/effectiveness of the brokerage system in terms of (a) Technical Assessment, (b) Functionality, (c) User satisfaction, and (d) Usability/Usage for the benefit of consumers, providers and brokerage platform administrators.*

Index Terms ¾ *Educational Brokerage, Quality Management, On-line evaluation, Electronic Learning Resources.*

1. INTRODUCTION

This paper aims to demonstrate the value and feasibility of an open exchange of learning resources between higher education institutions across Europe. As part of the large-scale European project UNIVERSAL, the work focuses on the design, implementation and evaluation of a brokerage exchange supported by the Universal Brokerage Platform (UBP) [1, 7], allowing offers, enquiries, booking and actual delivery of learning resources (LRs). The aim of the *EducaNext* service, which is based on the UBP, is to develop and validate a model and standards that could later expand, so as to embrace other groups of higher education institutions and that could be transplanted into the market for training in industry, commerce and government.

The key innovation is to create and manage an open market of learning resources by employing a brokerage platform with a standard way of describing the pedagogical, administrative and technical characteristics of learning resources. The system enables institutions to enrich their curricula with remotely sourced material. It is compatible with a variety of business models pursued by different institutions, including open universities and alliances between peer institutions.

The value chain supported by *EducaNext* comprises of the following stages: learning resource provision, offer placement, advertisement, booking, and delivery (see Figure 1).
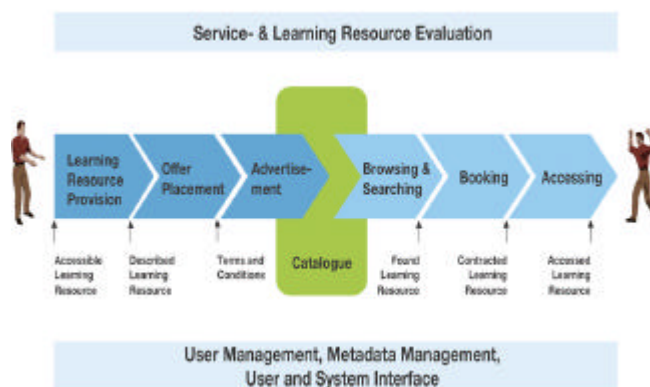

FIGURE 1: EDUCANEXT VALUE CHAIN

---

[1] Lampros K Stergioulas, Department of Communication Systems, Lancaster University, Lancaster, LA1 4YR, l.stergioulas@lancaster.ac.uk

[2] Bernd Simon, Department of Information Systems, Vienna University of Economics and Business Administration (Wirtschaftsuniversität Wien), A-1090 Vienna, Augasse 2-6, bernd.simon@wu-wien.ac.at

[3] Hassan Ahmed, Department of Communication Systems, Lancaster University, Lancaster, LA1 4YR, h.ahmed@lancaster.ac.uk

[4] Costa S Xydeas, Department of Communication Systems, Lancaster University, Lancaster, LA1 4YR, c.xydeas@lancaster.ac.uk

The provider notifies the platform of the existence of the learning resource by using the *learning resource provision functionality*. Educational material can directly be uploaded to the decentralized content repository. *Offer placement* functionality can be used to specify intellectual property rights und usage rights transferred to potential consumers. The *advertisement* stage comes next, encompassing entry of the learning resource in the *EducaNext* catalogue and/or availability of learning resource metadata to users with a matching profile via suitable notification services. If a consumer is found, booking will be carried out. The result of the agreement stage is a binding contract (*booking*). Following booking, which is considered as an agreement upon terms, the delivery phase follows. Once the formal transaction is complete, the learning resource provider actively delivers the learning resource or grants access for consumer-initiated delivery, through the *delivery management* system.

Quality management is a unique feature of the *EducaNext* portal. One of the key challenges of *EducaNext* is to manage highly complex technology and at the same time satisfy its users. For this reason, it is necessary to develop evaluation procedures that provide meaningful measurements of the performance of the brokerage system as well as of the content on offer. This evaluation includes both technological evaluation of the provided services and continuous monitoring of the customer relationship with *EducaNext*. Learning resource evaluation data helps to ensure that the quality of content remains at a high level as well as to improve the credibility of the material on offer.

Thus the evaluation process serves the following objectives:
- Tracks and ensures the successful roll out of the *EducaNext* business model;
- Provides key figures (statistics) of the *EducaNext* main activities;
- Identifies operational bottlenecks and possibilities for further improvement of the platform;
- Identifies possibilities for further improvement of LRs;
- Allows users to judge and therefore to make a better selection of LRs;
- Fosters a healthy competition among LR providers;
- Enables an objective benchmarking analysis
- Increases the credibility and objectivity of *EducaNext*.

The architecture of the *UBP* is described in Section 2. An overview of the evaluation service that provides a quality assurance dimension to the brokerage service is found in Section 3. "On-line" evaluation mechanisms for educational materials and educational activities are discussed in Section 4. Section 5 describes the development of "on-line" mechanisms for evaluating platform performance and monitoring quality of service. The use of such mechanisms in continuously monitoring and improving the brokerage service is also discussed. More specifically, these mechanisms evaluate the performance/effectiveness of the

EducaNext system in terms of Technical Assessment, Functionality, User satisfaction, and Usability/Usage for the benefit of consumers, providers and brokerage platform administrators. Finally, conclusions are presented in Section 6.

2. AN ARCHITECTURAL MODEL FOR AN OPEN EXCHANGE BROKERAGE SYSTEM

The Open Exchange of *EducaNext* consists of a brokerage platform and a number of delivery platforms (Figure 2). The brokerage platform is further divided into various engines. In our context, the term "engine" refers to an application, which provides a number of services to other applications.
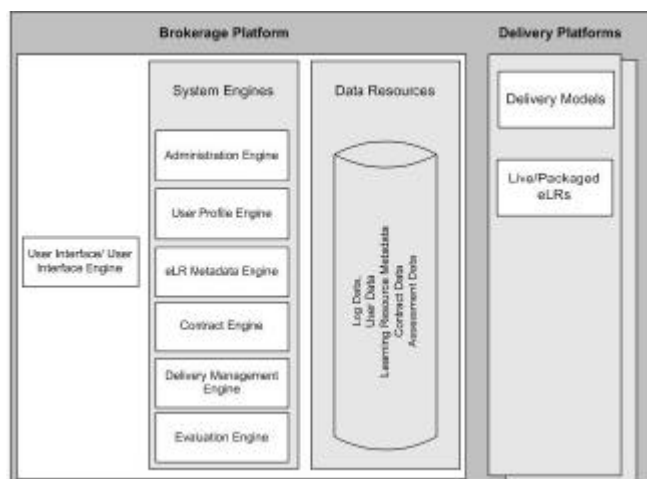

FIGURE 2: OPEN EXCHANGE MODEL

The *User Interface Engine* (UIE) is responsible for facilitating dialogue with consumers and providers. It allows users to interact with the UBP, in order to obtain or provide information. In interacting with users, UIE establishes relevant background knowledge and guides users in the selection of learning resources. Potential customers are presented with choices in terms of (a) pre-requisites and conditions attached to different types of LR (LR metadata), (b) the suitability of options (i.e. offers from different institutions on the same topic) and (c) the range of different delivery modes available for a particular LR. In the case of LR providers, the UIE is mainly used to provide feedback from the system to the content provider and handle the process of content provision to the brokerage system.

The *Administration Engine* maintains the platform's data depository and tracks activity on the system. Thus it processes records of users and transactions and makes these records available to other platform engines. General user administration tasks are also performed by the administration engine. The *User Profile Engine* is responsible for creating and maintaining users' profiles and

user authentication files. The *Contract Engine* enables formal transactions between users and platform invokes contract formulation, acceptance and billing mechanisms.

LR Metadata Engine maintains LR metadata information. Its main operational objectives are to store LR metadata information in a database, search this database and provide information in response to user UIE requests.

The *Evaluation Engine* supports quality evaluation of learning resources and UBP activities. In doing so, it is focused on the following operational objectives: (a) to collect evaluation data and (b) to provide search and analysis capability for evaluation-related and other user-originated data. This engine is discussed in more detail in Section 3.

The brokerage platform does not store LR contents; instead it offers an interface layer, which provides communication functionality between UBP and various delivery systems. This is the responsibility of the *delivery engine*, which provides authentication and authorization services, delivery negotiation and delivery supervision. Presently, the UBP provides support to the following set of delivery systems [2]:

1. Standard web server
2. Learning Management Systems, such as IMC's CLIX
3. RealNetworks Real server
4. Isabel Video Conferencing

Data related to these engines are stored in UBP's data resources, which comprise the following databases:

- User Database
- Learning Resource Metadata
- Evaluation Database
- System Log
- Booking Log

3. EVALUATION SERVICES IN THE UNIVERSAL BROKERAGE PLATFORM

Evaluation is a unique feature of the UBP and applies both to the quality of the LRs supported by the UBP and the quality of the *EducaNext* service. Within this context, the interaction between the user and the system is vital, and is supported by the UIE part of the brokerage platform. UIE operates in several modes and the UIE evaluation mode covers most (but not all) of the user-platform assessment-related interaction.

In LR evaluation, the UBP collects from users LR evaluation data, which is then stored in the LR evaluation database. This data is analyzed by the evaluation engine and is transformed into meaningful LR evaluation information, which effectively adds a unique "LR quality" dimension to the UNIVERSAL brokerage operation. The platform can respond to requests from prospective consumers and LR providers with evaluation information on specific LRs, and by doing so, users can judge the quality of LRs. This kind of

feedback from and to consumers/providers will ensure that high LR quality standards are established and maintained within the *EducaNext* Brokerage service. A similar line of thought also applies to the second evaluation activity that relates to the quality of the service of the *UBP*. Feedback from users will result in a continuously improved quality control mechanism.

4. EVALUATION OF LEARNING RESOURCES

Recently a number of articles discussed the task of evaluating web-based LRs in specific areas of learning [4, 5]. This section addresses the issues involved in the development of an "on-line" evaluation engine [3, 6], as part of the *UBP*, for the evaluation of "live", "packaged" as well as hybrid learning resources.

The LR evaluation part of the *UIE evaluation service* allows the UBP to interact with the following users:

- Learners (students – consumers)
- HEI administrators and academic staff (faculty consumers)
- LR providers

Furthermore, the user-platform dialogue, communicating already collected LR evaluation information, is supported by the UBP user interface engine. The availability or not, of collected data to UBP users in general, is subject to the provider's approval. Some providers might not want to disclose evaluation information on their LRs, and the UBP caters for this case. Any available *a priori* LR assessment-related data (such as validation by independent experts, accreditation, previous assessments, etc.) is given to the system by the provider under the *LR provision service*.

Evaluation data is collected always upon completion of an LR. In case of self-contained (independent) LRs of duration equivalent to 10 hours or longer, evaluation data is collected from both learner and tutors, whereas for LRs of shorter duration, evaluation data collection is applicable only to tutors. LRs are evaluated as independent units, irrespectively of their pedagogical use (i.e. of whether they are used as stand-alone self-contained course or as parts of a larger composite course). In addition, certain LR evaluation data is collected initially from providers as part of the process of provision of LRs to UBP.

The evaluation data collection process is initiated by the administration engine. The administration engine logs all platform usage activity, including LR delivery, and is in a position therefore to activate the LR evaluation data collection process on-line. Thus, the administration engine plays a vital, proactive role. More specifically, the administration engine (a) determines the time when evaluation data collection takes place, (b) identifies suitable questionnaires/forms from the LR Evaluation Questionnaires Database of the evaluation engine and (c) initiates action for the UIE to display selected questionnaires/forms (Figure 3).
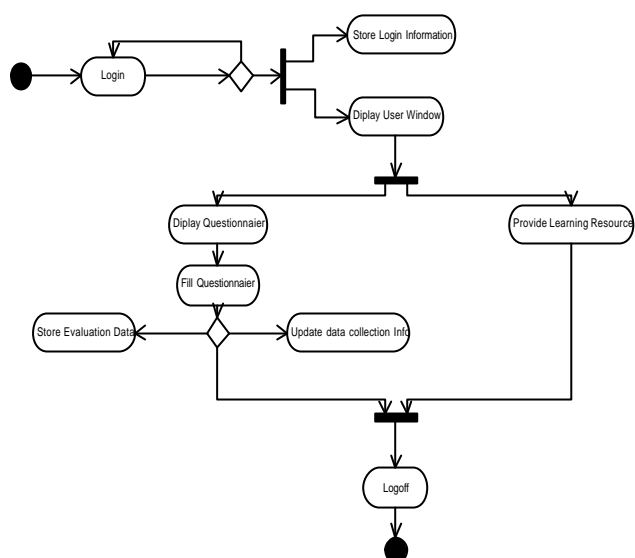
FIGURE 3: EVALUATION DATA COLLECTION

The user is then presented with the questionnaires/evaluation forms, which he/she has to fill-in interactively under UIE. On completion of the questionnaires, UIE sends this data to the LR Evaluation Database.

In cases where evaluation data collection occurs independently of LR delivery, passwords (with an expiry date) are issued by the administration engine per site and per LR delivery. Thus, students that take an LR at a particular site use the same password. However, in case of individual learners, one password per learner is issued. Both the timing of LR data collection and the type of questionnaire depend on the type of user (student/academic staff/provider) and type of learning resources.
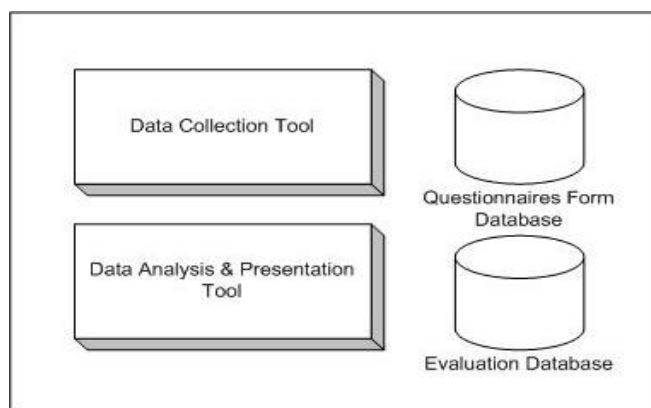

FIGURE 4: COMPONENTS OF THE EVALUATION DATABASE

The LR Evaluation Questionnaires Database (LREQD) (see Figure 4) maintains a variety of questionnaires/ evaluation forms, which cater for the different data collection scenarios. More specifically, this database stores information concerning the "application field" of each

questionnaire/form, i.e. the type of LR quality related information each questionnaire seeks to acquire. Learning resources are broadly classified into "packaged learning resources" and "live learning resources". Flexible hybrid-type (i.e. suitable for both live and packaged cases) questionnaires ensure the relevance of the required evaluation data to the specific learning resources. The questionnaires are available in both on-line (electronic web-enabled data collection, either as an integral part of the delivery process or independently following completion of delivery has taken place) and off-line (paper-based) forms, where the users are prompted to fill in sections that are relevant to the type of the LR in question.

LR evaluation data are made available to users through the UIE browsing facility. In this case, UIE activates the multi-functional Analysis and Presentation Tool of the Evaluation Engine, which enables users to view statistical summaries and user reviews, extract/process/analyse data, cross-examine more than one LRs at the same time, and finally the extracted data in a variety of forms [6].

5. EVALUATION OF THE UNIVERSAL BROKERAGE PLATFORM

Evaluation of the *UBP* is performed throughout the following UBP development stages:
1. Design
2. Implementation
3. Use

Technical Evaluation Testing
Technical evaluation tests are used to identify key problem areas as well as particular strengths of available technologies. This enables the formation of a suitable continuation strategy, which can successfully balance the current situation (weaknesses/strengths) with future development objectives.

Functionality Testing
These tests take place during the development stage and are intended to assist the developers in making adjustments and steering the development process towards a "desirable" or "acceptable" direction. The required adjustments may involve technical modifications, changes in "content" or even strategic reconsiderations. Evaluation data from these tests provide vital information about the relevance, effectiveness, suitability, performance, and user-friendliness of the UBP.

This type of evaluation may result in radical changes affecting the basic structure/design of the application and may thus play an essential, guidance role throughout the development process of UBP. These tests will terminate at the point when there is reasonable confidence that the overall desired objective is achieved.

User Satisfaction Testing

Such tests have been carried out after the development cycle of the UBP is complete, i.e. ready to be used in real-life experiments/trials. The primary objective in this case is to ensure that the UBP is adequate for the job it has been designed for. For this objective to be achieved, a sufficiently large number of users are needed. These tests mainly involve collection of user feedback data, which are then used in developing improved versions of the UBP. A positive perception will affect the success and acceptance of the UBP as well as the attitude of future users towards it.

More specifically, the user satisfaction tests aim to evaluate the effectiveness of the UBP from a user's perspective, concentrating on the following:

- Usefulness of content, such as compatibility, feasibility and accreditation of provided LRs
- Ease of use in terms of presentation, navigation, interaction and user support
- Perceived added value services.

An essential element of an effective evaluation procedure is the analysis of traffic measurement statistics from UIE and internal activity reports generated by the various engines, as well as by data collection via online surveys and questionnaires.

The integration of the UBP evaluation capability into the UBP as a dedicated platform component is necessary in order to sustain smooth and guided evolution of the platform and ensure universal adoption and viability. This task is the primary responsibility of the UBP evaluation engine, which provides the functionality to enable UBP testing in terms of the above-described criteria.

6   CONCLUSION

The *EducaNext* service aims to facilitate collaboration in terms of exchanging learning resources among higher education institutions via the *Universal Brokerage Platform.* This platform enables brokerage of learning resources between providers and consumers, by making learning resources directly available to interested parties.

We have presented the main challenges in designing and developing such a system, focusing in particular on high-level functionality issues. We have also addressed the key architectural issues as well as the strategic considerations for electronic educational markets. This novel design/architecture/functionality approach, together with innovative technical implementation using semantic web technologies, will serve as a good starting point towards future standardisation in learning resource management, brokerage and delivery, leading to better quality and interoperability.

The continuous evaluation of both learning resources and the brokerage service has also been addressed. Critical user feedback and fertile interaction between the brokerage platform and users will contribute towards improving the information resources available to consumers/providers and promoting acceptance of the overall system, as well as maintaining a high standard in terms of the quality of the educational material on offer. Continuous feedback of learning resource evaluation results, together with iterative cycles of critical assessment of the evaluation data and other available statistical information, will guarantee a high standard of quality assurance to this service.

REFERENCES

[1] UNIVERSAL project, The UNIVERSAL Exchange for Pan-European Higher Education, http://www.ist-universal.org/

[2] Guth, S., Neumann, G., and Simon, B., "UNIVERSAL - Design Spaces for Learning Media. In: Sprague, Ralph H. (ed.)" *Proceedings of the 34th Hawaii International Conference on System Sciences. Maui, USA 2001, IEEE.*

[3] Ahmed, H., Stergioulas, L.K., and Xydeas, C.S., "An adaptive, on-line, data acquisition/presentation engine for the pedagogic assessment of Learning Resources", *Proceedings of the eLund European Conference on e-Learning, Lund, Sweden*, 2001, p. 356-367.

[4] Doughty G.F., Magill J., and Turner I. (1994). Interactive Multimedia Computer Based Assessment. *Active Learning*, 1, 38.

[5] Brown M.I., Doughty G.F., Draper S.W., Henderson F.P., and McAteer E. (1996). Measuring Learning Resource Use. *Computers & Education,* 27, 103-113.

[6] Stergioulas, L.K., Ahmed, H., and Xydeas, C.S, "Adaptive Web-based Engine for the Evaluation of eLearning Resources", *IEEE Educational Technology and Society*, in print, 2001.

[7] Ahmed, H., Stergioulas, L.K., and Xydeas, C.S, "Design and Evaluation of an Open, Multimedia Brokerage Platform for Distance Learning: The UNIVERSAL Project", *Proceedings of the eLund European Conference on e-Learning, Lund, Sweden*, 2001, p. 175-184.