A Model Driven Approach for Design Flexible e-Assessment

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Abstract: Currently, there are many problems in the domain of the development of the e-Assessment process such as the difficulty to use a same e-assessment process by different e-learning platforms, the low rate of the e-assessment model reuse by various e-learning systems and the hardness to guarantee the consistency between designs and codes. Therefore, to resolve these problems, we need an approach aiming to develop a generic e-assessment process model which will be adapted automatically to any e-learning system. Hence, we propose a model driven approach for design flexible E-assessment process. We use an abstract description provided by UML activity diagram language and coupled with LTSA standards.

1 INTRODUCTION

Nowadays, universities and higher education institutes have become more and more interested to use computers to deliver their formative and summative assessments. Hence, the e-assessment plays a most important role as it constitutes an appropriate technique to gather student feedback relatively to provided course content.

However, the e-assessment strategy is not defined as a similar and a unique e-assessment strategy for different sections and departments of a given education institute. This is because each of these departments develops an e-assessment system based on its specialization and courses. Therefore, at a same university, we can have more than one e-assessment system. While the usage different systems gains recognition and acceptance amongst institutions, there are new problems arising that need to be solved. Because of multiplicity of platforms and approaches used for various systems implementation, it becomes increasingly difficult to exchange pieces of information among these systems. In fact, the variance of the e-assessment strategy has a bad influence on the e-assessment systems in the same university.

To solve such problems, we propose to develop a generic e-assessment model able to support any kind of assessment strategy.

Model Driven Architecture (MDA) (Kleppe et al., 2003) has emerged as a software engineering framework for dealing with the problem of system interoperability across different execution platforms. Then, MDA code generation mechanisms allow generating code from developed models.

Actually, many teams have committed to resolve e-learning problems by using MDA approach. Authors in (Bizonova et al., 2007) have used a Reversed MDA paradigm. Through the most popular Learning Management Systems (LMS) Moodle and OLAT, they have generated a Platform Independent Model (PIM) suitable for a general learning management system (LMS). Authors in (Bizonova and Pilatova, 2010) focusing on interoperability of two aspects of LMSs, such test question types and assessments.

In summary, these approaches provide a solution to the problem of LMS interoperability but they present many limits and disadvantages. All the suggested approaches do not follow a well defined e-learning standard. Moreover, they do not have specified the e-assessment process in their modelling activity.

In parallel, it is necessary to guarantee the interoperability across different LMSs to save development effort, time and cost. The need for interoperability of e-learning systems has been intensively treated in recent years and several new standards have been created such as SCORM (Sharable Content Object Reference Model) (Welsch, 2007) and IMS-LD and LTSA (Learning Technology Systems Architecture) (Corbiere and Choquet, 2004). However, these standards have limits concerning personalization and contextual expressiveness. In addition, most LMSs have been

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created without regard to standards and therefore cannot be considered as a part of an overall solution. But is it possible to achieve the goal of interoperability and data exchange even among LMSs that are not based on standards?

In this paper, we suggest to solve the problems mentioned above by proposing a common framework that can be used to specify and classify existing or future learning management systems (LMS). We are interested to propose a model driven approach (MDA) for e-assessment platform.

In this proposal, our objective is to give a high level of abstraction to our model by coupling the MDA and the LTSA. For the reason that, it has been observed that LTSA is too abstract to be adapted in a uniform way by LMS developers. A high level design that satisfies the IEEE LTSA standard has been proposed for future development of efficient LMS software.

In the first level of our approach, we propose a generic specification and design step for the e-assessment process based on workflow technology and learner profile adaptability.

As mentioned above, e-learning needs to be more adaptive and flexible to support any kind of learner according to his/her capability. In the e-learning process, the e-assessment plays a most important role not only to evaluate student knowledge but also to gather student feedback relatively to a learning content. An e-assessment is the fact that the learner responds to question given by the tutor to evaluate the learner knowledge. Therefore, in e-learning environment, learning and assessment processes must work together and in parallel as a complete learning process.

Consequently, we need a solid e-assessment approach to evaluate efficiently the learner knowledge in one hand, and on the other hand to allow tutor to regulate, update and improve his teaching strategy. Such e-assessment approach could not be suitable for all types of learners as they present different knowledge profiles and learning behaviours. Some of them need to be assessed on the complete learning materials to evaluate their overall knowledge. Others may only need to estimate their knowledge at a particular stage of the learning process in order to access to the suitable learning material.

Hence, we need a flexible e-assessment approach which evaluates each learner's knowledge relatively to its learning behaviour profile. To attempt this objective, we propose an approach to specify a generic e-assessment process. We use workflow technology to coordinate different tasks and to model e-assessment process. To specify this e-assessment workflow process, we use UML activity diagram language. Then, our approach is based on a workflow composition by refinement to reduce complexity. In addition, we define a set of refinement rules to adapt the e-assessment process for each learner.

The rest of the paper is structured as follows. In section 2 we present used technologies: explain the benefits of MDA- based instructional design, especially when compared to design based on Technology Learning Standards. Section 3 discusses scientific work related and presents MDA approach. We end with a conclusion and an overview of future possibilities.

2 USED TECHNOLOGIE

2.1 A Model Driven Architecture

Model-driven architecture (MDA) focuses on the evolution and the integration of applications across heterogeneous middleware platforms. It provides a systematic framework using engineering methods and tools to understand, design, operate, and evolve enterprise systems. MDA promotes modelling different aspects of software systems at levels of abstraction, and exploiting interrelationships between these models. In this paper, we propose a model-driven approach to e-learning system development based on core Object Management Group (OMG) MDA standards.

Many researches on MDA in e-learning have been conducted in recent years.

Zuzana bizonova Authors in (Bizonova et al., 2007) have used a Reversed MDA paradigm. He compares platform specific models of systems and creates a platform independent model that covers common functionalities of some learning management systems. Authors in (Dehbi et al., 2013) present LMSGENERATOR, a multi-target Learning management system generator with a model-driven methodology based on MDA approach coupled with component approach. Nathalie Moreno Authors in (Moreno and Romero, 2005) present a framework model called e-MDA which is ideal for the "4+1" view model, and equivalent to the calculation of independent models (CIM) in MDA. Authors in (Wei et al., 2006) proposed a model-driven development approach for e-learning platform. He establishes the domain model (CIM) through the analysis of business logic, and then stratified n the PIM under the J2EE framework, and proposed the method of transformation from PIM to PSM layer by layer.

Aimed at the problems that have been mentioned above, we proposed a development approach which is for developing e-learning platform with MDA.

We would like to use MDA (Soley et al., 2000) principle as the background for solution of the proposed problem with LMS integration. We can compare platform independent models of different systems and create a platform independent model that covers common functionalities of all learning management systems. Our goal is to define a generalized model of LMS system consisting of features of all other LMS systems that can be mapped into it.

2.2 LTSA

The largest effort on developing Learning Technology System architecture has been carried out in the IEEE. The LTSA deals with the Learning Technology System as a whole, encompassing human resources, infrastructure and learning resources as well as their interactions.

The LTSA describes high-level system architecture and layering for learning technology systems, and identifies the objectives of human activities and computer processes and their involved categories of knowledge. These are all incorporated into the 5 layers, as presented in Figure1.

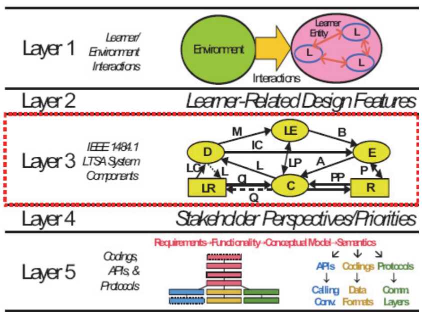

Figure 1: LTSA Layers.

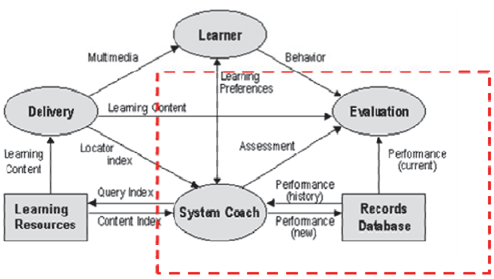

Figure 2: LTSA processes.

Concretely, the LTSA identifies four processes: learner entity, evaluation, coach, and delivery process; as shown in Figure 2.

However, the use of this standard presents certain disadvantages. Some of the functional areas not included in LTSA are identified and a brief report of the same is presented here.

a) The model does not regard the learning object designer as an integrated component in the learning process. b) The students evaluation records are stored but how to use it is not specified. c) For a distance mode learner, if the learner possess some fundamental wrong/incomplete idea and the feedback system fails to identify it, then the LTSA layer II algorithm falls under a never ending iterative cycle. d) Students counseling is not included in the LTSA architecture. Students take on courses generally by only the name of the course. Many a times they overlook the prerequisites.

Considerable attention has been focused recently on MDA (Model Driven Architecture) as an alternative solution to systems that guarantees personalization while ensuring interoperability based on software engineering standards. Our current research focuses on proposing coupling between MDA and LTSA. This coupling aims to resolve limits of LTSA standard and to improve the abstract view in our approach. Then in our work, we propose a new version learning application is totally independent of any underlying platform. Therefore, it will follow the guidelines proposed in MDA (OMG group). Models of LTSA system will be structured explicitly into Platform Independent Models (PIMs) and Platform Specific Models (PSMs).

3 THE APPROACH OF DEVELOPPING A GENERIC E-ASSESSMENT PROCESS

MDA is a way to organize and manage system architectures; it is supported by automated tools and services for both defining the models and facilitating model types. We would like to use MDA principle as the background for solution of the proposed problem with LMS integration. We can compare platform independent models of different systems and create a platform independent model that covers common functionalities of all learning management systems. Figure3 presents the three levels of model driven approach for designing and integrating flexible e-assessment process.

3.1 Development of Generic e-Assessment Process

In this section, we consider two subjects: flexible e-assessment and the use of workflow in e-learning environment.

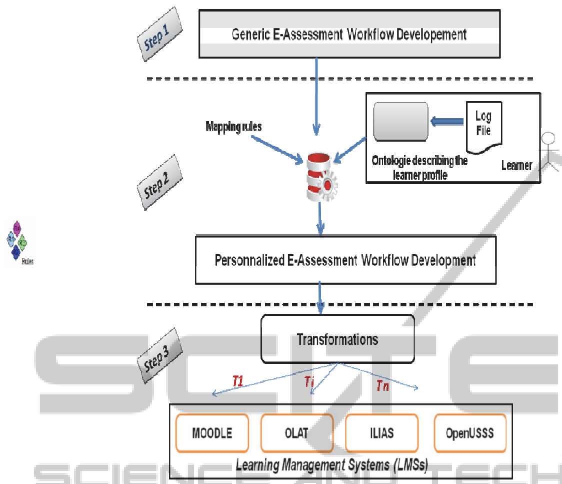

Figure 3: MDA approach.

We present in this section the development of a generic e-assessment process using the Learning Management System (LMS) (Petrina, 2004) (Aljenaa et al., 2011) and based on the Learning Technology System Architecture (LTSA) (Corbiere and Choquet, 2004) which we extend by some features required to such development. The generated e-assessment model is specified by UML activity diagram language.

The advantages of using standards in learning design have already been pointed out as Standards are generally developed for use in systems design and implementation for the purposes of ensuring interoperability, portability and reusability.

It has been observed that LTSA (LTSC, 2002) is too abstract to be adapted in a uniform way by LMS developers. The LTSA describes high-level system architecture and layering for learning technology systems, and identifies the objectives of human activities and computer processes and their involved categories of knowledge.

In our work, we are interested in Evaluation process that presents the processing of behaviour to produce assessment and performance information. But, some of the functional areas concerns e-assessment are not included in LTSA. There are identified as follow:

(a) The student's evaluation records are stored but are not useful in the system.

(b) For a distance mode learner, if the learner has some fundamental wrong/incomplete idea and the feedback system fails to identify it, then the LTSA layer II algorithm falls under a never ending iterative cycle.

To fulfil these limits, we propose in our approach to adapt the developed generic e-assessment model to the relative profile of each learner to avoid the algorithm deadlock. To define the learner profile we use the evaluation records stored in his\her log file which are not useful in the LTSA.

To build this generic e-assessment process, we are brought about following the next steps, as presented in Fig. 3:

- ***Step1:*** Analyze and study the existing LMSs functionality.
- ***Step2:*** create the generic e-assessment activities from existing LMSs e-assessment tasks.
- ***Step3:*** create the generic e-assessment process.

3.1.1 Analyse and Study the Existing LMSs Functionality

We have studied and analyzed a set of existing LMSs (Learning Management System) such as Moodle (Moodle Project), OLAT (OLAT Project) and LAMS (LAMS Project)… These LMSs provide several e-assessment tools and not a global e-assessment process. In fact, we have explored the functionalities that they offer to realize the e-assessment.

3.1.2 Create the Generic e-Assessment Activities from Existing LMSs e-Assessment Tasks

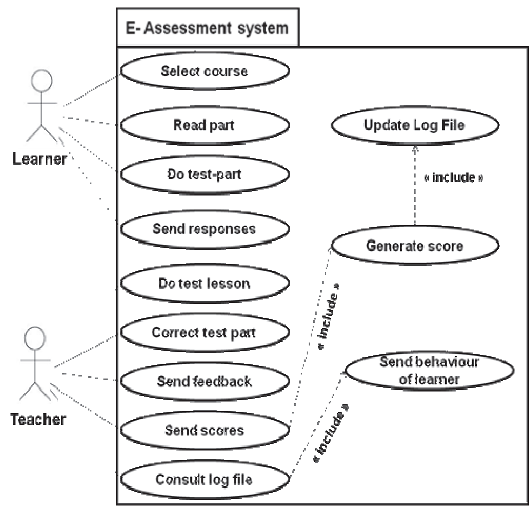

Figure 4: Generic e-Assessment process activities.

In this step we have collected the e-assessment tasks and concepts used by several LMSs to specify and define generic e-assessment activities. A typical e-learning system is represented by the following important concepts: (Student, Teacher, Course Administrator, Course, Content, Class, Goals, Test, Assignment, Assessment…). We propose a set of activities collected from the LMS specific e-assessment tasks. These e-assessment activities, corresponding to our generic e-assessment activities, are presented in a user case, as shown in Figure4.

3.1.3 Create the Generic e-Assessment Process

We have defined the e-assessment process by coordinating the generic e-assessment activities, generated from the previous step, in a workflow structure. We use workflow technology to have abstract, generic and flexible e- assessment process.

A workflow consists of a set of linked activities. It represents an abstract and global view of the work of a person or a group of persons. Therefore, with workflows, we manage, in an abstract manner, the synchronization of the e-learning and the e-assessment activities between learners and tutors.

This e-assessment workflow model should be a good communication axe between teachers, learners and the e-assessment system. Due to the lake space, we reduce our e-assessment process to a normal scenario: we try to test learner on each level of training to guarantee its comprehension and to help him to reach a high level of knowledge. In fact our e-assessment process is not independent from the e-learning process.

In our work, we are interested in the formative e-assessment because learners are more concerned in how they have performed their activities more than to compare their work to other learners. Furthermore, we are interested in the two varieties of question: objective and subjective tests. To design our e-assessment process, we are based on the learning cycle described in LTSA layer II by combining two methods of evaluation: the e-assessment part method and the e-assessment lesson method.

Our e-assessment process scenario is defined as follows:

a. The learning starts by choosing his studied course. Then, the e-learning content is composed into smaller parts to facilitate deployment and execution assignment.
b. After the reading of each part, the learner carries out a set of objective test activities. This satisfies the LTSA layer III which describes the e-learning components.
c. The e-assessment system corrects automatically these activities and gives a score according to the answers of the learner.
d. Learner passes to the following part only when he\she reaches a score determined by the teacher. This score and the interval time of the execution activities are saved into her\his file log.
e. If the result is under the score given by e-assessment system, the tutor gives additional stages for the learner to help him to overcome the crossed difficulty.
f. In fact, learners need regular feedback in order to know how their performance was evaluated, and how they can improve it, and also how their grades are computed. Thus, at the end of the lesson, tutor proposes a set of subjective questions in order to observe the complete view of what a student comprehend from the lesson. If results are under the score given by e-assessment system, the teacher would give more clarification to learner. This, feedback could be presented more frequently for the users who have started to make more mistakes, and feedback can be delayed to slow down students who are answering too quickly and sloppily.
g. After correction of activities, system affects score and updates a file log.

The above scenario is specified by the workflow modelled by UML activity diagrams and presented by Figure 5 and Figure 6.

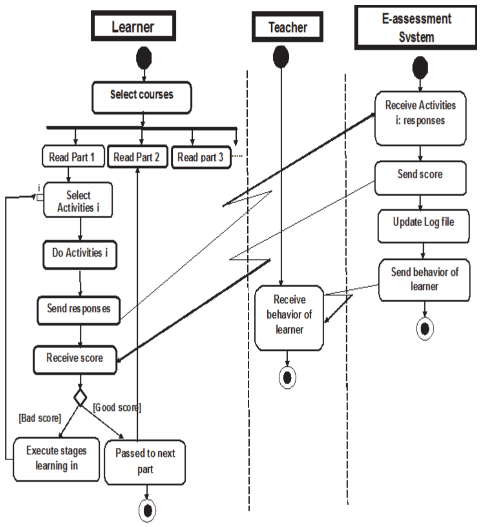

Figure 5: Part test.

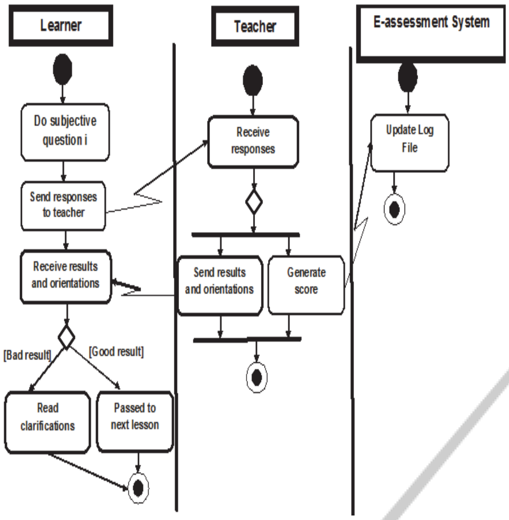

Figure 6: Lesson test.

3.2 Development of Adapted e-Assessment Process

Once the generic e-assessment process is built, it will be personalized according to a learner profile defining her\his level of knowledge. In fact, learner profiles consist of a set of attributes which describe the personal data of learners, their formal education and previous knowledge, their goals and their evaluation data. In the adaptive e-assessment process presented in this paper, learner profiles must maintain information about the knowledge of the learners on specific topics and data about their testing activities. These data will be used to adapt the evaluating and learning activity and could be also presented at the end of a testing activity in order to provide detailed descriptions of the progress of the student.

Hence, we observe the user during a learning process via her\his log file which contains the learner behaviour. We use the different information of the log file to establish and develop an ontology describing user profile. Each user profile will be an instance of the developed ontology. Using this generated log file, the tutor will define and adapt the learning and assessment material to the behaviour of the learner. If the learner's performance does not meet the pre-defined expectations, the presentation of the course content is adapted to his level of knowledge and the selection of the appropriate assessment content is then performed. Thus, each learner will be able to get a highly personalized course which will be appropriate to his level of knowledge. Therefore, the number and the kind of e-assessment activities are not similar to all kind of learners. In fact, to specify an adaptive and flexible e-assessment workflow, we propose to refine the generic e-assessment workflow by adding, deleting or editing specific e-assessment activities according to each learner profile. Based on the level of knowledge of a given learner, we define three refinement rules: add activity (***AddAC)***, delete activity (***DelAC)*** and edit activity (***EditAC)***. Applying these rules on a generic workflow, we provide an adapted e-assessment workflow relatively to the learner profile. The personalized refinement is, in fact, the solution of the exception triggered by the algorithm of the LTSA Layer II when the LMS fails to identify to which learner belongs the current assessment feedback.

Applying these functions on a generic e-assessment process, we provide an adapted e-assessment workflow relatively to the learner profile. An adaptation rules is defined as follows:

if ***Condition*** *then* ***Action***

Where *Condition* specifies a criteria choice of the adapted rule and the *Action* represents the adapting action based on the relative adaptation function.

3.3 Transformations

In this section, we define a set of rules to transform generic activities to specific LMSs activities.

In this paper, Moodle serves as an example of an open LMS. Moodle is implemented in PHP, uses a traditional Apache server and a relational database management system. Therefore the layout of the web site is not separated from the logic of the system. Table 1 is describing the mapping between our Generic e-assessment actors and Moodle actors.

Table 1: Mapping actors.

Generic e-assessment actors	Moodle e-assessment actors
Learner	Student
Teacher	Teacher
e-assessment system	Teacher, administrators
Administrators	Administrators

In the following, we present the set of the elaborated transformations. The goal of the third step is to create **mappings** between the PSM models of candidate LMSs and our generic PIM. Practically it means to create translation tables for data structures of a LMS system to the generalized system. Such relations or mapping rules can have forms of **1 to1** (*simple mapping)*, **1 to n** (*refining* mapping) or **n to 1** (abstracting mapping). The set of mapping rules is constructed by specifying the candidate LMS e-assessment activities and their correspondent of our generic e-assessment process model. The *simple mapping* case is trivial. We simply translate one activity to another one. The Table 2 shows an example of mapping the *G_SendTest* activity of Moodle LMS to *C_SendActivity* of our Generic E-assessment process.

Table 2: Simple mapping.

General PIM activity G_activity	**PSM Candidate activity** Moodle C_activity
C_SendTest	G_ SendActivity

There can also be a complex value consisting of many activities that need to be combined. See an example of **1 to n** on the Table 3.

Table 3: Refining mapping.

General PIM activity G_activity	**PSM Candidate activity** C_activity i + C_activity j

We can also describe a candidate activity by a set of general activities. See an example of **1 to n** on the Table 4.

Table 4: Abstracting mapping.

General PIM activity **G_activity i + G_activity j**	***PSM Candidate activity*** **C_activity**
Correct test-lesson + correct test-part	Correct activity

As expected, these rules need some extensions to cover other activities, such as their cognitive ability, possible disabilities, learning style, computer environment, etc. Also we would like to make the existing rules more flexible. Therefore, we define a cloud service implementing the adaptation process based on the adaptation functions presented above, as shown in Figure 7.

A cloud service can be specified and invoked through as any web based application or service offered via cloud computing. Cloud services can include anything from spreadsheets to calendars and appointment book (Masud and Huang, 2012). Cloud services can be flexibly provisioned and released, automatically, to scale and adjust to the levels of demand. For the customer, the services available usually appear to be unlimited and can be accessed in any quantity at any time.

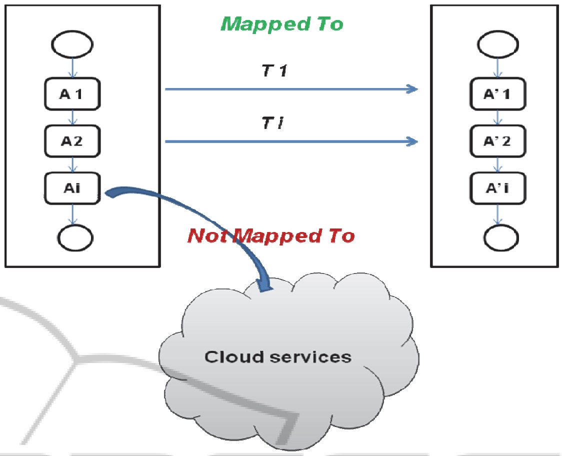

Figure 7: Activities transformation.

The innovation that this cloud e-assessment system defines the resulting generic and adapted e-assessment process as a composite cloud service allowing flexibility and interoperability between any LMS e-assessment, as shown in Figure 8.

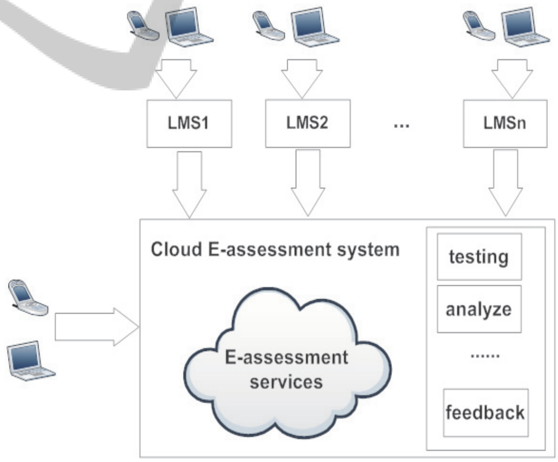

Figure 8: LMSs cloud interoperability.

4 CONCLUSION

In this paper, we have proposed a MDA approach for developing generic e-assessment based on flexible workflow for adaptation individual profile learner. We have specified the workflow model by a standard modeling language, the UML activity diagram language. We have used in our approach an UML-AD refinement technique for modeling and describing workflow applications. Based on this refinement, the first step of the approach provides an UML-AD specification of a generic workflow. In the second step, we have defined a set of adaptation rules to achieve an adaptable workflow for each learner. As future work, we plan to continue with the implementation of our approach using the cloud services.

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