USE OF ALTERNATIVE LEARNING PROCESS PATHS AS AN APPROACH TO PERSONALIZATION OF E-LEARNING

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Abstract: *The paper describes how BMU eLearning System supports three optional learning models. The first one provides a sequential learning process for all students. The other two, support personalized learning using different approaches: (a) use of alternative learning paths by different categories of students and (b) use of resource-based learning allowing free choice of learning objects needed to solve given specific problems. In this research, fine grain learning objects implementing DITA standard are used and published with process-centric LAMS Learning Management System (LMS), with a variety of its activities for interactions with students, but also with external systems.*

Keywords: *E-Learning, Distance learning, Learning objects, Personalized learning*

1. INTRODUCTION

Personalization of e-learning is widely recognized as one of major trends in research and development of e-learning systems [1,2]. Belgrade Metropolitan University (BMU) has been using e-learning for all its bachelor and master programs since 2005, and has adopted its e-learning development strategy that emphasizes the strategic orientation of BMU to use personalized and adaptive e-learning [3-6]. This paper reports further research results of BMU in this direction, focusing on learning processes specified by using LAMS (Learning Activity Management System) LMS (Learning Management System) [7,8] providing different learning paths, i.e. alternate sub-processes to students with different knowledge backgrounds, learning styles, motivation, and learning goals[1].

2. THE CONCEPT OF A FLEXIBLE E-LEARNING SYSTEM

Students are different in age, knowledge levels and skills, they use different learning styles, have different motivation and learning goals. They are not ready to read long textbook chapters (it is their comment) or long HTML-based learning materials posted on LMS. Having their learning habits in mind, as well as different learning theories and practices [9,10], BMU is developing a specific e-learning system that could satisfy most of different students requirements and expectations (Figure 1). The elearning System of BMU aims to support the following learning models:

a. *Linear or sequential learning process* (Figure.1a) requires that students read all learning objects and pass all verification activities of acquired knowledge. Sequential execution of all learning and verification activities may be obligatory or optional.
b. *Alternative learning paths* (Figure. 1b), are specified as sub-processes of a specified learning process. Students choose or the systems suggest students to choose different optional learning paths, based on their existing knowledge, learning styles, and learning goals (i.e. target grades).
c. *Resource-based learning* (Figure. 1c) provides students with specification of problems that they need to solve (one by one) and with a set of possible learning objects (LO) from BMU LO Repository and from external LO sources. To solve a problem, students need to search, select and implement the knowledge from LOs.

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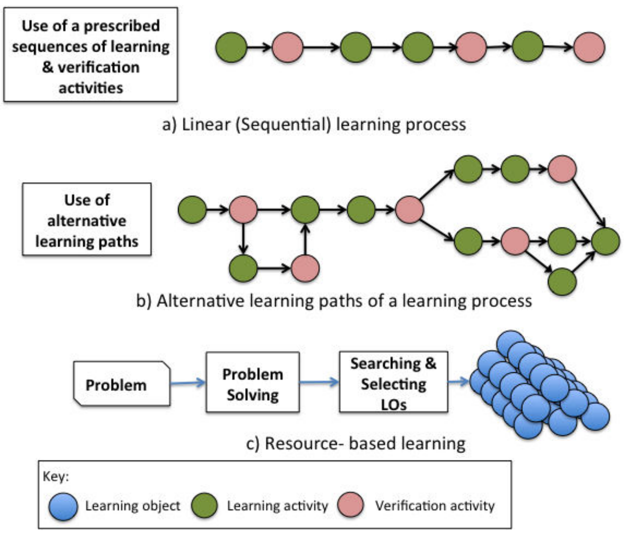

Figure 1: e-Learning system supports three different learning models

Figure 2 shows how an online lesson, offered by BMU e-learning system, provides all three learning options to students.

Students with relatively low knowledge level and with an average reasoning skill or self-learning capabilities (such as 1st year bachelor study students - BS Y-1,), usually prefer to get entire learning material what they need to read, without any restrictions. Students like to use PDF lecture notes [16]. Proposed system provides both Web and PDF versions of learning objects (LOs) that are prepared by using an opportunistic learning model [9, 10].

Students who are aiming to obtain specific grades and have different goals and motivation can choose appropriate learning paths provided by a specified learning process of an online lesson. This approach implements the constructivist learning model [9, 10]. Use of alternative learning paths may be used by all students, but it is expected that it will be used mainly by students in BS Y2-Y4 and students who are high achievers with high motivation.

The third option, resource-based learning is the most convenient to student of final years and in MS i PhD programs. For each specified problem, students search provided set of LOs which are both in BMU LO Repository and other external resources. This type of learning is based on analysis, and evaluation of knowledge sources and on synthesis of new knowledge (supporting levels 4,5 and 6 of Bloom's taxonomy [11]).

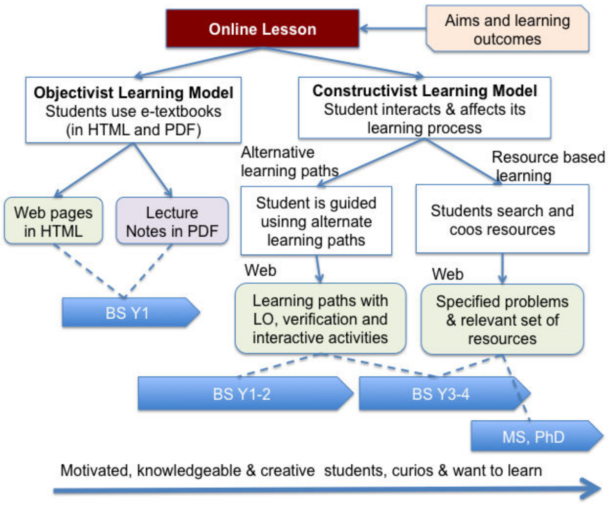

Figure 2: Learning materials of an online lesson produced using different learning models

3. IMPLEMENTATION TECHNOLOGY

Figure 3 shows a simplified view of the production process of learning materials at BMU. Non-technical and supporting activities are omitted for clarity.

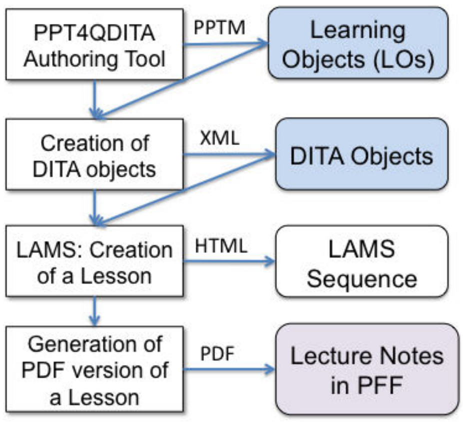

Figure 3: Production process of learning materials

PPT4QDITA is a specific authoring tool allowing authors to create learning objects and online lessons, using Power Point with a specially developed plug-in for QDITA [6], which converts PPTM files into XML-based DITA objects. DITA originated from IBM, but it is now OASIS standard that supports technical writing and publishing [12]. DITA supports all needed concepts needed for realization of BMU e-learning personalization strategy. All learning objects [13-15] and created online lessons are stored as DITA objects and DITA maps, respectively, in DITA objects Repository.

Figure 4 shows the structure of a learning objects created by PPT4QDITA authoring tool.

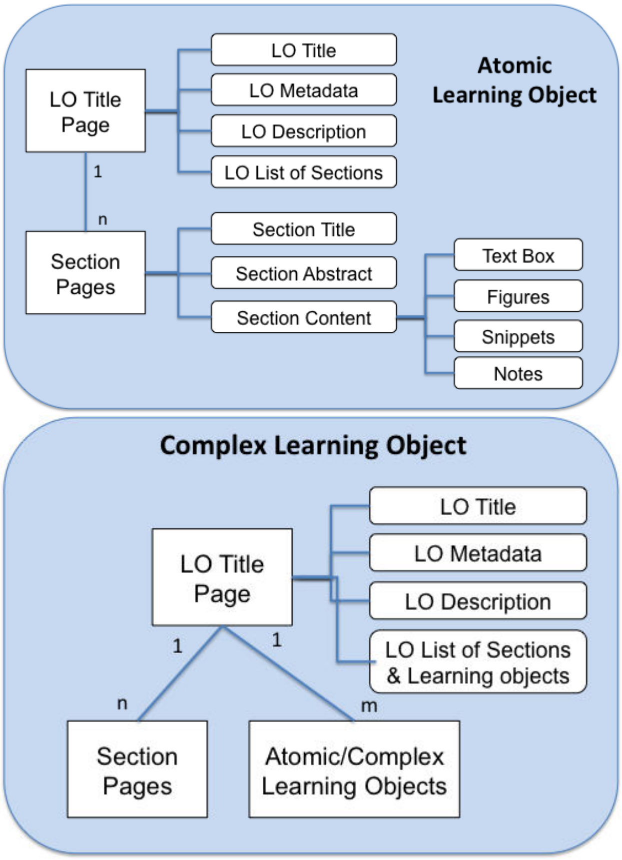

Figure 4: The structure of an atomic and complex leaning object

An atomic or simple learning object consists of a title page and one or many section pages, which holds the content (Figure 4). The title page is holding the LO title, metadata, short description and a list of sections belonging to the LO. Each section page has three components: Section Title, Abstract and Content, which holds the actual learning content in form of text boxes, notes, figures, snippets etc. Sections contain learning contents in small chunks of knowledge, which make students easier to learn and remember what they learnt. A section may hold 250 to 300 characters. Sections of learning objects should be written in a concise and clear text, combined with pictures, notes, snippets (for computer programs' source codes). Section title and abstract should be carefully specified in order the represent its content properly. A LO typically has 1-9 sections. Figure 5 gives an example of a section.

The goal is to create small LOs in order to have more flexibility when creating online lessons, as lessons usually have up to 14 learning objects. If a lesson has to include more learning objects, than the author may create complex learning objects, not consisting of only of sections, but also of other atomic or complex objects. This allow authors to create complex learning objects with a number of other atomic or complex learning objects and sections (Figure 4). In order to support reusability of learning objects and personalization [13,14], it is advisable to keep learning objects as small as possible.

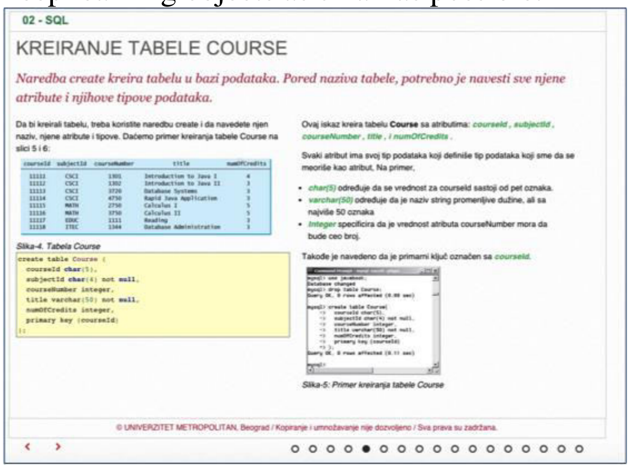

Figure 5: An example of a section (a web page)

LAMS [7,8] is a LMS that supports both learning processes and learning objects, integreted as a subsystem of the enterprise system used by BMU as institutional information system. LAMS allows authors to integrate their learning objects with a variety of LAMS activities supporting interactions of professors with students, with other systems, such as wiki and external resources, and many usual activities related to learning and collaborative learning (Figure 6).

As all learning objects are created by BMU course instructors, these LOs are stored in a shared LO Repository. LO authors can search and find LOs that they need to incorporate in their online lessons with or without modifications. The reusability of LOs reduces the cost of content development.

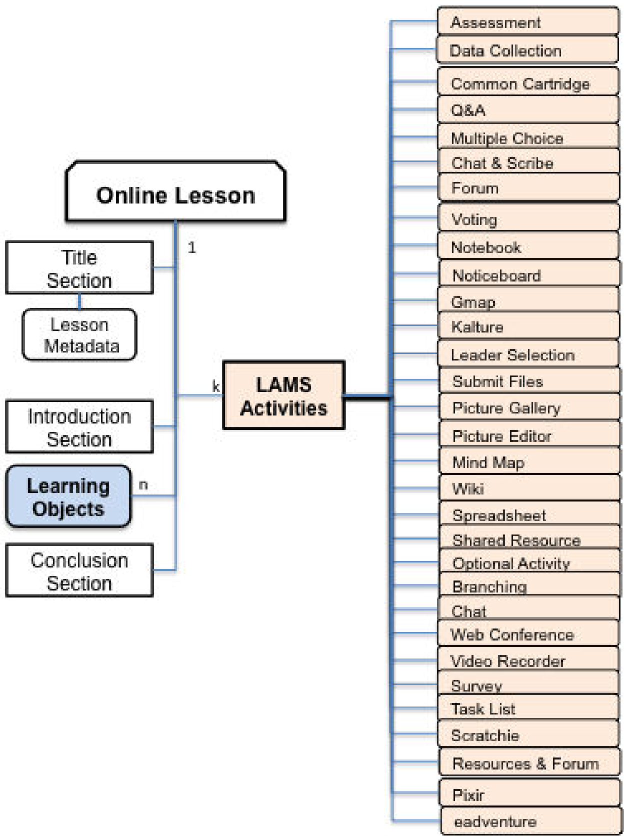

Figure 6: Online lesson creation by integration of learning objects, LAMS activities, and title, introduction and conclusion sections

As BMU uses learning objects with fine granularity, it is possible to use many of them in a typical lesson, mixing them with LAMS activities, thus creating complex learning processes. Each of them consists of a number of sub-processes developed to provide different learning paths to different categories of students. Those, seeking higher grades and having high motivation for learning, will use learning paths with more learning objects, providing deeper or wider knowledge related to concepts thought. Those with lower expectations may choose learning paths providing the required basic knowledge for a course, avoiding more advanced topics and learning objects. Figure 7 shows an example of four different learning paths generated from a single complex learning process of a lesson. Each of these learning paths is designed for a specific category of students. Each learning activities is using an appropriate atomic or complex learning object.

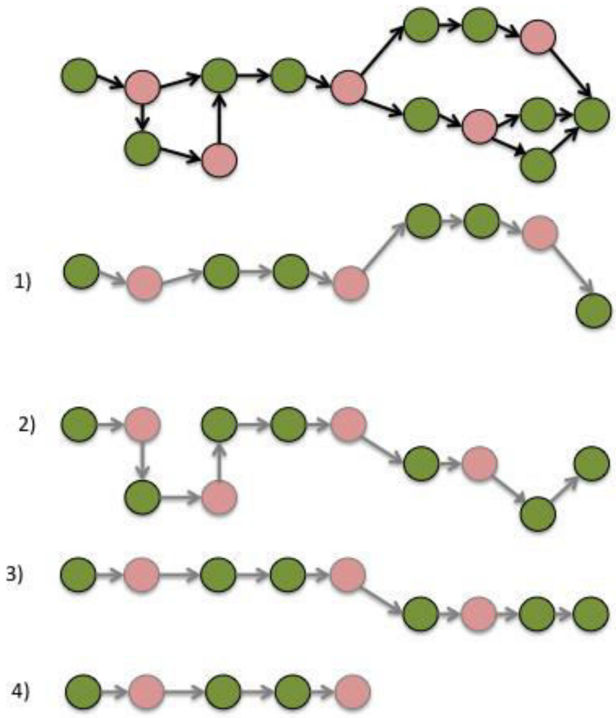

Figure 7: An example of four generated learning paths from a learning process of a lesson

4. DESIGN OF LEARNING PROCESSES

Combining learning objects and LAMS activities, different complex or simple learning processes may be designed and developed. Figure 8 shows three created processes linear, sequential learning processes, with- and without verification of the acquired knowledge (using a multiple choice test), and with- and without some of interaction LAMS activities. These sequential learning processes are mostly used for the implementation of the objectivist learning model (Figure 2).

For the implementation of complex learning processes based on the constructivist learning model, different branching of LAMS activities must be implemented. Figure 9 shows three cases of creating loops and branches in a learning process.

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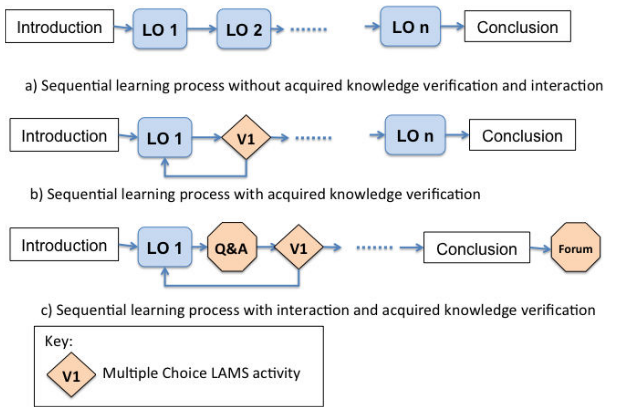


Figure 8: Creation of sequential learning processes

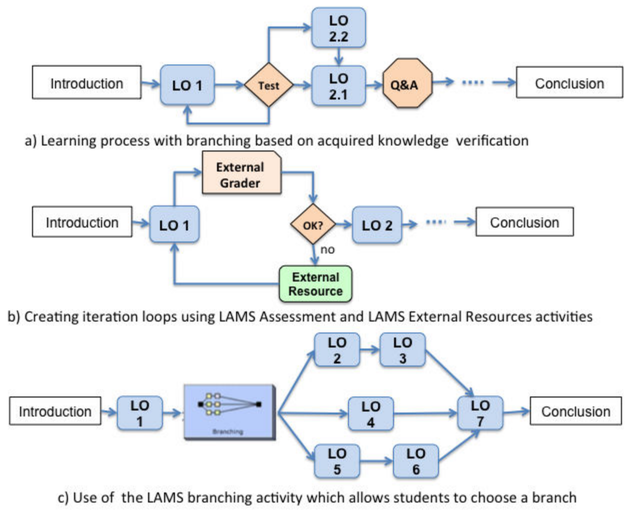


Figure 9: Creation of branches and iteration loops

Figure 9.a shows how a LAMS Multiple Choice or Assessment activity may be used to create two branches (to LO2.1 or LO2.2) or a feedback loop to LO 1 based on the results of assessment.

Figure 9.b shows how LAMS External Resources can be used for students that have a lack of background knowledge, after implementing LAMS Multiple Choice activity. This case shows how to validate small programs developed by students *in Java, C++ etc.) using an External Grader. External Graders are not currently supported by LAMS and BMU is now developing an External Grader for Java. Once external grader is developed, the system will automatically verify Java programs created by students, as solutions of given problems after students read learning objects.

Figure 9.c shows how LAMS can use *LAMS Branching* activity allowing students to choose which path to take in their learning process, according to their learning needs. Combining *LAMS Branching*, Multiple Choice, *Assessment* and *External Resources* activities, authors can create complex learning processes with parallel branches, feedback loops and visits to external knowledge resources and external graders.

The third learning model – resource-based learning - supported by BMU e-Learning System (Figure 2) can be realized by using *LAMS Optional Activity*. It allows students to choose one, few or all learning objects related to this activity, but also other LAMS activities (Figure 10). In an extreme case, an author may specify all learning objects and LAMS activities relevant to a lesson as elements of a *LAMS Optional Activity*, if he wants to support resource-based learning.

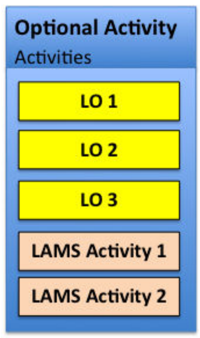


Figure 10: LAMS Optional Activity specifies all learning objects and LAMS activities that a student can optionallu choose

5. EXAMPLES

This section gives several examples that illustrate how different learning processes can be developed using LAMS.

Figure 11 shows a lesson of *CS102 Objects and Data Abstract* course, presented as a sequential learning process that contains several «gates» that may be opened if assessments of the acquired knowledge were satisfactory or if a student participates in the forum. Author of this lesson uses the following LAMS activities: *Multiples Choice, Optional Activity, Forum* and *Voting*.

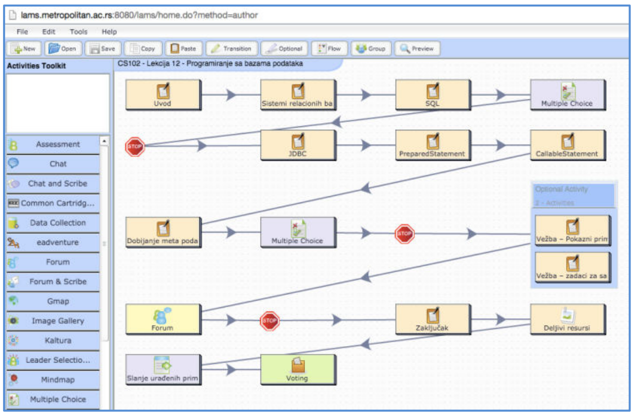
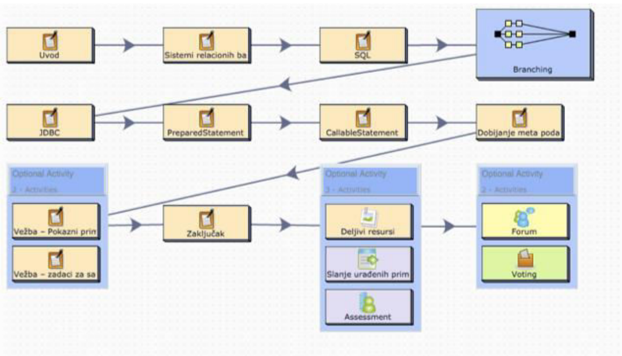
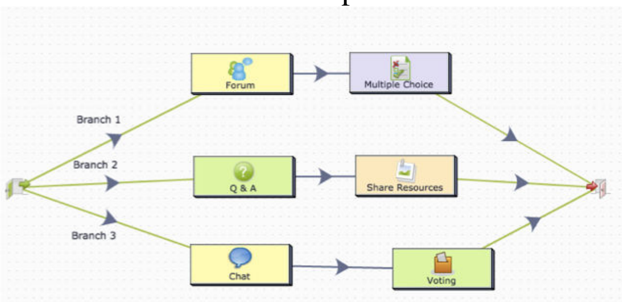


Figure 11: An example of a sequential learning process with gates and few LAMS activities

Figure 12.a shows the learning process of the same course, but with different LAMS activities. *LAMS Branching* activity is used to allow students to choose different branches of the process. These branches are shown in Figure 12.b. A student may choose any of these branches. If the student wants, he may go back to the *Branching* activity and choose other two branches. Once the student completes a branch, the learning process continues with the activity specified after the *Branching* activity in Figure 12.1. The process also has three *Optional Activities* - one before the conclusion section, and two after it.



a) The learning process with one Branching Activities and three Optional Activities



b) The content of the *Branching* activity with three optional branches

Figure 12: The learning process with a *LAMS Branching* activity and three *LAMS Optional Activities*

Figure 13 shows another implementation of the same lesson, supporting the resource-based learning model. By using four *LAMS Optional Activities*, all learning objects and planned LAMS activities may be chosen by a student in any order. By using the *Branching* activity, each student may choose a branch with the most suitable additional learning objects and LAMS activities.

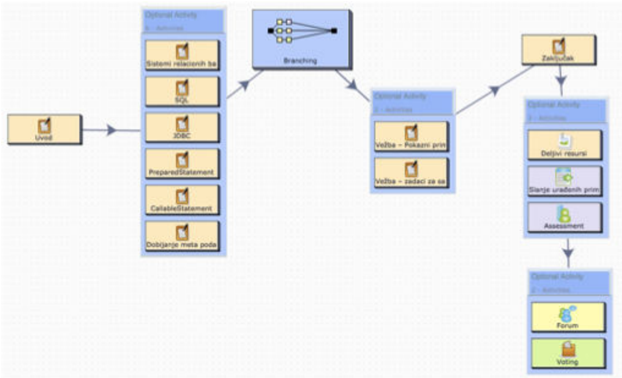


Figure 13: Implementation of the resource-based learning model for the same lesson

These examples demonstrate the richness of LAMS with offered activities supporting students-students and professor-students interactions, and interactions with different external systems. Combing of use of fine-grain learning objects, DITA and learning process-centric LAMS LMS, BMU e-learning System provides a significant degree of flexibility supporting three learning models (Figure 14):

1. *Fixed sequential learning process:* All students use same learning material in two forms:
    a. HTML –web pages
    b. Lecture notes in PDF
2. *Alternative learning paths:* Students choose (or are guided based on assessment) the most appropriate learning path based on their individual preferences, capabilities and/or learning goals.
3. *Resource-based learning:* Students may choose learning objects needed to solve specified problems. Using *LAMS Optional Activity*, a broader set of learning objects may be provided, as well as links to external resources, thus allowing students to search

and select needed learning objects to solve the problems given to students.

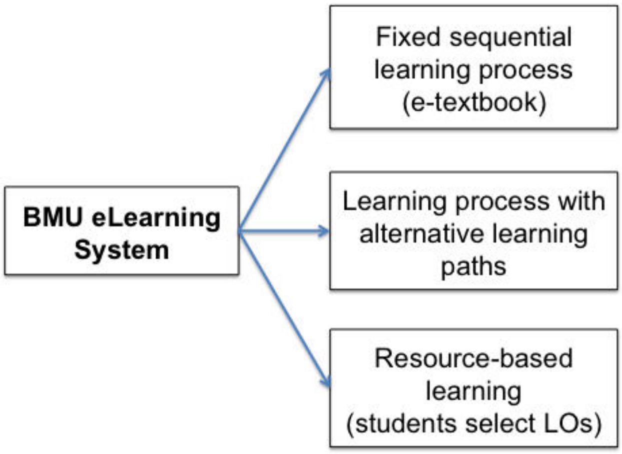


Figure 14: Three different learning models supported by BUM e-learning System

6. CONCLUSION

BMU e-learning System provides three optional learning models. The first one requires that all students use the same sequential learning process (web pages) or lecture notes in PDF. Other two optional learning models provide different approachesto personalized learning:

a. *alternative learning paths* for different categories of students or
b. *resources-based learning*, allowing students to select learning objects needed to solve specific problems.

By using fine-grain learning objects based on DITA standard, and implementing LAMS, as an integrated LMS module, BMU e-learning System supports two different approaches to personalized learning. They are now in research and exploring stage, but may be in an implementation stage in one to two years.

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