A Knowledge Flow Driven E-Learning Architecture Design: What is its Stratification and How is it Personalized

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Abstract
How to personalize an e-Learning system has become an interesting question. The purpose of this paper is to demonstrate an innovative idea of personalizing an e-Learning system driven by Knowledge Flow and show the stratified architecture and the current progress made in Peking University.¹

1. Introduction:
E-Learning has become increasingly hot in the past decade but is still on its way to a new acme. However, learning is so highly personalized that a sound e-Learning architecture should guarantee that every participant can get a distinctive guide fitting him best. An e-Learning participant doesn’t need to be a skilled computer operator and they aren’t expected to be restricted by age or background. These expectations require a computer-based learning system that is easy to handle, clear to be evaluated, free to achieve distinct study goal from distinct start points and learning paths.

We are designing a personalized and internet-based learning system with highly personalized property. We design the architecture with an assumption that an e-Learning system is driven by Knowledge Flow (KF), similar to the Material Flow in e-Business.

2. Knowledge Flow and How it is Involved in an E-Learning System:

2.1 What is Knowledge Flow and Why is it Important

As an analogy to Material Flow, we can describe an e-Learning model as being driven by Knowledge Flow, which is an abstract of those entities of information flow between participants, all sorts of knowledge bases, guiders and outside information sources. As an abstract of information transport, it includes information (knowledge content), transport direction, transport methods and density, etc, and functions like information filtration, methods selecting and self-adapting personalization.

2.2 How is Knowledge Flow Involved

We can safely define our Knowledge Flow based e-Learning system into a structure of three apparatuses: guiders, learners and Knowledge bases, extended by an apparatus of outside Information source.

This structure is not a static but an interacting system. It contains various entities of Knowledge Flow that connect the four apparatuses. Categorizing these flows by information transport directions, we can safely come to the following structure view:

3. A Personalized E-Learning Architecture Driven by Knowledge Flow:

3.1 Stratification and System Architecture Design

The goal of our design is to build a highly personalized e-Learning system that fits participants with various backgrounds and study plans. According to the classification of personalized learning by Walberg¹, we design our system based on the “multi-faceted Learning” theory, which means participants can finally reach the same target through personalized paths.

We divide our workflow into four consecutive steps,

Figure 1: Knowledge Flow Driven Interacting Structure of E-Learning System

1. Knowledge classification and courseware making
2. Info searching & mining from outside Info base
3. Knowledge learning from knowledge base
4. Applying knowledge to solve problems
5. Learning Interacting
   a. Between participants
   b. Between participant and guider
   c. Between participant and computer
6. Discover new knowledge
7. Evaluating and testing
8. Fetching feedback to guiders
(P1/P2: short for participant 1/2)

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namely, knowledge classification, personality mining, adapting and learning evaluation/testing.

As the first step, knowledge classification is done by domain experts. Domain knowledge can be classified into hierarchic ranks. Learning objectives of each level depend on the achievements of knowledge and skills of its lower levels. Bloom has divided knowledge into 6 levels from low to high\(^2\), which enables participants to run an object-oriented learning model. All six levels are interwoven which form a network. Participants can choose personalized start points and learning paths, all of which lead to the top target of the network.

The middle two steps of personality mining and personality adapting are simultaneous. On one hand, intelligent agent can discover what a participant prefers and which learning method fits him best based on his background and feedbacks of in-pace tests; on the other hand, it can adapt itself to these personalities. This personalization cannot be made thorough unless the KF are fully concerned. The architecture design of our e-Learning system can be figured as following:

![Diagram of Learning Flow and Knowledge Classification](Image)

Knowledge Flow & Courseware Making

- Knowledge Classification
- Personality Mining
- Personality Adapting

Evaluation & Testing

- Knowledge citing - Intelligent search engine
- Knowledge applying - personalized task system
- Learning - Path selecting
- Schedule selecting
- Automatic QA model
- Participants interacting
- Between participant and guider
- Knowledge developing - Add to knowledge

Figure 2: Stratification and Architecture of E-Learning System Driven by Knowledge Flow

The last step in the learning workflow is evaluation and testing, which are vital to define whether a learning method fits a participant. With the feedbacks, computer can find out at which level the participant grasps knowledge, as well as the advantages and disadvantages of his current learning methods. Consequently, system can recommend a learning path or method which seems to fit him better and choose the best way to demonstrate knowledge, or advise him skip a knowledge point. We are designing a reusable Computer Adaptive Testing (CAT) system to run the evaluation and testing step.

3.2 Important Technology Involved and Current Progress

Intelligent Agent, Media Stream, XML and Natural Language Processing (NLP) are crucial technologies involved. Through training, the agent can attain participants' favorites, filtrate the information and pick out what the user may prefer. Media stream technology enables KF to be transported by means of various combinations of media streams. System can determine which combination is best adapted to each participant and adjust new ways to demonstrate knowledge.

Knowledge Flow also depends on language a lot. We can apply basic NLP principles to the design of a self-adapting QA (question and answer) sect. Computer Science Department of Peking University has done a number of progressive works on Internet based data mining, Intelligent Search Engine, Interactive Courseware Building and has a strong background on Internetics\(^3\), NLP and web service. Now we are making full-scale progress in individual apparatuses discussed in 3.1 and considering an evaluation for personalization.

4. Conclusion:

In summary, we are designing a personalized e-Learning system with a stratified architecture driven by Knowledge Flow. Entities of KF are characterized by standard XML-based messaging. With the support of Internetics and other important computer technologies, this system enables participants to get personalized guiding service and adjust learning methods according to the feedbacks from evaluations and tests.

China has a great potential market of e-Learning projects. Only 10.5%\(^4\) of high school graduated students at the age of 18-21 can go to university. A good e-Learning product will be a storm. Despite a brighter industrial prospect than e-Business, e-Learning has been developed as a subject rather than an industry. Starting with this system, we can find more innovative ideas to promote the industrialization of e-Learning.

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6. Reference:


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\(^2\) Bloom’s 6 levels: KNOWLEDGE, COMPREHENSION, APPLICATION, ANALYSIS, SYNTHESIS and EVALUATION

\(^3\) Internetics include Internet resultant Infrastructure, service and tools. This concept is first put forward by Prof. Xiaoming Li