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Designing a "Three Rings" Theory Framework for Electronic Schoolbag

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Abstract: This paper designs a "Three Rings" theory framework for electronic schoolbag. This model is based on three important principles of designing e-schoolbag. The first principle is that e-schoolbag should be applied to classroom through providing the service for teachers. The second principle is that e-schoolbag should integrate the key elements of the teaching system into a whole through putting the activities in the center. The third principle is that e-schoolbag should be applied to the smart learning environments. "Three Rings" theory framework is composed of inner ring, middle ring and outer ring. The inner ring is the sequence of activities. The middle ring is the teaching system composed of social network, resource network, tool network.The outer ring is the source of adaptivity driven by data which have five functions: perception, processing, analysis, evaluation, recommendation.

Keywords: electronic schoolbag; principle; model; theory framework

1. Background

E-schoolbag is an informational portable terminal equipment for teaching and learning. It always use in K-12 education. It provides communication and exchange facilities particularly well adapted to education. It helps the users (learners, teachers, parents) to access resources and services through a single interface, their virtual desktop, available at any time, whatever their hardware, software, network infrastructure, or geographical location (Chabert et al., 2006). Some research indicate the central role of the electronic schoolbag (or e-schoolbag) and its textbook in traditional classroom practice (Li, Chen, & Kulm, 2009). E-schoolbag have been teaching experiment for many years in China, but the educational effectiveness is still controversial. Why is the schoolbag difficult to applied in the classroom effectively? This is an important question that we have to consider in designing an e-schoolbag platform.

There are two important factors to promote e-schoolbag using in classroom in Chinese K-12 education. One is the powerful promotion by the government. The other is the choice of schools and teachers. The former facilitates the usage of e-schoolbag in schools, providing the opportunity for the deep integration of technology and education. The latter is related to the real users of the e-schoolbag and the practitioners of the deep integration of technology and education at the same time. Especially the teachers who are the most important gatekeepers of using technology in the classroom.

2. The Important Principles of Designing e-Schoolbag

2.1 Applying e-Schoolbag to Classroom through Providing the Service for Teachers

Teacher is the key point of in the process of deep integration of information technology and education. He/she decides which technology can enter his(her) classroom and how to use it. The teacher is the real gatekeeper of using technology in the classroom. So when designing e-schoolbag, we have to think about how to let teachers willing to use e-schoolbag in his (her) classroom. K-12 teachers have a lot of complicated teaching and management work every day. If using e-schoolbag will increase their work burden, it is difficult to make teachers willing to use e-schoolbag. Therefore, one of the ideas of designing e-schoolbag is avoiding complex technology, simplifying the operation of technology and

making use of technology more simply and friendly, so that teachers can concentrate on their own teaching. Then teachers' work will become more easily and effectively.

2.2 Integrating Various Elements of the System by Virtue of Activity-centered Teaching

Classroom is the key area of deep integration of information technology and education. The only measure that information technology has a revolutionary impact on education is the changing of teaching structure in traditional classroom. This is reflected by the changing of the status and role of the teaching system elements (Kekang, 2014). There are four essential elements in a teaching system: teachers, students, contents, and media. In the classroom using the e-schoolbag, teachers and students are humans, the content can be expanded into resources, the media is the tools of e-schoolbag. Therefore, through putting the activities in the center, e-schoolbag can integrate the key elements of the teaching system into a whole at the same time, teachers can organize the activities which integrate humans, resources and media into a whole.

2.3 Applying to Smart Learning Environments

Nowadays the new technologies such as cloud computing, large data, pervasive computing and social networks are emerging, which provide a realistic foundation and technical support for the construction of smart learning environments (Kang & Dossick, 2015). Smart learning environments are defined as physical environments that are enriched with digital, context-aware and adaptive devices, to promote better and faster learning (Koper, 2014). E-schoolbag can be applied not only in the traditional learning environments but also in the smart learning environments. E-schoolbag platform used in smart learning environments such as smart classrooms can provide corresponding services for teachers and students according to the characteristics of learners as well as process, analyze, evaluate the information. Therefore, e-schoolbag should have five functions: perception, processing, analysis, evaluation, recommendation.

3. "Three Rings" Theory Framework for Electronic Schoolbag

The theoretical framework of the e-schoolbag is composed of inner ring, middle ring and outer ring. The inner ring of the model is the sequence of activities. The middle ring is the teaching system composed of human, resource and tool. The outer ring is a data-driven intelligent system. In the middle, human, resource and tool are represented by social network, resource network, tool network respectively. They communicate with each other and constitute the learning community of network. The outer ring provides support to the learning community of network. In a smart learning environment, through organized activities teachers integrate various elements of the teaching system (human, resource, tool) supported by the source of adaptivity (Fig. 1).

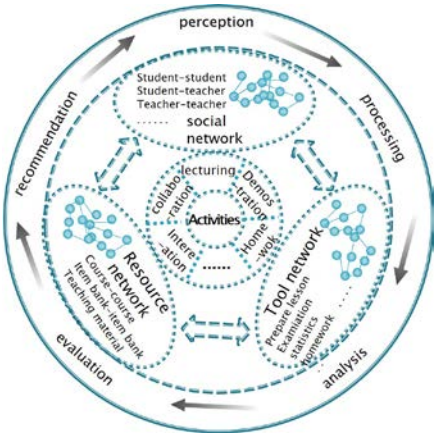

Fig. 1. "Three Rings" theory framework.

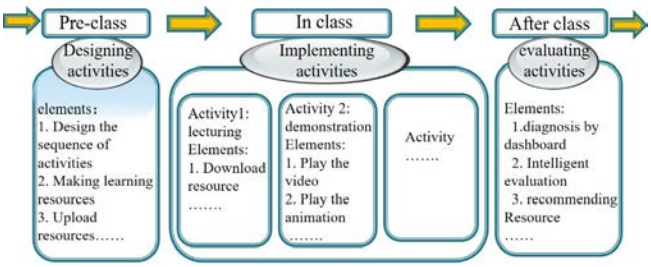

Fig. 2. Design the sequence of activities.

3.1 The Inner Ring: Sequence of Activities

Learning activities is the sum of behaviors of teachers and students to achieve a specific learning objective. Different learning activities constitute different learning process or learning models. This reflects the different teaching strategies which point to the different teaching objectives. According to the theory of activity, the design of e-schoolbag can be regarded as a linear or non-linear sequence of activities with a specific purpose. A complete process of teaching or learning must include a number of learning activities. An activity may contains multiple tasks or only one task (Wu Fati, 2003). The goal determines the task in the goal-oriented learning activities. According to the characteristics of the task, we make the appropriate arrangements for the sequence of the activities and then refine the design of each learning activities gradually.

3.1.1 Pre-class

Before the class, the teacher carries out instructional design through schedule the sequence of activities(Fig.2). There are common activities used by teachers and students in the platform of e-schoolbag. Each kind of activity in the platform are represented by a special icon. The platform distinguishes special activities according to the disciplines. Such as in physics teaching, the same activities are practice, examination, discussion, display, explain, sharing, evaluation, voting and the special activities include experiment, etc. When a teacher wants to design activities, he or she only needs to drag the icons to the process line, then the system will pop up the corresponding link (such as ppt, video, animation, etc.). The teacher complete the content settings of the activities by clicking on the mouse. When the teacher complete setting all the activities, the sequence of scheduled activities is formed. Then the teacher can upload the resources and sent the materials to students.

3.1.2 In Class

In the class, the teacher carries out teaching according to the sequence of the designed activities (Fig. 2). The scheduled sequence of activities can be changed and deleted at any time and the new sequence of activities can be generated at any time. The platform can diagnosis the problems of students based on the data of learning process and output diagnostic results. These can provide decision-making and evaluation for teachers and students. Homework or test can examine the learning results in the stage. Students can seek help from experts, teachers and companions in the social network. The platform can intelligently evaluate the student's homework or test. The results of the evaluation will be recorded in the student's electronic file.

3.1.3 After Class

The activities after class are the process of digesting, reshaping and expanding knowledge. The process is to expand, extend and secure individual knowledge network based on the results of early diagnosis.The student determines his own learning path based on the diagnostic result. The platform will collect time, space, scene data of the student, then put them into the student model. In the next step the platform recommends the individualized resources to the student based on the learning style, learning needs, learning ability and other personal information. At the same time, the platform also recommends social network to the students. Students can approve and add them into their own network. Then the individualized learning circle is formed that can support the exchange and collaboration between students.

3.2 The Middle Ring: the Learning Community of Network

At the beginning the “Community” was introduced into the subject area as the concept of sociology. Dewey introduced the "community" into education and put forward the concept of “learning community”. Learning community of network is an organization of learning on online. We should not only consider the cultural and situational aspects of the learning community of network, but also think them as a system which can achieve the whole function. Human, resource and tool are the basic

elements of the teaching system and each of them can be seen as a network respectively (social network, resource network, tool network). They together constitute the learning community of network. The learning community of network not only represents the relationship of them, but also expects them should emerge the characteristics as a whole.

Connection is the foundation for the learning community of network. From the perspective of learning theory of connectivism (Siemens & Conole, 2011), the network is composed of numerous nodes. The closer connection between nodes, the stronger the adaptability of system. The seamless connection of social network, resource network and tool network can make learning occur at any time. The process of learning is starting from learners' internal network, connecting the external nodes, extracting reasonable ingredients, opening up the internal cognitive neural network, reorganizing the concept of the network, and ultimately the personalized learning network is formed.

3.2.1 Social Network

Social network is composed of students, teachers, administrators, experts, etc. In a social network, each person of a learning community is thought as a node and the relationship between people is thought as an edge. Nodes and edges make up the map of the network. In the learning process, nodes can communicate, collaborate and evaluate at any time. Individual node can connect with existing nodes or external nodes that can be traced to get feedback and guidance.

Some important nodes (such as teachers, experts, etc.) in the social network can help student to expand the breadth and depth of knowledge. Therefore, the platform of e-schoolbag should automatically help student trace the important nodes and recommend information such as e-mail, blog, website of experts. The interaction between the resource network and the tool network is facilitated to connect the social network as well. When a single node (student A) is preferred to trace a resource node and a tool node, student A will find student B who have the same preference. They may form a small learning community with others who have the same learning needs and preferences. The diversity of small learning communities is conducive to the ecological development of social networks.

3.2.2 Resource Network

The resource network is a collection of resources related to learning contents, learning outcomes, auxiliary resources and so on. Learning contents include micro learning resource, PPT, animation and so on; learning results include learning log, learning reflection, learning evaluation, learning products and so on; auxiliary resources include item banks, materials and so on.

The resource network integrates the learner model and the resource matching. On the one hand, the system provides the personalized recommendation through the technology of situational awareness, data mining and intelligent aggregation. The high-quality resources will be recommended to teachers and students preferentially. On the other hand, through the continuously connecting and creating new resource nodes, a unique personal resource network can be formed. The diversification, selectivity, availability and timely accessibility of the nodes will change the distribution of information resources and will achieve the reconstruction of the educational relationship in essence.

3.2.3 Tool Network

The tool network is a collection of tools. It includes preparing lessons tool, choosing questions tool and evaluation tool for teachers. It also includes homework tool, wrong answer tool for students. It includes searching tool, communication tools and collaboration tool for all. Tools can be matched and recommended on the basis of the task and the student's needs. The combined using of these tools can support the production, processing, sharing of knowledge. It can also support exchanging and interaction of information between people.

In the learning process, students accomplish task of learning through connecting resources, tools and humans. At the same time, each network continues to eliminate the weak nodes and generate new nodes, so that network will continue to evolve and ensure learning community is optimized. In short, social networks, resource network and tools network come into an entirety who have mutual effects. If one party has a problem, teaching activities cannot be carried out smoothly.

3.3 The Outer Ring: the Source of Adaptivity

The source of adaptivity in outer ring is data-driven composed of perception, processing, analysis, evaluation and recommendation. They provide support to the network learning community by offering information collection, processing and services.

3.3.1 Perception

Perception is that the platform of e-schoolbag can get students' all kinds of data in the learning process. The platform percepts students' physiological information, environmental information and relationship information through the mobile phone, PAD, wearable equipment, sensors and other sensory. Physiological information includes breathing, blood pressure, pulse, heart rate, body temperature, etc.; environmental information includes time, location, scene, temperature, speed, etc.; relationship information includes social networking partners, teachers, experts, online status, etc.. This multi-source, multi-scene and multi-modal data aggregation makes the diagnosis, prediction and intervention becoming more accurate.

3.3.2 Processing

Processing is that the platform of e-schoolbag can convert the unstructured data to the structured data through the individualized student model. Building an individualized student model is important to intelligent processing. At present, the common individualized student models include coverage model, deviation model, cognitive model and Bayesian model.

The coverage model is based on the comparison between performance of students and expert knowledge to judge the students' situation. The deviation model constructs the student's behavior model based on expressing the students' misconceptions as the deviation of the expert knowledge. The cognitive model quantifies and measures the student's cognitive ability to reflect the student's knowledge level, cognitive ability and psychological factors. The Bayesian model constructs model by determining the network structure and conditional probability distribution.

3.3.3 Analysis

Analysis is that the platform of e-schoolbag can use technique of learning analytics to analyze the data of learning process, then provide individual learning diagnosis, learning decision, precision recommendation, multiple evaluation and other learning services. The quantification of the learning process makes it possible to analyze the data of the whole process. The learning process data can describe and explain the existing phenomena, early warn and intervene the learning process and predict future learning. With the data collection gradually breaking the technical constraints, the data collection in classroom will not be limited in the questionnaire survey, artificial observation and other methods, but also record students' facial expressions, eye movement and other data through the perception of equipment. It will greatly enrich the type of data. It will become a reality to build a learner-centered holographic digital model.

3.3.4 Evaluation

Evaluation is that the platform of e-schoolbag can evaluate, predict students' academic achievement and output the results. Visualized dashboards can help teachers and students understand the process and results of learning activities intuitively such as participation, goal completion, learning ability, knowledge map, etc. This information can help students to construct self-awareness, self-reflection and meaning (Siemens, G., 2013). At present, there are three methods for evaluation and prediction. The first is the use of statistical methods to analysis and predict the students' behaviors and academic achievements. The second is to use the labeled behavioral samples to establish a multi-feature fusion classification model, mining the data of behaviors and identify unknown samples. The third is to model

the dynamic evolution of learners' behavior in time series and predict the results of learning dynamically.

3.3.5 Recommendation

Intelligent recommendation is that the platform of e-schoolbag can quickly and accurately choose the most appropriate information and provide personalized information services to students. The algorithm is a key part of the design, which determines the quality of service. At present, the common recommendation algorithm is based on the recommendation algorithm of association rules, content-based algorithm, collaborative algorithm based on collaborative filtering and hybrid recommendation algorithm. The hybrid recommendation algorithm is better than a single recommended algorithm, because it can avoid the weakness of other recommended algorithms.

4 Conclusion and Perspectives

In this article, we have presented a “Three Rings” theory framework for Electronic Schoolbag. This theory framework gives an example for designing an e-schoolbag system or other similar adopt systems. This theory framework inspires the designers that the educational theory, the applicability of technology, the local policy and market demand are important factors when they design an adopt system.

This theory framework is the theoretical model of Standard Project of Chinese Education Informatization. The standardization of educational information is of great significance. From the macroscopic point of view, it is of great significance to formulate a unified standard that is conducive to the steady development of the education informatization. From the micro point of view, the unified standard can provide help to the enterprises who develop the products for education informatization. Unified standards of application is the guarantee of market and can avoid repetitive inputs and low level development. Finally, we should research the practical application of the "three-ring" model, then test and modify it for the next step.

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