Chen, W. et al. (Eds.) (2016). Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education

Training Teachers to Develop Work-process-oriented Curricula

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Abstract: The work-process-oriented curriculum (WPOC) becomes increasingly popular in vocational education and training (VET). It links the curricula and ultimately the learning processes to the work activity and simultaneously to promote action-oriented learning at the curricular level. In particular, information and communication technologies (ICTs) are more and more applied in WPOC for effective and efficient working and learning. However, it is difficult for a teacher in VET to develop a WPOC, because comprehensive technological pedagogical content knowledge (TPACK) is needed for developing a sound WPOC. To help teachers learn to acquire TPACK, we developed a web-based learning environment with three training curricula that addresses the situated nature and complex interplay of technology, pedagogy and content. In this paper, we present the development of our web-based WPOC authoring and delivering environment and the development of the three training curricula. By exploiting the tools and the curricula, the teacher can be trained to develop a work-process-oriented curriculum in a way of Learning by Design (LbD). Through testing, the technical feasibility and potential usability of this LbD environment are initially demonstrated.

Keywords: Work-process-oriented Curriculum (WPOC), Vocational Education and Training (VET), Learning Arena, Technological Pedagogical Content Knowledge (TPACK), Learning by Design (LbD), Learning Design

1. Introduction

In the past decades vocational education and training (VET) has experienced multiple changes, as a consequence of the technological advances in different fields. In the context of the changes in VET didactics concerning work and work processes, work-process-knowledge is regarded as a central category of knowledge. In particular, the work process as a new didactical reference point has increasingly moved to the center of interest in research (Spöttl 2008). Germany‟s tradition of discipline-based vocational school curricula is to be replaced by a system which prioritizes the work processes characteristic of an occupation as the focus for curricula structured around learning arenas (KMK, 1996). Learning arenas are didactically reflected occupational fields which follow the international trend of competence-based curricula (Fischer and Bauer, 2007). In such a learning arena approach the gap between school-based learning and in-company training, between theory teaching and practical work experience, between subjective knowledge and objective knowledge is considered (Fischer and Bauer, 2007). Therefore, the learning process via learning arenas is related to a complete process of work including information gathering, planning, execution, and evaluation while also being aware of inter-disciplinary aspects (Rauner, 2007). Especially in today‟s digitalized world, digital media are deeply integrated into the work processes due to an increased application of computers and the Internet. Learning and work tasks can be supported by using the different potentials of digital media in an educational context (Howe and Knutzen, 2013; Howe and Staden, 2015).

In Germany a paradigm shift from discipline-organized curricula in VET schools towards work-process-related and competence-based curricula can be observed since 1990‟s (Rauner, 2007). Since the start of the new millennium, the theories, strategies and methods regarding learning arenas are introduced by Chinese scholars who studied in Germany. They advocated the concept of action-orientation and promoted the ideas that curriculum design should take the work process as the

referential criterion (Zhao & Xu, 2008). Since then a curriculum reform in VET promoted by Chinese government has taken place. However, the WPOC practice is still far from widespread. One of serious impediments to WPOC‟s diffusion in VET is that teachers, with few exceptions, do not have the expertise to transform a discipline-organized curriculum into a work-process-oriented curriculum, because they are well-versed in teaching and lecturing discipline-based knowledge, but have less work-process-oriented knowledge and, in particular, less theoretical knowledge and practical experience about how to develop and deliver a work-process-oriented curriculum (Zhao & Xu, 2008).

It is crucial to train teachers in developing work-process-oriented curricula for promoting the reform of the VET. Currently teacher training in developing work-process-oriented curricula is often in a traditional way of face-to-face, lecture-based training. Viewing the development of work-process-oriented curricula as a complex interplay process of technology, pedagogy and content, we propose to train teachers to develop work-process-oriented curricula by taking work-process-oriented curricula as well. In this paper the authors present the design and development of a web-based learning environment with three curricula, which foster the acquiring technical pedagogical content knowledge (TPACK) needed for developing work-process-oriented curricula through adopting learning by design (LbD) approach. In the remainder of this paper, we first characterize the work-process-oriented curriculum. Then we present our learning by design approach to train teachers in developing a work-process-oriented curriculum. The following section demonstrates the technical feasibility and potential usability of this approach by presenting the implementation of a web-based learning environment for developing and delivering a work-process-oriented curriculum. Finally, we summarize our work and indicate the future work.

2. Characterizing a Work-process-oriented Curriculum

The work-oriented change in the didactics of VET identifies „significant‟ vocational work situations and the associated work-process-knowledge as the pivotal factor in the design of vocational curricula and processes (Rauner, 2007). Learning takes place when the learner encounters a problem situation during the work process and during the execution of work tasks.

The theoretical framework of work-process-oriented and competence-based curricula is based on the socio-cultural understanding of learning rooted in activity theory (Vygotsky 1978; Engeström 1987), situated learning (Brown et. al. 1989), and community of practice (Lave and Wenger 1991; Wenger 1998). This theoretical orientation considers the context of learning and the community of practice as key elements influencing the process of learning. Situated conceptions of learning have revealed the way in which learning in contextualized settings, such as the workplace and its simulation, results from participation in socially valued activities within communities of practice. Situated theories of knowledge acquisition argue that learning, as it normally occurs, is a function of the activity, context and culture in which it takes place. A work-process-oriented and competence-based curriculum can be generally characterized pedagogically as: 1) focus on authentic problems from professional practice; 2) integration of the acquisition and application of knowledge and skills; 3) self-directed/responsible/managed learning; 4) collaborative learning; 5) new forms of assessment; 6) use of ICT. In this section, we especially emphasize two important characteristics (Klink, et. al. 2007).

2.1 Structuring the curricula based on work process

The term “work process” refers to the sequence of individual work steps and describes how professional tasks are carried out. They are usually described for enterprises, and trainees can easily find out about them for themselves from the relevant documents. VET acknowledges the work process as an important “content” for learning and offering learning processes. In this respect, work processes are increasingly becoming topics of vocational educational research with the aim to identify those elements beneficial for learning within the processes (Spöttl, 2008). The term work-process-knowledge refers to the knowledge needed for working in flexible and innovative business environments. This concept is based on the premise that much of the knowledge that guides and supports work is created through the process of work itself (Boreham, 2002). The orientation of vocational learning according to (occupational) work and business processes - from a structurally oriented perspective - implies that work activity has a rationality of its own beyond the one-dimensional scientific rationality typical of the discipline-based curriculum (Rauner, 2007).

According to Reinhold et al (2003) it is assumed that every profession or occupation could be empirically described by a defined number of professional tasks. A specific occupation is described through a relationship between different aspects of the work (e.g. objectives, tools and requirements for work) and tasks that are typical of the occupation and provide a complete picture of it. Professional tasks as elements of the curriculum are not regarded as a single ability or action, but rather as a complete process of work that encompasses all aspects of the occupation. Furthermore, it is need to analyze professional tasks and their organizational structures as well as how the skilled workers are coping with core professional tasks. A general description of how a professional task is carried out contains the specific requirements of the task, its planning and execution and the assessment and evaluation of the resulting work (Kleiner et al 2002).

In VET, an integrated learning environment would better be created with four components: learning tasks, supporting information, just-in-time information and task segmentation. The most important component is authentic learning tasks based on situations from professional practice. Each learning task contains the entire professional task and is conducted in a realistic professional situation. Learning tasks form the „backbone" of VET. The other components are developed in relation to the learning tasks. Learning tasks are divided into classes arranged in order from simple to complex, depending on the degree of support. There must be enough variation between the learning tasks in one task class. A learning task from the highest task class, in which the task is carried out independently, can be used as a test (Hoogveld et al, 2002; van Merriënboer, 1997).

2.2 Developing competence through action-oriented learning

After identifying typical professional tasks and the necessary appropriate core competences and determining the curricular structure, it is required to didactically process the learning contents. The didactical basics for the design of the identified learning contents represent a development-logical didactical approach which concentrates on competence development by working on concrete work tasks and on problem-solving in challenging real work situations.

In terms of learning theory, development logical didactics constitutes a further development which - in contrast to behaviorism - applies some elements of the constructivist approach (Grantz, et. al. 2008.). The orientation to concrete professional tasks thus clearly differs from the stimulus-reaction scheme of learning on the one hand but also from learning processes based on the mainly experience-based construction of knowledge. Knowledge is not a static copy of real life phenomena but includes dynamic structures that support the personal mastery of action demands. In a pragmatic sense this means the primacy of action and experience over cognitive representation (Waibel, et. al. 1997). The orientation on professional tasks makes greater demands on the ability of self-learning in the context of work situations and contains active learning and self-reflection processes in the context of work situations. In addition, the perspective of holistic learning processes is in the focus of development logical didactics: knowledge and acting form a unit and allow the gaining of both implicit and explicit learning experiences. This means that competence development is perceived as a behavioral change oriented to consequences or as a context-specific generation of knowledge and skills.

In practice，a learning process was usually triggered by a problem resulting from a work situation. Professional tasks or problems in VET are solved like in the real world of work in sequential and logical steps (activities). The activities make up a complete, multi-dimensional work process that copes with a corporate work order, corporate problem-solving or unknown tasks. The tasks must always be seen with all their implications and must always aim at a work result (Spöttl, 2005). A complete and multi-dimensional approach also reveals previous and successive processes, objects and tools, as well as work methods as elements and takes into account that this complex process is important for the individual.

In WPOC knowledge and skills are acquired and applied in an activity where knowledge originates. While performing an activity, action-oriented learning takes place. This contains phases of holistic acting (e.g., gathering information, planning, implementing and evaluating) and thus facilitates the required holistic competence development process. Action-oriented learning in VET needs suitable tasks for the learner to offer chances for self-responsible and self-organized learning with processes of communication and cooperation between the learners and the teacher(s). The main difference compared to traditional teaching is the change of learners" activity. The teacher is no more lecturing knowledge and skills which the learner has to learn. In action-oriented learning the learner has to acquire the

knowledge and skills himself to find appropriate solutions to solve the task. Teaching is no more "one-directional" from the teacher to the learner, who has to follow the teachers‟ instructions. Action-oriented learning means that the learner has to gather the necessary information (e.g., from teachers/experts and from internet) and to acquire the knowledge needed to fulfill the task. The learner himself is responsible for his performance and his progress. The institute and the teacher provide a learning environment with all necessary facilities including information resources and ICT tools.

3. Supporting the Development of TPACK through Adopting Learning by Design Approach

Work-process-orientation as a new didactic concept in VET relates to organizational development as a whole and thus confronts the teacher in occupational pedagogy with fundamentally new tasks (Koch & Meerten, 2003). As analyzed above, it is obvious that teachers must have comprehensive knowledge in technology, pedagogy and content for developing a work-process-oriented curriculum. In recent years, technological pedagogical content knowledge (TPACK) has emerged as a strong framework (Mishra & Koehler, 2006). It describes the kinds of knowledge that teachers need in order to teach with technology, and the complex ways in which these bodies of knowledge interact with one another. To help teachers to develop TPACK, a learning environment must address the situated nature and complex interplay of technology, pedagogy, and content.

Jonassen and his colleagues (Jonassen, 1995; Jonassen, Peck, & Wilson, 1999) pointed out that integrating ICT into instructions requires a change in teaching and learning. Technology should be used not only as tools to convey information or knowledge, but also as cognitive tools for learners to learn with. However, teacher education programs have been criticized for not adequately preparing teachers to use technology effectively for instruction. One major criticism of teacher technology preparation has been that technology was taught as a set of context free and separate knowledge and skills in technology classes and workshops (e.g. Ertmer, 1999; Mishra & Koehler 2006; Pope, Hare, & Howard, 2005; Schrum, 1999). The argument behind this criticism is that technological knowledge and skills alone are not sufficient for teachers to unleash the power of technology and catalyze educational changes. Another criticism of teacher technology preparation is the lack of theoretical foundations. Mishra and Koehler (2006) argued that technology use in education had lagged far behind advocates‟ vision. One reason is that researchers and practitioners lack a theoretical base for understanding the process of technology integration in education. In teacher technology preparation, practices should also be based on a theoretically well-articulated grounding (Schrum, 1999).

In addition, new pedagogies such as project-based learning and case-based learning and innovative use of technologies such as virtual collaborative environment and mobile devices seem to offer much promise in terms of providing new educational experiences for learners. However in reality practitioners are overwhelmed by the plethora of choices and may lack the necessary skills to make informed design decisions about how to use these theories and technologies (Conole, Oliver, et. al., 2007). Designing high quality, pedagogy-sound and technology-supported learning experiences is a significant challenge for teachers (Lockyer, et al., 2008; Miao et. al., 2009).

Considering these challenges, what should teacher preparation programs do to prepare technologically competent teachers? Discussions of this question highlight the reform of teacher technology preparation programs. The TPACK framework identifies the essential knowledge for a teacher to effectively integrate technology into instruction. In recent years, teacher educators and researchers have developed an increasing interest in this framework and have been using it to guide the design of technology preparation programs for teachers (Jaipal & Figg, 2010).

Based on the TPACK framework, the authors designed and developed a series of three curricula that integrate pedagogy and technology. The goal of this initiative is to help teachers in developing online or blended work-process-oriented curricula by gaining TPACK. According to Koehler and Mishra's (2005) suggestion on how to teach TPACK, teachers should learn about teaching with technology by designing technological artifacts to solve instructional problems. They proposed learning by design (LbD) as a promising approach to help teachers develop TPACK (Koehler & Mishra, 2005). Through the act of designing, teachers construct both online classes and an awareness of technology‟s role in reaching instructional goals for specific content. This design-based process is an authentic context for learning about educational technology that recognizes that design-based activities take on meaning and occur iteratively over time. In light of LbD approach, we develop a web-based,

work-process-oriented curricula authoring and delivering environment with three courses. By taking the curricula in our learning environment, pre-service teachers or in-service teachers who lack of knowledge about the development of work-process-oriented curricula and about the development multimedia courseware can be engaged in the design of an online or blended work-process-oriented curriculum for a real-world context whereby they construct their understanding and meaning towards the topics of both pedagogy and technology.

4. Development of a Work-process-oriented Authoring and Delivering Environment

In order to foster learning by doing, concretely speaking, learning by designing a work-process-oriented curriculum, we provide a web-based platform for teachers to acquire the knowledge needed for developing an online or hybrid work-process-oriented curriculum and meanwhile to apply the acquired knowledge in the application context. This section briefly presents the development of our work-process-oriented curriculum authoring and delivering environment

4.1 Development of a work-process-oriented curriculum authoring tool

To support learning by design, we attempt to provide a means for the teacher to represent design ideas as a computational description (called a script) of the design results in the light of IMS Learning Design (LD) (Koper and Tattersall, 2005), an international e-learning technical standard. Learning design has emerged as a distinct field of research, which is concerned with the development of methods, tools, and resources for helping learning designers in their design process (Conole, Oliver et al., 2007; Lockyer, et al., 2008; Koper and Miao, 2008). By adopting an approach of a pedagogy-specific learning design language (Miao, et. al. 2014), we develop a work-process-oriented curriculum scripting language. Using this scripting language, a work-process-oriented curriculum, representing a learning arena, can be specified by setting values of the attributes of the learning arena (e.g., title, typical professional task description, time schedule, learning objectives, prerequisite, organization of the occupation, objects of the occupation, tools, methods, requirements of the occupation, and assessment standard) and by defining a sequence of learning situations, from simple situations to complex situations. A learning situation represents a concrete work task that provides a learning task with learning context. A learning situation is specified by setting values of attributes of the learning situation (e.g., title, learning situation description, time schedule, prerequisite, learning objectives, work organization, work objects, tools, methods, work requirements, and assessment standard) and by defining a sequence of learning activities (or called sub-tasks). All learning activities within a learning situation make up a complete work process to fulfill a work task or to solve a problem. As a work step, a learning activity is specified by describing generic information (e.g., title, activity description, time schedule, prerequisite, learning objectives, learning content, guiding questions, difficult and important points, and completion condition), by providing information chuck to present associated theoretical knowledge and practical knowledge needed for performing this learning activity, and by defining a series of actions categorized as information-gathering, planning, decision-making, implementation, monitoring and controlling, and evaluation. An action is an elemental unit that specifies which role(s) act to handle/produce which artifact(s) with which tool(s) in which work mode towards which goal.

In order to facilitate teacher in representing a design of a learning arena, we develop a work-process-oriented curriculum authoring tool. We design and implement this tool by making use of the Business Process Model and Notation (BPMN) standard. Based on the BPMN, this tool provides a diagram-based user interface. As illustrated in Figure 1, a teacher can to specify a learning arena in a hierarchical structure by using the constructors of BPMN. Figure 1 presents two screenshots of the tool. Besides the menu-bar and the BPMN component list in the left side of the window, the major part of the user interface (UI) of the tool is an edit space, where the teacher can define a learning arena model. The teacher can start to define a learning arena by opening a new page and dragging/dropping learning situation nodes on it. She or he can define the sequence of the learning situation nodes by creating arrows between them for specifying the learning path. To set the values of the attributes of a learning situation, the teacher can fill the blanks in a dialog form opened when choosing a menu-item of the associated learning situation node. Through double-clicking a learning situation node, the teacher can open the learning situation page to define internal structure of the learning situation, a network of learning activities, as a diagram. The simplest work-process structure is a linear structure. It is allowed

for an experienced teacher to define a complex work-process structure as a diagram by using the gateway and control conditions defined in BPMN. In order to making a detail design of a learning activity, the teacher can choose the "edit" menu-item of the learning activity node as shown in the back screenshot of Figure 1. Then the teacher can see a pop-up dialog with a set of tabbed-forms. The teacher can represent detail design through filling the blanks and making choices in the form. As shown in the front screenshot of Figure 1, the teacher is defining the actions of the learning activity "the design of learning situation and assignment". The first action of this learning activity is "designing learning task". The instruction about how to do the action is described and a rich-text editor is defined as the tool used in this action. Using the authoring tool in the way described above, the teacher can represent a complete design of a work-process-oriented curriculum as a script.

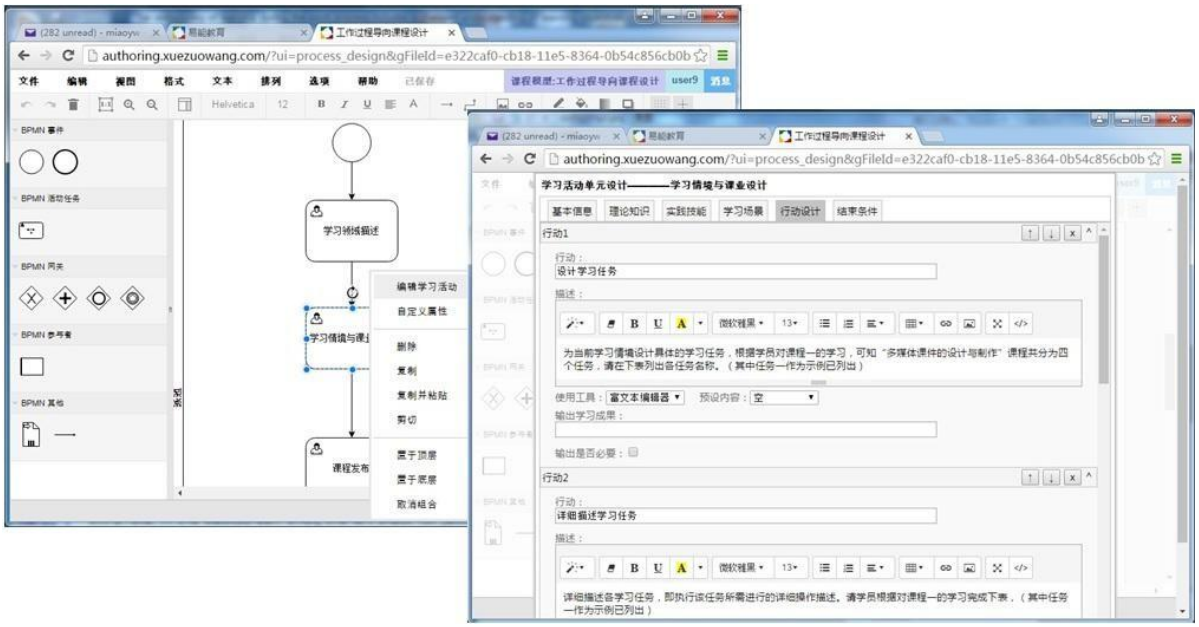

Figure 1: a screenshot of the work-process-oriented curriculum authoring tool

4.2 Implementation of a work-process-oriented curriculum delivering tool

By using the authoring tool a script can be created, stored, and retrieved. Similar to a unit of learning that can be instantiated and played in an IMS LD-compatible execution environment, the script can be instantiated and played using a web-based, work-process-oriented course delivering tool.

In Figure 2, the user interface (UI) of the work-process-oriented curriculum delivering tool is shown within a web browser. The tool has three columns: activity navigation bar, learning space, and work space. If a learner starts to take a work-process-oriented curriculum, she or he can open the web page of the curriculum with a list of learning situations, from simple to complex, according to the script. She or he can go through the curriculum one by one to complete it. During the learning process, she or he can take a learning situation by clicking the chosen one. Then she or he can see a web page as shown in Figure 2. The activity navigation bar lists all learning activities of the learning situation according to the script. As the back screenshot in Figure 2 shows, the learner is currently performing the second learning activity that is highlight in the activity navigation bar. When the cursor moves out of the navigation bar, it will retract to the left side as shown in the front screenshot of Figure 2. The learner can read general information about this learning activity such as title, learning objectives, learning content, guiding questions in the learning space. In the work space all actions are presented as tab forms, in which the description and guidance of each action can be seen and the tool for performing the action is available according to the script. In Figure 2, a rich-text editor is provided for doing the assigned action "defining learning objectives and learning content" in this case. If the learner has problem to complete the current action, the prepared theoretical knowledge and practical knowledge are available. The links to the associated theoretical knowledge and practical knowledge can be defined in the guidance of the action, so that the learner can easily access context-related information at the proper time in the learning environment, e.g. conceptual description, operation instruction, video clips of expert demonstration,

and detailed solutions. The learner can also make contributions to curriculum by adding information about theoretical knowledge and their valuable learning experience in the current activity. Moreover, the learning experience acquired during the execution of the work processes could later be retrieved, deepened and reflected as well.

Figure 2: a screenshot of the work-process-oriented curriculum delivering tool

5. Development of Three Curricula

In order to promote professional competences of Chinese teachers in developing a work-process-oriented curriculum, we provided three online curricula as part of the LbD environment. These three curricula, from simple to complex, are designed and structured in accordance with the cognitive development process. This section presents the development of these three curricula.

5.1 The concept and fundament of the work-process-oriented curriculum

Viewing the need to introduce some basic concepts about work-process-oriented curriculum at the beginning, we developed the first curriculum as three micro-courses presenting the fundamental knowledge. The title of the first micro-course is “the basic concepts of curriculum and instruction in VET”. It introduces the concepts such as curriculum and instruction. Through describing the historic and current situations and the origination of the reformation in Chinese VET, it helps learners to construct fundamental knowledge and understandings about work-integrated learning curriculum. The theme of the second micro-course is "work-process-oriented curriculum", aiming at fostering learners to understand characteristics of the work-process-oriented curriculum. To achieve this goal, it presents knowledge about "work process and work-process-knowledge", "problems to be solved in work-process-oriented curriculum”, etc. The title of the third micro-course is “a brief introduction of the development process of the work-process-oriented curriculum”. Through being introduced a seven-step model, students can acquire fundamental knowledge and preliminary understandings about the development process of a work-process-oriented curriculum.

5.2 The design and development of a multimedia courseware

The main objective of this work-process-oriented curriculum is to help learners to have a preliminary perception of a work-process-oriented curriculum and of the difference between a traditional discipline-based curriculum and a work-process-oriented curriculum. Considering that fact that the learners have various professional backgrounds, we have to choose a commonly interested learning arena as the base of a work-process-oriented curriculum. The design and development of a multimedia courseware is such a typical professional task. We arranged two learning situations in this curriculum: the design and development of a PPT-based courseware and the design and development of a simple

micro-course. Taking the development of the first curriculum as an example and meanwhile an assignment, this learning situation enables the learner to experience a learning arena with multiple learning situations and a complete action-process including six phases: information-gathering, planning, decision-making, implementation, monitoring, and evaluation. Furthermore, the learner can have perception of the important concepts such as learning arena, learning situation, learning activity, action, work object, tool, and work method when taking this work-process-oriented curriculum.

5.3 The design and development of a work-process-oriented curriculum

It is an online work-process-oriented curriculum. It is important to note that the objective of this work-process-oriented curriculum is to guide the learners to design and develop an online work-process-oriented curriculum through an LbD approach. It is expected that the learner can develop competences in developing an online work-process-oriented curriculum in such an LbD environment through acquiring TAPCK in a series of guided actions.

This curriculum is designed as only one learning situation with three learning activities: the design of a learning arena, the design of a learning situation and assignment, and the design of a learning activity. As shown in Figure 2, the learner can learn following the guidance from the first learning activity to the last one step by step using our work-process-oriented curriculum delivering tool. The learning situation of this curriculum is to develop the experienced curriculum "the design and development of a multimedia courseware" described above. The learner can experience a complete work process to design and develop a work-process-oriented curriculum by doing actually design work using our work-process-oriented curriculum authoring tool. In each learning activity, the learner is required to do assigned actions to complete parts of design work. When she or he has problems or lacks of knowledge or skills to solve the problems in design, she or he can access the information chucks categorized into theoretical knowledge and practical knowledge available in the learning space of this learning activity. As shown in the back screenshot of Figure 1, a user can learn how to design the structure through drawing a diagram with a sequence of learning activities. The front screenshot of Figure 1 illustrates that the user can make a detail design of a learning activity through setting values of attributes and elements of the learning activity on the aspects of generic information, theoretical knowledge, practical knowledge, learning scene, action design, and completion condition, respectively. At the moment of taking the screenshot, the user was defining a series of actions for making a detail design of the learning activity "the design of a learning activity".

6. Summery and Outlooks

In this paper, we characterized the work-process-oriented curriculum. The structure and content of the work-process-oriented curriculum are based on work process and work-process knowledge. The knowledge is acquired in an action-oriented learning in the context of application. Developing a work-process-oriented curriculum is a result of a complex interplay of technology, pedagogy, and content. In order to train teachers to develop a work-process-oriented curriculum, a learning environment with traditional lecture-based approach with discipline-organized knowledge transference is not appropriate, because comprehensive TAPCK is needed. It is wildly accepted to develop TAPCK through an LbD approach. To promote such as action-oriented learning, we developed an LbD environment for training teachers to develop a work-process-oriented curriculum. The LbD environment is consisted of the work-process-oriented curriculum authoring tool and delivering tool and three curricula. In fact, a work-process-oriented curriculum is developed for training teachers to develop a work-process-oriented curriculum. In addition, a learning design language approach was used in developing our work-process-oriented curriculum authoring tool and delivering tool. Through internal test, it is initially demonstrated that it is technical feasible to develop such an LbD environment by adopting the learning design language approach and that the work-process-oriented curricula are potentially useful to train teachers to develop a work-process-oriented curriculum.

Our LbD environment can be characterized as 1) motivating and engaging the learner in learning by assigning an design work, 2) facilitating design by guiding the learner to do actions, 3) fostering contextualized learning by providing knowledge chucks in proper time and in the context of application, and 4) assessing the learning by monitor and evaluating the design results.

This paper focuses on presenting our design ideas and technical development work. Recently we have finished the development work and intensively tested them on the aspects of the functions. The test results demonstrated the usability of the tools and the feasibility of the technical approach. We planned to conduct serious evaluations to investigate the usefulness of the LbD environment in real-world setting. We will report the evaluation results in the near future. Furthermore, we will improve the tools and the curricula according to the evaluation results.

Acknowledgement

Thanks to Fangzhou Tang, Jie Li, Longlong Zhang and Kui Tong for their contributions to the implementation of the authoring tool and the delivering tool.

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