Activity theory as a framework of information architecture for an e-learning system in vocational education

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ABSTRACT: E-learning in vocational education has become an important model for learners in developing their skills. Information architecture (IA) in an e-learning system for vocational education is recognised as a key to the successful design of effective skills training. The use of activity theory centred on IA design principles for an e-learning system in vocational education is proposed in this article. An IA model is built highlighting the learner's activity experiences. This IA model can be used to guide learners effectively, step-by-step, to obtain the needed information in the course of completing the learning objectives and tasks.

INTRODUCTION

E-learning in vocational education has become an important model for learners in developing their skills. Information architecture (IA) of an e-learning system in vocational education (eLSVE) is recognised as a key to the successful design of effective skills training. Information architecture involves the art and science of structuring and organising an information environment to help people achieve their goals [1]. In the design process of IA for eLSVE, designers often adopt the waterfall model from the field of software engineering. It states what the new application should do, but does not describe how it will be accomplished. However, the waterfall model characteristics are quite sensible and are dictated by the activities being performed, the environment and context, and the high-level goals [2]. Supporting real behaviour requires activity theory as a framework for IA focusing on the tasks, activities and goals for eLSVE. Despite its rich foundations, there are no reports intended to assist practitioners who design IA for eLSVE. More work is needed to delineate what an activity theory-based design process might look like applied to the practice of designing IA. The aim of this article is to explain and clarify IA for an eLSVE activity framework and the hurdles practitioners may face.

ACTIVITY THEORY

Activity theory is derived from cultural historical psychology [3]. It incorporates the notions of intentionality, mediation, history, collaboration and development [4]. Also, it explores human activities and work practices in a particular historical, cultural and social context. The activity is the unit of analysis in activity theory. An activity is composed of a subject and an object, mediated by a tool. A subject may be an individual or a group participating in an activity. The activity is undertaken by a subject using tools to produce an object, thus, transforming it into an intentioned outcome [5]. Tools mediate the relationship between subject and object. Tools can be physical or psychological, e.g. computers, artefacts, languages, cultures and ways of thinking. An object is tangible or intangible and is shared by the participants of the activity.

Activity theory also includes *labour division*, *rules* and *community*. Labour division informs how tasks are divided horizontally between community members. It also refers to any vertical division of power and status [6]. Rules control actions and interactions within an activity. Community consists of one person or more sharing the same object with the subject. Rules mediate the relationship between subject and community, and labour division mediates between the community and object.

IMPLICATIONS OF ACTIVITY THEORY FOR DESIGNING IA FOR eLSVE

The purpose of vocational education is to develop the skills and talents in the labour force to satisfy society's needs. E-learning in vocational education uses on-line learning and skills training to achieve these aims. eLSVE is not just the

organisation and integration of textbook knowledge, but is also a constructed environment for skills development. It allows through the design of appropriate projects to develop skills and help learners integrate theory and practice; hence, getting good practical experience, as well as a career education. Reflecting these characteristics is critical in designing eLSVE. Therefore, eLSVE should be planned and developed as follows.

Information Needs and Activities for Learners as the Starting Point for IA

Everything is generated from needs. As a result, the learners' needs should be analysed and synthesised, paying attention to the learners' objectives. These objectives stimulate the transformation of learners' needs into motivation. It provides direction and contrasts the results of actions with the established goals. The object is adjusted and amended so as to stimulate the achievement of the goals. Correct goals help to promote behaviour leading to the realisation of personal values and personal development. The internal driving force of skills training for learners in eLSVE transforms needs into motivation and, then, motivation drives behaviour in reaching the objectives. This is the idea of IA for eLSVE. The learner's needs are the starting point. Producing eLSVE provides motivation, which determines the design of eLSVE. Finally, the realised eLSVE should meet the needs of the target learners.

Using Activity Tools to Unfold IA Design Based on Learners' Habits

People often use tools to meet their information needs, such as clarification of meaning, search and recognition. Different learner groups have different tools and methods. In general, there are three basic tool actions that can be undertaken by learners: browsing for *opportunists*; searching for *attentionists*; in-depth studying for *rigorists*. Opportunists typically have a vague concept when searching. They use basic search tools to browse the information provided by the interface and, then, improve the search based upon the results. Information-organising for this kind of learner means paying attention to classification. Usually, function-unfolding and classified navigation of common terms, concept maps or fuzzy search tools allow learners to browse and search content.

Attentionists need a single answer to a specific question. They hope to reduce information to a small set of candidate information and, thus, quickly improve the search. In this case, indices are likely to provide necessary filtering so that search engine tools can quickly focus on the answer. Rigorists look for in-depth understanding of a specific topic. A wide range of information organisational methods is most suitable for this type of learner, such as advanced search options and the multi-faceted range of choice-setting.

These information-organisational methods can quickly identify an answer. Specialised systems, such as expert systems can be used in the analysis and research of specific content to meet research needs. Regardless of the type of learner, activity goals are achieved with specific tools. So, effective planning for eLSVE starts with the practices and favoured tools of the learner. The special requirements of skills development in vocational education needs accustomed tools for a variety of learners.

Operational Steps Designed According to the Missions and Objectives of Activity Skills

The process of determining the information or support required by learners can be understood as a demand- and motivation-driven activity. Any activity has some rules and steps. Analysing the motivation for learners' needs, orientating activity tasks and clarifying the context of learner participation are included in various elements of activity theory. The links between learners and the results of activities are also emphasised and included in various elements of activity theory. So, the process of building an eLSVE should be mapped to the elements of activity theory. Learning activities for vocational skills are based on the task objectives and task-driven operations are designed to complete the activities. So, functionality and models of eLSVE should conform to task goals and operational steps of skills activities.

Experience in Practice as Valuable Feedback

Feedback enables the eLSVE's design and interaction to be improved, enabling a good experience for the learners. Practical experience is the best feedback to reflect an eLSVE value; the better the experience, the higher the value. Therefore, synthesised learners' experience is fed back to indicate the value of an eLSVE.

Organisation of Resources: Easy to Find and Access

Well-organised information resources in an eLSVE is an important quality indicator in evaluating eLSVE. It allows learners to quickly understand content, structure and relative location of resources and, thus, easily access useful resources in a complex environment.

Activities Produce a Sense of Immersion in Real Experiences

An eLSVE is an infinite logical environment and the behaviour of learners in an eLSVE is determined by the available operations. eLSVE should provide realistic scenes, taking account of the various behaviours of learners. As a result, it enables learners to have a better sense of immersion and to acquire the same realistic experience as in real-life learning.

Simple Interaction: Efficient and Easy to Complete Activities

The set up of operational steps and interaction design are the core technologies in eLSVE. Timely interaction is very useful for learners, as it eliminates the anxiety of waiting during an operation. It also reduces the possibility of learners giving up when encountering problems. Good operating experience and interactivity enable learners to experience eLSVE in a high-speed and efficient way, and it is easier for learners to complete activities.

Diverse Operational Tools of Activities Makes it Easy to Experience Self-realisation

Various operational tools can make it easy for learners to experience feelings of self-fulfilment. Channels to access the information content should be diverse, and the learners can select the channels they like and the tools used for target activities. For example, some learners like the navigation to link content, some learners prefer to use the search tools directly to and some learners seek on-line help. Therefore, the eLSVE design should provide a variety of operational tools by which to meet the needs of the learner.

ACTIVITY ELEMENTS OF IA FOR eLSVE

The design of IA is based on activity theory, IA design activities and the activity processes of learners in eLSVE. The activities of learners in eLSVE are conscious behavioural actions composed of a series of operations and behaviours. Activity theory provides a framework model for the elements in the course of action of this series. As mentioned earlier, the basic unit of activity theory is the activity. The activity system consists of three core components (subject, object and community) and three minor components (tools, rules and division of labour). The IA design elements of activity theory, in reference to classification and analysis, and the relationship of content are shown in Table 1.

Table 1: IA design activity items and relationship.

Activity subject →	Activity object →	Activity tools →	Activity rules
Users' needs	Information organisation	Web site map, directory index	Task analysis
User behaviour objectives	System functions	Remote learning support services	Behavioural actions
Level of cognition and skill	Structural framework	Software or products	Operational habits
Environment analysis	Activity task	Quick links and helps	Modes of thinking

Activity Subject

In IA design, the activity subject is a learner who takes part in the activities of eLSVE. The subject analyses the learners to understand their needs, goals, cognitive level, emotion, skills and other characteristics. In doing so, this analysis is conducive to architecting information in eLSVE, reasonably arranging information content and designing learner-friendly operations. These are key factors in assuring successful completion of learners' behaviour.

Activity Object

In IA design, the activity object is the modules involved in eLSVE-building, such as information organisation, function modules, structural framework, navigation and search. The *object* of activity can be affected by the change of subject. Analysis and design will change according to the situation of the subject, and they should meet certain requirements; so, the object is both subjective and objective.

Activity Tools

In IA, activity tools can be understood as being the system map, directory index and other information tools to help learners to access eLSVE, including the collection of all the tools used in IA. Activity theory takes account of aids to human activity. Good design tools can make eLSVE both usable and operable; eLSVE is a place for learning activities. Learners need tools to complete activities in eLSVE. The benefit of eLSVE is that learners can use it as a learning tool, which is advantageous. The activity tool design of IA can make eLSVE become a better learning tool for servicing learners, including learning through the services and special design of the function modules.

Rules of Activity Behaviours

Behavioural rules of IA design arise from activity theory. Certain rules are needed as constraints or limits when completing the activity. Similarly, in IA design and building eLSVE, designers and learners need to follow behavioural rules. The reasonable rules of the IA co-ordinate the eLSVE framework as a subject and the learner's goals as an object. In IA design, activity behaviours include analysis and understanding of activities and tasks, limits of behavioural actions, points of operating training and answers to questions. Those elements determine the design of the operational model of eLSVE.

Division of Labour in Information Architecture

The labour division in IA is that different learners have different rights to access eLSVE. The most common roles are the administrator, ordinary learners, registered learners or other senior members who have different rights. They play different roles and different divisions in eLSVE. Different roles will have different work experiences. However, in the case where learners have the same rights by which to compare different experiences, the learner can only be in the same category as compared with different variable factors. In doing so, a comparison of the effect of learners' experiences is more objective. All the learners with different rights have the same experience, as shown in Figure 1.

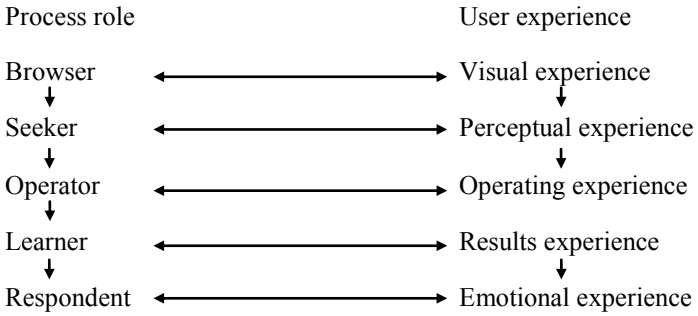

Figure 1: Labour division in IA.

Activity Theory's Hierarchical Structure

Activity theory has a hierarchical structure, involving three levels: activity, action and operation. Specific and detailed level design is shown in Table 2.

Table 2: Activity hierarchical structure in IA.

Level of activity →	Level of action →	Level of operation
Data collection and analysis	Action anticipation	Detailed design
Feasibility analysis	Behaviour construction	Information link
Design activity goals	Action problems	Interaction method
	Action methods and solutions	Decomposition process

IA MODEL OF eLSVE

Information architecture is a kind of organisational structure of information. Its task is to create a channel between information and learner, and enables learners to obtain desired information. The effective IA model can guide learners step-by-step to get the needed information according to actual needs during their completion of the objectives, tasks and process. In this article, under the concept of an activity-centred design of the IA model based on activity theory, every design step is aimed at the practical needs of learners.

From front-end organisation to the platform tools, and the design elements of the operational model, every design step aims at the practical needs of learners. Every design step follows behavioural rules of active operation, and ultimately leads to the operating experience of the learner's behaviour by way of feedback. It highlights the eLSVE focus on the operating experience ideas of IA design. The model is shown in Figure 2.

Design of Front-End Organisation: the Activity Subject

Organisation of learners' needs: Learners' needs are the base for building eLSVE, and its organisation and research become a critical factor in eLSVE experience. The organisation of learners' needs in eLSVE is the set of information, which describes the problems of information (why learners have such a demand); and the useful information (that is, what information is useful for a particular learner). It also describes learner behaviours and characteristics (the features and services provided), and demand constraints (eLSVE limitations). The organisation of learners' needs leads to achieving correctness, necessity, completeness and traceability. There are a few effective ways to organise learners' needs and the most common is through data analysis. The data sources can be statistical results through contacting and communicating with learners, or they can be statistics on experience according to the properties of the characteristics of learner groups. For example, a case of Wal-Mart's beer and diapers (nappies) is enough to reflect the enormous value of professional data mining. Interviews, questionnaires and prototyping technologies are also used to organise learners' needs.

Learner behaviour goals: The understanding of learners' needs implies that learners' behaviours must be analysed: sometimes the learner must be made aware of detail, which he or she may not be particularly interested in or really want to know. Specific behaviours of operations are considered *real* and can reflect the target orientation of needs. As is known, traffic and log files, and eye movement experiments can be used to track learners' actions (behaviour).

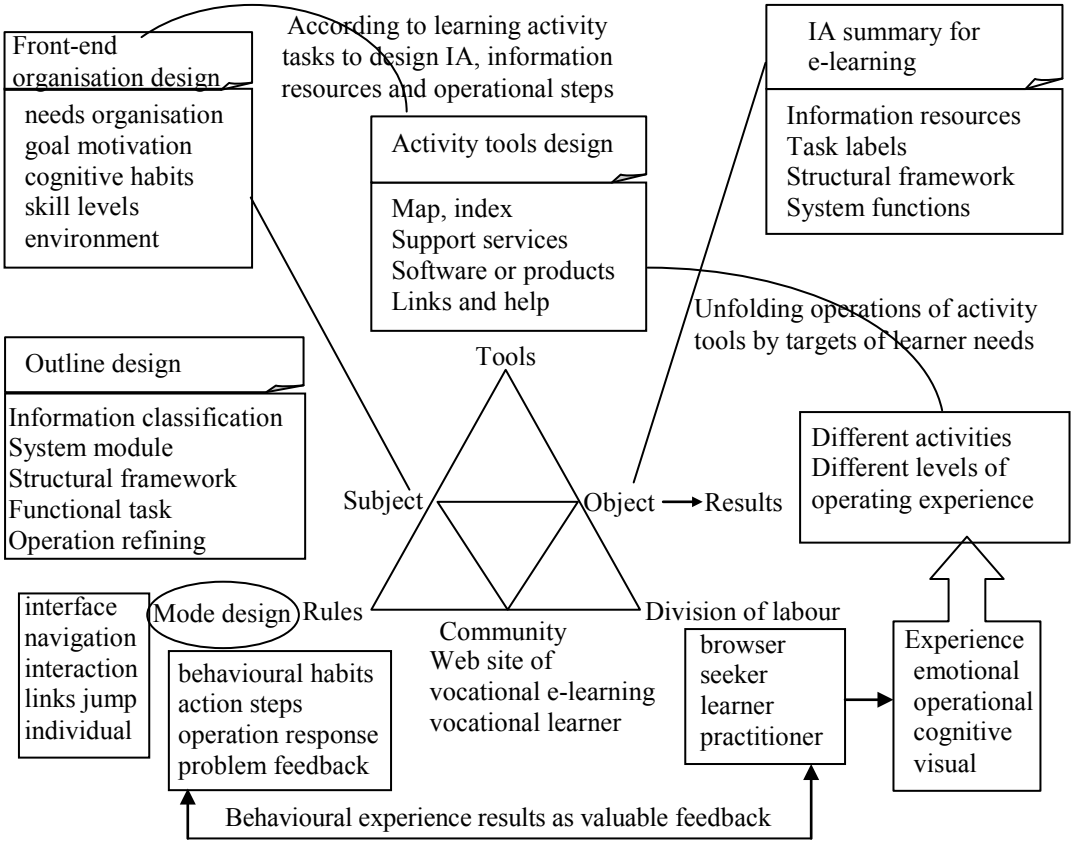

Figure 2: IA model of eLSVE.

At the same time, interviews and questionnaires can be used to understand why the learners do a particular action (the goal). Scene investigation, usability testing and customer relationship management (CRM) statistics are relate to goals and behaviour. The above is commonly used to study the operating behaviours of learners in eLSVE, and together can provide good ideas for the eLSVE's IA. Performance indicators of the learner's behaviour include the stay duration of learner's time spent on the eLSVE; the number of clicks; the number of times the scroll bar is used; and the ways of browsing.

Learner levels of recognition and skills: The organisation and analysis of learners' needs and learners' behavioural goals involve the study of learners' expectations and motivation, and they belong to a future status quo analysis. Past studies for learners are very rarely mentioned in the early organisation of eLSVE, such as why a learner gives up or leaves and why a learner cannot find information already presented. Satisfactory explanation of these issues may not be gained from the learner's expectations and motivation. Therefore, the learner's own cognitive ability and operational level of skill must be understood, so as to better meet the learner's expectations.

Environment analysis: The information environment holds the same important position as does the human growth environment, and directly affects learners' feelings and experiences. The information environment includes external factors and internal factors. External factors include network hardware and the software environment. Internal factors include the learner's own background and reality. The external network environment is more objective and not easy to change, but it is a decisive factor. Analysis of the external environment helps in grasping the macro view (large scale view) of eLSVE. Internal factors are more trivial and often changeable, but analysis of them is also essential. As to IA in eLSVE, the learners' scenarios of browsing and operation can be analysed. The external factors are at school or at home; internal learning is task-driven or interest-driven.

Design of Content Summary

Learning resources: The content hosted by eLSVE are learning resources that are planned effectively, and the reason why they are organised into eLSVE is to enable learners to use them effectively. Learning resources may be texts, images, audio, video, software, databases, etc. However, as a functional learning system with specific learner groups, eLSVE must have its own featured information resources. These featured information resources are featured content, featured themes, featured services and featured practices and presentations.

Components of function: Structured functional components can present system information flow and present data distribution, organisation and classification. The main functions of eLSVE are to complete on-line instruction and learning. Therefore, the functional division of the modules is also based on the requirements of instruction and

management. They include a course management system (curriculum library, teacher library and exercises library). They also include a user management system; resource management (upload and download system and a content publishing system); the forum system, information retrieval systems and the messaging system. These are just the basic functional modules and can be added or deleted in the actual development.

Activity task labels: The tasks are those which engage people during various purposeful activities in their daily life, work and recreation. The learning activities of eLSVE are completed by choosing different learning tasks. Task labels are beneficial to completing activities. Task labels in eLSVE are an implicit or explicit concept of knowledge, such as content identification, action buttons, lists and navigation. All actions or events that allow learners to achieve goals can be considered task labels and they are the entrance to learner activity. For example, if the learner wants to complete a task of downloading documentation for a job, the download system appears in the navigation of *Download*. Download can be considered a task label, the entrance of the activity. Those identifications with goal tasks are also task labels.

Structure schema: The right information structure helps learners to quickly identify and use information content. A structural framework relies on many aspects, such as the Web page layout structure, appearance, style and interface design, and information plate design following the visual effect, information layout, navigation position and content columns.

Design of Learning Tools

Information carrier and scenario platform: As an information-carrier, eLSVE provides learners with a platform for interaction with the network, which has instrumental characteristics. Learners carry out learning activities and access knowledge with the eLSVE platform. eLSVE also stages a scene in which the learner is made to perform well and to do that requires IA. Information architecture sets up special scenarios and also sets up a special eLSVE for the operational scenarios of the learner's activities.

Software or products: eLSVE can provide learners with downloadable software or products, so as to realise objects of an activity.

Learning support services: Learning support services enables counselling for the learning process, job testing and examination services. A comprehensive support and help service are the most important aspects of distance education. Support services can guarantee the quality of e-learning in vocational education. The e-learning support system can provide discussions on learning, on-line guidance counselling, the answering of questions, etc.

Quick links and *help*: Quick links can provide a variety of content links. For example, the system link allows learners to link to other professional Web sites or well-known eLSVEs. The tool link enables learners to link to a popular search engine and to learn more through the search engine tool. The resource link is to a network that provides more resources by which to expand learners' knowledge and enrich learners' resources. The help function of the eLSVE not only provides the solution to the procedures, it also provides real-time on-line help or the means of advice by which to solve various problems encountered by different learners. It can also provide intelligent on-line assistants that are able to follow learners' behaviour and intelligently change the help topics, thus, providing indicative operational services.

CONCLUSION

Information architecture for an e-learning system in vocational education is recognised as a key to the successful design of effective skills training. Activity theory arising from an historical psychology can be used as a framework for designing eLSVE, which involves an activity subject, object, tools, rules and labour division, as well as a community. These elements can be mapped to IA design. Under activity theory, the concept of activity-centred IA and design of an IA model are proposed. From front-end organisation and platform tools, to the main outline of designing elements of an operational model, every design step also aims at the practical needs of learners and follows behavioural rules of activity operation. The experiences derived from operational activities that feed into IA design are also highlighted in eLSVE.

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