

**Construction of Independent Learning Network  
Platform for Engineering Students  
based on Metacognition**

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### Abstract

The development of the network technology offers a good platform for independent learning for engineering students. Metacognition theory is introduced into the construction of independent learning network platform. First, relevant researches are summarized. Second, independent online learning and metacognition theory are discussed and the relationship between both are discussed respectively. Next, elements of network independent learning are analyzed, and the independent learning network platform is designed. Then the network platform of “reliability theory” is established, and independent learning effect is noticed to have improved through actual application. Engineering students are satisfied with this network platform, and obtained good independent learning ability.

**Key words:** independent learning, engineering students, metacognition theory, network platform.

## بناء منبر شبكة تعلم لطلبة الهندسة وفق ما وراء المعرفة

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### المخلص

يتناول هذا البحث موضوع تطوير شبكة تقنية لتوفير منبر للتعليم المستقل لطلبة الهندسة. وهو يستعرض نظرية ما وراء المعرفة في سياق بناء منبر للتعليم المستقل. فأولاً، يقدم البحث عرضاً للدراسات السابقة. وثانياً، يتحدث عن التعليم المستقل من خلال الشبكة العنكبوتية، ونظرية ما وراء المعرفة، ويتبع ذلك مناقشة العلاقة بينهما. ثم يحلل البحث عناصر شبكة معلومات التعليم المستقل. ومن ثم، يقدم تصميمًا لشبكة تعلم مستقل مسمى نظرية المؤثوقية *reliability theory* ويختبرها ميدانياً على طلبة الهندسة؛ حيث بينت نتائج التطبيق العملي لهذه الشبكة عن تحسن التعليم المستقل. كما بينت هذه النتائج أن هؤلاء الطلبة كانوا راضين عن منبر شبكة التعلم وأنهم قد تكونت لديهم قدرات جيدة للتعلم.

**الكلمات المفتاحية:** التعليم المستقل، طلبة الهندسة، نظرية ما وراء المعرفة، شبكة التعلم، منبر التعلم.

## Construction of Independent Learning Network Platform for Engineering Students in View of Metacognition

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### **Introduction :**

The rapid development of the internet has changed the educational environment, which offers convenient information processing platforms and diversified communication approaches.. Therefore the net provides rich learning resources, and many web-based independent learning platforms are constructed. Students can study independently based on the network platform. With the social development, knowledge updates regularly, therefore life-long learning era has become a fact. In this era, engineering students should master the latest science and technology, and they are required to continue learning for life. Independent learning ability of the engineering students is a critical factor that decides if engineering students can grasp the latest technology quickly. In recent years, engineering students showed poor independent learning ability, and their scientific attributes became low. So now they can carry out independent learning online. Independent learning based on the web can make engineering students more independent from teacher, and the teacher's role and the teaching management is easy to be weakened. Massive information under network environment can lead to information overload for them, and the randomness of information organization can make them choose effective information with difficulty. They also have some deficiency in self-monitoring, therefore in order to achieve effective independent learning the learning network platform based on metacognition is designed. It can offer essential metacognition support, and the independent learning ability of the engineering students can be improved.

In recent years, independent learning based on metacognition and network

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technology has been the concern of many scientists, and some good achievements have been obtained. Lucia Mason et al. examined epistemic metacognition as a reflective activity about knowledge and knowing in the context of online information searching on the Web. They studied whether Internet-based learning was influenced by epistemic metacognition and the individual differences examined. Results showed that prior knowledge was not related to epistemic metacognition in the search context [1]. Mornar Vedran et al discussed the use of blended e-learning model, which was based on a mixture of collaborative learning, problem-based learning, and independent learning. It has a combination of a face-to-face environment and online learning. Results showed that students were satisfied with the pedagogical approach, and their academic achievements were better than expected [2].

Ching-Huei Chen et al tested the unique and interactive effects of cognitive and motivational variables when learning in a supportive online learning system based on a path model, and explored the relationships between students' motivational, cognitive, and metacognitive strategy use and online performance. Results showed that students' learning goals and cognitive preferences predicted metacognitive strategy use and later influenced their performance [3].

C. G. Knobbs et al. presented curriculum innovation method in which so-called 'soft' skills, specifically inter-personal and intra-personal skills. This method was established to improve independent learning and develop non-technical skills, essential for students on the threshold of becoming practicing engineers. Results showed that students' appreciation of the need for these skills, as well as their own perceived competence, increased during the course, and their ability to function as independent learners also increased [4].

Nada Dabbagh studied the Personal Learning Environment or PLE that can integrate formal and informal learning based on social media and support student self-regulated learning in higher education contexts, and conceptualized the connection between PLE, social media, and self-regulated learning. A three-level pedagogical framework for using social media was provided to create PLEs that support student self-regulated

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learning [5]. Pao-Nan Chou explored engineering students' self-directed learning abilities in an online learning environment. The instructional activity in one experimental study was to simulate an online learning task in the real-world online courses. Results of the study showed that a significant, positive relationship existed between engineering students' self-directed learning abilities and online learning performances [6].

Karsten Stegmann explored the relation between argumentation in online discussions, cognitive elaboration, and individual knowledge acquisition. The effect of an argumentative computer-supported collaboration script (with vs. without) on the formal quality of argumentation, cognitive elaboration, and individual knowledge acquisition in online discussions was studied. Results showed that a computer-supported collaboration script can foster formal quality of argumentation as well as corresponding cognitive elaboration [7].

As seen from the existing research achievements, the metacognition theory has been integrated into independent learning, and the effect of learning on students has been promoted. At the same time, independent learning based on network has been applied in the teaching procession, and the teaching level has been improved. However, independent learning network platform based on metacognition theory is unusual, especially for independent learning of engineering students, therefore, it is necessary to study the construction of it.

### **Characteristics of online independent learning:**

At present network learning has become the main independent learning means for engineering students, and the network learning is necessary supplement for the classroom teaching. Currently independent learning is a main mode of network learning, which attracts engineering students who have positive attitudes towards it as the passive acceptance situation of engineering students is low. It stimulates their interest in learning, and develop their creativity. The network independent learning has the following characteristics [8]:

(1) Network independent learning breaks up the limit of space and time:

The network independent learning can break space and time constraints.

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Not only can engineering students obtain the teaching information to study at any time, but they can also repeat what they learn, and the learning effect of independent learning can be ensured.

(2) Network independent learning contributes to interaction between teachers and students

The real-time and non real-time two-way communication between teachers and students can be achieved through BBS (bulletin board system), E-mail, QQ groups and suspect-replying system and other network connections. Teachers and students can interact effectively, and the good teaching effect can be obtained.

(3) Network independent learning benefits individualized learning

Engineering students can choose learning content and procession independently according to the own actual situation in the procession of the network independent learning, and the learning motivation can be developed well.

(4) Network independent learning advantageous to individualized learning

Students can always communicate with each other and share all kinds of learning resources through the network. They can carry out effective learning in depth based on completing the learning task together through network discussion exchanges, cooperation, and competition.

The network independent learning can bring some problems, which are listed as follows [9]:

(1) Engineering students lack learning self-discipline

Questionnaire investigation is carried out among the engineering students in Liaoning Shihua University, 400 questionnaires are issued, and 357 questionnaires are collected. According to the findings of the questionnaire investigation, most engineering students do not know their learning characteristics, and spend less time on independent learning, 71% engineering students spend less than one hour on studying, and 22% spend about 2 hours on studying and only 7% students spend over 2 hours. One-third of those surveyed can not make the independent study plan and sort out the learning content in time. Because the network teaching management is loose, the learning consciousness and self-discipline of the engineering students are relatively poor.

(2) Engineering students can not get learning guidance in time. Under network environment, interaction between teachers and students is relatively lacking. Students do not communicate with each other, therefore they can not get the guidance of teachers when they encounter difficulties in learning. They will have serious psychological fear, severe cases will cause students to be weary of studying.

(3) Network independent learning lacks effective feedback mechanism

Network independent learning has the characteristics of separating from space to time. Although the network course can offer some self-test questions. Students only know the existing problems, and they can not get feedback information in time. Therefore, during the procession of independent learning they have somewhat learning burnout phenomenon.

### **Independent learning and metacognitive theory:**

(1) Independent learning theory

Independent learning theory is not only a learning attitude, but an ability to learning. It can develop the subjective initiative of students fully, and make them choose and decide the various aspects of learning with a positive attitude, and the good learning effect can be obtained.

There are some factors affecting the improvement of the independent learning ability for students, which are listed as follows:

(a) Some engineering students do not take specialized course seriously; they think that professional knowledge is applied in the actual work rarely. They lack understanding of raising their own professional qualities.

(b) The teaching content of specialized course has relative low update speed, however with the rapid development of science and technology the update speed of professional knowledge increases quickly, but the current teaching content does not follow the frontiers of scientific development. Therefore students are not interested in specialized courses.

(c) The teaching method of specialized course is improper, and the learning enthusiasm for engineering students can not be aroused well. During the procession of traditional classroom teaching, teachers rarely communicate with engineering students. Independent learning platform is relatively



limited, and the engineering students can not get the guidance of independent learning method.

At present, some engineering students have been aware of the importance of independent learning, and they hope to improve their learning ability, but there is no independent learning platform for supporting independent learning for engineering students. Therefore, it is necessary to establish independent learning platform based on network.

## (2) Metacognitive theory

Metacognition is a cognitive activity that regulates the cognitive process. It includes metacognitive knowledge, metacognitive experience, metacognitive monitoring and control. The object of metacognitive knowledge is on the individual, task and strategy. The metacognitive experience often accompanies cognition and emotion during the intellectual activity. Metacognitive monitoring and control is a regulating mechanism used in the procession of solving the actual problems. The three main factors interact during the procession of cognitive activity [11].

## (3) The relationship between metacognition and independent learning online:

Engineering students should set learning goals, make a study plan, and do good preparation for studying before the learning activity, and they should self check, summarize and evaluate the learning procession. The network independent learning put forward higher requirements for metacognition ability, such as self-monitoring and self-regulating ability, therefore independent learning and metacognitive ability of the engineering students are the critical affecting factors for network independent learning. Metacognition procession is an important part of network independent learning where learning is achieved under the metacognitive monitoring and control. Through network independent learning, engineering students can develop their metacognitive level, they can accumulate more metacognitive knowledge, improve the metacognitive monitoring and controlling ability. Therefore the learning efficiency of engineering students can be improved, and the sense of self-worth of the engineering students can be promoted [12].

## Elements of network independent learning:

Network independent learning platform is made up of four elements: engineering students, learning tool, learning resources and teachers.

### (1) Engineering students

Engineering students are the main body of independent learning; network independent learning emphasizes “student-centered” teaching method. Engineering students can search, read, analyze, identify, and process the learning resources based on network. They can construct the knowledge preliminarily, and therefore can control the whole learning process. Every action of engineering students can affect the learning effect.

### (2) Network platform

Network platform is a teaching tool for the whole learning process, which is a basic condition that can achieve the network independent learning. The formidable information resources of network can offer rich learning resources for engineering students, and the network platform can ensure independent exploration of engineering students. At the same time, network platform can offer a series of assisted learning tools to support communication between teachers and students, for example, network platform can provide the video courses, BBS, exchange area of students, opening and sharing platform between teachers and students. The network platform can evaluate the learning process and affect of the engineering students and adjust the learning method according to the evaluating results.

### (3) Learning resources

One of the distinct characteristic of the network is the rich source of information, engineering students can obtain the information needed conveniently based on the search engines in the computer. Network platform can help the engineering students study specialized course, which can offer the broad space for independent learning.

### (4) Online tutor

During the procession of independent learning, engineering students also need the guidance of the teachers; therefore network platform can act as a teacher.

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## **Design of independent learning network platform:**

### **(1) Independent learning resources**

Independent learning resources include conventional and special teaching resources. Conventional teaching resources mainly include teaching program; course description, course standard, teaching plan, exercises, multimedia courseware, examination items, teaching effectiveness assessments and so on. The special teaching resources include expert course, hotspot, animation demo, teaching video, online test, course forum, interactive platform between teachers and students. The special teaching resources are an important part of the independent learning platform; it should not only highlight the characteristics, have peculiar style, but also should show the level of teaching and research of specialized course.

The construction of course resources includes developing, collecting and organizing the independent learning resources of engineering students. The teaching resources with the characteristic of ease-to-use and ease to-update can be constructed based on computer, network, and digital technology. The figure, color, and font should be matched appropriately. The content of independent resources should be correct, standard, and complete.

### **(2) Web page design**

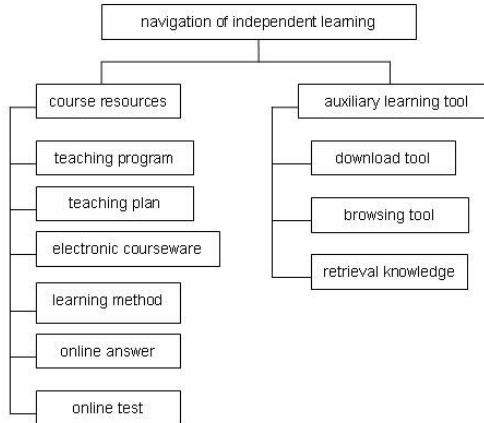
The network center in the college is in charge of technical support for the operation and maintenance of the network learning platform. The web design can be carried out based on Dream weaver software, and the image used in the web page can be designed based on Photoshop software. The web page of network independent learning platform applies the HTML-ASP dynamic and static mixed information mode. The network learning platform can be compatible with multiple file formats, such as “\*.doc”, “\*.ppt”, “\*.mp3”, “\*.rmvb”, “\*.mov” and so on. During the process of constructing to the network platform, teachers should be in charge of developing the teaching resources databases based on network technology.

### **(3) Navigation design of independent learning**

Independent learning network platform can offer a first-class self - study conditions. In order to make every engineering student use the platform easily, good navigation tools should be designed. Navigation design of independent learning network platform should manifest the idea of taking students for

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basis, navigation can help the engineering students overcome psychological fear, and the engineering students can use the network resources easily, then independent learning can be achieved. The navigation structure of independent learning platform is shown in figure 1.



**Figure 1 Navigation structure of independent learning network platform**

### **Design of independent learning process based network platform**

Under the independent learning network environment, independent learning based on metacognition includes the following learning activities: before independent learning, choice of learning task, setting the learning goals, and making learning plans. During the process of independent learning, students should search the help of network system, carry out independent inquiry, do self guided learning, and make self-records. After independent learning, students can show their learning achievements, carry out self-evaluation, and evaluate other students. Engineering students can find out existing problems during the process of independent learning, and improve the learning method. They can improve their independent learning ability through using the independent learning network platform, and they can design the proper learning procedure, and regulate their learning process.

### **Case study:**

In order to verify the effectiveness of independent learning network

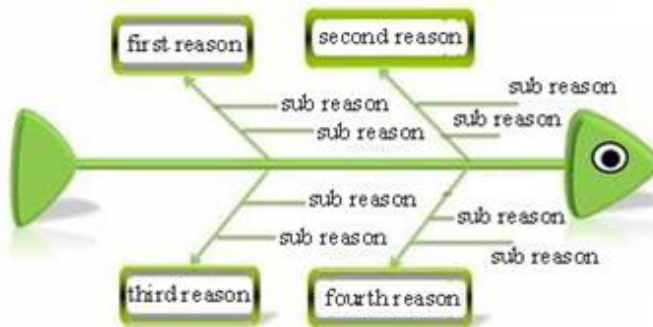
platform based on metacognition, a case study is carried out. The network platform “reliability theory” is established, and “reliability theory” is a professional basic course for them. This course is most closely linked with actual engineering problems as it is difficult to learn the network platform based on metacognition construction which can offer a good independent learning environment for engineering students. The layout of network platform is designed based on figure 1. The following main factors are considered:

(1) Enriching independent learning information

The network platform of course “reliability theory” includes the following materials:

- (a) Course information, such as teaching plan, teaching calendar and so on.
- (b) Outline of independent learning.
- (c) Outside reading materials and independent learning requirement.
- (d) Other learning resources, such as relating journal Web, blog, forum and so on.
- (e) Assignments and tests of independent learning.

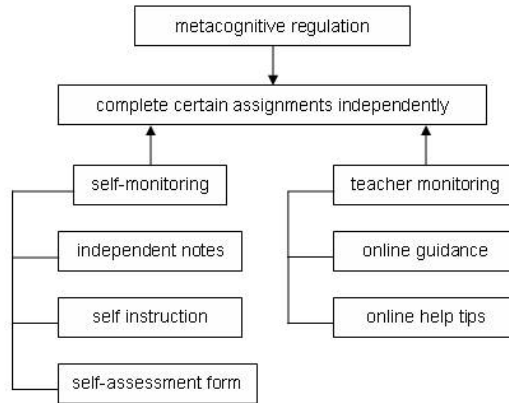
In order to make engineering students understand the learning content of course “reliability theory”, some pictures, animations, and videos can be put on the network platform. For example, causality diagram is common method for analyzing the fault reason in order to make students understand the basics of the theory. Corresponding figure should be shown to engineering students during the process of independent learning, which is shown in figure 2. They can understand the meaning of the causality diagram through seeing this figure.



**Figure 2** The causality diagram

## (2) Achieving self-control

Independent learning focuses on the autonomy of engineering students. However it takes some time for engineering students to learn controlled by themselves. Therefore the network platform should set the monitoring and managing mechanism, some modules are used in the network platform, which is shown in figure 3.



**Figure 3 The monitoring module of independent learning network platform**

## (3) Strengthening collaborative learning

The network technology can make engineering students conquer time and space, and make up for the disadvantage of communication and emotion interaction. Monitoring and control can be strengthened through collaborative learning. Students can deeply understand according to the evaluation of teachers and other students. They can understand knowledge, improve team work experience, and remove loneliness through communicating with other students and teachers. The common communicating tools can be put on the internet, such as BBS, MSN, QQ and so on.

This network platform is applied in the independent learning of “reliability theory”, and its effect on students is improved. Most of them can understand the basic theory of course “reliability theory”. The same time the independent learning ability of the engineering students is improved.

## Conclusion:

Independent learning network platform based on metacognition is

established, and students can obtain good independent learning environment. They should set clear learning objectives during the process of applying the network platform. The proper learning method can be applied, and blind learning can be avoided. Navigation system of independent learning network platform is important for improving the learning effect on students in order to go well. In addition, teachers should give appropriate help under network environment in order that students do not get lost in the process of independent learning. Based on the network platform, students can experience pleasure of independent learning, and get higher independent learning ability of specialized course to be suitable for the development of technology.

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