# Chapter 9
# Design of Theoretical Model for Smart Learning

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**Abstract** Smart learning is the learning activity which can enable high learning experiences, high content suitability, and high learning efficient. The research on smart learning and smart learning environment (SLE) is just at the very beginning. There has not been a mature research framework on smart learning. Thus, this paper proposes a theoretical model for smart learning, aiming to provide a research framework for smart learning. This theoretical model is composed of supportive SLE and smart learning cycle. SLE is an open-ended, intelligent, and integrated learning space based theoretically on constructivist learning theory, blended learning theory, and modern education methods, which is composed of the corresponding devices, tools, techniques, media, teaching resources, teacher communities, and learner communities. The smart learning cycle includes three factors of learner: metal system, learning behaviors, and outcomes. These three factors are connected by four types of interactions: the plan of smart learning from learner's mental system; the execution, monitoring, and evaluation of learning behaviors; the feedback from learning outcomes to learning behaviors; and the feedback from learning outcomes to mental system. This model could provide a framework for the further studies which aim at building an effective SLE by considering different features and factors of smart learning.

**Keywords** Theoretical model · Smart learning · Smart learning cycle · Smart learning environment

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## 9.1   Introduction

Technology is continuously transforming the way we live and work. The effect of information and communication technology (ICT) plays on reshaping education progressively appears. The way that ICT integrated into classroom has shifted from the initial peripheral participation in supporting the traditional teaching to the present key enabling factor that reshapes teaching and learning [1]. Bates [1] points out that technology reshapes learning from trends of online learning, blended and hybrid learning, open learning, and MOOCs. Actually, with the ICT infusing in education, it not only enriches the form of teaching and learning, but also radically transforms the requirement for talent who should have skills of global awareness, communication and collaboration, critical thinking and problem solving, social and cross-cultural skills, and self-direction and interactive. Namely, learning is understood more than merely the grasp of knowledge but cognitive skills, interpersonal skills, intrapersonal skills, and consideration [2], which calls for the radical reshaping of teaching and learning in the twenty-first century. However, a profound gap exists between the knowledge and skills most students learn in school and the knowledge and skills they need for success in the twenty-first century.

In order to prepare students with twenty-first-century skills in smart learning environment (SLE), we should firstly know what smart learning is like. Thus, a theoretical model for smart learning is critically needed. The paper first inspects the current study of smart learning and clarifies features of smart learning, on the basis of which the paper build a theoretical model for smart learning, aiming to provide a basis for the further study on smart learning.

## 9.2   Smart Learning and Smart Learning Environment

In 2008, IBM announced its smarter planet campaign, which aims to build a smarter planet of more instrumented, intelligent, and interconnected [3]. IBM kicks off a new era of "smart+" across all types of enterprises from "smart city," "smart transportation," "smart medical treatment" to "smart food." In response to the "smarter planet," researchers in education also coined the terms "smart education," "smart educational environment," and "smart learning." In the following of this section, features of smart learning and SLE are presented, and the theoretical foundations of the model to be constructed are clarified.

### 9.2.1   Features

The research on smart learning and SLE is just at the very beginning. There has not been a mature research framework on smart education, though some researchers

have started to explore some basic issues on smart learning and SLE. Some researcher defines smart learning as the learning mechanism that utilizes smart devices, along with cutting-edge ICT for education which emphasizes the devices used in learning are intelligent [4]. Smart learning is the learning activity which can enable high learning experiences, high content suitability, and high learning efficient [5]. It can also utilize modern scientific technology to provide students, teachers, and parents with a series of supportive and on-demand services. In addition, it can overall collect and apply data from both participants' status and teaching process to promote equity, continuous improvement of performance, and to cultivate excellence of learners.

The features of smart learning are concluded as sensible, adaptable, and caring [4]. Sensible refers to the state that various technologies (such as GPS, RFID, and QRCode), sensors (such as sensors for temperature, humidity, carbon dioxide, and illumination), and questionnaires are used to sense the environment indicators around learners and the learning features of them. Adaptable describes the condition that both the learning resources and the learning activities are on the individual's learning demand. Caring is the attitude that teachers and learners build and maintain a relationship of mutual trust through the process of learning.

As to SLE, scholars define it as a learning place or activity space of facilitating effective learning by perceiving learning scenarios, identifying the feature of learners, tracing learning process, and evaluating learning outcomes of learners [6]. In SLE, the boundary between physical and virtual worlds is eliminated, and it can provide students with seamless learning support and services. The featuring component of a SLE is smart tools with which learning scenarios can be identified, learning process can be traced, and the indicators of environment and learning features can be perceived.

With the changing of technologies, learning context as well as the learners' interests changes, but learning does change when it is understood as a naturally occurring process involving changes in what a person knows and can do [7]. The key element and the mechanism of smart learning are the issues that need further exploring; thus, this paper wants to build a theoretical model to explain this issue. In the following section, the paper first discusses the effective learning theory to lay a foundation for the model to build, on the basis of which a theoretical model for smart learning is built. The components of the model are further explained.

### 9.2.2  Theoretical Foundation

Although smart learning is different than traditional learning in learning context, learning methods, and learning strategies, learning does change when it is understood as a naturally occurring process involving changes in what a person knows and can do [7]. Thus, the construction of smart learning theoretical model should align with the effective learning theory in general.

On the whole, there are two different views on "what is an effective learning," which are "knowledge-conveying pattern" and "knowledge construction pattern." The traditional knowledge-conveying pattern believes that knowledge is objective existence; thus, learning is nothing but students receiving knowledge from experienced teachers and taking exams to demonstrate to what level they master the knowledge. Accordingly, the effectiveness of learning depends much on the teaching capability of teachers and the learning capability of individual learners. For the knowledge construction pattern, it insists that knowledge is not objective existence, and instead, it is acquired by learners through self-experience and construction in a certain context; thus, learning is a process of exploring and discovering on learners' own initiatives, and it should be controlled by learners themselves [8]. However, the "learning should be controlled by learners" does not necessarily mean that it is absolutely self-study without teachers. On the contrary, it is a process that learners acquire learning motivation, cultivate capability of self-directed learning, and develop the twenty-first-century skills of students through interaction.

From the view of constructivism and connectivism, smart learning is not simply to enhance the master of the existed teaching content prepared and delivered by teachers, but to provide several learning paths for learners or even allow students to design learning paths by themselves through the guidance of teachers, encouragement of peers, and the perception and support of SLE. In SLE, the process of teaching and learning is the process of interaction; therefore, the theoretical model for smart learning should made interaction as the core based on certain learning context. It is worth mentioning that the interaction transcends the one-way teaching content transfer, but extends it to the interpersonal interaction and human–environment interaction [9]. And interaction as the core to developing learners' twenty-first-century skills is the basic idea of smart learning, which provides a theoretical foundation for the construction of theoretical model for smart learning.

## 9.3 Proposed Theoretical Model for Smart Learning

A theoretical model for smart learning is proposed and shown in Fig. 9.1, which takes effective interactions as core of smart learning cycle and is supported by SLE. The smart learning cycle consisted of three factors, which are mental system, learning behaviors, and learning outcomes. Four types of interactions between learners and SLE connect the three factors, which are planning smart learning, executing, monitoring, and evaluating smart learning behaviors, feedback from learning outcomes to learning behaviors, and feedback from learning outcomes to mental system. In the following of this section, SLE in the theoretical model and each factors and interactions of the smart learning cycle are further explained.
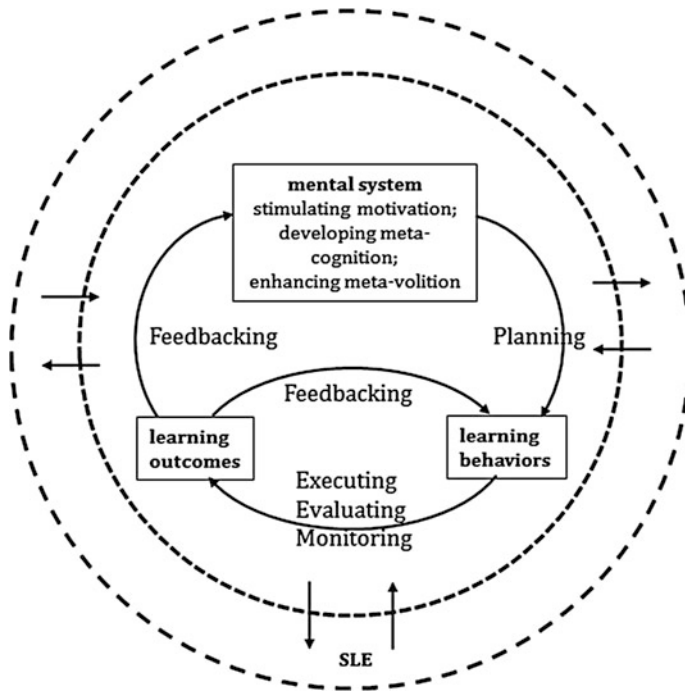
**Fig. 9.1** Theoretical model for smart learning

## 9.3.1 Smart Learning Environment (SLE) in Theoretical Model

Social constructionists believe that learning takes place in the process of conversation and social interaction [10]. By communicating with others, learners can examine and adjust their own views and, therefore, form the understandings toward things and their significance. In this sense, intelligent interactive environment plays a pivotal role in the formation of smart learning. Different scholars have presented conceptions of SLE from various perspectives. SLE is an open-ended, intelligent, and integrated learning space based theoretically on constructivist learning theory, blended learning theory, and modern education methods, which is composed of the corresponding devices, tools, techniques, media, teaching resources, teacher communities, and learner communities [11]. It is a type of learning space not only supports the self-construction of learners but also provides guidance in a timely fashion [11]. Malaysian scholars hold that SLE is based on the application of ICT centered on learners which provides support for lifelong learning in a way that adapts to different learning styles and abilities [12].

Reflected on the aforementioned demarcations, Huang et al. [6] define smart learning environment as "an activity space that is able to perceive learning situation

and learner profile, to provide appropriate learning resources and convenient interactive devices, to automatically record learning process and evaluate learning results in an effort to facilitate effective learning" [6]. The elements of smart learning include learning resources, intelligent devices, learning and teaching community, and learning and teaching styles [6].

On the technical level, SLE features four aspects, including the functions of tracking learning process, recognizing learning scenario, connecting learning communities, and perceiving physical environment, with a purpose of promoting easy, engaged, and effective learning. On the interactive level, SLE is characterized by equal interactive subjects, universality of the interactive contents, and edutainment of the interactive environment.

### 9.3.2   Smart Learning Cycle

Educational psychology research shows that the effectiveness of learning does not only depend solely on external environment. What is more, it asks learning environment and learning process to match with the mental features of learners [13]. Smart learning is the learning activity that involves the changes in mental system of learners. The factors and interaction of the proposed theoretical model are described in the following subsections.

**Factors**. The effective smart learning cycle consisted of three factors: metal system, learning behaviors, and learning outcomes.

*Mental System.* The key components of mental system are motivation for learning, meta-cognition, and meta-volition [13]. The mental preparation of effective smart learning includes arousing mental system of learners, developing meta-cognition, and enhancing meta-volition. To effectively arouse mental system of learners, we should arouse their motivation for learning, develop their meta-cognition, and enhance meta-volition. The condition for effective smart learning is that learners have the motivation for accepting learning tasks and want to participate in learning activities. Only when learners believe that the learning activities have positive value on their individual development will effective learning happen [14]. The supportive smart environment helps stimulate and sustain the learning motivation. Teachers, parents, and peers in SLE have multiple ways to communicate with the learners, through which it will help learners establish appropriate understanding on the relations between learning outcomes and learning behaviors. The smart tools cannot only provide instant feedback on the learning behaviors and help learners identify the value of their study, but also can indicate the gap between knowledge, skills, and anticipated learning outcomes by proposing challenging tasks that are relevant to learning goals, so that the learning motivation is motivated.

For the preparation of developing meta-cognition, learners should have three levels of effective cognition: cognition on learning, social cognition, and psychological cognition. Cognition on learning refers to the cognition that learners

understand their existing knowledge level, cognition styles, cognition strategies, and learning tasks, and how to attribute their learning outcomes; social cognition refers to the cognition by which learners understand and identify the social context of the SLE; psychological cognition refers to the cognition by which learners understand and identify the emotion that affects the implementation of learning tasks, including their concerns on learning goals, anticipation on learning, and values orientation. Obviously, learners' understanding on their knowledge level affects their learning motivation, and social cognition affects their engagement and benefits in SLE. Psychological cognition affects the involvement and their selection in learning behaviors.

Teachers and smart interactive tools are two factors that decide whether learners' meta-cognition will be fully developed. Teachers as one of the key components in SLE help learners to develop adequate expectation of learning outcomes through systematic instruction or organizing group discussion and reflection. Smart tools in SLE can for one hand track and record learning process and learning outcomes. It can also provide adaptive test for learners and analyze the test outcomes so that the learners and teachers will be informed with the learners' knowledge level.

For the preparation of enhancing meta-volition, meta-volition is the will by which learners engage in learning activities, fully make use of curriculum resources, and persevere in learning. Stable and strong meta-volition is the psychological guarantee depends on which sustaining effective learning happens. Teachers should create a cooperative atmosphere in SLE, an environment that is safety for exploring and experiencing. Besides, the user-friendly interactive interface and interactive tools will reduce the barriers when they are learning in SLE, which will improve learners' activity engagement, and the frequency and efficiency of group communication.

*Learning Behaviors.* Behaviors are a series of purposeful, motivated activities. Learning behaviors are two-way interactions between learners and learning environment, aiming to cause the relatively stable changes in what learners know and what they can do. Learners in SLE can decide learning goals and learning progress and select adequate learning strategies by themselves. What is more, learners can use the interactive tools provided by SLE to communicate with each other on a certain subject, and learning through online or face-to-face collaboration. These learning behaviors in SLE can be summarized as behaviors of information retrieval, information processing, information release, and interpersonal communication.

*Learning Outcomes.* Gagne classifies human's learning outcomes into five categories that include intelligent skills (procedural knowledge), verbal information (declarative knowledge), cognitive strategies (executive control processes), motor skills, and attitudes [15]. Each of these categories may encompass a broad variety of human activities. In this theoretical model, various learning outcomes are resulted from the different interactions in SLE.

**Interactions**. The three factors are connected by four types of interactions: planning smart learning, executing, monitoring, and evaluating on learning behaviors to learning outcomes, feedbacking to mental system, and feedbacking to learning behaviors.

*Planning Learners' Smart Learning.* Research shows that the level of learning strategy is relatively low, and learners lack the skills in self-directed learning and do not clearly know the relations between the learning environment and learning tasks are the common reason that will result in the failure of learning [16]. Firstly, teachers and smart tools in SLE should guide learners to plan practical and realizable goals and develop supportive social interactive environment on the basis of the recording and analyzing of learning behaviors. Secondly, teachers and learners use smart tools to analyze the learners' learning styles and knowledge status, and identify the correlation between the learning tasks and the former learning. Finally, teachers should help learners to divide the learning tasks into smaller and easier learning tasks.

*Executing, Monitoring, and Evaluating Smart Learning Behaviors.* The effectiveness of learning behaviors directly determines the effectiveness of learning results. Learning behaviors is a process where learners conduct learning activities according to plan by making the best of learning resources and smart learning tools in the learning environment.

To execute learning tasks effectively is a core link determining the results of smart learning. Within it, learners achieve learning targets through assimilation, obedience, integration, deduction, and retrospect; teachers in this stage facilitate learners in conducting learning tasks through an array of teaching methods and strategies. In practice, the choices of the methods and strategies are subject to teaching contents and goals, and SLE provides supports for conducting learning tasks and promoting successful learning practices. Effective monitoring of learning behaviors is a course where learners, guided by goals of learning, select the optimal routes of learning. In smart learning, learning control is divided into self-control and external control. It is also called internal control. Self-control refers to a process where learning resources and learning activities are selected and learning opportunities are created by learners to satisfy their learning demand, while external control functions in a way that teachers or smart learning tools dictate the topic, contents, targets, and routes of learning through highly structured curriculum that guarantees the whole learning process is on schedule [17]. None of effective learning is realized independently through internal or external control; instead, it is realized through the cooperation of internal and external controls.

Effective evaluation helps learners correctly assess their command of knowledge and skills, and therefore stimulates them to engage in new learning tasks. Speaking about evaluation or evaluation on learners, it should be emphasized that the role of evaluation is not for rating or a device-driving learners to finish their assignments, but for providing further learning feedback [18]. SLE not only assists learners in evaluating commands of the knowledge that is being learned, but also provides them with an emotional safety environment via the sharing of learning results and failures and sufferings in learning. Smart interactive tools record and store learners' achievements in a way that is convenient for learning reflection and further evaluate themselves through a comparison with peers.

*Feedbacking from Learning Outcomes to Learning Behaviors.* The most direct outcome of effective learning is the realizing of learning targets and the improving

learner's learning behavior such as their learning strategies and tactics. In the network interactive environment, teachers and other adults should help learners with an attribution analysis on learning outcomes. By recognizing both achievements and shortcomings, it motivates learners to make further efforts.

*Feedbacking from Learning Outcomes to Mental System.* Learning outcomes have a feedback effect on learners' mental system and learning behaviors as shown in Fig. 9.1. Feedback on mental system gives rise to change of learners' learning motives, meta-cognition, and the primary consciousness. In this process, other members in the SLE conduct a discussion, analysis, evaluation, doubts, and debate over the learner's learning results so as to help the learner reflect on his or her learning behaviors. Yukawa [19] noted in an empirical study that effective learning will change learners' level of skills and learning strategies so that learners' learning behaviors will become more skill and purpose oriented. In the next round of learning, learners will make clearer learning targets, and their learning behaviors become more effective. Lifelong learning ability is acquired exactly when learners effectively and voluntarily control their own learning behaviors.

## 9.4   Discussions and Conclusion

The learning and teaching activities of SLE are the interactive activities and learning behaviors which happen in a smart learning cycle of learning environment. Therefore, in the proposed theoretical model, an effective smart learning cycle should consider three factors of learner: metal system, learning behaviors, and outcomes. These three factors are connected by four types of interactions: the plan of smart learning from learner's mental system, the execution, monitoring, and evaluation of learning behaviors, the feedback from learning outcomes to learning behaviors, and the feedback from learning outcomes to mental system.

In addition, each factor is also supported by SLE in various ways such as supervision, evaluation, and correction. For example, teachers or other adults supervise the learning progress using smart tools in order to provide decision information relating to the correction of goals and strategies of learning. In another example, teachers can organize group supervision inside the learning community, which results in an empathic emotion of the success and failures of learning through among group members through discussion and interaction; network and intelligent technologies help to reduce learners' cognitive burden on learning supervision by effectively recording the learning results of the group and other peers, as well as their learning strategies. At the meantime, learners handle problems occurring in the learning process by editing, adjusting, and reconstructing materials relating to learning behaviors and strategies in an effort to realize their learning goals.

In conclusion, this study provides a theoretical foundation for designing the theoretical model of smart learning. Moreover, this model could also provide a framework for the further studies which aim at building an effective SLE by considering different features and factors of smart learning.

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