Chapter 2
Contexts of Smart Learning Environments

Abstract Considering the importance of education and learning for the development of creativity and sustainability of a city, smart learning environments (SLE) could be regarded as a response to the needs of the new knowledge society. This chapter aims to analyze smart learning environments in a broader way by integrating both formal and informal learning, as well as physical and virtual spaces in city learning scenarios. After proposing the definition of smart learning environments, we analyze the six aspects of smart learning environment which are: learning resources, learning tools, learning communities, teaching communities, ways of learning and ways of teaching. We also propose a system model and TRACE[3] functional model of smart learning environments. Finally, we analyze the five typical smart learning environments in a smarter city: "self-learning", "inquiry learning", "learning in doing", "learning in working", and "classroom learning".

Keywords Smart learning environments · Smarter city · Digital learning environments · Learning scenario

2.1 Introduction

We live in an information society where the creation, distribution, use, integration and manipulation of information has a significant impact on economic, political, and cultural development of the city. With the expansion of the digital world every sector of the society has been influenced by information technology. The digital world is a combination of the real world, and virtual world, thus, people's life style and ways of working have changed as well as the ways of learning. Nowadays, people learn everywhere, not only formal learning in classroom, but also informal learning at home and society. The spaces of formal and informal may be physical places or virtual environments, which could be called learning environments in cities. Learning environments in smart cities include school learning spaces, home learning spaces, community learning spaces, working places, learning stadiums, and other virtual learning spaces. The aim of smart learning environments is to

increase the public opportunities to learn, to improve the scientific literacy and knowledge acquisition capacity of citizens, and to upgrade the city's soft power.

With the development of information technology, the learning ways of mobile learning and digital learning became increasingly universal, digital learning resources constantly became richer, and the demands for personalized and smart learning became stronger. Smart learning environments should be built to provide smart learning opportunities for different kinds of people to meet the diverse learning needs. In a smart learning environment, learners can learn at any time, any place, any way, and at any pace. This kind of learning environment can also support learners with the experience of easy, engaged and effective learning. In other words, smart learning environments engage and integrate formal and informal learning in order to create autonomous adaptive learning environments for supporting individual learners with real-time and seamless learning experiences in ubiquitous settings (Kinshuk et al. 2016).

The term of future learning environment (Sevindik 2010), smart classroom (Lui and Slotta 2014), learning spaces (Long and Ehrmann 2005), smart campus (Kwok 2015), technology-enhanced learning (Chan et al. 2006), etc. are similar to smart learning environments, as all these concepts to refer to utilizing information technology to build for learners a personalized and adaptive learning environment. Hwang (2014) mentioned that technology-enhanced learning can be perceived as smart learning systems. In fact, smart learning environments are integration and combination of lots of different systems, such as intelligent tutoring, learning analytics, educational data mining, adaptive learning, and personalized learning (Yang et al. 2015).

However, the literature on smart learning environments indicates that the research of smart learning environments mainly focused on the technologies and pedagogies, and only few research had been done from a citizen's learning perspective. Therefore, the aim of this chapter is to analyze the definition, elements, functions, and scenarios of smart learning environments in a broader way by integrating both formal and informal learning in physical and virtual spaces in city learning scenarios.

The following sections will identify the definition of smart learning environments, as well as the differences between smart learning environments and digital learning environments. The learning modes in the smart learning environments of school, home and society will be described in Sect. 2.3. The constituent elements and functional model will be proposed in Sect. 2.4. The typical smart learning environments of self-regulated learning, inquiry learning, learning in doing, learning in working, and classroom learning will be discussed in Sect. 2.5.

2.2 Definition of Smart Learning Environments

With the development of ICT in education and considering scaling up the innovation of technology enhanced learning, researchers begun to conceptualize how learning environments can be made more effective, efficient, and engaging on a

large and sustainable scale (Spector 2014). The concepts of next generation learning space, smart learning environment, and smart classroom emerged. Learning space is a new emerging research area, with the aim to promote independent, flexible, and engaged learning by providing learner with appropriate technology and pedagogy (Huang et al. 2015). Smart Learning Environments (SLE) are defined as physical environments that are enriched with digital, context-aware and adaptive devices, to promote better and faster learning (Koper 2014). With technology support, smart classrooms become places where teachers and students could have rich and immersive teaching and learning experiences that they have never experienced before (Li et al. 2015). Hwang (2014) presented the definition and criteria of SLE from the perspective of context-aware ubiquitous learning. He also introduced a framework to address the design and development of SLE to support both online and real-world learning activities.

Zhong and Zhang (2006) presented that smart learning environments were a learner-centered intelligent, open, integrated digital virtual reality learning space. He maintained that the core elements of smart learning were corresponding equipment, tools, technology, media, textbooks, teachers, and students, etc., and all these core elements should be organized according to constructivist learning theory, blended learning theory and modern teaching theory. Chin (1997) argued that "smart learning environments were a learner-centered environment based on the application of information and communication technology, with the following characteristics: ① Adapt to different learning styles and learning abilities of learners; ② Provide support of lifelong learning of learners; ③ Provide support of the development of learners." Based on the above points of view and the analysis of the developmental trends of technology-enhanced learning, smart learning environments should have the following characteristics:

1. Smart learning environments should integrate physical environment and virtual environment. In the smart learning environment, the perceptive, monitoring and regulating functions of physical environment are further enhanced. The application of the technology of augmented reality create the seamless integration of virtual environment and physical environment.
2. Smart learning environments should provide better learning support and services according to the individual characteristics of learners. Smart learning environments emphasize the process record, personalized assessment, and evaluation of effects and content delivery of learners' learning. According to the learner model, it plays significant role in planning, monitoring and evaluation in the development learner's learning capabilities.
3. Smart learning environments support in-campus learning and off-campus learning, formal learning and informal learning. The learners in this situation are not only the campus learners, but also all people that have requirements of learning in their work.

Therefore, we regard smart learning environments as the learning place or an activity space that can aware learning scenarios, identify the characteristics of learners, provide appropriate learning resources and convenient interaction tools, automatically record the learning process and evaluate learning outcomes in order to promote the effective learning of the learners.

Smart learning environments are the high-end form of common digitalized learning environments, which are the inevitable result of the development of educational technology. There are significant differences in six aspects of learning resources, learning tools, learning communities, teaching community, learning methods and teaching methods between smart learning environments and common digitalized learning environments, as shown in Table 2.1.

Table 2.1 The comparison of digitalized learning environments and smart learning environments

	Digital learning environment	Smart learning environment
Learning resources	(1) Digital resources are based on rich media; (2) Online access becomes the mainstream; (3) Users select resources	(1) Digital resources are independent of the devices; (2) Seamless connection or automatic synchronization becomes fashionable; (3) on-demand resources
Learning tools	(1) All-function in one tool, systematized tools; (2) Learners judge the technology environment; (3) Learners judge the learning scenarios	(1) Specialized Tools are specialized and miniaturized tools; (2) Technology environment is automatically sensed; (3) Learning scenarios are automatically recognized
Learning community	(1) Virtual community is focused on online communication; (2) Self-selected community; (3) Restricted to information skills	(1) Combined with the mobile interconnected real community to communicate anytime and anywhere; (2) Automatically matched communities; (3) Depends on media literacy
Teaching community	(1) Difficult to form a community, which is highly dependent on experience; (2) Make the regional community possible	(1) Automatical∼ly form community, which highly concerns about the users' experience; (2) Make the cross-regional community fashionable
Learning methods	(1) Focus on individual knowledge construction; (2) Focus on low-level cognitive objectives; (3) Unify evaluation requirements; (4) Interest becomes the key to the diversity of learning methods	(1) Highlight the knowledge construction of community collaboration; (2) Focus on high-level cognitive objectives; (3) Multiple evaluation requirements; (4) Thinking becomes the key to the diversity of learning methods
Teaching methods	(1) Emphasize resource design and explanation; (2) Emphasize summative evaluation of the learning outcomes based on the learners' behaviors; (3) Emphasize observation of learning behaviors	(1) Emphasize activity design and guidance; (2) Adapt the evaluation of learning outcomes based on the cognitive characteristics of learners; (3) Intervene in learning activities

2.3   Learning Modes in Different Smart Learning Environments

In the ideal smart learning environments, every learner holds an intelligent mobile device (such as iPad) in his/her hand. Its screen is of the size close to printed textbooks. It can imitate all functions of printed textbooks, such as taking notes, inserting bookmarks, making markings and annotations, etc., and has the effect of turning papers as with printed textbooks. This type of "textbook" equipped with intelligent mobile devices is called e-textbook. The contents of e-textbooks are presented via multimedia. The links between knowledge points based on semantic relations can realize the personalized presentation of knowledge contents. Binding with the learning progress of the learners, e-textbooks can realize the synchronized cloud service of learning data, which can record the learning process of the learners, intelligently analyze the learning outcomes of the learners, present the analysis results in graphs and provide guidance and help to the learning of the learners in accordance with the viewpoints of teachers. For campus students, smart learning environments will make their learning in school, at home and in the community full of intelligence.

In the learning on campus, teachers can make use of augmented reality technology to present a variety of authentic learning scenarios, so that students can experience immersive learning objects to enhance their learning interests and motivations. According to the learning records of students in the system, teachers emphasize on the instruction of the knowledge points that students have difficulty and use the rich learning resources to design a variety of learning activities. They can flexibly control the learning terminals and provide real-time delivery of relevant learning resources with an integrated classroom control system. They can make fast grouping according to the characteristics of learners, so as to facilitate the organization of collaborative learning in class.

Students can use the convenient interactive tools provided by the system to interact with peers and teachers. They can also use the built-in voting machine to have real-time interaction with teachers so that teachers can obtain their feedbacks at the first time to adjust instruction based on the feedback information in time. Smart learning environments can provide intelligent support of instructional design to help the teachers with the instructional design in the classroom. It can automatically correct and analyze the homework and test papers submitted by students. It also provides social networking tools for facilitating the contact between teachers and students, and among students. This includes synchronous communication tools such as QQ, MSN, etc. and asynchronous communication tools such as micro-blog, virtual learning communities, etc.

In learning at home, students can use e-textbooks to preview the lessons and complete the assignments at home. While previewing the lessons, they mark out the important points and try to complete the assignments after the preview. The system can automatically give the feedback of the results of the assignments, offer tips and answers to difficult problems and provide the structure chart of the relationship of

knowledge points in accordance with the main and secondary knowledge points. The system can record the situation of the completion of students' homework, so teachers can provide targeted instruction and personalized guidance to the students according to the statistics. Smart learning system provides one-on-one counseling function to facilitate the students to "call" the teachers when they need learning guidance. Parents can know about the leaning progress on campus of their children from the learning records provided by e-textbooks, and their electronic signatures can be conveniently transmitted the school management system via e-textbooks.

In the social learning, smart learning environments can perceive the location of the learner. SLE will deliver the learning resources related to the environment of the learner according to their location and the learning style, so as to achieve adaptive ubiquitous learning. In some circumstances, it can divide the learners into groups according to their locations. For instance, it can put the learners in the same location in a group to meet their requirements of collaborative learning in authentic scenarios. Smart learning environments can provide the most suitable learning path and the most appropriate learning methods for learner.

For the adults and off-campus learners, smart learning environments can organically integrate formal learning with informal learning, to meet the citizen's needs of life-long learning, to adapt to the requirements of campus learning, home learning and social learning so as to truly realize the concept of "seamless learning".

2.4 The Constituent Elements and Technical Features of Smart Learning Environments

As shown in Fig. 2.1, the constituent elements of smart learning environments include six components: resources, tools, learning communities, teaching community, learning ways and teaching ways.

1. Smart learning environments mainly consist of the six elements of learning resources, intelligent tools, learning community, teaching community, learning ways and teaching ways.
2. Learners and teachers interrelate and interact with the other four elements by the teaching ways and learning ways, so as to promote the effective learning of learners together. If the learning ways and teaching ways were taken out, smart learning environments cannot be regarded as learning environments.
3. The occurrence of effective learning is the mutual result of individual knowledge construction and group knowledge construction. Learning community emphasizes the interaction, collaboration and exchange of learners, while teaching community is a continuum where teachers learn together, work collaboratively to pursue continuing professional development.
4. Learning resources and intelligent tools provide support of both learning community and teaching community. The development of learning community and teaching community is inseparable from the mutual effects of resources and
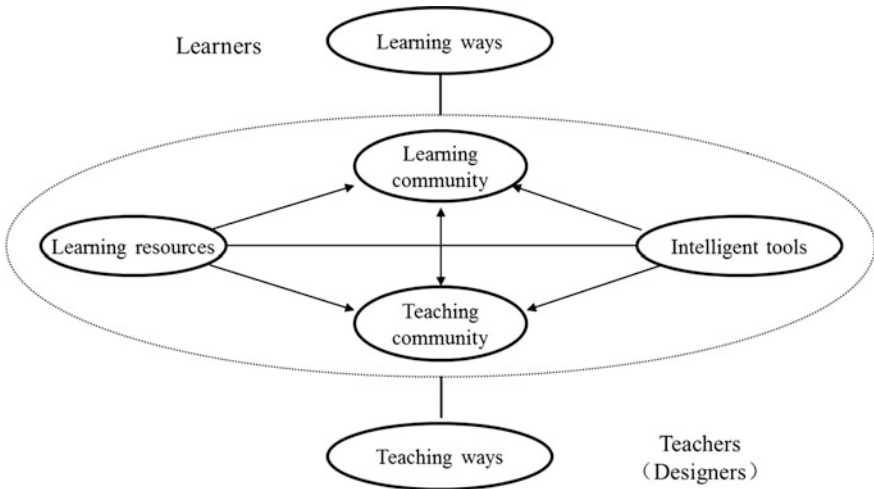
Fig. 2.1   The system model of smart learning environments

tools. All kinds of intelligent tools provide comprehensive support of the "intelligence" of the learning environments. At the same time, learning community and teaching community advance the evolution of resources and tools.

The technical features of smart learning environments are mainly reflected in the five aspects: tracking, recognizing, connecting and awareness, with the aim to promote easy, engaged and effective learning of learners.

1. Tracking learning process. Smart learning environments can be aware of and track the status of learners in the aspects of knowledge acquisition, classroom interaction, group collaboration, etc. By using technologies of motion capture, emotion computing and eye movement, SLE can track the learning process, analyze learning outcomes and establish the learner model, which provides important basis for providing more comprehensive and accurate assessment of the learning effects of the learners.
2. Recognizing learning scenario. Smart learning environments can provide personalized resources and tools for learners according to the learner model and learning scenarios to facilitate the occurrence of effective learning. It can recognize learning scenarios, including learning time, learning place, learning peers and learning activities. The recognition of learning scenarios provides support of teaching activities.
3. Awareness of physical environment. Smart learning environments can monitor air, temperature, light, sound, smell and other physical environmental factors with sensor technology to provide learners with a comfortable physical environment.
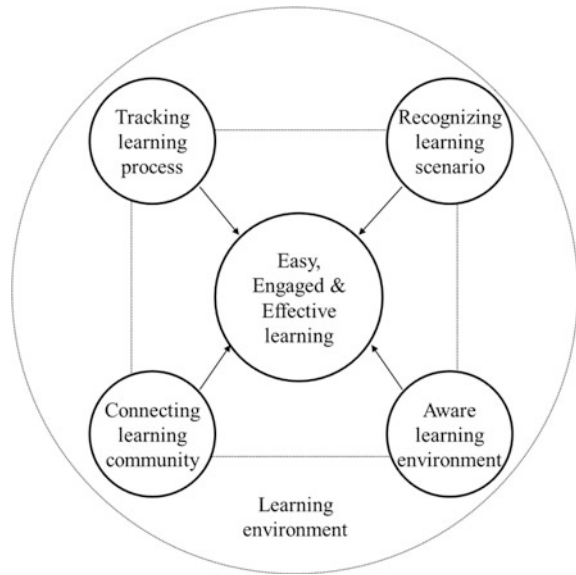
4. Connecting learning community. Smart learning environments can set up
   learning community for specific learning scenarios and provide support of the
   learners for their effective connecting and using learning community for com-
   munication and exchange.
5. Easy, engaged and effective learning. The objective of smart learning envi-
   ronments is to create the tracking, recognizing, awareness and connecting
   conditions for learning so as to promote the easy, engaged and effective learning
   of the learners.

The technical features of smart learning environments, described above have
also their functional requirements, referred to as TRACE³ functional model of smart
learning environments shown in Fig. 2.2.

2.5   Typical Smart Learning Environments

With the changes of learning scenarios, the requirements of learners in smart
learning environments are different from the previous generation of learners. Huang
et al. (2010) believe that learning scenario refers to the comprehensive description
of one or a series of learning events or learning activities, that comprehensively
describe the four elements of a learning scenario that are: learning time, learning
place, learning peer and learning activities. Accordingly, the learning scenarios can
be categorized into five typical learning scenarios, which are "classroom learning",
"self-learning", "inquiry learning", "learning in doing" and "learning in working".
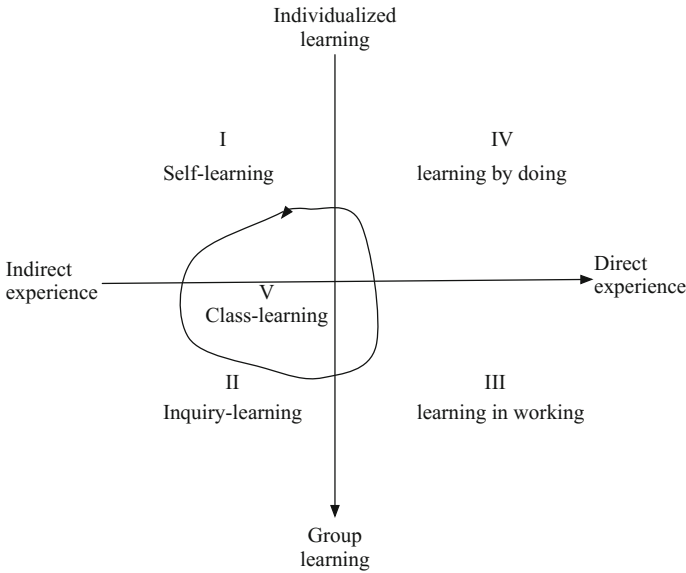
Fig. 2.3 The classification framework of learning scenarios

If the learning scenarios are studied in the two dimensions of the approaches of knowledge construction and those of knowledge acquisition, the classification framework of learning scenarios can be summarized as shown in Fig. 2.3.

Knowledge construction and knowledge acquisition are the two dimensions of studying the diversity of learning scenarios. Each dimension has two different orientations, which are individual learning and community learning of knowledge construction and indirect experience and direct experience of knowledge acquisition. Correspondingly the four quadrants of two-dimensional coordinates exist four learning scenarios, which are "self-learning", "inquiry learning", "learning in doing" and "learning in working".

According to the categories of learning scenarios, smart learning environments should provide the support of "self-learning", "inquiry learning", "learning in doing", "learning in working" and "classroom learning".

2.5.1 Smart Learning Environment Supporting "Self-learning"

"Self-learning" refers to a pre-agreed or voluntary learning behavior of learners, usually without teachers smart learning d mentoring, but with specific learning contents, pre-set learning objectives and evaluation methods. This type of scenarios is more flexible without fixed time and location, but in the learning process the

learners are easy to feel lonely and difficult to get help, which has high demands for
the readability of the learning materials and personal interests in learning. The smart
learning environments that is suitable for this type of learning scenario should have
the following features:

1. Learning Resources. In terms of the contents, the provided learning resources
   include digitalized media materials, online or offline digitalized courses, etc. In
   terms of the form, the provided learning resources should be of clear structures
   and lively forms, with the features of self-organization and rich media. In terms
   of the approach of acquisition, it allows the learners to have free access to the
   contents that have close relevance to the learning themes, which can be adopted
   at any time they want.
2. Intelligent tools. In order to accomplish the pre-set learning objectives, the tools
   typically include learner model measurement tools, information delivery tools,
   learning track recording tools and learning outcome evaluation tools, etc.
3. Learning community. The knowledge construction of learners is the mutual
   results of individual construction and community construction. The learning
   scenario of "self-learning" tends to the individual knowledge construction, while
   the establishment of learning community aims to encourage regular communi-
   cation and exchanges among the learners in order to relieve the sense of lone-
   liness in self-learning.
4. Teaching community. In order to promote the self-learning of the learners,
   teachers establish learning communities to study the teaching contents, learning
   support approaches, teaching methods, the design of learning resources and
   learning tools together. The establishment of teaching community contributes to
   professional development of teachers and also to the smooth progress of
   instruction.

2.5.2   Smart Learning Environment Supporting "Inquiry Learning"

"Inquiry learning" refers to the learning form with participation in small groups and
discussion as the main communication approach, which usually have specific dis-
cussion topics, moderate scales of members and strong organizers. The participants
in this learning scenario can easily become interested, but the organizers are
required to have strong organizational skills and good interpersonal
relationship. The smart learning environments that is suitable for this learning
scenario should have the following features:

1. Learning Resources. This type of learning scenario does not require a large scale
   of resources. It allows the learners to access to the contents correlated to the
   learning topics for the use at any time, but requires the teachers or organizers to
   prepare a high-quality inquiry topic in advance.

2. Intelligent tools. In order to accomplish the pre-set learning objectives, the tools typically include learner presentation tools, learner interaction analysis tools and learning outcome evaluation tools, etc.
3. Learning community. This type of learning scenarios tends to community knowledge construction and the establishment of learning community is the foundation of inquiry learning.
4. Teaching community. The teaching community established in this scenario is to facilitate the communications among teachers of the same subject and promote the development of the instructional design of theme-based classroom teaching.

2.5.3   Smart Learning Environment Supporting of "Learning by Doing"

"Learning by doing" refers to the learning form of implanting the activities of o facilitate the communications among teachers of the same subject and promote the development of the learning tasks and learning objectives, that of evaluation methods and tasks, that of support services and students and that of organizational forms and learning environments. The participants in this type of learning scenario can easily develop interest and acquire better learning results. As it may be difficult to get help when encountering difficulties, they are more dependent on the design of working tasks and the support services of learning. The smart learning environments that are suitable for this learning scenario should have the following features:

1. Learning Resources. In terms of the contents, the provided resources usually include the background information of working tasks and the support services of learning. In term of forms, the provided resources should be of clear structures, lively forms, with the features of self-organization, rich media and ubiquity. In terms of the approach of acquisition, it allows the learners to have free access to the contents that have close relevance to the learning themes, which can be adopted at any time they want.
2. Intelligent tools. In order to accomplish the pre-set learning objectives, the tools typically include learner model measurement tools, information delivery tools, learning track recording tools and learning outcome evaluation tools, etc.
3. Learning community. The knowledge construction of learners is the mutual results of individual construction and community construction. The learning scenario of "learning by doing" tends to promote individual knowledge construction, while the establishment of learning community aims to encourage regular communication and exchanges among the learners.
4. Teaching community. The teaching community in this type of learning scenario can help to predict in advance the difficulties that may take place in the "learning by doing" of the learners and provide relevant support.

2.5.4 Smart Learning Environment Supporting "Learning by Working"

The learning scenario of "learning by working" is a learning from experience gathered during in practical work, which is commonly used in corporation training. It usually requires the contents based on practical work, working tasks matching with the intensity of work and interpersonal relationship suitable for learning. Learners normally have interests in learning in working, but they are often unable to handle the relationship between working and learning, so it is of greatly importance to create the learning atmosphere in the organizations and improve the personal learning skills. The smart learning environments that are suitable for this type of learning scenario should have the following features:

1. Learning Resources. The learners usually put forward the practical problems or tasks in their work in the form of topics to cause the mutual discussion among their fellow leaners. The provided resources include digitalized media materials related to the topics, online or offline digitalized courses, etc. In terms of the forms, the provided resources may be loose and unstructured, but have to relate to the topics. In terms of the approach of acquisition, it allows the learners to have free access to the contents that have close relevance to the learning themes, which can be adopted at any time they want.
2. Intelligent tools. In order to accomplish the pre-set learning objectives, the tools typically include learner model measurement tools, information delivery tools, learning track recording tools and learning outcome evaluation tools, etc.
3. Learning community. The knowledge construction of learners is the mutual results of individual construction and community construction. The learning scenario of "learning by working" tends to the individual knowledge construction, while the establishment of learning community aims to encourage regular communication and exchanges among the learners.
4. Teaching community. The teaching community of this type of learning scenario tends to provide support of the difficulties that the learners may have in their "learning by working".

2.5.5 Smart Learning Environment Supporting "Classroom Learning"

The learning scenario of "classroom learning" refers to the learning in a real classroom or similar environments, which is a collective learning behavior, usually in the form of classes with fixed teaching environment, the teachers for face-to-face instruction and prepared teaching contents and assessment requirements. This type of scenario mainly focuses on knowledge delivery, which usually lacks of exchange opportunities. The learning outcomes are highly dependent on the teachers' teaching skills and the learners' existing foundations and their interests in the

contents. The smart learning environments that are suitable for this type of learning scenario should have the following features:

1. Learning Resources. In terms of learning contents, the provided resources are well-structured media materials designed by the teachers. In terms of content control, it generally does not allow the learners to have free access to or browse the contents that are irrelevant to the learning topics, so the learners can only acquire the contents that have greater relevance to the teaching topics, such as teachers' lecture scripts, special topic websites and special topic resource base and so on.
2. Intelligent tools. In order to accomplish the pre-set learning objectives, the tools typically include learner model measurement tools, information delivery tools, learning track recording tools and learning outcome evaluation tools, etc.
3. Learning communities. The knowledge construction of learners is the mutual results of individual construction and community construction. The learning scenario of "classroom learning" tends to the individual knowledge construction, while the establishment of learning community aims to encourage regular communication and exchanges among the learners.
4. Teaching community. The teaching community of this type of learning scenario tens to establish learning community for the teachers to study the teaching contents, learning support approaches, teaching methods, the design of learning resources and learning tools together. The establishment of teaching community contributes to professional development of teachers and also to the smooth progress of instruction.

2.6   Discussion

The smart learning environments not only consist of intelligent tools, learning resources, learning community and teaching community, but also the learning ways and teaching ways, which make the learning environments "smart" according to the different needs of learners. The TRACE[3] model proposed in the chapter is just a tentative effort to describe the functions of smart learning environment. More research should be done on the issues related to advancing current learning environments towards smart learning environments. These research should investigate such issues like the limitations of existing learning environments, need for reform of educational system, innovative uses of emerging pedagogical approaches and technologies, sharing and promotion of best practices, design and implementation of smart learning environments. We call for action in the following areas for promoting SLEs research and practice:

1. Research on smart learning environments calls for efforts from different areas such as education, computer science, psychology and engineering. The communication and collaboration in these areas are the basis for the development of SLEs.

2. New emerging technologies such as intelligent system, the Internet of Things, cloud computing should be integrated into the smart learning environments to support learning and teaching.

3. Personalized learning is the basic rule for design of smart learning environments, and high users' experience is the first principle. The research on how to improve the users' experience in SLE seems to be especially important.

4. The role of teachers in smart learning environments must change from that of an instructor to that of a facilitator. The community of teachers is a leading element of SLEs. Technological Pedagogical Content Knowledge (TPACK) has emerged as a useful frame for describing and understanding the goals for technology use in faculty development.

5. International collaboration on principles of smart learning and among different researchers is necessary to share case studies, promote innovations and best practices.

References

Chan, T.-W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., et al. (2006). One-to-one technology-enhanced learning: An opportunity for global research collab-oration. *Research and Practice in Technology Enhanced Learning, 1*(1), 3–29.

Chin, K.W. (1997). *Smart learning environment model for secondary schools in Malaysia: An overview* [*EB/OL*]. 10 October, 2011. http://www.apdip.net/projects/seminars/it-policy/cn/resources/kangwaichin/smartlearning-mimos.ppt

Huang, R., Chen, G., Zhang, J., & Wang, Y. (2010). Research on informationization learning mode and its digital resource form. *Modern Distance Educational Research, 6*, 68–73.

Huang, R., Hu, Y., & Yang, J. (2015). Improving learner experience in the technology rich classrooms. In: Kinshuk & R. Huang (Eds.), *Ubiquitous Learning Environments and Technologies* (pp. 243–258). Berlin, Heidelberg: Springer. doi:10.1007/978-3-662-44659-1.

Hwang, G.-J. (2014). Definition, framework and research issues of smart learning environments—a context—aware ubiquitous learning perspective. *Smart Learning Environments, 1*(1), 4. doi:10.1186/s40561-014-0004-5.

Kinshuk, Chen, N. S., Cheng, I. L., & Chew, S. W. (2016). Evolution is not enough: Revolutionizing current learning environments to smart learning environments. *International Journal of Artificial Intelligence in Education, 26*(2), 561–581. doi:10.1007/s40593-016-0108-x.

Koper, R. (2014). Conditions for effective smart learning environments. *Smart Learning Environments*, *1*(1). doi:10.1186/s40561-014-0005-4

Kwok, L. (2015). A vision for the development of i-campus. *Smart Learning Environments, 2*(1), 2. doi:10.1186/s40561-015-0009-8.

Li, B., Kong, S. C., & Chen, G. (2015). Development and validation of the smart classroom inventory. *Smart Learning Environments*, *2*(1). doi:10.1186/s40561-015-0012-0.

Long, P. D., & Ehrmann, S. C. (2005). Future of the learning space: Breaking out of the box. *Educause Review*, 40(August), 42–58. Retrieved from http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume40/FutureoftheLearningSpaceBreaki/157992

Lui, M., & Slotta, J. D. (2014). Immersive simulations for smart classrooms: Exploring evolutionary concepts in secondary science. *Technology, Pedagogy and Education, 23*(1), 57–80. doi:10.1080/1475939X.2013.838452.

Sevindik, T. (2010). Future's learning environments in health education: The effects of smart classrooms on the academic achievements of the students at health college. *Telematics and Informatics, 27*(3), 314–322. doi:10.1016/j.tele.2009.08.001.

Spector, J. M. (2014). Conceptualizing the emerging field of smart learning environments. *Smart Learning Environments, 1*(1). Retrieved from http://www.slejournal.com/content/1/1/2

Yang, J., Yu, H., Gong, C., Kinshuk. (2015). The research focus and future trends of smart learning environments. *E-educational research, 5*, 85–88, 95.

Zhong, G., & Zhang, X. (2006). A Building of the current intelligent learning environment model. *Computer Science, 1*, 170–171.