

# Promoting Citizen's Learning Experience in Smart Cities

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**Abstract.** Lots of research has been done on smart cities, however, only few studies can be found on smart cities from the educational perspective. This paper will discuss the framework of building smart city from educational perspective to identify the importance of promoting smart learning in smart cities. Then the characters of smart learning are elaborated, and the difference of traditional classroom learning, digital learning and smart learning are analyzed. After that, the paper analyzes the typical learning environments in cities: school, family, community, workplace, and museum. Based on the analysis, we develop indicators to evaluate learning environments in smart cities, which was used to evaluate the learning environments in the selected 68 cities in China.

**Keywords:** Smart learning environments · Smart cities · Digital learning · Smart learning

## 1 Framework for Smart Cities from Educational Perspective

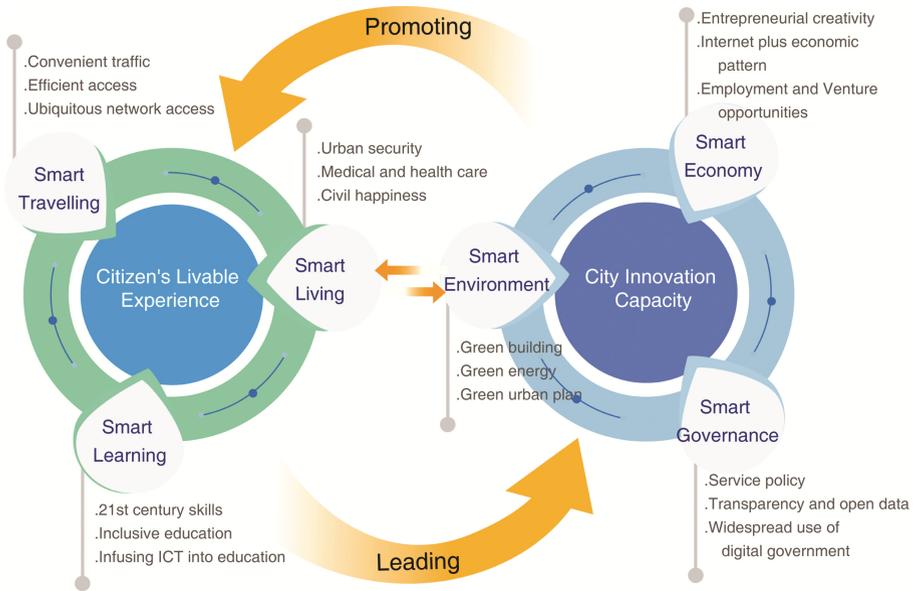
Smart cities are nowadays widespread all over the world to tackle urban sustainability issues. In the initial stage, both academic research and the practice of the smart city focused on how to utilize information technology to improve economic and political efficiency (Röller and Waverman 2001). With the development of smart city, the focus was no longer limited to the hardware facilities, but more attention was paid to the availability and quality of knowledge communication, as well as to social infrastructure (human and social capital).

Nam, T. and Pardo (2011) identified and clarified the key dimensions of smart cities, and re-categorized them into three categories of core factors: technology (infrastructures of hardware and software), people (creativity, diversity, and education), and institution (governance and policy). The most often cited dimensions of smart city appeared in the report of “Smart Cities-Ranking of European Medium-Sized Cities” by Vienna University of Technology, University of Ljubljana, and Delft University of Technology, in which Giffinger (2007) identified the six characteristics as a roof for the further elaboration of smart cities: smart economy, smart people, smart governance, smart mobility, smart environment, smart living.

The new citizens will have vital roles in building smart cities to promote all the innovations, who should be hyper connected, creative, entrepreneurs, and also actively participate in the cities' activities and decisions (Ljiljana and Adam 2015). With smart city technologies emerging and gradually contributing to a more sustainable and green

future, it is becoming apparent that creative skills to deal with these innovations in smart city must be taught to upcoming generations (Wolff et al. 2015). Education should become a vital part of the future of smart cities (Hall et al. 2000), and learning dimension is becoming more central within smart city discussions. However, they are often ignored in the construction of smart learning.

From educational perspective, we proposed a framework of smart city, as shown in Fig. 1. On the macro level, the construction of smart cities covers three aspects: The first one is smart economy, which involves urban enterprise creativity, the “internet +” economic form and its employment entrepreneurship atmosphere. The second aspect refers to smart environment which covers the planning of urban buildings, green energy and green city. The third aspect relates to smart governance (management) which mainly involves urban service policies, openness and transparency of data, as well as the popularization of e-government. In another words, the smart features of a city could be represented by “the vitality for urban innovation” which includes the three characteristics of smart economy, smart environment and smart governance.



**Fig. 1.** Dual-core framework of smart city

On the micro level, the construction of smart cities could also be considered in three aspects. The first one is smart mobility (travelling) which aims at providing the citizens with convenient transport facilities and efficient, ubiquitous access to internet. The second aspect includes smart living, which refers to people’s sense of security of urban life, medical and health conditions, and the citizen’s sense of happiness. The third aspect refers to smart people (learning), that should provide skills that the citizens should master in the 21st century. This can be achieved by accepting inclusive and technology integrated education.

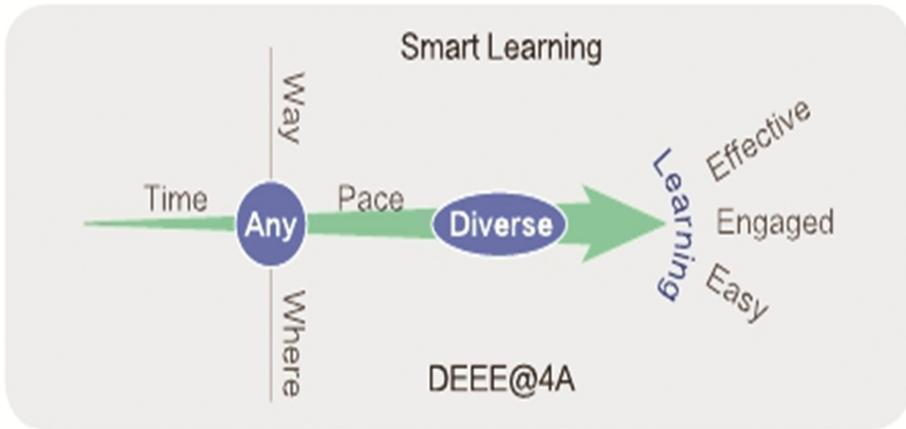
Therefore, smart city construction mainly consists of city-oriented macro level construction and citizen-oriented micro-level construction. The smart features that citizens can feel is "citizens' livable experiences" which cover smart travelling, smart living and smart learning. The concept of "smart citizens" in the context of "smart city" ultimately refers to smart learning.

It could be indicated from the above analysis that the mean of smart cities construction is diversified with many aspects centering on the two cores: "Citizen's livable experiences" from the micro-level and "City Innovation Capacity" from macro-level. On the left of Fig. 1, the core of citizen's living experience includes smart travelling, smart learning, and smart living which together provide bountiful living experience for citizen. Smart learning takes 21<sup>st</sup> century skills, inclusive education, infusing ICT into education, etc. into consideration; smart living takes urban security, medical and health care, civil happiness, etc. into consideration; smart travelling takes convenient traffic, efficient access, ubiquitous network access, etc. into consideration. On the right of Fig. 1, city innovation capacity includes smart environment, smart economy and smart governance which together provide the vitality of innovation. Smart environment takes green building, green energy, green urban plan, etc. into consideration; smart governance takes service policy, transparency and open data, widespread use of digital government etc. into consideration; smart economy takes entrepreneurial creativity, internet + economic pattern, employment and venture opportunities, etc. into consideration.

## 2 Characteristics of Smart Learning

The two cores of smart cities construction serve as the basic drive to promote a city's development, the main aim of which is to improve a city's benign operation and sustainable development. Advocating "smart learning" plays a cultural leading role for stimulating vitality for urban innovation and it also provides scientific support for citizens' livable experiences. In fact, it is the ultimate target of smart city construction to let humans have better urban living environments. The two cores that represent features of a smart city indicate that smart learning is the fundamental driving force to enhance citizens' wisdom and the basic solution to improve people's livable experiences. Therefore, it is necessary to understand the character of smart learning.

In smart learning, a learner can learn at anytime, anywhere, in any way and at any pace, which is short for "4A". The learning environment is capable of supporting "Easy Learning", "Engaged Learning" and "Effective Learning" (Huang 2012), which is short for "3E". In such smart learning environment, the easy, engaged, and effective learning (3E) at anytime, anywhere, in any way and at any pace (4A) could be regarded as smart learning. The character of smart learning was shown in Fig. 2, which is short for DEEE@4A with D stands for diverse.



**Fig. 2.** Characteristics of smart learning

**Table 1.** Comparison of traditional classroom learning, digital learning and smart learning

	Traditional classroom learning	Digital learning	Smart learning
Learning result and forms	Precision processing of knowledge, In unified forms	Knowledge interconnectivity, in diverse forms	Knowledge interconnectivity, self-adjustment
Learning task	Homogenization	Diversity	Personalization, differentiation
Learning method	Listening and teaching based	Blended learning (listening and teaching + online learning)	Seamless learning
Teaching strategy	Teaching based, but complemented with asking questions and discussion	Application of multiple strategies	Personalized learning instruction
Learning support	Face-to-face Q&A and tutoring	Online communication and support	Multi-channel communication and intelligent system support
Learning assessment	Standardized tests and exams	Online tests at anytime	Adaptable tests
Learning community and ways of participation	Groups and class, School arrangement	Virtual community oriented towards themes, Apply for participating	Virtual community oriented towards themes, Automatic matching and recommendation
Learning space	Fixed physical space	Physical and virtual space	Intelligent learning space
Learning pace and time sequence	Relatively unified	Relatively flexible	Arbitrary pace
Learning goal	Relatively unified	Diverse goals	Personalized goal
Learning resources and source	Textbooks and tutorial materials in hard copies, arranged by teachers	E-textbooks and network resources, recommended by teachers	Diverse digital resources free choice and intelligent recommendation
Learning media	Paper media only	Paper media, internet media	Across terminals, rich media

The differences of smart learning, traditional classroom learning, and digital learning are shown in Table 1. Traditional classroom learning refers to learning in traditional classroom environments with chalks and blackboard as teaching aids; digital learning refers to on-line learning environment or classrooms equipped with multiple technologies; smart learning is learning with the character of DEEE@4A in smart learning environments.

Face to face learning in traditional classrooms mainly involves refined knowledge learning processes which stress unified standards, unified learning paces and unified examinations. The learning paths that students take are linear and of the same nature, which results in monotonous, relatively rigid learning methods which further impedes the cultivation of creative capabilities among students. Learning in smart environments emphasizes the interconnection between knowledge nodes and aims to build a variously-typed, diversified, pluralistically-evaluated teaching and learning ecology. In such a learning method, learners are provided with diversified learning paths such as the linear type, point to surface type or whole to part type paths (Huang 2014).

Smart learning environments provide learners with room for deep-level communication. It can expand innovation spaces, enrich the depth and breadth of learner's knowledge structures, and create diversified supporting environments for them. The new model of instruction based on smart learning environments will incline towards the "4A" model under which smart learning pays more attention to students' diversities and individual variations. This makes it possible to carry out the educational concept of "people first".

Smart learning has three basic characteristics. First is Easy Learning, that is the prerequisite for engaged learning; smart instruction makes the learning process become easy and fun. Second, Engaged Learning, is the precondition for effective learning; only through engaged learning that students are able to perform good communication and cooperation with their fellow students and achieve designed learning objectives. Third, Effective Learning, is the target of smart learning, which means smart learning shall bring the desired learning results effectively.

### 3 Typical Learning Environments in Smart Cities

With the advancement of learning society, citizens could learn life-wide, and life-wide learning includes not just learning in formal contexts, but also learning in different contexts such as in the home, school, work, community and others (Desjardins 2003; Cambridge 2008). Therefore, smart learning could happen in school, family, community, workplace, museum and others. The following section will analyze these typical learning environments in smart cities.

#### **School Learning Environment**

During the whole life, school education gives people an overall, systematic and in-depth influence, and this period is the important process for learning and self-shaping of people (Wang 2007), and school learning environment is the primary tools and learning environment for people's socialization. Specially, a classroom learning environment is a combination of social and physical qualities that create the classroom experience. There

are several instruments used in prior research to assess perceptions of classroom learning environment. The implication from prior research is that student outcomes might be related to perceptions of classroom learning environment; in other words, student's achievement might be improved by creating better classroom learning environment (Fraser 1986; Madu 2010; Tas 2016). In addition, with integrating technology into education, growing number of researchers focus on smart classroom learning environment and new forms classroom learning environment like flipped CLE in recent years (Butzler 2014; Jena 2013).

### **Family Learning Environment**

The family, as the first group of individuals, provides the most basic conditions for people's socialization (Wang 2007), is the basic field of people's social life. The family learning environment is also the basic learning environment for people. Family learning environment consists of a series of characteristics, including language stimulation, learning materials available at home, such as books and computers, as well as parenting behaviors, such as engaging children in learning activities and providing children with learning experiences (Bradley and Caldwell 1995). Present researches pay more attention to the influence of family learning environment to children in cognitive abilities, learning performances and socio-emotional development (Melhuish et al. 2008; Foster 2005).

### **Community Learning Environment**

Community is the most basic social living base for majority social members, with multiple functions including politics, economy, culture and social management (Zhou 2002). Communities play important roles on supporting learning and teaching that occur outside of schools, and the cultural education activities in communities have significant influence on the teenagers, the adults and the elders. Community learning occurs when the knowledge created in the integrative "community process" is fed-forward and embedded at the level of community structure (Morse 2004). Moreover, the development of the Internet induces greater living space to the community with emerging a lot of online learning community.

### **Workplace Learning Environment**

The development of work tasks, the promotion of performance, the workplace training and so on, have an important role in promoting the individual development of in-service staffs, and workplace learning environment is one of the important fields for adult learning activities. Watkins and Marsick (1993) suggested that key components of the workplace environment include creating continuous learning opportunities, promoting equity and dialogue, supporting individuals in maintaining an openness towards new experiences, reflection, and translating the learning into practice, encouraging team learning and collaboration, empowering people towards a collective vision and connecting the organization to its environment. Zhao and Zhu (2015) considered that relying on new technology has very important value to workplace learning due to eliminating the conflict between working time and learning time. It benefits employees proceed informal learning and form the good habit of learning anytime and anywhere.

### **Museum Learning Environment**

In public places, people can conduct multiple social activities such as working, learning, culture, social communication, entertainment, sports, rest and traveling, and public place learning environment is the important constituting part of learning environments for citizens; it is a window reflecting the social material conditions and spirit civilization of a country or a nation. In this study, museum learning environment is represented the learning environment in public places. We use "museum" as a generic term that includes all kinds of science museums, historical museum, planetarium, and other interpretative centers for science learning. Museums are an integral part of the broader learning and provide education to the public that called 'museum learning', playing a key role in 'lifelong learning' and educational leisure. Museum learning is an important research topic in the field of informal learning. Currently, research on technology-assisted museum learning focuses on developing a learner-centered method and applying technology to assist learners in exploring and learning in a museum (Wishart and Triggs 2010; Hou et al. 2014).

## **4 Evaluating Learning Environments in Smart Cities**

The above five typical learning environments provide the atmosphere for learning in a city, which is vital for cultivating talents with creative skills to deal with all the innovations in smart cities. Citizen's learning experience, livable experience and city innovation development, are all connected with these learning environments. Therefore, it is important to understand the typical learning environments in smart cities, that is why we create the following indicators to evaluate these learning environments.

For school learning environment, it is normally evaluated from these aspects: the proportion of the number of students and the number of computers, the proportion of the number of teachers and the number of computers, network coverage, network equipment, multimedia classrooms, and so on (Liu et al. 2014). In this research, we chose computer resource allocation in primary and middle schools, multimedia classrooms and digital resource of primary and middle schools as sub-level indicators for the school learning environment indicator (Table 2).

For family learning environment, the Home Observation of the Measurement of the Environment (59 items version) is formed of eight subscales: (1) Emotional and Verbal Responsivity of Caregiver; (2) Encouragement of Maturity; (3) Emotional Climate of the Home; (4) Growth-Fostering Materials and Experiences; (5) Provision for Active Stimulation; (6) Family Participation in Developmentally Stimulating Experiences; (7) Paternal Involvement with Child; and (8) Aspects of the Physical Environment (Bradley et al. 1988). As reference, we chose family digital devices, family book possession and satisfaction with family learning environment as sub-level indicators for the home learning environment indicator.

Based on the research for the evaluation method of the effect of learning community construction, we can evaluate the effectiveness of the learning community construction from the organizational management, carrier design, learning activities, and the achievement of the construction. Thus, utilization of learning places in community, utilization

of community's information platform, participation of learning activities in community, and development of community education were chosen as sub-level indicators for the community learning environment indicator.

**Table 2.** Indicators for the five typical learning environments in smart cities

Indicator	Sub-level indicators
1 School learning environment indicator	1.1 Indicator of computer resource allocation in primary and middle schools
	1.2 Indicator of multimedia classrooms
	1.3 Indicator of digital resource of primary and middle schools
2 Family learning environment indicator	2.1 Indicator of family digital devices
	2.2 Indicator of family book possession
	2.3 Indicator of satisfaction with family learning environment
3 Community learning environment indicator	3.1 Indicator of utilization of learning places in community
	3.2 Indicator of utilization of community's information platform
	3.3 Indicator of participation of learning activities in community
	3.4 Indicator of development of community education
4 Workplace learning environment indicator	4.1 Indicator of Internet environment in workplace
	4.2 Indicator of learning engagement in workplace
	4.3 Indicator of online learning in workplace
5 Museum learning environment indicator	5.1 Indicator of the number of museums
	5.2 Indicator of utilization of the museum for learning
	5.3 Indicator of informationization in museum

On the basis of a review of the literature, Clarke pointed out the factors which influence workplace environment for learning outcomes: (1) supportive learning and development infrastructure; (2) particular types of learning opportunities; (3) empowerment and effective communication; (4) support for reflection and job challenge; and (5) support for learning transfer (Clarke 2005). We chose Internet environment in workplace, learning engagement in workplace, and online learning in workplace as sub-level indicators for workplace learning environment.

Referring to the characteristics of learning environment proposed by Chuang (2005) and Tsai (2008), Tsai et al. (2012) have constructed the evaluation structure of characteristics of learning environment in digital venues, which was composed of three dimensions: study subject, situation, and digital exhibits. Therefore, we chose the number of

museums, utilization of the museum for learning, and infomationization in museum as sub-level indicators for museum learning environment indicator.

According to the indicators, a survey was conducted to evaluate typical learning environments in cities. 68 cities in China were assessed, including Beijing, Shanghai, Tianjin, Chongqing, Guangzhou, and so on. Data are collected from China Statistical Yearbook, China City Statistical Yearbook, and statistical yearbooks related to the 68 cities. The results were presented in Table 3, in which the ranking of the 68 cities was listed according to the indicators of learning environments.

**Table 3.** Ranking of cities according to the learning environments indicators (Top 10 cities were listed).

Cities	Indicators for typical learning environments		School learning environment indicator	Family learning environment indicator	Community learning environment indicator	Workplace learning environment indicator	Museum learning environment indicator
	Rank	Score	Score	Score	Score	Score	Score
Shanghai	1	0.8547	0.9292	0.8340	0.7175	0.8880	0.9047
Yichang	2	0.7892	0.5597	0.9807	0.7500	0.9159	0.7396
Beijing	3	0.7733	0.7869	0.7944	0.7286	0.6890	0.8676
Qingdao	4	0.7720	0.4227	0.9615	0.8551	0.9560	0.6650
Dalian	5	0.7550	0.6587	0.8353	0.8312	0.8343	0.6156
Wuhan	6	0.7532	0.4599	0.9029	0.9140	0.7782	0.7112
Jinan	7	0.7378	0.5648	0.9149	0.7082	0.8494	0.6519
Hangzhou	8	0.7369	0.5911	0.8721	0.7578	0.7761	0.6875
Shenzhen	9	0.7362	0.7084	0.7468	0.6740	0.7034	0.8482
Wulumuqi	10	0.7289	0.7200	0.9602	0.6083	0.7431	0.6126

The results showed that there were differences on the development levels of five typical learning environments in different cities. Few differences existed in the 68 Chinese cities in the family learning environment and workplace learning environment. Huge differences existed in school learning environment. The results indicated that there was relatively large space for improvement in learning environment construction in some cities.

The top ten cities include 2 municipalities directly under the Central Government, 3 cities enjoying the provincial-level status in the state economic plan, 4 provincial capitals and 1 prefecture-level city (Yichang ranks as the second.). The indicator of home learning environment and working place learning environment are both higher than 0.9 in Yichang, which is the only prefecture-level city. Although the development of smart learning environments in cities is connected to some objective factors (e.g., economic level, city size, areal of distribution, etc.), some prefecture-level cities are at the forefront of the development as they provide their citizens with good smart learning experiences.

The indicators of learning environments of cities can reflect the status of the construction of a learning society, which also can reflect the development level of the construction of smart cities. The construction of a city's learning environments is based on the city's innovative capacity, with the goal is to improve the citizens' smart learning experiences.

The construction of learning environments in smart cities needs top-level design and support by the government. In addition, there is a need for participation of multiple parties including enterprises and a social commitment to gradually build a sound long-term environments to support smart learning.

The aim of learning environments in smart cities is to support smart learning. Smart learning should become an important part of the construction of smart city. Smart learning provides strong support for citizens' life-long learning, which is also the key feature of self-evolution of the urban system. Development of smart learning can improve the citizens' livable experiences, enhance the city's innovative capacity, and present the intelligence quality of a city.

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