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Research Article

INTELLIGENT TUTORING SYSTEM: BESIDES THE CHANCES AND CHALLENGES IN ARTIFICAL INTELLIGENCE ERA AND MAKER ERA

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ABSTRACT

ITS not only provides students with one-to-one tutoring but also provides students with a STEM-based knowledge acquisition method. The interactive nature of the ITS enables the integration of teachers and students with resources. Through the review and analysis of relevant Chinese and foreign literature, a deeper interpretation of the birth and evolution types of ITS was carried out, and the theoretical basis and development model of ITS development was illustrated in detail. Under the background of the development of new-generation mobile network technologies and big data learning analysis technologies, ITS normalization construction includes four aspects: development path (wisdom learning), audience objects (diversity), learning mode (hybrid), and ontology evolution (smartness) Learning Assistant) and key development directions (education fair). In addition, with the advent of the “Creator” and “Internet Plus” era, the issues that deserve attention in the development of ITS include cultivating students’ innovative abilities, expanding students’ individualized learning, and realizing the development of thinking toward higher-order thinking.

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INTRODUCTION

The intelligent tutoring systems (ITS) born under the leadership of artificial intelligence technology have begun to change the way of knowledge transfer and learning, and are also laying the foundation for the realization of learner's personalized learning [1]. From the perspective of education informatization development, primary and secondary school students' training is still in the factory assembly line mode, and the teaching team is scarce, ignoring the individual characteristics of students and specific learning needs so that students cannot achieve personalized learning [2]. The ITS pursues the goal of “one-on-one, one-on-one, smart coaching” to promote students’ full, free, and harmonious development in all aspects. It successfully implements personalized recommendations and appropriate interventions for learners, enabling the system to adopt appropriate content, starting points, and Means and methods to promote learner individualized learning [3]. In terms of educational technology, ITS is a continuation of past CAI and is a major step forward. It changes the previous single-line education communication model and makes full use of interactive functions to achieve online help, exams, progress reminders, peer assistance, and simulation. And so on, making learning easier and more fun on the web. ITS embodies learner-centered thinking, which can satisfy self-study, provide learners with a personal learning portfolio, adjust teaching materials, content, and progress according to learning needs and suggestions, and provide students with adaptive learning strategies for different learning characteristics. At the same time, ITS is also the best cognitive teaching resource. It is a complete and complete knowledge learning process. Students can not only follow the system recommendation and individualized instruction for customized learning but also strengthen their own cognition and metacognition.[4] . It can be seen that ITS not only embodies the explicit value of the student's fragmented self-study, but also enhances the student's subject quality, promotes professional development, and forms the hidden value of a lifelong learning atmosphere.

At present, many ITS have been introduced at home and abroad, for example, Betty's Brain[5] developed by the School of Electronic Engineering and Computer Science at Vanderbilt University, and MetaTutor[6] developed by several experts in psychology at the University of Memphis, USA. Co., Ltd. and Nanjing University developed a sentence correction network for Chinese writing [7], a professional business research university in Serbia and the United States, Proust [8] for information science and mathematics research in Novi Sad, and a team of Professor Guo Linke of City University of Hong Kong designed and developed Regarding the sudoku game Sudoku ITS [9], the

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University of Memphis developed AutoTutor [10] from 1997 and the South China Normal University Prof. Xu Jun's research group developed the iTutor [11], Patricia A. of "Computer Information Technology Foundation". Jaques et al. developed a rule-based intelligent tutoring system PAT2Math [12] that provides step-by-step guidance for solving algebraic problems. In 2010, Annabel Latham (Annabel Latham), an intelligent system team of the Department of Computing and Mathematics at Manchester Metropolitan University in the UK, described OSCAR as a dialogue intelligent guidance system [13]. In 2015, 44 freshmen undergraduates from the University of Malaysia participated in the experimental research. The teaching content was "Programming I". The FITS (Flowchart-based intelligent tutoring system) was based on a flowchart-based intelligent guidance system. Teachers had full experience in applying FITS. 14]. BioWorld is a computer-based learning environment. When students solve virtual patient cases, the system can support the learner SRL diagnosis inference process [15]. The team of Ronald A. Cole of America developed MindStar Books, a virtual tutor, and language therapist that integrates advanced technologies such as spoken dialogue systems, speech recognizers, and animated characters to provide teachers with production materials. With the tools and environment, teachers can design listening comprehension activities in the media, and students can listen and understand training in real time [16].

But can ITS meet student's need for autonomous or collaborative learning? How is the teaching process carried out? How are learners learning? Is it really promoting the reform of education and teaching? Where will the future development go? All these problems need to be tested and summarized in practice. This article takes "intelligent tutoring system" as a keyword in CNKI, Education Resources Information Center (ERIC), Wiley Online Library, ACM, ALT Open Access Repository, IEEEX plorer, Springer Link, JSTOR, PsyINFO, Google Scholar, and Science Direct (SD). Databases were searched in the database to collect the research results from 2008 to 2017 in the fields of educational technology and e-Learning. In addition, the research literature search source includes academic essays from the Artificial Intelligence in Education (AIED) organized by the International AIED Society and the National Science Foundation. Association of the Advancement of Artificial Intelligence (AAAI) and the International Association of Educational Artificial Intelligence sponsored by the International Conference on Intelligent Tutoring System.

This study collected and combed the ITS international conferences and the number of journals ranked in the top six from 2008 to 2017, and analyzed the content of the retrieved documents, from the concept, design quality, evaluation, learning theory, case analysis, learning groups and Multi-dimensional perspectives such as the practice model are used to study the ITS origins and theoretical practices, of which two types of ITS are identified. Then, the normalization of ITS practice is proposed in five aspects: development path, audience target, learning mode, ontology evolution, and key development directions. This is the research direction worthy of attention in the future, and it is also a review of ITS localization research. In addition, with the advent of the "artificial intelligence" era, it also brings new opportunities and challenges to the development of ITS practices in the new era.

Origin of It's and Evolution

Origin of its

Dialectical materialism believes that anything, any relationship, or any process in the real world has the dual attributes of necessity and contingency. The appearance of ITS can be said to be accidental, but according to Marxist philosophy, the occurrence of new things is potentially inevitable in accidents [17]. ITS is based on self-directed learning. Its goal is to simulate and support teachers, not only to provide students with simple mathematical principles and practice, but also to effectively adapt students' cognition, metacognition, and emotions. To adjust students, students do not need to enter the classroom. There is no age or academic qualifications. No matter what kind of foundation, regardless of the color, no matter what kind of foundation, just turn on the computer, you can choose the appropriate knowledge content according to your interests and become the education. "Intelligent assistants" arrange learning projects and learning processes according to their needs, and are effective models for personalized learning in the Internet era.

Evolution of ITS

The evolution of ITS has undergone a long historical process and has undergone tremendous changes in its own performance and external characteristics. By combing the relevant literature [18][19], the evolution of ITS is planned as shown in Table 1 below.

Table 1 Development history of ITS

1923	1950	1960	1970	1982	2017…
Pressey machine	Turing machine; Guidance products	Program teaching	AI application	ITS officially appeared	Big Data; Emotional intelligence
Multiple choice questions	Computer and intelligence	CAI/ICAI	AI computer	ITS	AITS/ATS

The development of the ITS was mainly from the Pressey machine in 1923. According to the teacher's choice of multiple choices, it presented preselected questions and answers. The realization of the correct answer for each learner gave candy, but this machine contains the modern learning theory "badge." ". An intelligent machine developed by Sidney L. Pressey, professor of psychology at Ohio State University, used to provide students with exercises.

In the 1950s, artificial intelligence had a binary system and an electronic processor, which had logical decision-making capabilities. The British scientist Turing linked the computer to intelligence and created the Turing test, involving specific issues with people and machines. The test is based on the exchange of dialogue to identify whether the other person is a person or a machine. In the mid-1950s, educational psychologists began to use guided products to provide an effective learning experience for humans.

In the mid-1960s, program teaching was applied for the first time, requiring designers to decide on input and output. When learners cannot answer questions correctly, the system can quickly correct incorrect feedback to ensure the accuracy of their programs. Program teaching is integrated into computer projects, known as computer-assisted instruction (CAI). There is no significant difference between CAI and ICAI, but ICAI is more refined than CAI.

In the 1970s, ITS was considered a good way to provide adaptive guidance products. AI is the smart thing to create a machine to accomplish human accomplishment, and it leads to more knowledge understanding. AI tutors work with students with different abilities to allow collaboration and integration of agents, awareness of students' perceptions, emotions, and social characters. These agents can identify learning defects and communicate and respond to student information when necessary. They guide and supervise student progress, based on content and public issues. AI technology can be referred to as a self-improvement mentor because mentors can assess their own teaching. Jaime Carbonell developed the SCHOLAR system of the South American Geography Course in 1970 [20]; Collins et al. developed the WHY system based on the SCHOLAR system in 1975 to teach students to explore the causes of rainfall [20]; 1977, Standford University Wescourt et al. designed the BIP system for assisting Basic language teaching [20]; and the WUMPUS game system for 1977, which can be used for training logic, probability, judgment theory, and geometry [20]. In 1982, Sleepen and Brogan coined the intelligent tutoring system to help distinguish them from the previous computer-aided teaching CAI. ITS tried to combine problem-solving experience and discovery motivation to effectively guide learning interaction [21].

After the 1990s, with the development of computer network technology, multimedia technology, artificial intelligence technology and its application in the field of education, the research of intelligent teaching systems began to support the individualized learning and collaborative learning of the RIDES system developed by the University of Southern California [22], MMAP system at Stanford University [23] and CIRCSIM-Tutor at Northern Illinois State [24]. A complete ITS development process realizes the development process of ITS from behaviorism to cognitivism to constructivism, and enables students to implement proceduralized teaching under operationalism to stimulus-responsive cognitivism to meaningful knowledge construction according to ITS, and to achieve independent learning for students. The process of group collaborative learning.

Classification of ITS

The method of student modeling in this study includes model tracking, probabilistic modeling, reconstructing bug models, and constraint-based models. Since student modeling is the core of ITS design, analysis of learning outcomes and types of student modeling often involves ITS is divided into four types[25].

Expectation and misunderstanding adjustment (EMT)

Since the 1970s, SCHOLAR is a typical ITS that uses natural language to communicate students with computers [26]. In 2004 AutoTutor supported teaching tips, feedback, claims, and clues for natural language conversations [27]. This kind of ITS achieves a dialogue-based learning, emphasizes knowledge rethinking, construction, and social network learning. Learners communicate with computers based on natural language and rely on system prompts, feedback, and clues to realize knowledge internalization and reorganization in their own minds. [28]. It is open, allowing learners to build their knowledge through dialogue dialogs in social ways. In addition, various cognitive scaffolds and prompting help in EMT-type ITS can improve students' cognition and metacognition.

Model tracing model tracking

Model tracking focuses on modeling using product rules and can be activated to automatically resolve domain issues [29]. Focus on knowledge diagnosis and dissemination, emphasizing rule-based learning. Learning objectives are pre-set by teachers or developers. Learners complete relevant learning tasks by watching examples, videos, etc., and are guided by system prompts, clues, and other supports. Receiving positive or false prompts about the subject's task process or program helps strengthen memory. In addition, all system supports (such as Andes, Algebra Cognitive Tutor) are designed in the platform, and the discussion space is limited and closed [29].

This student modeling is based on the modeling adopted by cognitive instructors developed at Carnegie Mellon University and based on Anderson's ACT-R Human Learning and Cognition Theory in 1993 [30]. The cognitive instructor process is designed and the skills learned are modeled by a set of product rules that can be activated to automatically resolve domain issues. Product rules are made up of operations and conditions that are selected to form the ideal psychology model for how humans solve domain problems. The operation of the domain model is proposed and students can choose them as problem solutions. Because the students choose model tracking process to map their domain model to a series of product rules. If the test is wrong, the system will give the student quick feedback and consider choosing a different operation. Applying model tracking to identify student application product rules, application knowledge tracking Bayesian programs can update learners' correct learning probabilities. Therefore, the knowledge tracking cognitive cognitive instructor multi-dimensional student model is composed of the probability of the product model of the domain model.

Constraint-Based Modeling (CBM) Constraint-based Mentor

Constraint-based modeling is a technique for student modeling, which is different from cognitive mentors' model tracking and knowledge tracking. CBM represents the domain knowledge as a logical constraint, and is related to each constraint that causes the state of the solution. The constraint consists of three parts: (a) indicates when the constraint is applicable and relevant conditions (b) satisfies the condition of the current student program state (c)) Feedback messages, when the condition of the program fails to satisfy the conditions, advise students to error and remind them of the main principles of error.

For modeling domain knowledge, constraints play an important role in model tracking based on constraint modeling, especially constraints that cannot be implemented to play an important role. Constraints can be used to model student knowledge in many ways. For example, ITS can demonstrate student knowledge as a constraint.

In addition, constraint-based ITS is a knowledge area that represents logical constraints. It focuses on analyzing the causes of student errors, emphasizing analysis of when students are bound, testing students' current program status, and prompting students to make major mistakes, and giving students appropriate feedback.

Bayesian Network Modeling

Bayesian network is a tool for probabilistic reasoning and indefinite knowledge presentation. In ITS, Bayesian networks are often used to present multidimensional domain models composed of multiple variables. The association between variables is specific to form a network that infers the value of variables in the network through Bayesian networks. Based on the student's input in the quiz project, applying Bayesian network will calculate the probability of each misunderstanding and error of students. Bayesian networks can be used to create more complex models, such as dynamic models of intelligent tutoring students' problem solving, which can provide tips and training. Such as Andes. Applying Bayesian networks as comprehensive, sound formalism deals with uncertainty. Applying Bayesian networks, we have designed a probabilistic student model for Andes to achieve a pedagogical interaction process that maximizes student initiative and freedom. The Andes model can provide long-term knowledge assessment, plan identification, and student actions that predict student problem-solving processes. Bayesian networks are a flexible method that can be used to present many different student models, including constraints-based models and knowledge tracking.

ITS theoretical design and practice case analysis
In order to encourage learners to complete the study of ITS knowledge, to avoid losing their fun and to give up halfway, it is necessary to put forward some feasible design principles based on ITS learning theory and teaching and technology.

ITS theoretical design

ITS learning theory

Cognitive load theory

The cognitive load theory is a teaching theory that considers limited working memory. The cognitive load includes internal cognitive load, external cognitive load, related cognitive load, and how they relate to each other. Internal cognitive load refers to the intrinsic difficulties or complex nature of substances or materials, as well as the level of the learner's expertise. In order to manage internal cognitive loads, designers can segment and serialize materials, so learners are introduced with new information. The external cognitive load can be directly changed by the designer because the external load is caused by inappropriate material presentation and unnecessary learner learning activity participation. The cognitive load theory indicates that the instructional designer should reduce the cognitive load as much as possible. And enhance learning and reduce working memory load.

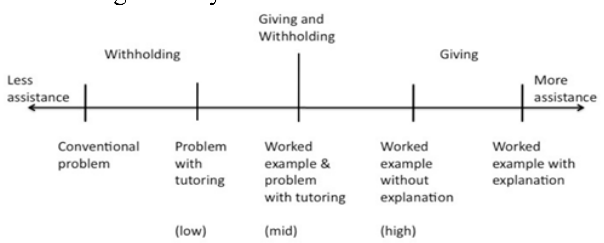

Fig 1 schema of levels of instructional assistance

The teaching methods often used to help learners are traditional issues and examples. When learning how to solve problems, people need different levels of assistance. Two commonly used methods to help learners are traditional problems and examples, as shown in Figure 1[34]. The traditional problem is that it is presented to the learner without any information on how to solve the problem. Because the assistance is not provided by default in the traditional problem environment, traditional problems will never provide such cases, and the types of issues considered are rejected. In contrast, the example shows a complete solution to the problem sequence steps to guide the problem scenario. Examples may be provided with or without explanation.

When students experience learning tasks, they need to increase the processing requirements of their working memory. The use of examples is a way to reduce thinking efforts because they emphasize the appropriate method of solving problems. In contrast, traditional problem learners need to use high-level thinking to work hard because he is actively looking for ways to solve problems.

In order to reduce the external cognitive load, ITS designers must consider how to present learners with teaching materials (application of static and dynamic images, application video, and placement of important information on the screen, etc.) to keep the content concise and consistent. Designers must ensure that they do not add a complete load, including unnecessary information beyond the learner's working memory capacity.

ACT-R theory

In the early 1980s, John Anderson, cognitive psychologist of Carnegie Mellon University, began to develop a theory, which later evolved into ACT-R (Adaptive Control of Thought-Rational) cognitive theory [35]. This theory assumes that human cognition occurs through the interaction between declarative and procedural knowledge. Declarative knowledge is knowledge about facts, and procedural knowledge is knowledge about problem solving. ACT-R implies that cognitive knowledge depends on declarative knowledge-to-problem-resolving product conversions, just as a set of IF-THEN rules, and that declarative and procedural knowledge requires strong practice. This theory helps ITS developers transform, construct, and creatively generate knowledge [36]. ACT-R is used to study different aspects of human performance, including perception and attention, learning and memory, problem solving and decision making, language processing, ITS, and human-computer interaction. ACT-R is a cognitive scaffold that simulates understanding of human cognitive theory and attempts to understand how humans organize knowledge to produce intelligent behavior. The goal of the ACT-R project is to enable the system to perform various human cognitive tasks and how to capture people's perceptions, thoughts, and behaviors.

ITS design principles

ITS teaching principles include two parts: smart mentors and media materials. Therefore, when creating an ITS, designers need to consider design factors, including the principles of intelligent mentors and media design principles, as shown in the figure.

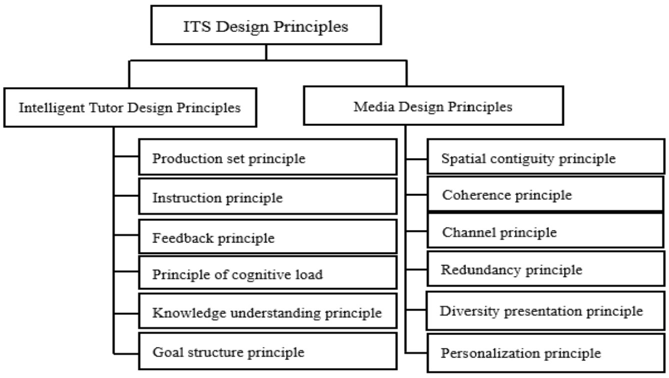

Figure 2 ITS design principles

Design Principles of Intelligent Tutors

The principles of smart mentor design include six aspects [37], in which student skills are presented as a product set: Designers should develop some mentors' rules and identify how students should act after teaching and thinking through content. These rules will help design course sequences, classification of information blocks, how students and interfaces interact, how and when learners receive error messages and tips, and teaching in a problem-solving environment: teaching should be in a problem-solving environment, designers need Using truly relevant issues, therefore, they will move problem-solving situations out of the classroom; communicate potential problem-solving structures: ITS often communicates target structures by decomposing goals into sub-goals, such as using brackets or setting clear goals within the interface. Help with feedback and mentoring to provide feedback; promote understanding of correct and general problem solving knowledge: Designers should promote a correct and abstract problem solving knowledge understanding. Learners, especially novice learners, did not have a solid foundation in the problem-solving environment. Our goal is to use hints and feedback information to enhance the generation, so learners can migrate their knowledge to other contexts; reduce working memory on learning external loads: designers should reduce the workload of working memory and present.

What is related to the current problem-solving steps? Unless students specifically need it, the system does not need to include additional help information. No additional information is placed on the interface, so student learning will not be hindered; provide immediate feedback based on ideal learning model performance: Mentor feedback should be prompt, can lead to faster learning, and can also motivate learners. Feedback also ensures that learners are on the right track to solve the problem.

ITS practice case analysis

Comparative Analysis of ITS Platforms

This paper selected eight different types of ITS cases and compared them from the three main aspects of STEM subject categories, environmental categories, and stent types (see Table 1).

Table 1 ITS literacy, environmental categories, stent types

		MetaTutor	Protus	Andes	Simustudent	Crystal Island	Wayang Outpost	Betty's Brain	AutoTutor
STEM category	science	P				P		P	
	biological	P						P	
	computer		P						P
	mathematics				P		P		
	physical			P					P
Environmental category	Hypermedia	P	P				P	P	
	Modeling and Simulation			P		P		P	P
	Narrative Centered				P				
	Gamification				P				
	Multiform					P		P	
Bracket type	prompt	P		P	P		P	P	P
	Dialogue	P	P	P	P	P	P	P	P
	Problem	P	P	P	P	P	P	P	
	Suggest	P	P	P			P	P	
	Example		P	P	P	P	P	P	

"P" Said to have; " " Does not have

From Table 1, we can see that all the ITS have a learning support and cultivate the students' literacy, and they are all ITS that promotes one-on-one sexual guidance. Most smart guidance systems have dialogue capabilities, such as providing students with appropriate learning and cognitive support through virtual agent conversations or prompt dialogs and questions. Most ITS are based on hypermedia environments, and only a small part of ITS is characterized by multiple environments.

ITS learning group analysis

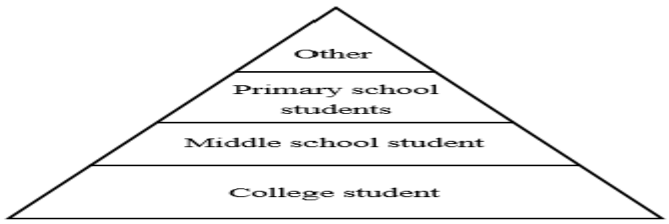

Figure 3 ITS learning group

The ITS learner group identity presents a pyramid shape (as shown in Figure 3). It is located at the bottom of the tower and belongs to college students. It is the learning group with the largest number of participants in the survey. They are mainly the base for educational research and are also important participants in the experiment. Followed by high school students, such students mainly use ITS to complete knowledge training and assessment, improve their cognitive and metacognitive; the third is primary school students, such students are mainly used for students on basic knowledge of mathematics skills training, Complete one-on-one effective coaching for students. The fourth type is other people, including kindergarten students, people who have already worked, etc. Although the number of users is relatively small in the survey of specific articles, the actual use objects are not necessarily less than others. It can thus be seen that how to improve the students' ability to learn independently and make passive participants become active learners, and thus to raise awareness and metacognition need deep thinking.

In addition, the survey empirically analyzed the degree of acceptance of ITS learning methods, and concluded that the majority of learners believe that the tips and suggestions provided by ITS can help improve students' thinking development. The difference is the emergence of virtual agent figures, which enables students to enhance The sense of presence and presence in computer environment learning. Of course, some scholars also question the ITS learning and give a negative attitude. For example, Matthew L. Bernacki and others in the United States found that students' performance goal scores have nothing to do with learning behavior and performance through actual surveys. Students who have a stable target method use more than one method. Students have better learning performance. Students who seldom use help-seeking behaviors during the learning process have better learning performance than those who often seek help during the learning process [40].

Analysis of ITS practice model

The purpose of ITS creation is to provide curriculum and knowledge content for students' one-to-one sexual tutoring. Students use the open terminal learning environment to not only learn relevant knowledge content, but also to grasp the methods and principles of relevant knowledge, so that students can learn from time to time. Everywhere can learn to provide students with adaptive knowledge recommendation and personalized support, enhance students' cognition and metacognitive ability, give consideration to students' cognition and metacognition, and improve students' subject quality and STEM literacy. However, because ITS is a result of the hard work and cost of the relevant participants, the development costs are high, especially for a series of courses. Although many ITS follow the road of public welfare, if you want to truly learn a certain knowledge Thorough learning, but also need to participate in the formal classroom teaching process. ITS is more about one-on-one counseling for students' characteristics, psychology, and learning background, and is not really suitable for widespread promotion. Even due to geographical differences, racial differences, and cultural differences, ITS cannot be as open and universal as MOOCs.

In conclusion, ITS currently conducts one-on-one sexual tutoring software systems for students. However, as more and more systems are embedded in virtual learning agents, they can promote and motivate students to learn collaboratively. In the normal system application process, ITS seldom truly Into the reality classroom, making it difficult for him to go far. Therefore, it is most important to find a balance between autonomous learning and collaborative learning in student application systems.

Normalization of its practice

With the development of ITS, the problem seems to slowly return to the "ITS where to go." Although ITS resources can be shared, different countries have different cultural differences. Therefore, based on the above research results, this paper discusses the normalization of ITS practice from the five aspects of development path, audience target, learning mode, ontology evolution, and key development directions, that is, revisiting the localization of ITS.

ITS development path: smart learning

This paper proposes that the future development path of ITS should be based on the cloud service platform, using a new generation of mobile network technology, big data, learning and analysis technology, etc., together with an adaptive learning engine and personalized recommendation strategies to achieve smart learning, such as As shown in Figure 7, the two-way integration of education and information technology is advanced. The MOOCs smart learning system respects the individualized and diversified development of digital generation learners, adapts to learners' "recent development areas" and solves the problem of "teaching without class". It not only stimulates the desire for knowledge and enthusiasm for learning, but also enhances the motivation of learning. It is also conducive to cultivating learners' creative thinking ability and ability to solve problems and promote the development of learning wisdom. It will become a new paradigm for educational technology research and the development of education informatization.

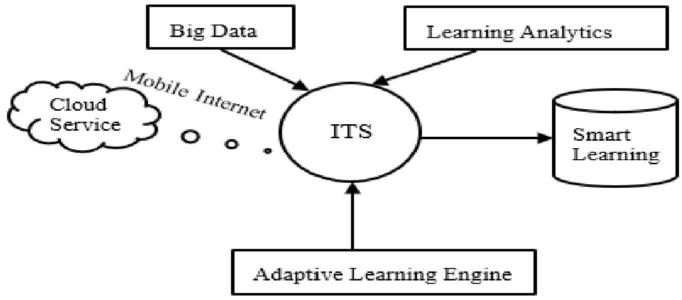

Figure 7 ITS development path

Audience of ITS: Towards diversified development

At present, ITS is mainly used to promote students' STEM literacy and personalize one-on-one tutoring for students. The audience is mainly from primary and secondary school students and college students. In order to open up the ITS application market, its audience should be diversified. In addition to universities and colleges, primary and secondary school basic education and vocational education should be promoted. Among them, for basic education personnel, ITS can solve the problem of unfair education among regions, between urban and rural areas, and between schools, and meet the educational needs of changing from "ability to go to school" to "to be good at learning"; for vocational education, occupations There are many technical schools in the country. The levels vary widely. Some vocational schools teach students with high standards. Some schools teach students with weaker abilities. ITS can start with vocational education and solve the problem of young children coming out of school. Not to work this problem. Of course, we should be more clear-headed to realize that the real big market for ITS is off campus. There are hundreds of millions of migrant workers and factory workers in China. They need training and they are willing to learn. If tuition is not expensive, they are willing to make some money. In addition, there are still many white-collar workers who want to start their own business and want to improve themselves. If they can subdivide the market according to their needs and open a lot of corresponding courses, they will have both the ability to pay and the requirements for learning. This will become The huge ITS market is conducive to promoting ITS business model development.

ITS Learning Mode: Advocating Autonomous Learning + Blending Classroom Teaching

In the ITS system, students use the resources in the environment to conduct autonomous learning, complete real-time quizzes, and read and work required after class. If the learning process is incomprehensible, you can get the corresponding support through tips, suggestions, virtual agents, etc. in the system environment. However, education is not only a knowledge education, but also involves aspects such as personality, study habits, and moral cultivation. Moreover, “value shaping” and “ability training” are difficult to achieve through simple human-computer interaction knowledge transfer process. Face to face communication and teachers The transmission of ideas and timely feedback from classmates needs to exist. For this reason, the combination of online learning and school education can be achieved through the "mixed teaching mode" of "flipping lessons", and ITS can be regarded as "BOOK". Students can use books to study on their own, but if they can learn better together with teachers, the classroom focuses on cultivating students' innovative spirit and practical ability. At the same time, through more face-to-face interaction between teachers, students and students, students develop healthy personality and correct feelings, attitudes and values. It can be seen that the self-directed learning + flipping classroom blended teaching model is a kind of teaching method that adapts to learners’ learning characteristics. It can not only enhance students’ independence and self-discipline, but also can provide favorable compensation for the actual problem of online learning emotions. The mental model of learning.

Key Development Directions of ITS: Resolving Education Equity

ITS has opened a door for everyone to learn. In view of the imbalance in the allocation of educational resources in China, ITS's focus should be on equitable education. If excellent ITS resources can be transferred to poverty-stricken counties and township-level secondary schools, students in underdeveloped areas will have more access to quality education resources in the country and achieve a scientific and rational allocation of limited quality education resources, thus solving education. The core part of fairness is the unfairness between teachers. ITS education will also become a powerful force.

ITS development opportunities and challenges in the new era
In the work points of the Ministry of Education, strengthening the construction of colleges and universities has first appeared in the annual work plan of the Ministry of Education, and has explicitly proposed to increase the development and application of high-quality digital education resources. This is a top-level design guideline for ITS development. In particular, with the arrival of the “customer”, “Internet+” and artificial intelligence era, new opportunities and challenges have been brought to the development of ITS.

Maker Education and ITS Development

General Secretary Hu Jintao pointed out at the 2006 Academician Meeting of the two academies [2] that the key to building an innovative country is talented people, especially innovative talents. Young people are the hope of the country. They are the most imaginative and creative. The future of science depends on them [3]. The U.S. New Media Alliance 2015 Horizon Report (Higher Education Edition) states that maker education is a medium-term application of information technology in higher education. The national government report also puts forward the “Constructive Guidance System for Entrepreneurial Entrepreneurship, Support for Entrepreneurship Camps, Entrepreneurial Innovation Contests, etc., Fostering Maker Culture, and Entrepreneurial Innovation become a common practice”. The so-called guest education refers to the education behaviors that cultivate the students' knowledge, ability, and industry, etc. needed for innovation and entrepreneurship. The effective application of ITS can solve the problem of innovation and creation during the Make-in-Chief era. The development of students’ innovative ability is the mid- to long-term trend of China’s educational goals. The Chinese education system must pay attention to the cultivation of students' innovative thinking, creativity and entrepreneurial ability. "The CPC Central Committee and the State Council's Opinions on Deepening the Reform of the System and Accelerating the Implementation of Innovation-Driven Development Warfare" (2015) clearly stated that it is necessary to "build innovative talent training models, carry out trials on reforms of heuristic, inquiry-based, and research-based teaching methods, and promote science. Spirit, creating encouragement for innovation, tolerance for tolerance, and innovation." University of Winchester professor Guy. According to Guy Claxton, "Innovation is a mixture of many mental habits, including curiosity, skepticism, imagination, determination, craftsmanship, cooperation, and self-assessment." Students enjoy full autonomy and free learning opportunities. Expanding the horizon of learning and making thoughts more open; honing divergent thinking, and quickly and flexibly changing the field of mind, will enhance internal drive and motivation for learning. Finally, its ability to innovate will be completely different.

It is true that the new generation of learners belongs to Digital Natives or New Humans. They were born in the information age and grew up in a digital learning environment. They mostly like new things, are uneasy about the status quo, or stick to stereotypes and are willing to change. , good at innovation. As a new thing, ITS breaks the traditional classroom model and integrates the characteristics of online education. It also breaks the limitations of physical universities and enables quality education resources to be shared, created, and optimized. Learning is no longer subject to time, space, and content. Dimensional restrictions and then outline the three-dimensional learning landscape of “lifelong learning”,“ broad learning and deep learning. "New humans" are willing to learn and are good at learning, but they spend less time focusing attention, tend to fragment content, and like simple, clear, refined, accurate information. They don't like passive listening or long talk. ITS meets these needs exactly. This enables them to reprocess and recreate their original knowledge in response to specific problems.

Development of ITS in the "Internet +" Age

In the government work report of the “two sessions” in 2015, the “Internet +” action plan was first proposed and formally established as a national strategy and education. The influx of emerging Internet technologies and the explosion of information revolution have made the online education rise sharply, bringing with it multiple sources of knowledge, information, and availability. Students have the right to choose and bring new opportunities for the development of ITS practice. It will also open a new era.

The ITS in the era of “Internet+” will continue to enable everyone to realize personalized learning, embrace new culture and new thinking with an open concept, and use big data storage, mining, and analysis capabilities to enable the formation of “smart” forces. The new learning system, reshaping the new learning form, that is knowledge acquisition, participation in the transformation of knowledge creation, is no longer an extension of the traditional university curriculum, but on the road of self-organization and customization.

The essence of education is to develop individuality and to make every student's personality develop healthily. If traditional school education still follows the standardized and indoctrinative education and teaching mode in the industrial age, the school is a teaching factory and the classroom is a production standardization talent. "The assembly line. The major "illness" of this teaching model is to kill people's personality. ITS will provide opportunities for personalized education. Through intelligent analysis and processing of big data learning and analysis technology, the use of information visualization methods to present learning results, the formation of personalized learning report, quantify self and self-understanding from the data, help to change the knowledge construction in the mind, and then improve the learning efficiency. And learning quality.

In the era of “Internet+”, under the background of the popularization of adaptive learning system application, the normalization of digital learning, and the application of big data, the rapidly emerging intelligent mentors with the goal of promoting one-on-one teaching have received extensive attention from researchers worldwide. And exploration. The common goal of ITS is to use various computing techniques to enable learners to promote student learning in meaningful and effective ways. At present, some ITS have been used in formal education and professional education environments to prove students' abilities and deficiencies.

Artificial Intelligence and ITS Development

In the era of artificial intelligence 2.0, artificial intelligence was widely used in the fields of economy, transportation, military, and education. In recent years, all countries have successively issued policies and reports on deepening the development and application of artificial intelligence technologies. On July 8, 2017, the State Council of the People's Republic of China formally promulgated the “Notice of a New Generation of Artificial Intelligence Development Plan”, which clearly stated the concept of intelligent education. , and pointed out that in the future we must use smart technology to speed up the promotion of personnel training mode and teaching method reform, and build a new education system that includes intelligent learning and interactive learning; we must carry out intelligent campus construction and promote artificial intelligence in teaching, management, and resource building. application.

Artificial intelligence integrates into human society in a more natural way and exists as a “partner”. Artificial intelligence can be transformed into a kind of intelligent companionship. The intelligent teaching agent is embodied as an assistant teacher or learning partner or an agent. The application of the conversational agent model to intervene in this collaborative learning of students, the learner's questioning and answering mode seems to be more inclined to the intelligent agent model.

Japan has brought artificial intelligence into a real online classroom. After three groups of controlled experiments, it is found that the learning effect of a robot-based online interactive environment is better than an online learning environment based on human-computer interaction and a three-dimensional virtual environment with similar robots [21].

Core Literacy and ITS Development

The human brain is the most complex and is a system with the complexity of nonlinear dynamic processes. Literacy is not knowledge, and the accumulation of knowledge does not necessarily lead to the development of literacy. If we uphold rigid, solidified views of knowledge and teach knowledge in an indoctrinated and trained manner, the accumulation of knowledge will lead to a decline or even annihilation of literacy. However, literacy can not be separated from knowledge, no knowledge, literacy is the passive water, no wood. With the knowledge society, the value of knowledge is increasing day by day. Transforming the way of knowledge learning is the premise of the development of literacy, so that the process of knowledge learning realizes the connection between critical thinking and social collaboration. To this end, we must advocate deep learning so that knowledge learning becomes a process of critical thinking and problem solving. Advocate collaborative learning and make knowledge learning become communication and collaboration, that is, the process of collectively creating knowledge.

The core quality is the “literacy of the 21st century” and it is the advanced ability and human form ability that people adapt to the needs of the information age and knowledge society, solve complex problems and adapt to unpredictable situations. Core literacy is the development and transcendence of "basic skills" in the era of agriculture and industry. Its core is creative thinking ability and complex communication skills. Core literacy has the characteristics of the times, comprehensiveness, cross-domain and complexity. At present, the core literacy that the world is pursuing is cooperation, communication, critical thinking, and creation. That is, “4C’s”. Core literacy is the advanced ability and human ability to solve complex problems and adapt to unpredictable situations. A deep understanding of the connotation of core literacy requires the proper handling of the relationship between literacy and knowledge, literacy and situation, literacy and performance, core literacy and basic skills. Core literacy refers to the individual's higher stability, which may be accompanied by a lifetime of attainment. Once acquired, it can be inseparable from the individual's life and life. Each ITS is subject-specific, and the integration of each discipline branch is not easy. It requires in-depth analysis and research to reveal the common nature of related objects.

Summary

Although there are still doubts about it, there is no doubt that it is a powerful new model for technology-assisted teaching and plays a pivotal role in the development of education, enabling students to learn the best without any obstacles. Knowledge and nutrition are already indisputable facts and have become important milestones and new forms of education in the future. So far, many researchers (especially foreign researchers) have focused on ITS, explored the influencing factors that influence ITS-based environmental learning, assessed the effectiveness of ITS learning, and conducted in-depth research on ITS design and development. This article is mainly from 6 journals and magazines. The dissertation collected and analyzed the relevant literature from 2008 to 2017, analyzed the evolution of ITS origins and theoretical practice from a multidimensional perspective, hoping to help people thoroughly understand the ITS under the new normal.

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