

# Chapter 5

## Artificial Intelligence and Education



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### 第 5 章 人工智能与教育



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**Abstract** As the progressive ladder for human society, education aims at ensuring cultural heritage and social development. More importantly, it may inspire human imagination. In this sense, education is very critical in the development of a nation and even in the whole human society. Education will vary with different times in its concepts, contents and modes and accumulate energy for the transformation of social patterns. Now, AI has been used in nearly all the industries and trades, posing a powerful impetus in promoting economic development and social progress. The in-depth development of AI will be bound to accelerate the process of social order restructuring, ensure the harmonious coexistence between mankind and nature, coordinate the development man and science and bring unprecedented development opportunities as well as challenges to education. In intelligence age, with more and more educational resources available, more flexible modes and patterns and multi-variant intelligence systems in teaching, great changes will take place in education, during which people may acquire knowledge in the forms of clustering and individual education and their ability will be greatly improved. Meanwhile, the new topics will emerge on how to enlighten people's mind, how to reforge their values and how to tap their potential.

## 5.1 New Educational Modes Initiated by AI

AI will reconstruct educational modes and constantly renew teaching contents so as to meet the requirements in the new era. In intelligence age, people should be initiative in understanding the principles and methods of information processing, catch on and admit AI products and service, enjoy the benefits brought by scientific progress, care more about human destiny and actively cope with the coming opportunities and challenges.

AI impact on education may fall into three respects:

- (1) AI will trigger the innovation of educational means and methods, really bringing about "individualized teaching" and "edutainment." Based on the educatee's physiological, psychological, competent and aspiring conditions, AI will design individualized program, including content selection, releasing ways and adaptive adjustment in light of the feedback. The selection and generation of teaching contents should be educatee and object-oriented, which will affect the educatee's consciousness and his/her subconsciousness so that he/she may direct his his/her thinking and remold his/her personality in the virtual environment similar the games.
- (2) In the era that AI is extensively used, mankind will focus on developing his core ability. Such assignments as environment perception, data acquisition, discovery of principles, prediction and control based on experience will be undertaken by intelligent tools or intelligent systems. Under such circumstances, man will gain

more time and energy for innovation, exploration, imagination, aesthetic taste and order reconstruction. These are the reasons that human beings can not be replaced by machines or be the vassals of machines.

- (3) AI development will encourage people to constantly pursue new freedom and targets. With the binary order “physical space—social space” evolving into ternary order “physical space—social space—cyber space,” people will revalue and deposition themselves. With the progress of intelligence systems and externalization of human partial ability, they will gain an in-depth understanding of the possibility between themselves and the external world and acquire a broader developing space and more abundant profitable resources.

### ***5.1.1 Historical Evolution of Innovating Educational Modes***

There is no lack of advantages in traditional education, but educational inequality is rather striking due to the limited teaching resources, qualified teachers in particular. In information age, the advent of Internet has broken the boundary between space and time in traditional education and people have achieved learner’s autonomy, a trend that brings about educational equality to certain extent.

The quietly coming intelligence age offers people mega-data and techniques of machine learning and virtual reality, from which people acquire ample educational resources and teaching means, bringing about educational autonomy and intelligence. In this context, people have to redefine the cultivation of the coming talents so as to achieve the coordinated development between human intelligence and artificial intelligence.

#### **(1) Traditional Education versus Internet Education**

Before the application of IT, schools act as the carriers of traditional education. As such stereotyped education is featured by classroom interaction between teachers and students, students not only acquire knowledge, but also submerge themselves in cultural nurturing. Strict in management, standardized in modes, favorable in environment, traditional education focuses on knowledge impartment, during which teachers protrude predominantly, whereas individual orientation of students is ignored, resulting in languishing cultivation of creativity. Moreover, due to the uneven economic and cultural development in different regions, there gives rise to the striking issues, including disproportionate distribution of educational resources, educational inequality, etc.

With the popularization of Internet, the spatial and temporal boundary in traditional education is broken, the conventional concept and practice has been subverted. To forge a dynamic and open educational environment becomes a marked feature in Internet education. To reform teaching modes by means of IT and network platform is the developing trend, with the successful cases shown in “overturning classroom teaching” and “massive open online courses” (MOOC for short).

Compared with traditional education, Internet education has the following advantages in education resources, teaching methods, teaching modes and other aspects: Firstly, Internet education can realize anytime and anywhere sharing of teaching resources. Students can use all kinds of information and resources on the Internet, and they can also study at any time and any place, breaking the limitations of traditional classes and making the learning process flexible and convenient. Secondly, Internet education is easier to meet personalized learning needs. On the Internet education platform, students have greater autonomy in course selection and can also learn according to their own interests, basis and methods, which are not limited to a unified specification. Finally, education has various teaching forms and novel and interesting teaching methods.

Internet education teaching is not limited to text, sound, animation and other forms and easy to present the teaching content through a variety of methods and stimulates students' interest in learning and learning enthusiasm.

The development of the Internet has had a significant impact on the traditional education model; especially, after the concept of "Internet +" was put forward, the impact of information technology on education model has a new development, people have a new understanding of the change of traditional education, but the action is just beginning.

## (2) From Internet Education to Education in the Age of Intelligence

Internet education breaks the limitation of traditional education space and time and expands the traditional closed classroom into an open interactive platform, which to some extent reflects the autonomy of learning and promotes the equality of education. However, the disadvantages of Internet education are also obvious: Firstly, the effect of Internet education depends on students' self-control, judgment and self-study ability. Internet education is usually a one-way transmission process, which is difficult to guarantee the learning effect. Secondly, the spiritual and cultural depth of Internet education is not as deep as traditional education. Education is not only the transmission of knowledge, but also the promotion of the spiritual world and the development of cultural concepts. Internet education focuses on the innovation of teaching content and teaching methods. It lacks communication between people and pays less attention to the construction of humanistic concepts.

When people are still enjoying the convenience brought by the Internet, the era of intelligence has quietly come. With the help of big data, machine learning, cloud computing and other technologies, AI has demonstrated its perceptual ability, judgment ability and evolutionary ability. With the help of various types of sensor networks, artificial intelligence already has vision, hearing, touch and temperature body sense. With the help of machine learning theory, artificial intelligence has some advanced reasoning, planning, prediction, decision-making and other intelligent behavior.

Applied in educational field, AI will trigger revolutionary changes in educational modes, a developing trend indeed. Now, various AI teaching systems have been put into use and replaced the role of teachers to certain extent. Endowed with massive teaching resources, robots may tirelessly simulate the dialogue and communication

between human experts and students and exercise accurate individualized teaching on the basis of students' conditions. How to achieve educational automation and intelligence by AI innovative educational modes is one of the major assignments for the coming educational revolution.

In intelligence age, a fundamental task on education is to achieve multiple advantageous integration of individual language, logic, interpersonal relationship and self-recognition. The cooperation and competition between human intelligence and AI in the future will yield brand-new educational modes, in which people should not only develop AI ability, including its competence in rapidly processing information and making logical judgment, but also exploit the capacity that AI is not adept, covering the skills of interpersonal communication and self-recognition peculiar to mankind so that man can better coordinate the machines. In such era, an eternal assignment for education is how to enlighten people and stimulate their creativity in technology and art so as to remold a better world.

### ***5.1.2 Opportunities and Challenges for Education in Intelligence Age***

Education aims at enlightening people, during which one soul awakes another one. Student-oriented, modern education advocates ten concepts, including people first, all-round development, quality education, creativity, initiation, individuality, openness, diversification, eco-harmony and systematic concept. The education during intelligence age should be student-oriented, diversified and individualized. In addition to the reform in teaching resources, teaching contents and form, guaranteeing of teaching quality, it is imperative that we should inflame students' desire of making innovation, remold their values and foster their psychological and physical quality. Such cooperation and competition will help reconstruct educational business and educational market and bring new opportunities and challenges to students and teachers.

#### **(1) Basic Contents and Elements for Talent Cultivation in Intelligence Age**

What kind of talents to be cultivated and how to cultivate are the two everlasting themes in education. Prof. Qian Weichang, renowned educationalist, late President of Shanghai University, once remarked, "Our students should be, first of all, the talents of all-round development, patriots, dialectical materialists and men of moral integrity and artistic culture. Secondly, they should be the graduates with professional knowledge, the prospective engineer and experts." It is the requirement of times for us to cultivate specialists with all-round development. Both teachers and students in intelligence age should complete such an assignment—reconstructing their knowledge structure.

This reconstruction is embodied in traditional knowledge system, which demands the compression and merge of certain knowledge to some extent and then emphasizes

the addition of the contents related to AI. Teaching will involve remolding of values, cultivation of the ability to analyze and solve problems and the training of creative thinking. The details cover the following contents and elements.

Information literacy is the basics for education and a fundamental capacity that people must acquire in the context of global information and intelligence, which is shown in the following eight respects: (1) to use information tools—one should be skillful in using various information tools, network communication tools in particular; (2) to acquire information—based on his own learning goal, one should be effective in collecting learning materials and information, adept in obtaining information through reading, access, seminar, visit, experiment and retrieval; (3) to process information—one should be able to deduce, classify, store, differentiate, screen, analyze, integrate and generalize information that he gathers; (4) to generate information—one should accurately overview, integrate, implement and express the needed information, making it more concise, smooth and characteristic; (5) to create information—on the basis of interaction of the information collected, one should find out innovative opportunities, breed growth points of information so as to create new information and realize the terminal goal of information collection; (6) to give play to information—one should be adept in solving problems with the information he gathers so that the information yields the maximum social and economic effects; (7) to coordinate information—one should turn information and information tools into the intermediaries for spatiotemporal spanning and “zero-distance” communication and cooperation, making it the efficient means for improving himself and establishing harmonious cooperative relationship with outer world; (8) to be immune to information—as fine and bad information is often intermingled, one should develop the ability to screen the good from the bad one with his positive outlook on life and values and consciously reject and eliminate spam ill-healthy messages with his self-controlling, self-disciplined and self-regulating competence, equipped with the ethical quality which conforms to information times.

Information literacy covers information awareness, information knowledge, information competence and information morality, among which information awareness comes first in that it covers such respects as sensibility to information, enduring attention and discretion on values. As the base for information literacy, information knowledge involves scientific principle of information, tools for information application. To be the core, information competence implies the ability to screen the needed message in the massive and unordered information ocean and to apply it into knowledge innovation in reasonable way. Information ethics offers the assurance in sustaining the normal order in information operation and prevents it from endangering the society and infringing the legitimate rights and interests during acquisition, application, processing and dissemination of information.

The twenty-first century marks an age of multidisciplinary science represented by intelligence, an era initiating “singularity” mode of technological development, during which the concept “major disciplines” is generated by “AI + X,” bringing about the in-depth integration of interdisciplinary subjects. How to study and how to think are the fundamental skills for mankind in the new era because lifelong learning can enable people to deal with the constant challenges.

## (2) Talent Cultivation Driven by the Requirements in Intelligence Age

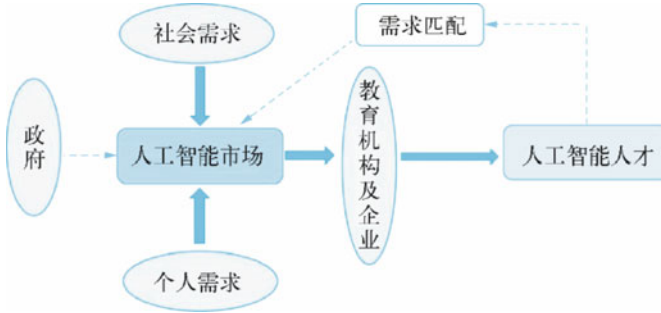
Different from traditional education era and Internet education era, the education in intelligence age covers all the scientific contents in the past several hundreds of years, brimming with enormous potential in scientific development, industrial production and overall social planning. It is predictable that AI is critical to national competitive edge and productive forces. AI will exert influence in the following respects.

Firstly, AI may bring effects to national defense, financial institutions and social groups. In addition to the elevation of efficiency, AI is also critical in China's core competitiveness in the new era. At present, international financial institutions have brought in AI decision-making mechanism, which validates the advantages in decision-making efficiency, costs and rate of return, as against the previous man's decision. Moreover, AI proves its superiority in games and tests to mankind. With further development in AI, to master autonomous and advanced AI hardware and software is the prerequisite for improving national competitive edge.

Secondly, with regard to economic development and enterprise competition, AI will directly reduce costs in labor and management and elevate production efficiency. Microsoft, Google and Baidu have taken the lead in helping enterprises to forge AI platforms so that they may clearly get to know customers' requirements and formulate their marketing strategies. In addition, AI will exert huge potential influence on public order, social security, medical service and people's livelihood. Now, the commercial applications of the new techniques and new modes such as face recognition, health monitoring, tele-medical care and intelligence diagnosis have effectively promoted economic and social development.

Thirdly, AI's affect on individuals mainly manifests itself in employment, business initiation and living style. In recent years, the dramatic development in Internet and mobile Internet has greatly facilitated people's shopping and intercommunication. While generating "the phubber," the two networks are also conducive to Internet employment, in which the operation ability of computer terminals is a prerequisite in most posts of duty. Moreover, AI will further transform man's lifestyles, forms of employment and modes of business starting as well. Individual occupations will be subject to impact and change in AI times.

To acquire national competitiveness and elevate social and economic effects, the core strategy for AI aims to promote the overall development by quality talented people. The core concept in talent cultivation is how to achieve coordination among governmental departments, educational institutions and non-governmental organization so that we may bring up the professionals in planning, management and technology to meet the needs of AI markets. As shown in Fig. 5.1, AI market will be supported by Central Government, driven by social and individual requirements. Oriented by market requirements, educational institutions and enterprises should formulate their comprehensive and specific programs for talent cultivation. Additionally, they must constantly see to the matching condition between talent cultivation and market requirements so as to make the necessary revision and regulation on the programs.



政府： Government

社会需求： Social requirements

人工智能市场： AI Market

个人需求： Personal requirements

需求匹配： Need-supply fit

教育机构及企业： Educational institutions and enterprises

人工智能人才： Artificial intelligence talents

**Fig. 5.1** Talent cultivation driven by requirements in AI era

AI will bring opportunities and challenges to a country and its social groups, or to enterprise and individuals, and promote reform. To seize the opportunities and settle the challenges so as to hold a lead in this field, we should train a number of teams and professionals adaptable to or even leading the reform, which is taken as the assignment for educationalists as well as the driving force for educational transformation and upgrading. As it is an even-developing technology, we may tap the enormous potential in AI, explore and exploit many unknown and applied realms. As to the pioneering talents in new technologies, it is critically import to stimulate their motive force, which comes from their mission to propel human civilization, their responsibility for driving social development and their blessedness in realizing individual objects. It is a special task for cultivating talents in AI age that we should endow them with the dynamic subjective initiative by means of motivation.

The particularity in cultivating outstanding AI talents manifests itself in professional foundation and integral innovation. For the former, how far AI can go is decided by highly developed ability of manufacturing hardware and in-depth computational algorithm. For the latter, the integration of scientific, technological and industrial knowledge so as to bring about technical innovation controls the degree of width and acceptance of AI in social application. The cultivation of relevant personnel also calls for the pertinency and openness at multiple levels so as to address the unemployment brought by industrial restructuring in AI age.



### (3) The Trends of Talent Cultivation during AI Age

While eliminating some work posts, AI will bring opportunities for re-employment. In this age, educational reform has been undergoing, which will focus students' lifelong learning, creative thinking and their ability to adapt themselves to time requirements. To educational sector, the educatees should get themselves ready for the challenge so that they may be adaptable to the rapid development in the future.

For students, the major skills that they should master are as follows:

- (1) Socializing skill. Even if robots are put into use, interpersonal communications are still indispensable in that collaboration is a good way for improving efficiency.
- (2) Ability for sustainable learning. As science and technology are developing in an amazing speed, resulting in the disjunction between one's acquired knowledge and practical competence, one of the important skills in autonomous learning is how to study, called "metacognition," through which a learner is clear of his own thinking mode so as to study in effective way.
- (3) Machine's intelligence quotient. The so-called machine's IQ means the ability to understand robot's operating modes. When robots prevail in the near future, the higher the machine's IQ, the more advantages one will get.
- (4) Computer programming. Prof. Wu Jun, a computer scientist, holds that with 30-year critical progress made in computer science, it can be predictable that major advancement in the coming decades will still be achieved in this field. Mr. Wu is also an author of technical best sellers, whose works cover "Aesthetic Mathematics," "The Mystique of Silicon Valley," "The Light of Civilization" and "The Intelligence Age." The progress will serve as an impetus for AI development. In intelligence era, everyone should master the technique of programming, a basic skill in computer realm.

## 5.2 Objects, Requirements and Relevant Discipline Construction for Talent Cultivation in Intelligence Era

In intelligence era, life means to learn, to work and to create, which compels people to constantly create new things so as to adapt themselves to new life. In addition, all the people need to be trained in an all-round way, the advanced professionals in the relevant disciplines in particular.

### 5.2.1 *Objects for Talent Cultivation in Intelligence Era*

The ever-bubbling AI services are incessantly changing people's ways of life. Different objects call for the corresponding competence of the talented people, learning contents and cultivation modes.

## (1) New Types of Business and Innovation in Educational Modes

Employees in all walks of life will be inevitably affected in intelligence era. The advent of new type of business and new professions will, in turn, spur new requirements on talent cultivation. People's demands for training or further studies will draw forth a huge education market. In addition to schools, more enterprises will embark on educational field. It is predicted that more network (distance) training institutions will come out, offering various kinds of training to college students and adults, by which educational resources will be re-allocated. School education will focus fostering man's quality more and training institutions will attach more importance to applied skills. In this way, mutual complementation will be achieved between school education and social training, between schools and enterprises and between two different industries.

In intelligence era, there will more resources in massive open online courses (MOOC for short), as a result of which more AI products and technology will be available. Under the accurate AI guidance, students will achieve better results and higher efficiency in their learning and their individuality will be greatly improved. Moreover, teachers will endeavor to improve their professional ability and spare more attention to the overall development of their students, while schools will lay more emphasis on quality molding, value formation and motivation of creativity.

New educational modes will promote educational equity. By means of AI teaching, the people in different regions will share the same education and receive the precise instruction from "the best teachers." Additionally, the consummate Internet facilities will lower educational costs to a great extent, making possible the global free education.

In addition, with more accurate and convenient educational appraisal system available, several circulations within courses, disciplines and schools will be automatically formed. Joining hands with enterprises, schools may make survey on the quality of their graduates, an act conducive to improving their teaching.

## (2) Lifelong Education

### (1) Lifelong education will come out in intelligence era.

Lifelong education covers five age periods, namely children, juvenile, youth, mid-adult and elder, for which the educationists will plot out the coherent teaching pertinent to these periods. Each period is offered the particular teaching contents.

(A) Educational Period for Young Children (pre-kindergarten education and kindergarten education). AI education should begin from "young children," for whom AI products will be available either as toys or tools in an attempt to arouse their curiosity and foster their information literacy. For example, intelligent bracelets will be standardized devices for young children, which are used to surveil children's physiological signals, such as heartbeat, breath and pulse, and which can serve as GPS apparatus, informing their parents where their children are in real time. During this period, young children are required

to understand the functions of the intelligent product and its usage, enabling them to experience “AI is ubiquitous and AI products are human friends and assists, which will ensure our security.”

- (B) Period of Compulsory Education (from primary to middle school). The courses in computer science will cover knowledge, technique and application in AI. Apart from the courses in computer, AI will be basic course for all the disciplines. For example, teachers will show the cognitive principle of human brain in biology classes and introduce the relationship between AI and human brain. In the course of civilian and society, there should be the contents in AI. During this period, all the curricula must involve AI, with the focus on the extensive applications and the positive roles of AI in social life and all walk of life, such as intelligent medical care, smart housing, intelligent traffic, intelligent health and elder’s life, intelligent finance, etc. In addition, ethical and moral principles will be a course for students in intelligence age.
- (C) College Education (undergraduates, master and doctoral candidates). During this period, AI will be a separate discipline for undergraduates, who will systematically study fundamental knowledge and technology in AI, covering in-depth learning, processing of natural language, machine vision, reinforced learning, virtual reality, intelligent perception, theory of mega-data, etc. AI specialties will be founded for master and doctoral candidates, who will further their studies in the subdivisions of AI. Moreover, both compulsory and optional courses will be offered to the students of non-AI specialty so that they may get to know the fundamental principle of ethical norms, legal regulation and social affect in intelligence age, who will use AI in a better way, improve their life quality and elevate their learning working efficiency with AI technique. In a nutshell, such moves as cultivation of information literacy and training of computational thinking will permeate into all the disciplines in universities so as to foster students’ ability to apply and create AI.
- (D) Continuing Education for Adults (education upon employment). AI will be an effective and powerful tool for employees, who are required to study and apply the updated technology and products of AI. As AI is developing with each passing day, “recharge of knowledge” will be a normal state for adults and their modes for studies will be multivariant. AI contents in continuing education of adults will be closely related with their occupations. For instance, employees in financial sector will take AI as a tool in developing financial derivatives. After lecturing the course on AI tool, virtual teachers will unfold Q&A on financial tool in virtual scenes with the means of virtual reality.
- (E) Education for Elders (re-learning of aged people). Simplified contents in AI will be offered to elders. With the ever evolution of AI, while greatly facilitating elders in their life, AI equipment and products will

incur inconvenience in operation. To elderly persons, “One is never too old to learn” is no longer a motivational saying, but a real situation that they are confronted. If they hate continuing learning, they will fail to keep pace with AI development and will be unadaptable to modern life. Therefore, through education in intelligence age, elders should learn how to use intelligent nursing products, such as smart temperature and light regulatory system, wearable multimodal sensors, smart tumble-proof clothes, robot pets and intelligent walking machines. Based on above competence, elders should further get to know how to use other AI products, including recreational and communicative devices of virtual reality, which can enable elders to perform remote interactions with their relatives.

- (2) In intelligence age, what our society needs are the talent people who are innovation-conscious, powerful in communicative expression and social competence, globally perspective and internationally competitive.

Although benefitted from AI, various talents hold different interpretations and acquire diverse competence in AI. With regard to this situation, in the near future, three kinds of people will receive lifetime education from childhood to advanced age.

The first kind of people are the leading experts in AI. When they are still young children, teachers and their parents should judge whether they are outstanding in “AI quotient,” a new quotient as against IQ and EQ which is used to measure one’s quality and competence in AI. “AI quotient” can be something either congenital or acquired through training. Among the children of the same age, those who are highly gifted in “AI quotient” will be specially trained so as to arouse their interest in computer and other branches of sciences. During the compulsory education period, those children will acquire the knowledge and skills in AI and develop their creativity. As man’s brain is far superior to machine in imagination and creativity, leading experts will focus these two respects in their lifelong education. Intelligent education technology will offer students interactive learning experience, a condition that ensures the adolescent who will potentially be the leading experts to efficiently study and arouse their imagination and creativity. After they complete their advanced studies in schools, they will turn themselves into AI leading talents or become entrepreneurs with international horizon and reap achievement in AI products. Even in their advanced age, they can still update their overall quality and act as technical consultants in AI development through continuing learning.

The second kind refers to the proficient users who will receive AI education in their childhood and constantly acquire AI knowledge and skills in their juvenile, youthful and prime years. To be specific, these kind of people will be trained to arouse their enthusiasm and curiosity in AI products in childhood, to acquire the knowledge in AI and its products in their juvenile years, to continue their study and research in AI and to be adept in applying AI products in their prime

years, to reserve and enforce their proficiency in operating AI products in their venerable age.

The third kind of people are AI beneficiaries, who just keep acquiring popular knowledge of AI in lifelong education. A conventional mode is specified for them, in each period of which they will just learn about the relevant knowledge in AI and can use AI to elevate their working skills and improve their life. While attending senior middle school, they may be free to choose the courses they prefer and the previous class will be turned into “optional class,” during which teacher should focus individualized education, identify the students of expertise and potential in AI, develop their favor and specialty from mega-data and customize the courses for individuals. In both the third and fourth periods, they should also receive the regular training in AI and its products. In this way, AI will seamlessly penetrate into the work and life for this kind of people and bring them more convenience.

### (3) The Focus of Talent Cultivation in Intelligence Era

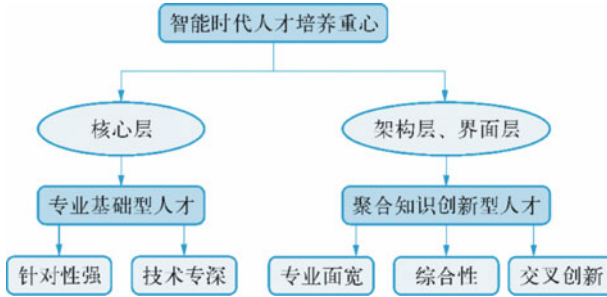
The education in intelligence age adopts a lifetime, universal and incessant mode aiming at developing AI in an all-round way by high-quality professionals who are the indispensable workers in this era. The program for cultivation covers theory, technology, platform and application.

At present, the overall layout for AI industry falls into three level, namely core level, framework level and interface level. The first one involves AI chips, algorithm and relevant hard and software. The second one covers cloud platform and data center, through which people may allocate computer resources, collect and store data and bring about certain functions. The last one enables the functional processing to be linked with users on the basis of resource allocation and achieves realistic functions, such as intelligent perception, pilotless driving, intelligent manufacturing and smart medical health. As shown in Fig. 5.2, the planning layout should be based on the above-mentioned three levels for AI talent cultivation.

To the core level, we should bring up specialized talents who are featured by pertinent specialty, profound expertise, and steady accumulation of professional knowledge. The talents should be able to develop the chips characteristic of low energy consumption, high performance, programmable trait and human brain simulation, and in-depth learning algorithm as well. Only by constantly intensifying basic research and making breakthroughs in chips, fundamental algorithm and theoretical studies can we reap incessant achievements in AI.

The framework level and interface level involve multidisciplinary fields, conducive to cultivate versatile and innovation-aware talents who must acquire wide-range knowledge, strong integrity, interdisciplinary innovation ability and flexible application of compound skills. These two levels aim at cultivating new-type talents who may integrate the functions of mega-data, cloud computing, intelligent hardware into AI application.

The focusing fields in AI industry cover algorithm for machine learning, AI chips, processing of natural language, speech recognition, computer vision,



智能时代人才培养重心：The focus of talent cultivation in the age of intelligence

核心层：Core Layer

架构层、界面层：Architecture layer, interface layer

专业基础人才：Basic professional talents

聚合知识创新性人才：Aggregate knowledge and innovative talents

针对性强：Tobeconciseandtothepoint

技术专深：Deep technology

专业面宽：Wide range of Knowledge

综合性：Synthesis

交叉创新：Cross innovation

Fig. 5.2 Focus of talent cultivation in intelligence era

technical platform, robot, pilotless driving, UAV, etc. To keep pace with these industrial developing trends, we should focus cultivation of the talents with wide-range knowledge and innovation awareness.

### 5.2.2 Requirements for Talent Cultivation in Intelligence Age

#### (1) Competence Requirement

Based on computer science, perception technology and cognitive science and oriented to merge-data from physical space, social space and cyberspace, intelligence science and technology will survey the law of data, reveal intelligence mechanism and make use of intelligence technology to promote technical progress and social development.

Intelligence science and technology aims at cultivating the undergraduates who should acquire the basic knowledge in mathematics, physics, computer and information processing, and interdisciplinary knowledge in psychology, physiology, cognition and life science. The undergraduates should master the basic theory, knowledge, skills and methods of intelligent science and technology. They should also be nurtured in humane atmosphere, trained with scientific thinking, equipped with the ability to

process intelligence information, to study and develop the systems of integrating intelligent behavioral interactions and intelligent apparatus. They should have the awareness of teamwork and the communicative ability, and be capable of updating their knowledge and making innovations so that they are competent to deal with the coming challenges. They should be prepared with the following abilities.

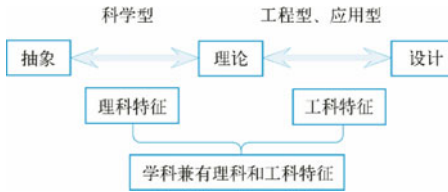
- (1) Cognitive ability of systems. They can apply the fundamental principle and methods in intelligence science and technology to systematically analyze where the problems lie from bottom-up and up-bottom sequence, who can know very well the details in different levels of intelligence systems and recognize the intelligent property of the system from macro perspective.
- (2) Ability to apply theory of intelligence science. They should master the fundamental principle and methods in theory of intelligence science, cognitive theory and intelligent computing and develop the strong ability to analyze and solve the problems at least in one direction.
- (3) Practical ability. They can apply the principle of intelligence theory, intelligence technology and methods to design an intelligent application system so as to solve the problems existing in complicated projects.
- (4) Innovation and entrepreneurship. They should have the development experience in a comprehensive project, equipped with fair teamwork and communicative ability.
- (5) Ability to be adaptable to society. They should have an acute perception ability to study the new theory and technology in intelligence science and technology, loaded with self-learning ability and steady confidence and adaptable to the new requirements in technical progress and social development.

In addition to strong theoretical knowledge, the postgraduates in intelligence science and technology are required to participate in or take charge of certain research projects and make new innovation. For doctoral candidates, they should develop the ability to find out problems, make theoretical innovation or to take charge of major research or engineering projects in interdisciplinary subjects.

## (2) Forms of Intelligence Science and Requirements for Talents

There are three disciplinary forms in intelligence science, namely theory, abstraction and design, for which professionals in AI will correspondingly fall into scientific type, engineering type and applied type. While cultivating these professionals, schools of different functions will offer the courses pertinent to the specific type, as shown in Fig. 5.3.

The talents of scientific type (also called academic type or research-oriented type) focus more abstraction and theoretical studies which are characteristic of scientific property, so they are adept in studies. The professionals of engineering type give consideration to both theory and design, whose work is featured by technical trait and who are suitable for project design and implementation. Mainly emphasizing design, the applied talents should get to know the theory related to system structuring and master description methods of basic issues, who are engineering professionals



抽象: Abstraction

科学型: Science-orientation

理论: Theory

工程型、应用型: Engineering and application

设计: Design

理科特征: Characteristics of science

工科特征: Engineering characteristics

学科兼有理科和工科特征: The subject enjoying the characteristics of science and engineering

**Fig. 5.3** Forms of intelligence science and types of talents

deft at project design and execution and who care more about the external features of the system.

What type of talents will we need in intelligence age? In the “pyramid structure” of talents, a large number of service-oriented people are at the bottom layer. Those who take AI as a tool in innovation and engineering are placed at the second layer. Those who are capable of making new inventions and technologies fall into the third layer, while those at the fourth layer are the first-class experts who are interdisciplinary professionals. Those who are able to invent new AI and control it are, of course, standing at the top layer.

### 5.2.3 Constructing Relevant Specialties in Intelligence Age

What scientific studies deal with in the twenty-first century are the complicated systems consisting of intelligent components, so the theoretical principles and methods will penetrate into the relevant disciplines. In the talent cultivation programs of relevant subjects, we not only take AI advancement in the relevant fields as the contents of general course in our seminars, but also offer the concerning courses on the in-depth studies and application in AI technology in a systematic way.

In the context of new economic booming propelled by new technology, new type of business and new industry, colleges and universities should cultivate engineering talents who are capable of making innovation, initiating business and integrating multiple disciplines. In February, 2017, Education Ministry of PRC released “Notice of Higher Education Department, Education Ministry on Unfolding Studies and Practice of New Engineering Disciplines.” New engineering disciplines correspond the emerging industries, such as AI, intelligent manufacturing, robot, and reform



and upgrading of the traditional engineering disciplines as well. New engineering disciplines focus “five new” research contents, namely new concept of engineering education, new structure of subjects, new patterns of talent cultivation, new teaching quality and new system of classified development.

The disciplinary intersection and penetration is vitally important to the cultivation of AI professionals, and exerts huge influence on philosophical subjects such as aesthetics, logic, ethics, on science category including mathematics, physics, biology, psychology, on engineering disciplines covering computer science and technology, electronics science and technology, control science and engineering, instrument science and technology, and on liberal arts embracing linguistics, applied linguistics. To offer “AI + X” courses, “AI + X” courses for the students of the second major (students holding double bachelor degrees) in particular, is a feasible solution. To take communication technology and automation for an example, AI poses new requirements on the construction of relevant subjects. With regard to traditional engineering subjects, the emerging industries and new economies will call for “new engineering” talents who are powerful in engineering practice and innovation, and outstanding in international competition. They know how to make use of technology in social and economic development and management, acting as a leading role in the coming technology and industries. We will take the following two specialties as case study.

(1) AI’s New Requirements for Constructing Relevant Specialties of Telecommunication

The competition in AI industry is competition for talent and knowledge base in the final analysis. Only by employing more scientific workers and constantly enforcing basic research can we gain more AI technology. We’d like to make the following comparison between China and the USA in terms of AI basic research and talent cultivation.

The USA focuses more fundamental studies, as a result of which it is advantageous in cultivating AI professionals who are mostly research-oriented. Specifically, it has gained a leading and lasting position in such fields as disciplinary construction, patent application, publication of academic papers, high-end research and development talents, venture capital and top-level enterprises. By June, 2017, AI professionals in the USA are twice as many as those in China. Its 1078 AI enterprises employ 78,000 workers, while China’s 592 companies engage 39,000 employees.

AI professionals at bottom layers in the USA are 13.8 times of those in China. America takes the lead in four critical areas, including processors (chips), machine learning and application, processing of natural languages, intelligent UAV. But top-level AI talents still fall short of demands.

From the perspective of component proportion ratio of working years of AI talents between China and the USA, the professionals with over 10 years of working experience come up to 50%, whereas China’s counterparts are less than 25%. The proportion of those who are with less than 5 years of working experience in USA amounts to 28%, while China’s is over 40%. Although China’s AI professionals are less than those in Europe and USA, and its employees with the working experience

of over 10 years are much fewer than the said countries, the proportion of new generation of AI professionals in China is rather high and there leaves broad space for AI development as shown in the structural distribution chart of working years of the employees.

Intelligence age will be doom to trigger a new round of industrial revolution. In this context, it is imperative for us to make an early deployment in the cultivation of AI professionals in the educational reform induced by the new industrial revolution. The AI experts used to be the applied talents in colleges, research institutes. Now as more and more hi-tech companies set up robot or AI branches, the professionals in AI or machine learning become blue-chip talents. With some hi-tech enterprises such as Baidu, Alibaba, Tencent, Huawei and DJI, unfolding research and application in AI, more capital will be invested in and more AI professionals will flood into AI commercial fields.

Information communication network is an indispensable part in AI, which will, in turn, exert influence on the network, endowing it with new ability. With the advent of intelligence age, the coming network development will be far beyond people's imagination. The greater influence of AI on network, the more powerful the network will be. As in-depth integration of AI and the future communication is advancing in a speedy way, communication specialty will meet the research requirement and conform to the developing trend with its disciplinary advantage, a supportive subject for intelligence technology that will be the orientation for discipline construction and talent cultivation.

The year of 2017 witnessed the enterprise-class deployment in Aiby Daidu, Alibaba, Tencent, which were marching to vertical field. In addition, all walks of life are increasingly experiencing the impetus of "intelligence." With a great number of hi-tech enterprises pooling capital and equipment into AI, the shortage of AI talents is increasingly severe in AI commercialization. At present, the courses in communication specialty may offer the support for AI talent cultivation to certain extent, but there has left much to be desired.

Cultivation of AI professionals involves an interdisciplinary and systematic project, in which communication technology is a major means to give AI power to full play. Through "pan-communication" curricula system, we may introduce the courses AI algorithm and machine learning to our classroom, which will serve as the supplement to signal process and data communication in traditional communication faculty. To enforce and perfect the present support of communication specialty curricula to AI professional cultivation, we start from the following respects.

- (1) As there exists overlapping point between AI communication project, we may conduct studies into machine learning and data mining in random signal, for which we may unfold research in the theory of automatic control, while image processing is conducive to the study of computer vision. We should perfect the courses on those overlapping points so as to help the students to improve their cognition in AI application. The interdisciplinary faculty between computer science and humanities are offered in Stanford University and MIT, which aims to seek for the ways to stimulate students' creativity. These courses may

trigger AI's application in fields of medical health, legal department, financial institutions and media, etc. The establishment of new engineering specialties will be based on Internet and industrial intelligence, which will be merged into other close polytechnic faculties. Moreover, art and design specialties will be admitted into the field of new engineering disciplines so as to AI professionals with broader knowledge.

- (2) We may establish some specialized courses related to AI, such as intelligent communication and intellectualized network. Based on new intelligent learning methods forged by Internet platform, interactions in the learning scene will be getting better, the sense of reality will be stronger and more opportunities of teacher-student and student-student coordination will be available. Based on cloud-distribution service and virtual reality as carrier, cloud computing technology will present the specific scene of living and studying from multiple directions and angles in a more comfortable, convenient, efficient and real-time way. The development of emerging teaching technology and tools will re-separate of the spatial-temporal order in classroom, re-establish intercourse order and reconstruct perception way, which will bring about new changes the teaching and learning ways, learning state and leaning context. In addition, through industry-school-research cooperation, the vitality of innovative inspiration will be fully released in "talent, capital, information and technology" so that we may explore and set up innovation platforms for different kinds of studies, various coordinating innovative modes and collaborative innovation, through which we may strengthen our ability to pool more resources and our vitality to make innovation, and accelerate the in-depth industry-school-research merge.
- (3) We can associate AI and present research focus of communication, such as intelligent optical network and 5G wireless communication. We may also introduce Software Defined Network control surface into AI and machine learning. In the coming years, data flow will increase by 4 times or over, while the transmission distance of millimeter wave technology sued in 5G communication will be shorter, which will yield more requirements from marginal networks and thousands of terminals connected to Internet of Things will be troubled by this problem. Additionally, as client's demand is at micro-second level, how to respond to client's requirement while client's experience won't be lowered is a challenge for present-day operators. But machine learning can remove this trouble in a better way.
- (2) AI New Requirements for Constructing Relevant Automation Specialties  
Automation refers to the operation that machines, equipment or system can, according to man's order, perform automatic inspection, information processing, manipulation control to bring about the expected goals, with little participation of man or even no participation. Automation is widely used in such fields as industry, agriculture, military affairs, scientific study, transportation, commerce, medical care and household management. The cultivation of undergraduates involves automation specialty, a subject which exercise control on various kinds of automatic devices and systems, based on the theories of automation and intelligent control and with the technologies in electronics, computer infor-

mation, detection and sensors. To postgraduates, they should major in control science and engineering, which, based on cybernetics, systematology, informatics and AI, deal with the issues of common features, a discipline on how to set up system model, how to analyze its internal part and environmental information and what control and decision to be adopted so as to bring about control objectives. In addition, with regard to different application backgrounds, there are some other relevant specialties on mechanical automation and industrial automation. With the rapid development of theory and technology, intelligence automation has gradually replaced traditional. On one hand, AI is studied by the scientists in the relevant faculties of automation, while the development of automation promotes theoretical innovation in AI on the other. At the end of 2016, the White House released “Artificial Intelligence, Automation, and the Economy,” which elaborates the expected influence on economic growth by AI-driven automation, and puts forth the strategy on more AI benefits and lower costs.

Now the global focusing industries are robot, pilotless driving and intelligent manufacturing. As the products yielded by the integration of automation AI, these industries involve the following multidisciplinary overlapping and amalgamation.

- (1) Intelligence science and technologies. These disciplines mainly explore the operating mechanism of man’s natural intelligence, which take cognition and learning as research objects, study the realization mechanism and methods of intelligent machines. AI will apply these ways in remolding artificial system and develop kinds of AI, endow the system with certain intelligence so that this system can make logical judgment and decide its operating mode according the specific environment and conditions, or acquire certain learning ability and solve the complicated problems through training and leaning. In this way, machines can work for human beings, freeing man from the complicated and fatigue some jobs.
- (2) Mechanical design and manufacturing automation. The intersection, penetration and amalgamation between various high technologies and mechanical design and manufacturing bring profound changes in intelligent manufacturing and automation. With the updated design and manufacturing technology, we may apply advanced manufacturing and technical theory and ways to address the headache technical issues in modern engineering projects so as to realize intelligent design and manufacturing.
- (3) Information engineering of smart grid. This kind of engineering involves such fields as electrical engineering, energy technology, IT, control technology and computer technology. At present, all the countries intend to build their grids into efficient, clean, safe, reliable, interactive intelligent grids, to turn their equipment of power transmission into intelligent, integral and greening apparatuses. These two trends will bring unprecedented opportunities to the development of relevant specialties.

- (4) Human brain science. The generalized brain science deals with the studies into man's brain structure and functions, plus cognitive neuroscience. Now the scientists of different countries extensively focus brain science. For example, deeply affected by Human Genome Project, US government initiated the brain program for exploring the mystery of human brain, followed Europe and Japan and China's similar program is under planning. Although rapid progress has been made in the studies of brain science in recent years, scientists are still making unremitting efforts to further explore the unknown realms.

To offer the general courses, professional theoretical courses and internship courses in automation AI, we should start from the general courses so that students show their interest in the fundamental knowledge in automation and AI. Then they will turn to systematical learning of specialized courses so as to master the core knowledge of automation and AI and develop certain practical ability. These specialized courses cover "intelligent control," "intelligent meters," "intelligent optimization" and "computational intelligence." In addition, we should put equal emphasis on theory and practice, enforce the construction of internship courses in automation, for which we will include AI elements. For example, we will establish the course of intelligent sensor by cramming AI into sensors, intelligent controller by merging AI with microcontrollers. Obviously, the general course, specialized theoretical courses and internship courses in automation and AI are badly needed in cultivation of automation professionals in intelligent age.

We should further merge AI and automation specialties with research orientations. In in-depth learning, we will simulate human brain to construct neural network for studies so as to bring about such functions as speech recognition, image identification and processing of natural languages. Moreover, we will infuse automation theory to machines so that they can read information, reflect and make decisions. The integration of mechanical intelligence and automation will enable machine to know what to learn and where to learn, to clearly know the environment and to interact with it so that people can make decision and exercise control over the relevant operation. These fields may be the focuses for automation studies, and will be widely used in the correlation studies. In addition, in the areas of intelligent manufacturing, smart housing and robot, the progress in automatic control and sensors will integrate intelligent operation and intelligent machines, merge people's daily life with intelligent machines, resulting in greatly elevating production efficiency and living standards as well.

### **5.3 Technologies and Modes for Talent Cultivation in Intelligence Age**

The coming education will focus students' lifelong learning, creative thinking and ability to be adaptable to the time requirements. "Autonomous learning, creative learning, mutual benefit and share" will be the major themes in the future education.

General education, creative education, emotional education and education on social responsibility will highlight their values in intelligence age, because comprehensive ability is man's distinct advantage over machines. Therefore, creative thinking will become the rigid demand in learning and working, while man-man communication and emotional exchange will be occupational demands, which constitute an indispensable part in education of social responsibility.

### ***5.3.1 Reforming the Technologies for Talent Cultivation***

If traditional education is compared to be a "cat," the present Internet education is a "tigre," while AI adds a pair of wings to the "tigre." As a "winged tigre," education in intelligence age will make full use of such new technologies as image recognition, processing of natural language, in-depth learning, virtual reality, mega-data mining and processing for education, an act that is conducive to talent cultivation. The education in intelligence age will highlight virtual reality and trans-regional education represented by the people-oriented and customized learning, teaching automation, lively man-machine interaction freedom of objective restrictions.

#### **(1) Individualized and Customized Learning**

Through adaptive machine learning technology and students' massive learning data to predict students' future performance, individualized and adaptive learning program may cover the following three parts. (1) To capture and acquire the kinds of students' learning data from various channels, to set up individual learning file and predict students' performance in different subjects. (2) To match the contents to individual student and recommend adaptive learning plan to him so as to improve his learning efficiency. (3) Customize and adaptively adjust individual learning plan on the basis of individual learning performance acquired from the mega-data. In a word, the individualized and customized learning mode aims at displaying different course contents and achieve intelligentized "private customization" on the basis of each learner's proficiency test and training result.

To a coming student, the invisible intelligent "teacher" may offer him "private customization" service in the following areas. (1) To rectify his pronunciation, spelling and grammatical mistakes in language learning, and instruct him how to write logical sentence and passages in the context. (2) To offer tiered reading platform and to recommend suitable reading material to the students of different reading levels by AI and automatically update reading material and reading program based on students' dynamic changes. (3) To construct identifying and optimizing content mode and file knowledge graph so that customers may easily and accurately find out the adaptive or "deficient" knowledge, for whom AI will bring forth customized drills and quizzes and the relevant learning strategy. (4) To offer "learning diagnosis report" at monthly or semester intervals so that students may be aware of their knowledge and ability acquired and make analysis into their own disciplinary advantages and disadvantages, from which they find the proper ways to improve their learning.

In a nutshell, individualized and customized learning technique can make clear students' existing knowledge, ability structure and different learning requirements so as to help both students and teachers to acquire authentic and effective data, which will make students to be aware of their weakness, while teachers may pinpoint the specific conditions, select different teaching objectives and teaching materials, through which teacher are able to practise customized teaching so as to improve teaching pertinency, effectiveness and scientificity.

## (2) Intelligent Appraisal of Homework and Test Papers and Audio Evaluation

By virtue of AI technologies in processing of natural language, recognition in speech, character, image and composition of speech and picture, we may exercise automatic scale-based appraisal of homework, test paper, record of natural language and offer individualized feedback as well. The coming automatic homework-checking machines can understand the whole text of homework and written report, make judgment on the accuracy of grammar, logic and contents and offer the proposal for rectification. Through the key uploading system, automatic rectification of the objective items will be completed and then scores will be given in paperless and automatic way. Added to teachers' marks on the subjective items of the test paper, the aggregate scores of a test paper will be given. In the back end, the machine will make analysis into the mega-data, making clear high erroneous rate of certain items and the students of low score. According to students' deficiencies, the machine will bring forth the similar items for students to re-practise. With the development in the technology of automatic homework-rectifying machines, the scores will be more accurate for objective items while improvement will be made in the scoring inaccuracy. In addition, by means of machine vision technique, we may answer the sheet in the way of shooting the key and the machine will automatically identify and offer solutions. The machine will simulate the perception, memory, cognition, analysis, association, judgment, decision-making and establishment of experience and knowledge bank by human brain during the problem-solving process. Similar to human being, machines will improve their problem-solving capacity in constant learning and training.

In terms of speech recognition and appraisal, AI will replace human labor in a rapid and accurate way. For example, while appraising spoken English, machines can quickly evaluate the speech and reveal the inaccurate pronunciation in the audio material. Through repeated appraisal of clients' spoken language, machines can be adept in evaluating the grammar, vocabulary, fluency, pronunciation, listening and reading in the audio material. By means of such learning modules as scene simulation, situational dialogue, pronunciation challenge and practice of prone audio mixing, we will achieve man-machine interaction and improve students' learning efficiency.

## (3) Fatigueless and Patient Virtual Teachers

A large amount of teacher's repetitious manual work will be replaced by AI technology. In other words, intelligent machines can substitute teachers to certain extent and even evolve into teachers. In intelligence era, students must "seek for teacher's

assistance” before computer screens, who are called “chip teachers.” Never feeling tired and extremely patient, “chip teachers” will repeatedly show the students how to rectify their mistakes in homework, how to consolidate their knowledge, and inspire their creativity. By virtue of intelligent image and character recognition, when students come a crossing problems, what they should do is to write down the title of the problem on their mobile phones or shot it into photograph, and then transmit the title or photograph to AI teachers, who will feed back the key and the way of solving the problem in real time.

Apart from graphical user interface (GUI), virtual reality (VR) and augmented reality (AR) will further “personalize” the personality attribute of AI teachers, making them looking more like the real persons. In the virtual classroom that is approximate to the true one, students will accept the individualized instruction from AI teacher, through which they will dramatically improve their learning efficiency. The interdisciplinary subjects, such as simulation technique which is integrated with VR and AR, computer graphics, man-machine interface, multimedia, sensor technique and network technology, will generate a three-dimensional virtual world through simulation, providing customers with visual simulation, which makes users feel immersive in the real scene and observe the three-dimensional space in real time and without restraint. In addition to personalization of teachers, VR and AR will concretize teaching contents. With the help of VR and AR, students can interact not only with teachers but also with knowledge in the coming education, in which every respect of knowledge may be vertically presented, making students immersive in a particular scene for their learning. VR and AR will be applied in the teaching of English, biology, medicine, geography, physics and history as well as in driver training, which is indeed an indispensable learning mode in the future. With many advantages, VR and AR will enable students to acquire necessary knowledge and skills.

#### (1) Perfect Representation of Spatial Relation and Internal Structure of Matters

The representation is shown in chemical molecular geometry and geometric spatial relation, etc. The three-dimensional simulation technique of VR and AR will enable students to get a better understanding of matter’s internal structure and the concept of spatial relation in those subjects. For example, some scholars put up three virtual learning scenes in Second Life for students to learn about chemical concept, in which students may turn over chemical molecules by such interactive devices as mouse and keyboard in the virtual reality so that they may gain a better understanding of molecular structure.

#### (2) Simulation to Particular Scene

The commonly seen simulation scene mainly represents the setting that there doesn’t exist in real life or that man is inaccessible to, such as historical scene or dangerous scene. The verisimilar scene will offer students immersive experience, an act that will easily arouse students’ learning enthusiasm. In the lecture of European history during the First World War, students will be ardent and active in discussions and exchange of ideas if they are thrown into virtual scenes.



### (3) Simulation of Skill Operation

After some researchers make a comparison of police training between virtual environment and realistic scene, they discover that the acquired knowledge and skills in virtual scene are as effective as the transferring results of traditional training in realistic scene. In addition, some researchers explore the application of virtual reality in dance teaching, a result of which makes them convincing that the teaching based on such technique not only greatly reduces the cost, but also settles the spatial-temporal restraint in traditional teaching. Moreover, in medical education, such immersive video processing technologies as VR, AR and three-dimensional holographic imaging will play an interactive role in medical training, construct high-precision and high-resolution virtual scene. If exquisite VR and force feedback are adopted, we can achieve three-dimensional immersive visualization in the anatomic form of major human organs (heart, liver, skeleton and muscle), and conduct teaching interaction through force feedback. We can also simulate the details of surgical operation, turn the figurative actions into the virtual scene within reach, and perform simulating exercises with force-feedback apparatus.

### (4) To Intensify Students' Learning Motives

Virtual learning environment may help elevate students' learning motives, realizing "entertaining learning." Through emulational environment, such technique will bring students the immersive experience, an experience that makes students feel that they are in the learning environment of virtual reality rather than in the realistic environment. In traditional classroom teaching, the students with low learning motives will be prone to disperse their learning attention because of some classroom environment factors, whereas the learning environment of virtual reality offers them the opportunities to conduct interactions and gives them real-time feedback. Such immersive interactive feedback brings students intense sense of immediacy, which greatly arouses their enthusiasm in learning. Moreover, "one-to-many" teaching mode in traditional classroom makes students feel deficient of emotional requirements, whereas the learning environment of virtual reality brings them a sense of "one-to-one" care, an psychological experience that motivates their initiative in learning.

### (4) Intermedia Teaching Environment for Overall Control of Learner's Mood

Through video processing-based action and emotion-capturing and recognizing technique, plus infrared ray-based non-touchable heartbeat detecting technology, AI will better control students' emotion and mental state in teaching. In other words, in particular teaching context, AI can capture the changes of human facial expression and heartbeat so that AI may make real-time judgment on learner's emotion and response, keep track of their facial expression and heart rate to predict and understand students' reaction to teaching contents. Those physiological signals make AI and mankind work tacitly, which may timely rectify teaching modes and ways.

Speech synthesis technique is very critical in realization of man-machine audio interactions in AI realm, which will also play important role in constructing closed teaching environment. For example, the virtual anchor in "Penguin FM" makes use

of speech synthesis technique to bring about more intimate and fluent man-machine interactions. To improve the fluency of synthesized speech, Tencent adopts in-depth module in acoustics and rhyme in its speech synthesis technique, which makes the pronunciation of the synthesized speech sounding natural, distinct and fluent in rhyme and which can be customized in light of customer's specific requirements. Different speech may improve students' learning interest and meet the individualized demands of users as well. In addition, Tencent's speech synthesis technique may help the special groups of people to unfolding learning. To the people who have lost their linguistic competence, this technique can input the words to be expressed into the experience platform or application system, in which the words will be changed into speech.

In intelligence age, people can even conduct man-machine interactions through brain wave, and bring about closed-ring teaching environment. When man generates an idea in his brain, he has to spend much time to change the idea into words, audio, picture or video, but now he can shorten the transfer time by brain wave and transmit his idea to other party, a technique that intuitively represents and reconstruct man's idea by virtue of brain wave.

#### (5) Trans-school and Transnational Education

The education in intelligence age will further break the traditional regional limits and resource limits, because the duplication of educational resources costs little and quality educational resources are shared by all the people. The unbalanced distribution of educational resources at present day is, in essence, the uneven deployment of quality teachers, whereas mega-data bank and the strategy of sharing educational resources will be a solution to this problem. AI will bring about knowledge structuralization of educational industry and digitalization of teaching contents, and forge transnational "wisdom classroom," by which the optimized educational resources will be transmitted to the whole country and global underdeveloped regions. In this way, "wisdom campus" will be founded and AI will be applied in the whole process of trans-school and transnational teaching, management and resource accumulation.

### ***5.3.2 Transforming Talent Cultivation Modes***

Internet is changing our lifestyle in a reversing way, and exerting influence on education. In essence, Internet means interconnection, making people ignore the distance between one man and the other. By virtue of Internet, everybody may be free to select various on-line educational resources in any place. If the restraint of coverage by Internet infrastructure at present stage is removed, we may hold that Internet has already achieved "No social distinctions in teaching" as advocated by Confucius, enabling everyone the opportunity to receive education.

However, Internet hasn't fundamentally changed educational modes and contents in that education is still directed by teachers and in classroom, they impart knowl-

edge to students (including actual classroom, network classroom, and practical classroom). As the beneficial experience for years of quality teachers, their individualized teaching to different students, their personal attraction and their patient and instructive attitude cannot be duplicated and replaced, plus the their finite energy, quality teachers and quality educational resources become extremely scarce. However, such scarcity breeds three defects in traditional education, namely low teaching efficiency, high tuition and inequity. To make up for the three defects, we should endeavor to promote educational development with AI technology.

AI will lower the costs of educatees, as compared with cultivation of experienced teachers, a new technology that will duplicate unlimited outstanding assistants, teachers, supervisors who will exert influence on every respect of human life. In the near future, education will be no longer limited to only classrooms and educational modes will be changed in teaching materials and teaching methods.

### (1) Dramatical Elevation of Teaching Efficiency

In the initial stage of intelligence age, AI will give full play to its advantages, record the learning result of each student, which will be the data for assistants to analyze and serve as conclusion for teachers. At present, some training institutions have developed AI assistants. Based on the information (such as student's personality, the mastery of relevant knowledge and learning efficiency) provided by assistants, teachers will offer pertinent contents to individual student, which results in the best teaching effect. With development of AI industry, "AI partner" will be available to accompany a learner and record his lifetime data. The partner will collect more complete data about a person and reveal more his information that is generally ignored in daily life so that people may better understand this person. Moreover, this "AI partner" will assist every student in knowing his acquired knowledge in a comprehensive and accurate way so as work out the pertinent learning plan and put forth proposal for growth of each student. It will get better knowledge of a student's personality, disposition and hobbies than the man himself. At this stage, AI cannot change the educational modes and the scenes of occurrence, but it makes teaching more effective for both teachers and students. Similarly, AI at this stage cannot strikingly transform educational contents and means, but the high teaching efficiency will lead to further width and depth of learning contents. This situation requires schools, universities in particular, to accelerate the speed of cultivating compound and specialized innovation talents, who are more aspiring and creative, bringing core competitiveness to the country.

### (2) Students: the Focus of Talent Cultivation

The time for teaching and learning is finite, but AI experience can be share. In the intermediate stage, every AI teacher may share and learn from massive experience (mega-data) so as to improve teaching and learning, approaching to Confucian standards "great teacher" and "model teacher of all ages." Every teacher dreams of becoming a great teacher and he/she may realize his/her dream at low cost during this stage. Moreover, he/she may meet the private and individualized requirements of

the students by offering them customized teaching, a move that brings about education equity. During this stage, not much changes are made in contents, but education providers offer students AI teachers rather than human teachers. As AI teachers offer quality teaching to students who study at low costs, educational focus turns from “teaching” to “learning.” Only by cherishing the determination “One is never too old to learn” will he/she acquire whatever knowledge he/she desires at the most efficient route and way suitable to himself/herself. As the width and depth of knowledge is no longer confined to “teaching,” teaching contents and objectives will center around cultivating innovation-aware talents who are motive and ready in learning.

### (3) Reversion of Teaching Contents and Teaching Modes

When AI develops to advanced stage, it will transform its role from external tool into internal tool, becoming an organic part of everybody. It will be possible that man is willing to integrate himself with AI, through with man and machine mutually enforce so that man can acquire the ability that is beyond his reach at present day and becomes “super” mankind. Thus the communication between “super” man and AI will be more fluent, just as man obtains information by his eyes and ears. In this context, enormous changes will take place in educational modes and contents as “super” man will no long need to memorize various kinds complicated knowledge and the trivial work that man is not adept in doing will be done by AI machines. At that time, “super” man acquires knowledge as quickly as a book is downloaded from a computer. When the time for memorizing a book is equal to the time needed for downloading the book, it will be amazingly easy for man to acquired extensive and profound knowledge. The width and depth of “super” man’s knowledge has got nothing to do with either “teaching” or “learning.” At this stage, IQ, EQ, personality and hobby of “super” man will be identical with one another because they share the knowledge in the same width and depth. What a “super” man should do is to learn how to apply and control the AI machine that is integrated with himself and to complete the creative work where AI is weaker than man. In addition, how to maintain the intuition, perceptual knowledge and individuality peculiar to man will be the important part in education during this stage.

### (4) Alteration of Assessment Methods

Throughout all ages, test has been the major means for evaluating students’ learning effect. But the assessment mainly focuses the memory of knowledge and the routine methods for solving problems. At present, such archaic and inefficient appraisal means remains to be people’s favor. However, AI is expected to reverse this way in form and contents and evaluate students’ performance in a more accurate way. In terms of form, the ubiquitous “AI partner” will thoroughly and precisely record a student’s whole learning process, pertinently test student’s knowledge and skills, analyze his loopholes so as to formulate learning plan to make up for the shortage. Every student will be clear what he has learnt, what he has mastered and what he has ignored. This assessment mode will eliminate the final examination for every semester and the certificate tests on proficiency of certain skills. With regard to the

contents, to the “super” man of brain-machine integration, the memory of knowledge points and routine methods for solving problems will be as easy and quick as man downloads a book to his computer from Internet, which will be no longer the contents for learning. The open, comprehensive and interdisciplinary contents for assessment will replaced the existing standardized contents in the examination.

### ***5.3.3 Emergence of Socialized and Familial Education***

- (1) Socialized education denotes such education that in the context of particular social and cultural environment, individual is taught to develop his social ability through social interaction and perform his social responsibility. Socialized education emphasizes interaction between learning individual and society, who presents different forms at each life stage. When he is a student, he may join in social interaction through various patterns of social practice organized by schools so that he may acquire the knowledge for different social roles. When he becomes an employee upon graduation, socialized education for individual will make him contact and acquire the knowledge and moral norms necessary for social life on one hand, and he should pursue self-learning of specialized knowledge in occupational training institutions.

At present, socialized teaching pattern is featured by individual–social interaction, which is completed in the context of authentic physical space and time. For example, while attending social practice, students would, organized by schools, receive socialized education in the particular time and place and through the interaction with real persons, so is the individual occupational training. In intelligence age, with such technologies as cloud computing, mega-data, machine vision, processing of natural language, emotion computing and AI technique represented by VR and AR, socialized education for individuals will break the restraint of physical space and time. Though the terminal devices such as VR and AR equipment, individuals can gain access to cloud-service platform which is based on intelligent education to fetch cloud-end socialized educational resources, and receive education at any time and at place in the immersive virtual social scenes remolded by cloud-end system, a mode which, free from any spatial-temporal limits, provides socialized education beyond the reach of traditional pattern.

Based on the different stages of socialized education, such education is characteristic of the following respects in intelligence age.

Socialized education in intelligence age will highly depend on cloud-service platform based on AI education. On cloud-service platform amassing such technologies as cloud computing, mega-data analysis, machine vision, processing of natural language, emotional computing, VR and AR, socialized education offers the corresponding teaching contents prepared with relevant technologies to individuals or group of different requirements. Through rapid and reliable Internet or mobile Inter-

net, individuals or groups may purchase the education service or log in cloud-end education platform for the service.

For the students who are still attending schools, the typical socialized education based on cloud-service platform can be described as the following. Individuals or groups organized by schools log in the cloud-service platform for education service of social practice purchased previously, and then equipped themselves with VR/VA devices. With the activity going on, students may conduct various activities in the virtual scenes simulated by VR/AR, including visits, communication with teachers and other students or completion of certain tasks. In the meantime, mega-data analysis system will record different representations of the students and make analysis into their activities, and automatic bring out the summary on each student's performance, encouragement and proposals after the activity is over.

To individual occupational education, the typical education based on cloud-service platform can be described as the following. Similar to the social activity attended by students, the individuals or groups for occupational training log in the cloud-service platform for occupational education service, and then equipped themselves with VR/VA devices. If they have participated in the previous training, mega-data analysis system will show individual performance in the past training and then put forth proposal for successive learning or recommend some focusing points in initiative way, or add some contents pertinent to learner's weak points. During the training, the system will visualize the knowledge points, providing interactive questions and answers, and recording learner's performance on certain knowledge points, which will serve as base for successive learning proposal or learning contents. When the training is over, learners may consult the system on certain questions by audio means and the system will offer the keys by virtue of speech recognition, semantics analysis and intelligent Q&A in the forms of synthesized speech and graphs at VR/AR terminals.

## (2) Familial Education in Intelligence Age

Different from school and social education, family-based education mainly involves the influence of parents' words and deeds. By virtue of AI, apart from specialized education and occupational training, the above-mentioned intelligent educational service platforms can also support family-based education, and it will be effective even if parents are absent from the scenes.

In familial education, children usually show their puzzlement and curiosity, for which parents tell their children the reasons and clear up the confusion. In intelligence age, as intelligent Q&A system is highly reliable, children will get the key or solution through cloud-end-based system, from which children can acquire the key and solution more comprehensive, specialized and liberal than those given by their parents. If such system is merged with VR and AR technology, the answers will be more vivid, intuitive and visual, plunging children into an immersive environment. In addition, through cloud-end-based machine vision and speech recognition technologies, the machine may automatically identify children's speech and deeds. It will commend the good manners of the children in real time, whereas it will also criticize the undesirable manners and rectify children's improper words and deeds.

In the absence of parents, intelligent machines can offer favorable familial education, help children to form their correct view of life, values and outlook. Moreover, when AI develops to certain extent, virtual parents who are verisimilar to real parents in character and temperament will be modeled in cloud-end system after it analyzes the daily speech and deeds of real persons. In the shortage of real parents, virtual parents will accompany the children in the form of AR virtual persons or life-like robots. Simulating the words and deeds of real parents, the virtual parents or robots may talk with the children and interact with them.

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