

The Role of AIGC in Higher Education Viewed from the Learning Sciences

Hongwei Niu

Tianjin Renai College School of Foreign Languages Tianjin300000, China

Abstract: With the continuous development of artificial intelligence technology, AIGC products have been more and more widely used in advertising, entertainment, education and many other fields. There's no denying that AIGC has the potential to bring about various changes and influences in the realm of higher education. However, the use of technology can contribute to learning only when it is designed from the outset with an understanding of student learning in mind and when it is integrated with teacher-student interactions in the classroom. Adopting desk research, this paper reviews researches on AIGC's potential to improve education and students' learning. Based on the theories of the learning sciences, especially Jean Piaget's theories, the author proposes a theoretical framework for China's higher learning against the backdrop of the advancement of AIGC, namely, deep understanding of concepts, equal emphasis on teaching and learning, creating appropriate learning environments, construction on students' prior knowledge, and timely reflections. In the process of the digital transformation of colleges and universities, the role of AIGC should always be that of a facilitator, supporting and helping students to engage in deeper learning, and humanistic care and humanistic thinking should be maintained before, during, and after the generation of content by AI.

Keywords: AIGC, higher education, the learning sciences, Piaget

I. Introduction

Artificial Intelligence Generated Content (AIGC) has made noteworthy advancements in recent years, especially in the realm of natural language processing (NLP). One of the most promising NLP technologies is ChatGPT, the cutting-edge language model developed by OpenAI which can generate a variety of texts based on user input, such as poems, stories, codes, etc. ChatGPT provides a more natural and humanized interactive experience. In terms of image generation, Midjourney is an image generator based on OpenAI's DALL-E model, which can generate corresponding images based on text descriptions inputted by users, and can also perform image attributes editing and partial editing, such as changing colors, shapes, positions, etc. Midjourney can be used in the fields of creative design and educational presentations to stimulate the users' imagination and creativity. Waymark is a platform for producing TV commercials and digital video advertisements. It integrates the ChatGPT model, which can generate video scripts in different styles and languages according to users' needs and preferences, thereby improving the efficiency and quality of video production.

As the research subject and the application field of new information technology, higher education will be the first to usher in the opportunities of digital transformation. Naturally, the role of AIGC in higher education has garnered a lot of attention. A number of AIGC products have been used to provide services such as interactive experiences, assisted education, and game-based learning for college and university classrooms.

II. The Impact of AIGC on Higher Education

Then what impact will AIGC have on higher education? There is no denying that AIGC has the potential to bring about various changes and influences in the realm of higher education. It has become an international consensus that the development of skilled human resources is a key course of action for the digital transformation of higher education. For example, the Education 4.0 framework proposed in the white paper *Schools of the Future: Defining New Models of Education for the Fourth Industrial Revolution* released by the World Economic Forum contains eight critical characteristics in learning content and experiences, namely, global citizenship skills, innovation and creativity skills, technology skills, interpersonal skills, personalized and self-paced learning, accessible and inclusive learning, problem-based and collaborative learning, lifelong and student-driven learning. These characteristics represent key aspects that are deemed crucial for education in the context of the fourth industrial revolution. Stanford University has carried out a project called "Stanford 2025" to explore how time, space, expertise, accreditation, and student agency may change within higher education in 2100. It innovatively proposed a future that features open loop, paced education, axis flip and purpose learning. In 2022, China's Ministry of Education released its criteria for the education sector called "Digital Literacy of Teachers", which outlined the digital literacy framework for teachers. The framework involves digital awareness, digital technology knowledge and skills, digitalized application, social digital responsibility and professional development. The digital transformation of higher education has become an irreversible trend. An ideal model of higher education is illustrated in Fig. 1.

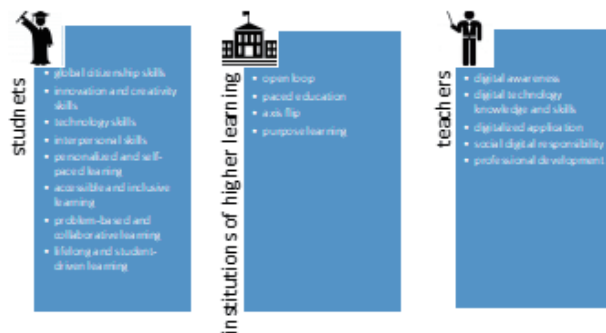


Fig. 1 An ideal model of higher education

Many scholars are excited at the powerful capabilities of AIGC and have carried out fruitful researches on it, pointing out its potential to improve education and students' learning. Zhai Xiaoming (2022) conducted a study by piloting ChatGPT to write an academic paper, and the result suggested that ChatGPT is able to help researchers write a paper that is coherent, (partially) accurate, informative, and systematic, so he concluded that adjustments to the educational learning goals, learning activities, and assessment practices are pressing and essential to prepare students to succeed in their future lives. Terwiesch, a Professor at the Wharton School of the University of Pennsylvania, indicated that it usually takes 20 hours of work to create an exam and another 10 hours for TAs to test the exam and write solutions to it. However, ChatGPT was able to create the exams within 10 hours and reduced TAs time to 5 hours. This shows 100% productivity increase in the "exam writing operation" (Terwiesch, 2023). Herft (2023) provided "A Teacher's Prompt Guide to ChatGPT". He believes that this powerful tool can help teachers enhance student learning and improve pedagogical and assessment practices. For example, teachers can use ChatGPT to generate discussion prompts that encourage students to think critically and solve problems; they can use it to generate lesson plans that align with the scope and sequence of the syllabus and consider the need of their students; additionally, they can use it to generate self-assessment tools, such as rubrics or checklists, that help students evaluate their own work. A study by Peng and colleagues (2019) demonstrated that a generative model-based conversational agent could provide effective support for students learning English as a second language, resulting in improved language proficiency.

However, it is essential to note that the specific impact of AIGC on higher education will depend on several factors, including the implementation approach, the level of integration within educational institutions, and the adaptability of the technology.

III. Educational Technology

Although AIGC has the potential to bring about great changes and influences in the realm of higher education, we should still keep a clear head. It's not advisable to rashly apply it to China's educational institutions before we make necessary preparations. We need to learn from the lessons of the past so as not to repeat the failure of, say, the US E-rate program.

In the 1960s, the first educational software based on B. F. Skinner's behaviorism was designed, and these systems became known as computer-assisted instruction (CAI) which has been used ever since. By the 1970s, a number of AI researchers were involved in educational research and had developed intelligent tutoring systems as well as other applications. In the 1980s, cognitive scientists Roger Schank and Seymour Papert claimed that computers could fundamentally revolutionize school education. By the 1990s, there was a strong consensus among politicians, parents, and entrepreneurs in many countries that computers had to be used in schools. (Cuban, 2003). Programs to bring computers and the Internet into the classroom received a strong boost during this period. In the United States, this boost included the federal government's E-rate program, which provides discounts to assist schools and libraries in the United States to obtain affordable telecommunications and Internet access. However, the results of this huge investment have been very disappointing. As of 2000, there was still no research that demonstrated a direct correlation between improvements in student achievement and the use of computers. When researchers tried to figure out why computers had played such a minor role, they found that the use of computers had not been based on theories of the learning sciences: teachers simply took computers as an addition to the traditional programs found in this sector (Cuban, 2003). Learning science researchers are well aware of the failure of computers to be used with teachers and students. To quote Larry Cuban, computers are "oversold and underused".

The use of technology can contribute to learning only when it is designed from the outset with an understanding of student learning in mind and when it is integrated with teacher-student interactions in the classroom. The learning sciences explain why computers in schools aren't doing what they're supposed to. It's because most educational software to date is still based on instructional theories, and computers still play the role of traditional teachers. Researchers of the learning sciences believe that computers should act as facilitators, supporting and helping students to engage in deeper learning.

IV. Integration of AIGC into Higher Education Based on the Learning Sciences

As "the great pioneer of the constructivist theory of knowing (von Glasersfeld, 1990)", Jean Piaget argued that all learning is cognitively mediated by schemata, structured clusters of concepts which can be used to represent objects, scenarios or sequences of events

or relations. The philosopher Immanuel Kant first proposed the concept of schemata as innate structures used to help us perceive the world.

According to Piaget's theory of cognitive development, children move through four different stages of intellectual development which reflect the increasing sophistication of children's thought, namely, sensorimotor stage, preoperational stage, concrete operational stage and formal operational stage.

The formal operational period begins at about age 11. As adolescents enter this stage, they gain the ability to think in an abstract manner, the ability to combine and classify items in a more sophisticated way, and the capacity for higher-order reasoning. Adolescents can think systematically and reason about what might be as well as what is. This allows them to understand politics, ethics, and science fiction, as well as to engage in scientific reasoning (McLeod, 2023). College students are basically in the formal operational stage. Educators should take into account and fully utilize the characteristics and abilities of students at this stage in designing instructional programs.

Piaget's theory places a strong emphasis on the active role that children play in their own cognitive development. According to Piaget, children are not passive recipients of information; instead, they actively explore and interact with their surroundings. This active engagement with the environment is crucial because it allows them to gradually build their understanding of the world. In his book *The Equilibration of Cognitive Structures: The Central Problem of Intellectual Development*, he intends to explain knowledge development as a process of equilibration using two main concepts in his theory, assimilation and accommodation, as belonging not only to biological interactions but also to cognitive ones.

When our existing schemas can explain what we perceive around us, we are in a state of equilibration. However, when we meet a new situation that we cannot explain it creates disequilibrium. This is an unpleasant sensation which we try to escape, and this gives us the motivation to learn. According to Piaget, reorganization to higher levels of thinking is not accomplished easily. The child must "rethink" his or her view of the world. An important step in the process is the experience of cognitive conflict. In other words, the child becomes aware that he or she holds two contradictory views about a situation and they both cannot be true. This step is referred to as disequilibrium. To get back to a state of equilibration, we need to modify our existing schemas to learn and adapt to the new situation. This is done through the processes of accommodation and assimilation. This is how our schemas evolve and become more sophisticated. The processes of assimilation and accommodation are continuous and interactive, as is shown in Fig. 2.

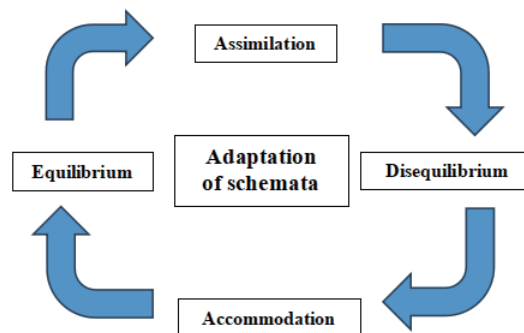


Fig. 2 Adaptation of schemata

According to Piaget, assimilation and accommodation require an active learner, not a passive one, because problem-solving skills cannot be taught, they must be discovered. And AIGC products like ChatGPT can dig out valuable information and ideas from the huge amount of data to provide more inspiration and enlightenment for college students. They will definitely provide more motivations for students' assimilation and more assistance for their accommodation.

Based on the theories of the learning sciences, especially Jean Piaget's theories, the author is now proposing a theoretical framework for China's higher learning against the backdrop of the advancement of AIGC.

A. Deep Understanding of Concepts

Studies of brain workers have shown that specialized knowledge does include facts and procedures, but that people who have only mastered facts and procedures do not qualify as brain workers. For them, declarative and procedural knowledge of facts is useful only if they know the context in which they can apply the corresponding knowledge and can modify it appropriately to meet the needs of new contexts, i.e. "assimilation" and "accommodation" in Piaget's theory. Only when students understand certain concepts in depth can they transfer the facts and procedures they have learned to real situations in a more practical way.

AIGC has the ability to mimic human beings and reproduce scenarios. For example, GPT-4 exhibits human-level performance on various professional and academic benchmarks (OpenAI, 2023). By describing their directions in the "system" message, users can ask it to play the role of a specialist in a certain field to discuss and exchange professional issues with students in real time. One of the core ideas of the learning sciences is that students can learn at a deeper level if they are engaged in daily activities that are similar to the work of specialists in a particular field. Authentic practice has become an important directive in many U.S. documents of education standards. AIGC makes the virtual space in the educational metaverse more real. When necessary, it can simulate the environment and process of a real classroom, and can also be used as a virtual laboratory. It can rightly facilitate connections between classroom learning and real-world applications, helping students understand the relevance of what they are learning and how it can be applied in practical contexts. With the aid of appropriate

instructional strategies, ChatGPT can be used as a learning tool for different scenarios, enabling students to work in groups to collaboratively solve problems, thus promoting cooperation among students and letting them grow through experiencing.

B. Equal Emphasis on Teaching and Learning

Improving teachers' teaching skills alone will not enable students to learn to understand concepts in depth. Students can understand concepts in depth only if they are actively engaged in their own learning activities. The new learning sciences are precisely the sciences that focus on processes of learning as well as teaching. Piaget believes that this active engagement with the environment is crucial because it allows them to gradually build their understanding of the world. Then how do we get students actively involved in their own learning activities? The answer is "interest". Interest can be triggered by multiple variables: novelty, challenge, surprise, complexity, and uncertainty (Berlyne, 1960). When learners have interest of a higher phase in learning, they will be sufficiently motivated to be able to self-regulate their learning behaviors, set goals for themselves and reach those goals.

AIGC can provide students with tailored help and guidance according to their learning stage and learning needs, leveraging its capabilities of intelligent generation, natural language comprehension and data analysis. This can not only better meet the learning needs of students, but also improve the learning effect and learning interest of students, thus achieving tailored teaching. GPT-4 provides a wealth of teaching resources and tools which are never short of novelty, challenge, surprise, complexity and uncertainty. On the traditional Internet, retrieving is the main means of seeking knowledge, and students cannot interact with it when they access learning resources. GPT-4, however, provides a rich set of learning resources and tools and a perfect experience of interaction. And it can be used regardless of time and place. Using ChatGPT, students can evaluate different strategies and approaches to solving problems and achieving goals through game-based learning or other student-centered pedagogies (Sutton & Allen, 2019). Students who enjoy immersive, hands-on learning experiences can benefit from incorporating ChatGPT as an educational tool to enhance their learning journey. By employing effective instructional strategies, ChatGPT can serve as a valuable tool to promote collaboration and teamwork among participants. Various student-centered learning approaches can be developed to encourage group activities. The versatility of the ChatGPT application enables the creation of diverse scenarios where students collaborate to solve problems and achieve shared objectives. This not only cultivates a sense of community but also facilitates mutual learning and support among students.

Rudolph et al. (2023) explored the possible applications of ChatGPT in higher education, including introducing innovative assessment for teaching and learning, innovating instructional strategies, providing experimental learning, and promoting collaborative learning and teamwork.

C. Creating Appropriate Learning Environments

We can and should prepare ideal learning environments for students, i.e., make diverse preparations for subject matter content, learning interests and motivations. When designing the learning environments, differences in learners' interests, motivations and levels of engagement are important factors to consider. To create appropriate learning environments, we need to construct interactions based on subject matter content and construct scaffolding for interactions with subject matter content.

a) Constructing Interactions Based on Subject matter Content

Learners may lack interest, motivation or engagement if they start learning in a field very early or if they have not been able to make an effective connection to the field for the time being. With this in mind, the design of learning environments needs to clarify the utility of the content to be learned and its relevance to the learner, and to stimulate interest in the content through novelty, challenge, surprise, complexity or uncertainty. Learning environments have to be designed to help learners make connections between the real world and the content, or between different topics within the field of study (Jörvelö S. & Renninger K. A., 2006, 2014).

AIGC increases the possibilities for student engagement by allowing students to access learning content in multiple ways, and by utilizing different approaches to thinking about and working with design activities and design tasks targeted at learning content. The design of the learning environments can occur both in the classroom and off-campus as well as in virtual environments. Computer-based tools, computer-based collaborative learning, online modules, and social media in the learning environments can provide tailored learning support that promotes self-regulation and active task interaction. AIGC products can effectively support learning task-based active interactions when interactions with teachers or peers are not available and students need to learn independently.

b) Constructing scaffolding for Interactions with Subject Matter Content

It is vital that students in the early developmental stages of interest, motivation and engagement find the utility of the subject content or its relevance to them, or find the content that arouses their interest. For students with high levels of interest, motivation and engagement, it is vital to set up scaffolding that helps them engage directly with their learning and that supports them in expanding their understanding of what they are learning. Students need to continue to develop and deepen their thinking, and the learning environments need to be able to support them in finding answers to the questions they are curious about. Scaffolding that incorporates subject matter content provides the building blocks for students to independently explore what they are learning.

AIGC products offer step-by-step instructions, suggestions, and prompts to support students as they engage with new concepts or skills. It can break down complex tasks into more manageable components, helping students build a strong foundation. They provide detailed explanations, examples, and additional resources to deepen understanding. They can also demonstrate problem-solving approaches or modeling techniques, showcasing how to tackle challenges effectively. When students make errors, AIGC products can provide corrective feedback, highlighting misconceptions or suggesting alternative approaches. When utilized wisely, AIGC can act as competent scaffolding

for students' learning.

D. Construction on Students' Prior Knowledge

Students are not empty vessels waiting to be indoctrinated. They have a preconceived notion of how the real world works before they even get to class. Some of these preconceptions are fundamentally correct, while others are misconceptions. If teaching fails to address prior knowledge, students' learning will be geared toward test-taking, and students will continue to use those misconceptions outside the classroom.

There are various ways for teachers to assess students' prior knowledge. For example, teachers can administer pre-tests or quizzes at the beginning of a course or unit to gauge students' understanding of key concepts. They can also ask students to create KWL charts to identify what they already know about a topic and what they are interested in learning. This is where AIGC products can make a big difference. They can quickly and accurately help teachers design and create these tests and charts, tremendously reducing teachers' workloads. GPT-4 can accept a prompt of text and images, which—parallel to the text-only setting—lets the user specify any vision or language task.

After learning about students' prior knowledge, AIGC products can still be leveraged to achieve personalized learning. For example, ChatGPT can adapt its responses based on the individual learner's needs, preferences, and skill level. It can tailor its guidance to accommodate different learning styles and provide personalized support. By describing directions in the "system" message, users can even enjoy Socratic tutoring, which may provide intelligible new concepts for students and help overcome their misconceptions.

E. Timely Reflections

According to the learning sciences, students learn better if they try to describe what they are learning—through conversations, writing, reports, or artwork that allow them to reflectively analyze the extent of their knowledge acquisition. The learning sciences have repeatedly demonstrated the importance of reflection for deeper understanding of learning. Many classroom designs based on the learning sciences take into account the development of students' reflective skills, mostly by providing tools that make it easier for students to express their developing understanding. Once students have expressed their developing understanding, the learning environment should support students in reflecting on what they have just expressed. One of the central themes of research in the learning sciences lies in exploring how to support students to engage in effective educational reflection.

In the absence of in-person guidance from teachers, AI-powered tools promote students' self-reflection by analyzing their learning data and performance, thereby promoting deeper learning. Personalized adjustments are made in accordance with students' learning progress and different students' ability levels. Students can choose their corresponding learning styles, establish knowledge connections and make knowledge transfer. We still take ChatGPT as an example. Its ability to generate dynamic and interactive conversations makes it a valuable tool for supporting students' reflective practices and promoting self-awareness, personal growth, and metacognition. First, ChatGPT can generate thought-provoking prompts or questions to help students reflect on their learning experiences, achievements, challenges, and areas for improvement. These prompts can encourage deeper reflection and self-awareness. Students may feel more comfortable sharing their thoughts and reflections with ChatGPT, as it eliminates the fear of judgment or criticism. ChatGPT can provide a safe space for students to express their ideas openly and honestly. Second, ChatGPT can analyze students' reflections and provide personalized feedback based on their responses. This feedback may include highlighting strengths, offering suggestions for further exploration, or providing guidance on specific areas of improvement. ChatGPT can engage in conversational exchanges, allowing students to have a back-and-forth discussion about their reflections. It can ask follow-up questions, seek clarification, and provide additional insights to deepen the reflection process. Furthermore, based on the content of students' reflections, ChatGPT can recommend relevant resources such as articles, videos, or books that can further support their learning and reflection. By saving and reviewing previous reflection sessions, ChatGPT can help students track their progress over time and identify patterns or changes in their thinking and understanding. Nazari et al. (2021) found that, in the absence of human assistance, intelligent feedback can reinforce students' writing autonomy by helping them to recognize their writing errors, identify incorrect patterns, and reformulate them.

V. Conclusions and Recommendations

As the research subject and the application field of new information technology, higher education, compared with other stages of education, will be the first to usher in the opportunities of digital transformation. In the process of digital transformation, the role of technology should always be that of a facilitator, supporting and helping students to engage in deeper learning.

The Czech educator Comenius (1799) believes that the nature of education lies in the development of a sound individual. With the assistance of advanced technology, it is technically feasible for us to achieve personalized cultivation of students, but technology also has utilitarian characteristics. In the new landscape of the learning society, focusing on technology at the expense of thinking may pose many potential risks like integrity crisis, cognitive overload, rigidity of thinking, and cultural subversion. Higher education is different from other social fields in that it is not a programmed social activity. If we consistently use intelligent education systems to measure learners' learning activities, analyze learners' learning status, and give machine-made conclusions, we are missing humanistic care, and we are missing the "human" values.

Xu Xiaodong, one of the translators of *The Cambridge Handbook of the Learning Sciences*, suggests in "The Translator's Afterword" of the book that in the formation and development of schools in the nineteenth and twentieth centuries, school designers and administrators, teachers, scholars, and educationalists did not understand how people learn, and that the schools that have survived to the present day have been extremely poorly adapted to this rapidly evolving and highly variable age of knowledge economy. In response, the contributors of the book offered different approaches to designing new schools using computers. However, if the content of social information is entirely

generated by AI, it will lead to a lack of human subjectivity. The German sociologist Max Weber categorized human rationality into instrumental rationality and value rationality, with the former pursuing the efficacy of tools and technological advancement, and the latter caring for the fate and dignity of human beings. AI technology can justifiably be included in the category of instrumental rationality, and humanism in the category of value rationality, and they are opposites and unity. The digital transformation of colleges and universities should be based on the humanistic spirit throughout the application of technology, and humanistic care and humanistic thinking should be maintained before, during, and after the generation of content by AI. David Morley, a British professor of media, also reminded people not to exaggerate the impact and influence of new media on humanistic traditions, and not to get lost in the myth of technology, as he believes that the newest technology can also be used for the most traditional purposes.

Still, it is important to note that we must not reject technological advances. With Microsoft trying to incorporate ChatGPT holistically into its products (Rudolph et al., 2023), in no time ChatGPT will be conventional, and it may possibly be too late for educational institutions to rethink their policies and practices to guide and support their students in using ChatGPT safely and constructively.

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