Research on the Evaluation Model of Students' Independent Learning Effectiveness in the Perspective of Generative Artificial Intelligence

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Abstract: Currently, generative artificial intelligence is widely used in various fields. In the field of education, it provides a new paradigm for the construction of new education systems such as intelligent learning and interactive learning. As an innovative tool for project-based independent learning, it can assume multiple roles such as intelligent assistant, learning companion, teacher, etc., provide students with training and support for innovative thinking in all aspects, and enhance their innovative skills for independent learning. In the student-oriented project-based independent learning, the traditional evaluation method still exists the problem of focusing on the results but not the process, ignoring the process of students' efforts, AI technology can bring changes to the evaluation method through voice recognition, image recognition and other technologies to form a combination of quantitative and qualitative, taking into account both the process and the results of the scientific evaluation model that is more targeted.

Keywords: Generative Artificial Intelligence; Autonomous Learning; Evaluation Models

1. Introduction

Generative Artificial Intelligence (GAI) is one of the most compelling research directions in the current science and technology field, and its emergence has brought about a huge impact on all walks of life, demonstrated amazing creativity, and has a wide range of applications in the field of education. In July 2017, the State Council issued the "New Generation Artificial Intelligence Development Plan" proposed that the use of intelligent technology to accelerate the reform of talent training mode and teaching methods, and build a new education system that includes intelligent learning and interactive learning[1]. In July 2022, the 'Guiding Opinions on Accelerating Scenario Innovation to Promote the High-Quality Development of the Economy with High-Level Application of Artificial Intelligence', issued by the Ministry of Science and Technology and other six departments, explicitly proposed that the continuous excavation of AI application in the field of education and other scene opportunities [2].

The theoretical origins of self-directed learning can be categorized as metacognitive learning theory, constructivist theory, and humanistic learning theory. These theories have in common that they are student-centered, that students have full autonomy over the content and process of learning, that they advocate meaningful learning, and that they monitor and regulate learning to meet students' learning needs. In the current context of education reform, Project-based Learning (PBL) has been emphasized by the education sector as a learning mode based on the cultivation of core literacy. Through Project-based Learning, students are able to apply what they have learned in real-world problems to solve problems, practice relevant skills and enhance core literacy in their disciplines.

In the teaching process, targeted evaluation of different teaching sessions (e.g., answering questions, group discussion, independent learning, etc.) makes the evaluation method and effect more accurate. However, in the actual teaching process, student-centered evaluation is often overlooked, and phenomena such as micro-change and micro-progress of students are often ignored. With the wide application of generative artificial intelligence in the field of education, students can utilize intelligent technology to automate the generation of multimodal data such as text, images, audio, etc., which not only enhances

students' understanding of knowledge and cross-disciplinary cognition, but also improves the presentation of learning outcomes and increases interactivity. Thus, the establishment of multidimensional senses through artificial intelligence technology can evaluate the motivation and effect of student learning under different teaching sessions in real time, and better motivate students' learning [3].

2. The Role and Implications of Generative Artificial Intelligence for Student Autonomous Learning

Self-directed learning generally refers to the process or ability of an individual to consciously determine learning goals, formulate learning plans, select learning methods, monitor the learning process, and evaluate learning results [4]. The focus of project-based learning is driven by real problems or projects, which can guide students to experience the process of applying principles, the process of computational thinking, and the process of applying digital tools, help students construct knowledge networks, and enhance their problem-solving, cooperation and self-management abilities. In the process of project-based independent learning, the advantages of digital tools can be used to empower knowledge construction, skill cultivation and thinking development. Project-based learning emphasizes the understanding of core knowledge, the formation of expert thinking in “doing”, and triggers cross-situational transfer, which can well solve the problem of disconnecting knowledge and practice, and is an effective way to implement the core qualities of the discipline. This requires students to be able to think independently, identify problems, propose solutions and solve problems in the process of learning and practicing, i.e. to have certain creative thinking and innovative skills.

2.1 Promoting Creative Thinking for Independent Learning

Students' creative thinking is mainly reflected in the learning and problem solving can think out of the box, the use of innovative thinking, to put forward original ideas and specific solutions. Creative thinking plays a very important role in students' independent learning and career development. Creative thinking is usually divided into four stages, such as preparation, brewing, openness and verification, as shown in Figure 1, and generative AI can provide students with multiple supports at each stage.

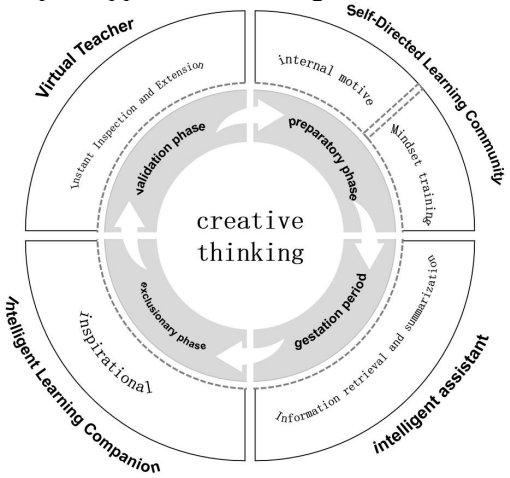

Figure 1. Generative Artificial Intelligence for Creative Thinking

2.1.1 Stimulating students' interest in learning

The personalized learning model significantly enhances the freedom and flexibility of the learning content, and the GAI robot can generate exclusive learning content according to the students' interests, transforming the boring learning process into an interesting and relevant journey of exploration. This student-centered learning model not only stimulates learners' interest in learning, but also promotes the development of their independent learning ability and innovative thinking. When students ask the GAI robot for help and ask questions, they can continuously explore and actively think through continuous questioning, and this process of asking questions and searching for answers is essentially a process of actively constructing a knowledge system, which helps to cultivate students' interest in learning and independent learning ability.

2.1.2 Provision of training and mentoring

With its powerful generative capabilities, GAI is able to intelligently plan and adjust learning paths based on students' goals, learning styles, pace, and other personalized factors. GAI can dynamically plan or adjust each student's learning path, including sequencing, degree of difficulty, length of time, etc., based on the student's goals, style, pace, and other factors. For each student, GAI can tailor the educational program and learning rhythm according to their cognitive characteristics and mastery level. It not only flexibly adjusts the sequence and level of difficulty of learning

content, but also accurately controls the duration of learning to ensure that students master knowledge at the most appropriate pace. This personalized learning path not only improves learning efficiency, but also enhances students' independent learning ability. Through conversations with the GAI robot, students can be exposed to creative thinking styles and methods such as brainstorming and mind mapping, and can learn how to use these tools from the GAI robot. These tools can help students develop skills such as critical thinking, logical thinking, and creative thinking, which can improve their innovation ability.

2.1.3 Assume multiple roles such as intelligent assistant, learning companion and teacher

The GAI robot is able to act as a learning intelligent assistant for students through dialog, providing them with a large amount of information and knowledge, thus providing rich material for creative thinking. Compared with traditional search engines, GAI robots have powerful information processing capabilities, which can avoid receiving false information and advertisements, reduce the redundancy of information, and thus substantially improve learning efficiency.

At the same time, the GAI robot also has a strong language processing ability to understand and generate human language, laying a smart and smooth communication and convenient channel for students, i.e., it becomes an intelligent learning companion in the process of students' independent learning, and students and their intelligent learning companions can communicate with each other on various issues, viewpoints, and ideas, so as to strengthen the learning support, cultivate the ability to learn independently and motivation, in order to improve the learning effect.

In addition, the GAI robot is also able to accurately understand and evaluate the learning effectiveness of students, and become their intelligent teacher. Students can optimize the GAI robot's evaluations repeatedly until they form relatively optimal solutions, thus broadening the boundaries of their thinking.

2.2 Enhance Students' Creative Skills for Independent Learning

In the age of artificial intelligence, traditional academic knowledge, skill mastery and independent thinking are regarded as the basis for success, while the ability to work with artificial intelligence puts more emphasis on taking advantage of artificial intelligence to enhance one's innovativeness, judgment and problem-solving ability [4]. The combination of human intelligence and AI has become a trend and an inevitable choice, and the education system needs to gradually strengthen the cultivation of learners' comprehensive abilities supported by AI to help learners solve problems more efficiently in their learning practices [5], as well as to better cope with innovations in work styles brought about by new technologies in their future careers.

With the development of artificial intelligence technology, generative AI can not only assist teachers in teaching, but also help students better understand and apply knowledge, providing new possibilities for the improvement of students' innovative skills. First, students can use generative AI to design personalized learning programs according to their own learning needs; second, students can understand knowledge more deeply by interacting with generative AI; again, generative AI can provide instant feedback to help students adjust their learning strategies in time; finally, students are often hindered by the limitations of their skills and are unable to show their research results in multiple ways, while generative AI provides students with multiple forms and even program design support [6].

2.2.1 Designing project-based self-directed learning situations

In personalized learning, students are supposed to act as cognitive subjects and actively participate in knowledge construction. However, in past educational practices, students were often regarded as passive objects whose learning content and learning plans were manipulated by machines. With the advent of the GAI era, the personalized learning model has undergone a profound change. the GAI empowers students with more autonomy through intelligent learning resources and feedback mechanisms. This increased initiative not only enhances students' motivation to learn, but also increases their engagement and satisfaction in the learning process. More importantly, GAI significantly strengthens students' subjectivity in cognitive, affective, and metacognitive aspects through dynamic interaction and intelligent support. On the cognitive side, GAI helps students

understand and master knowledge more deeply by providing personalized learning resources and feedback. On the affective side, GAI is able to sense students' emotional states and provide appropriate emotional support through emotion recognition and analysis technologies. For example, when students show fatigue or frustration, GAI can generate encouraging dialogues or motivational clips to create a more positive learning atmosphere. In terms of metacognition, GAI helps students better master learning strategies and methods by guiding them in self-reflection and assessment.

The contextual design of project-based independent learning is to provide students with a learning environment with practical significance and challenging difficulty in order to stimulate students' interest and initiative in learning. The GAI robot can assist teachers in the context design of project-based independent learning. According to the role characteristics set by the teacher, the GAI robot can engage in role-playing dialogues with students to let them experience real work scenes and work processes, and encourage them to find problems and use innovative skills to solve problems in real situations.

2.2.2 Learning resources for students

In traditional education systems, knowledge is often viewed as a static entity that is imparted to students through teachers. However, with the introduction of GAI technology, students are provided with personalized learning resources and feedback through intelligent means. The GAI system is more prominent in its core capabilities of inspirational content generation and dialogue context understanding, and is able to generate inspirational and creative texts based on given topics or contextual information identified during multiple rounds of dialogues and, based on the contextual information from the multiple rounds of dialogues, perform semantic comprehension and reasoning, capturing the user's intention and dialog context, and generating logical and coherent responses to bring a good interactive experience to the user [7]. This dynamic learning process allows each student's knowledge structure to be continuously updated and improved with the learning process and intelligent feedback. For example, GAI can dynamically adjust the difficulty and presentation of learning content according to students' learning progress and comprehension ability. At the same time, by intelligently analyzing students' learning behaviors, GAI can also provide targeted feedback and suggestions to help students better understand and master knowledge. This dynamic knowledge building model not only improves learning efficiency, but also enhances the fun and interactivity of learning.

In the information age, students are faced with a huge amount of various learning materials and information, but not all information is accurate and reliable. The GAI robot is able to analyze the demand for project-based independent learning and students' knowledge and skill mastery based on the input data, filter false and invalid information from multiple information sources, screen and recommend appropriate and valuable learning resources, so as to carry out learning activities more efficiently and avoid getting lost in the flood of information.

2.2.3 Records and evaluation

GAI is not only able to provide students with learning content, but also able to deeply participate in their learning process and provide more personalized learning feedback. For example, in programming learning, GAI can analyze students' programming process and results in real time, determine their learning status, and provide specific feedback and suggestions. When a student encounters a problem, GAI can not only point out where the error is, but also provide a variety of optimization solutions to help the student deeply understand the relevant knowledge points and improve their skills. This personalized learning feedback not only enhances students' independent learning ability, but also promotes the development of their critical thinking and problem solving skills.

Teachers can develop more effective teaching plans and strategies, personalized suggestions and directions for improvement through students' learning trajectories and performance recorded by the AI learning platform. This will help reduce teachers' workload while supporting students to improve their innovation skills and develop their ability to solve complex problems through continuous improvement of the quality of their innovation outcomes in practice.

3. Designing a Student Autonomous Learning Model in the Perspective of

Generative Artificial Intelligence

To design a project-based and project-driven student self-directed learning program based on generative artificial intelligence in conjunction with specific self-directed learning practices, with a view to implementing self-directed learning through the use of GAI tools in an intelligent learning environment (Fig. 2).

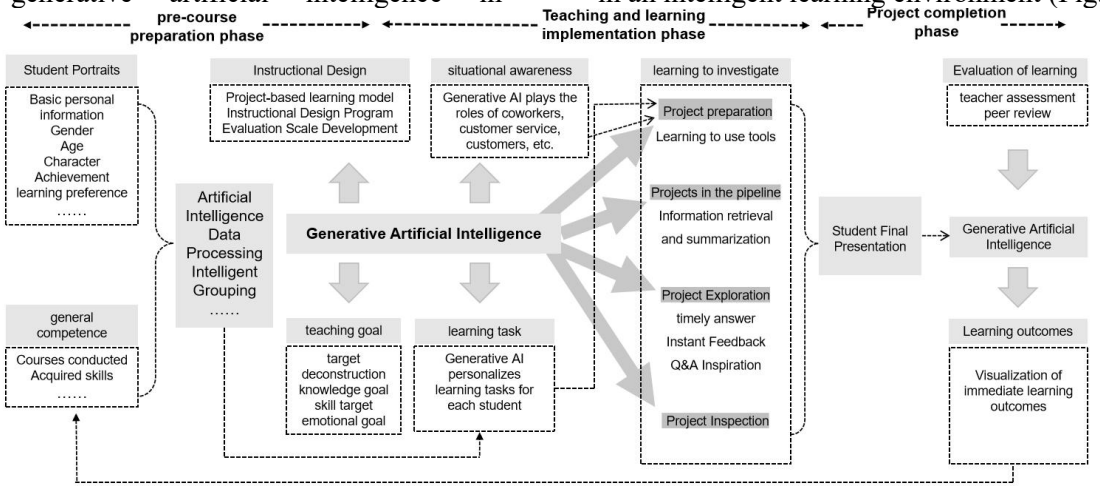

Figure 2. Project-Based Autonomous Learning Design Model Based on Generative AI

3.1 Preparatory Phase

3.1.1 Student portrait modeling

In the construction of student portrait, it is mainly carried out by using cluster analysis and regression analysis, with student characteristics, learning motivation, learning style, cognitive level, online learning behavior and other aspects as the main components, while in the application of student portrait, it is mainly researched from the aspects of resource recommendation, learning guidance and teaching evaluation. Before the start of students' independent learning, teachers can call the basic information of students, learning behavior data (learning time, learning content preference, etc.) and the basic situation of mastered skills in the AI platform to initially build a student portrait model for the subsequent development of more scientific independent learning programs and plans [8].

3.1.2 Self-directed learning goal setting

Learning objective development is a crucial aspect that is directly related to learning outcomes. Using GAI tools, project-based learning objectives, learning modes and progress design can be quickly retrieved and tailored by combining student portrait models. However, GAI tools are still lacking in understanding human thinking and emotions, and the generated independent learning programs still need to be improved and supplemented by teachers.

3.2 Implementation Phase

3.2.1 Self-directed learning context setting

In the context creation step, the teacher can let the GAI robot play different roles and communicate with the students, providing advice on projects, tasks and collaboration. The students will learn about the needs and expectations of the “virtual customer” and collect data or information through conversations with the “virtual customer” in the GAI robot's simulated real-life work scenarios.

3.2.2 Issuance of learning tasks

Teachers can output “customized” self-learning tasks and evaluation plans based on student profiles, skill mastery, and other student profiles, and analyze them with artificial intelligence. The GAI system can output a variety of different task plans that are suitable for specific students and this project-based course according to the actual situation and personalized needs of different students, and with reference to excellent project-based cases in the database. The GAI system can refer to the excellent project-based cases in the database according to the actual situation and personalized needs of different students, and output a variety of tasks suitable for specific students and this project-based course. These tasks can take various forms, such as group discussion, teamwork, individual research, etc., according to the requirements of the projectized course, so as to better improve the effectiveness of independent learning.

3.2.3 Dynamic data analysis and real-time feedback

In the process of independent learning activities, the GAI system carries out dynamic analysis and instant feedback through the trajectory and progress of students' participation in independent learning activities, mastery and other data. On the one hand, it is convenient for teachers to grasp students' learning status in time. On the other hand, students' independent learning data are transmitted back to the data cloud, and the GAI system can adjust the progress, difficulty and depth of learning tasks according to the data in a timely manner.

3.3 Evaluation Phase

The GAI system acts as an "intelligent teacher" for students, comprehensively evaluating their learning and output results according to their performance in the independent learning program, and giving them feedback and guidance and other evaluation programs to help them improve the output of the program results. However, there are still limitations in the length of the dialog memory of the GAI robot, resulting in certain limitations in data recording, real-time feedback and evaluation, if there is a breakthrough in this area, it will have a wider range of applications.

3.4 Student Feedback

The above learning process and results presentation basically achieved the expected effect of project-based independent learning, and also received high evaluation from students [8].

First, students recognized the project-based learning process and the form of presenting results. Some students said that they used to memorize the knowledge in class, which was rather boring, but now they can pay attention to the needs of life, jump out from the single subject learning, and not only learn to apply cross-disciplinary knowledge to create products and put it to practical use, but also benefit other students, so that their sense of value has been enhanced. In addition, some students who did not have a firm grasp of the knowledge in class have improved their learning efficiency, and in the process of project implementation, these students "have to" supplement the basic knowledge, focus on real problems, coupled with the assistance of innovative tools, increased learning initiative.

Secondly, the innovative format of the results display had a significant motivational effect on the students. Students perceived the interactive part of the presentation as having a sense of accomplishment, and the group members' demonstration of their operations attracted the interest of other students, who put forward their own ideas and suggestions according to their needs and preferences, thus enhancing the interactivity.

Thirdly, the application of innovative tools broadened students' thinking and stimulated the vitality of the project. Students believe that this learning approach enhances mutual learning among students and strengthens their ability to divide and cooperate, indicating that the model of "project-based learning + GAI" can help students better understand and apply their knowledge, and divide and cooperate within a group, so that they can better cope with teamwork in the future. Generative Artificial Intelligence empowers project-based independent learning to achieve more results.

4. Constructing an Evaluation Model of Students' Focus on Independent Learning

In the process of students' independent learning, most of the traditional teaching evaluation is through the students' mastery of knowledge, that is, the evaluation of learning achievements, and the students' learning concentration is often ignored. Therefore, accurate and real-time monitoring and feedback on students' learning motivation and concentration, as well as encouragement and praise, are more likely to stimulate students' learning motivation and are an indispensable part of the student-centered evaluation [9].

4.1 Data Acquisition

Data collection mainly includes data of learning process and result data such as students' basic information, learning status, and emotional (concentration) status. Learning platform operation data, classroom videos, scale data, and evaluation scale data (offline data) are the main sources of quantitative data acquisition. Among them, the data acquisition of learning concentration mainly comes from the real-time monitoring video of students in the learning process by the GAI device. In order to make the evaluation more objective, in the process of data acquisition of students' learning status, the natural state is maintained

as much as possible, with moderate light, to ensure the authenticity of face, voice, and motion detection and classification, and to ensure the clear acquisition of each piece of data status information.

4.2 Data Identification and Analysis

4.2.1 Emoji data

In the process of independent learning, students' expressions will appear small changes, and the duration is very short, teachers are often difficult to detect such emotional changes in students, and such changes are closely related to the students' learning state. When students are in the process of independent thinking and learning, the facial expression of pleasure or neutrality, indicating that the students are actively and positively looking for solutions to the problem, the content of learning is related to the learning task, so as to comprehensively determine the degree of seriousness of the students. When joy or sadness is present, mood swings may be caused by looking at the content of the learning task, but are not significant if they occur only occasionally.

4.2.2 Voice, motion data

It is difficult to analyze the active degree of students' independent learning from the perspective of image recognition alone, and the accuracy is limited, so compared with facial expressions, voice and movement data are more intuitive and better reflect the students' learning status. When a student makes sounds that are not related to the student's task during the learning process, or when a large body movement occurs, it can be directly determined that the student's learning effect and attitude are not good enough.

4.3 Evaluation Modeling

Combined with the different focuses of students in the independent learning process, the evaluation model is set up to establish different evaluation systems and evaluation methods for the degree of concentration in the process of independent learning through the three sensory dimensions of voice, expression, and action recognition, in order to realize real-time tracking and analysis, and to form a targeted process evaluation mechanism (Figure 3). At the same time, the data are statistically analyzed to form a comprehensive evaluation report that takes into account both the results and the process of learning performance and the degree of concentration [10].

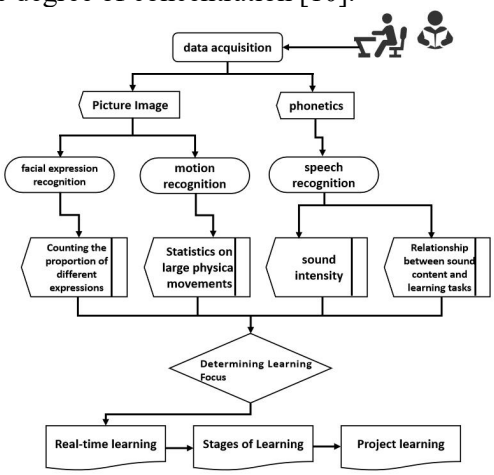

Figure 3. Evaluation Process of Students' Concentration in Independent Learning

5. Concluding Remarks

In recent years, the rise of the generative AI industry has provided a new way for students to learn independently. Compared with the traditional way, it can help students build a more complete knowledge system according to their points of interest and knowledge needs, and students can get more personalized learning support. This instant dynamic interactive learning method can not only improve learning efficiency, stimulate learning interest, broaden students' horizons, and cultivate diversified thinking ability, but also better cultivate students' independent learning and problem solving ability.

At the same time, it is also important to recognize the challenges that generative AI brings to teachers and students. For example, students' over-reliance on generative AI in their independent learning activities can lead to the degradation of students' internal drive for independent thinking and problem solving, and will instead inhibit the cultivation of students' innovative ability and critical thinking. Therefore, it is necessary to strengthen the positive orientation of generative AI on students' independent learning, so that students can maintain the correct concept of digital ethics and critical thinking ability in their learning interactions with generative AI.

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