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The Dialectical Relationship between "Changing" and "Unchanging" in GIS Practice Teaching in the Social Transition Period

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Abstract: New requirements have been proposed for GIS practice teaching in colleges and universities in response to the developmental changes of national and industrial sectors during the social transition. Meanwhile, the underlying core characteristics of GIS should remain unchanged in GIS teaching to ensure they serve as the inherent attributes distinguishing GIS from other disciplines. Therefore, the clarification of the dialectical relationship between "changing" and "unchanging" in GIS practice teaching becomes the primary issue to address in relevant teaching reform. To address this issue, the present study systematically analyzes the structural contradictions in GIS practice teaching in the social transition period, and then closely examines the dialectical relationship between "changing" and "unchanging" from the key aspects of educational philosophy, teaching content, teaching methodology, and teaching assessment. Next, using the course of "GIS Practice Design" at the Central South University as an example, the present study describes this university's reform and inheritance in GIS practice teaching, aiming to provide reference for GIS practice teaching in other universities or majors.

Key words: social transition; GIS Practice Design; practice teaching; student-centered; Central South University

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1 Introduction

Higher education is one of the most important key links of talent training in China. China is currently in a period of intense social transition, and it is facing increasingly complex situations at home and abroad, rapid economic and social development, intensified ideological and cultural exchanges, and the occasional occurrence of emergencies such as the coronavirus epidemic, which causes the talent needs of the national and industrial sectors to vary constantly with social development. Meanwhile, new information technology is constantly developing and emerging, and the traditional technology supporting industrial development is constantly being updated or even replaced by cutting-edge technologies such as artificial intelligence and big data analysis technology. The recent situations mentioned above are bringing a series of new opportunities and challenges for China's higher education; consequently, the question of how to carry out teaching reform during the social transition period and cultivate professional talents that adapt to social development has become an

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urgent issue to address in higher education[1-2].

To address the abovementioned issue, experts in related fields have conducted extensive and in-depth research and discussions, resulting in a series of teaching reform concepts and methods, which have provided rich references for the development of higher education[3-5]. However, the variety of teaching reforms also introduces additional uncertainty into higher education teaching. In other words, the frequent updates of teaching models have caused the teachers and students to be in a constant state of adaptation, which makes it likely that they will neglect to reflect on and improve teaching performance. In fact, everything has core characteristics that remain unchanged. Both the traditional Chinese philosophy and the dialectical philosophy emphasize that while everything in the world is constantly developing and changing, each thing has some unchanging nature (or law) that serves as the essential characteristic distinguishing it from other things. In recent years, some scholars have begun to reflect on the "changing" and "unchanging" in education and have raised a question: are there some teaching principles that remain unchanged throughout the constant changing and updating of the teaching model? This has stimulated extensive discussions on the dialectical relationship between teaching reform and inheritance[6-7].

As a multidisciplinary subject of geography, cartography, remote sensing, and computer science, Geographic Information System (GIS) has been widely used in land planning, ecological and environmental protection, social and humanity research, and many other fields. In this context, an increasing number of colleges and universities are providing GIS majors and courses as well as they have trained a large number of professional talents for the national and industrial sectors[8]. Practical teaching, as an important part of the GIS course, focuses on fostering students' practical ability to use professional knowledge for meeting national and industrial needs. The relationship between "change" and "invariance" of the GIS course starts from the date of its birth and will exist throughout the whole evolutions of GIS and the relevant disciplines. In the social transition period, national and industry needs are constantly changing while new information technologies such as artificial intelligence and cloud computing are emerging, which introduces new requirements for GIS personnel training, making the alignment of GIS practice teaching with the social development trend urgent. However, like other professional courses, the reform of GIS practice teaching also faces the problem of how to balance "changing" and "unchanging", which has become the primary issue to address for the continuous improvement of the course.

The present study systematically analyzes the uncertainty faced by GIS practice teaching in the social transition period, and then closely examines the dialectic relationship between "changing" and "unchanging" in the whole teaching process from the aspects of educational theory, teaching content, teaching methodology, and assessment. Next, using the course of "GIS Practice Design" at the Central South University of China as an example, the present study describes this university's reform and inheritance in GIS practice teaching, aiming to provide reference for the design of GIS-related practice courses.

2 Uncertainty Faced by GIS Practice Teaching in the Social Transition Period

Driven by both social demand changes and information technology development, the traditional model of GIS research and application is now under pressure, which further affects the goal of GIS practice teaching. In this section, we systematically analyze the structural contradictions in GIS practice teaching from the aspects of educational philosophy, teaching content, teaching methodology, and assessment in order to lay the foun-

dation for the dialectical analysis of the relationship between social development and GIS teaching.

2.1 Controversy between process-oriented and output-oriented philosophies

Educational philosophies are the guiding principles that underpin all teaching and learning activities. According to the focus of attention, common educational philosophies can be broadly divided into two types: the process-oriented educational philosophy versus the output-oriented educational philosophy. The former is typically represented by the Conceive-Design-Implement-Operate (CDIO) framework in engineering education; the CDIO framework aligns with engineering project design and aims at innovative ability training, focusing on developing students' systematic engineering skills, especially the ability to conceive, design, develop, and implement projects in the whole process[9]. The latter is mainly represented by the Outcome-Based Education (OBE) framework; the OBE framework sets an expected learning output as the core goal and accordingly organizes, implements, and evaluates the education and teaching process[10]. The CDIO framework requires a holistic consideration of the overall process of teaching and values student training in each key link, which is favorable for achieving the goal of whole-process education. However, the association between education quality and each key link is not strong, and the teaching results are weakly reflective of the teaching process. Hence, it is unsuitable for evaluating education effectiveness and continuously improving the teaching process. The OBE framework sets an expected output as the clear core goal and relies on backward reasoning to perform teaching activities while the evaluation results provide effective support for reflection on and continuous improvement of teaching practice. However, the evaluation results have a time lag to some extent, and therefore, the OBE framework fails to provide whole-process supervision for student learning. Different educational philosophies differ significantly from one another in teaching content, methodology, and evaluation, and hence, adopting a reasonable teaching philosophy in alignment with the nature of the course has become the prerequisite for course teaching.

2.2 Controversy between new technologies and GIS principles

Traditional GIS teaching mainly focuses on GIS data acquisition and analysis, including vector/raster data acquisition, transformation, and storage, as well as GIS spatio-temporal analysis. In the rapidly developing information era, new technologies such as artificial intelligence and big data technology continue to emerge, greatly affecting the traditional GIS teaching content. Moreover, national and industrial sectors have obtained a wide range and large amount of source data as the ubiquitous Internet has further improved its performance in collaborative data monitoring, which makes it increasingly difficult for the traditional GIS data management and the spatio-temporal analysis approach to support data analysis in solving complex geospatial problems. Therefore, it is crucial to introduce new methods and technologies to enrich the content and connotation of GIS course teaching. Otherwise, a growing body of scientific research relies heavily on the "black box operation" of big data and undervalues the importance of the inherent geoscience principles and mechanisms (such as the human environment relationship) of GIS data. This practice negatively affects GIS education: ① GIS education in colleges and universities is invariably more biased toward the teaching of new technologies, which makes GIS education increasingly reliant on computer skills; ② The training system cannot ensure that GIS students reach the same professional level as students of computer science majors, which introduces uncertainty in GIS teachers and students, thereby leading to GIS students being less willing to continue the profession after graduation.

Therefore, a coordinated relationship between new technologies and the basic principles of GIS is an important prerequisite for the sustainable development of GIS courses.

2.3 Controversy between information-based teaching and traditional classroom teaching

Traditional classroom teaching is mainly characterized by "teacher speaking and student listening," and the interaction between teachers and students is effective, which is favorable for creating an atmosphere of discussion and inquiry to enhance students' understanding and mastery of course content[11]. Under the guidance of the "student-centered" teaching philosophy in recent years, new teaching models and methods such as the "problem-oriented method" and the "task-driven method" have emerged, greatly enriching the form and content of classroom teaching. In addition, with the continuous development of information technology, online teaching methods such as "MOOC" are gaining increasingly wide application in higher education teaching owing to their flexibility, and they have become another important teaching model in addition to traditional classroom teaching[12]. However, different education providers have different perceptions and understandings of teaching methodology, which leads to inevitable deviations and collisions between the attitudes of schools, teachers, and students regarding traditional classroom teaching versus modern teaching. For example, considering subject evaluation indicators and other external factors, some teaching administrators believe that online teaching models (such as "MOOC") will terminate traditional classroom teaching and that "MOOC" will eventually replace the traditional classroom[13]. However, most teachers do not accept such kind of argument, and instead believe that under the impact of modern teaching models in the new era, the traditional classrooms will certainly change along with social development and that they are still far from being abandoned or replaced[14-15]. Therefore, effectively resolving the controversy between online teaching and classroom teaching will provide an important path for improving teaching quality.

2.4 Controversy between paper-based exams and diversified assessments

Assessment results are important indicators of the quality of course teaching, and they provide an important basis for continuous reflection and improvement in teaching practice. Currently, paper-based examinations remain the main approach for course assessment. Under the guidance of OBE philosophy, the overall level of students' learning performance and the degree of their mastery of each knowledge point can be effectively assessed by quantitatively scoring each knowledge point. However, paper-based examinations are mostly criticized for having a relatively simple format—namely, for having questions mainly in the form of multiple-choice questions, true-false questions, fill-in-the-blank questions, short-answer questions, and discourses, which makes it difficult to provide a comprehensive yet personalized assessment for each student. In addition, paper-based examinations are still essentially a form of exam-oriented education and fail to reflect students' understanding of knowledge fully. Moreover, some students can still obtain high scores by simply cramming for a test at the last minute, which will likely have a negative impact on the learning motivation of other students. To address this issue, some teaching experts have recently proposed non-standardized examinations in the form of classroom discussions, practice reports, and course defenses to evaluate students' mastery levels of each knowledge point systematically in different teaching sessions, but this practice is relatively subjective and greatly influenced by teachers' subjective views[16]. Therefore, to achieve an objective and accurate evaluation of students' learning performance, it is necessary to integrate the characteristics of both paper-

based examinations and non-standardized examinations and conduct a whole-process, all-round assessment, which will provide scientific data support for course evaluation and continuous improvement.

3 Dialectical Analysis of the Relationship between "Changing" and "Unchanging" in GIS Practice Teaching

Facing the new social transition driven by both changes in social demand and technological innovation, it is not only necessary to update the teaching content and methodology for GIS practice teaching so as to align with the social development trend, but also to identify the most basic principles of GIS teaching that differentiate it from the teaching of other disciplines in the context of complex social development, so that GIS professionals with strong professional characteristics who have adapted to social development can be trained by effectively integrating "changing" with the "unchanging" of GIS teaching. Specifically, the following dialectical relationships between "changing" and "unchanging" should be coordinated when conducting GIS practice teaching in the social transition period.

3.1 "Changing" and "unchanging" in educational philosophies

Educational philosophies do change, but they have different connotations with social development. The educational model in the CDIO framework focuses on carrying out teaching activities throughout the process—from syllabus design to teaching practice. In the social transition period, the differences between different industrial sectors are becoming increasingly obvious, and hence, the requirements for specialized professional training are becoming more rigorous. As a result, the importance of the OBE framework is being increasingly valued in higher education. However, regardless of how the educational philosophy changes, the "student-centered" educational principle should remain unchanged and run throughout the teaching process; it is also the core guiding principle in the CDIO and OBE frameworks. Being "student-centered" has the following connotations: ① Teaching activities should be outcome-oriented to meet the talent needs of various industrial sectors in the new era; ② Teaching activities should be carried out throughout the whole process and in key links covering a wide range of aspects, such as teaching content, teaching methodology, and assessment; ③ The dynamic learning performance of students should be monitored continuously to reflect on and continuously improve teaching performance. Some experts have already explored and implemented some related teaching reform measures. For example, Li[10] introduced the CDIO framework into remote sensing experiment teaching to transform scientific research results into experimental teaching, and adopted the OBE framework to organize, implement, and evaluate project-based teaching with a focus on the expected learning output of students. In other words, Li[10] used outcome to drive the overall training of the CDIO syllabus to construct a new CDIO-OBE teaching model, which can provide reference for GIS practice teaching. Therefore, the educational philosophies of GIS practice teaching contain two types of components—the "changing" components, which refer to the components that have improved after reflection on the education philosophies, and the "unchanging" components, which refer to the "student-centered" principle as the basic guiding principle for the whole teaching process underpinned by both moral and professional education.

3.2 "Changing" and "unchanging" in teaching content

GIS is an application-oriented technology. In the information era, GIS courses have more content and find more applications with the continuous development of national and industrial sectors. Therefore, the teaching content of GIS practice course should be up-to-date

with social development by covering cutting-edge technologies and their typical applications in order to meet the new needs of engineering practice and the academic frontier. Recently, the new technologies, represented by Artificial Intelligence (AI), big data, cloud computing, location-based services, dynamic geospatial data handling and citizen-led initiatives, showed great potential in understanding and transforming the complex world. These technologies should be adopted in the teaching content for keeping pace with the times. However, any discipline has inherent characteristics that distinguish it from other disciplines; in other words, its basic definition and principle are the foundation for designing the teaching content of the discipline. Without this theoretical foundation, the GIS course will become subordinate to other disciplines and it will be difficult to truly reflect its characteristics. According to the basic definition of GIS, it is "a spatial information system that collects, stores, manages, analyzes, and describes geographic distribution data in the entire or part of the earth's surface and space"[17], with "space" and "information system" being the two key words. The ability of students to use GIS to solve practical problems of national and industrial interest can be trained by teaching a series of spatial data-related content such as data collection and storage, data management and analysis, and data presentation. It therefore needs to deeply explore the spatial theory from the new technologies of AI, big data and cloud computing. A few teachers focus too much on new technologies such as artificial intelligence and big data analysis while neglecting the importance of "spatiality" for GIS teaching, which weakens the characteristics of GIS as a "spatial" information system. As a result, the distinction between GIS technology and computer science is becoming less obvious. Moreover, the trained GIS students have no advantage in computer skills compared with computer major students who receive systematic training, which greatly compromises the training quality of GIS students. Therefore, the relationship between reform and inheritance should be dialectically reflected in the content of GIS practice teaching. In other words, while the teaching content changes to some extent as new technologies are adopted to meet new needs so that the students can adapt to social development, it also has an invariant component, namely, a consistent emphasis on strengthening the GIS spatial thinking ability of students so that they become specialized professionals with distinctive characteristics and unigue skills.

3.3 "Changing" and "unchanging" in teaching methodology

The implementation of any educational philosophy and model should always require human activities. The innovation of teaching methodology can effectively enhance the diversity and vividness of classroom teaching and improve students' interest and enthusiasm in learning. However, it is noteworthy that there is an undesirable tendency to excessivety pursue new teaching methods, and some teachers are so committed to innovating teaching methods that they neglect the teaching content. For example, the teaching reform-related publications in the past 10 years were retrieved by searching the CNKI database with the Chinese keywords "在线教学" ("teaching online" in English), "线上教学" ("online teaching" in English), and "混合式教学" ("hybrid teaching" in English) outnumber the classroom teaching-related publications. In particular, online teaching realized the target of "Classes Suspension without Learning Suspension" ("停课不停学" in Chinese) during the COVID-19 pandemic period, which showed great advantage and potential in the emergency events[18-20]. However, any teaching method must serve the purpose of teaching specific content. In other words, it is necessary to choose the appropriate teaching methods flexibly according to the teaching content. The modernization of

teaching methodology has been an inevitable trend throughout the development history of higher education, while the inheritance of teaching philosophies and ideas is an important guarantee for the healthy and sustainable development of education. In GIS practice teaching, students are required to use mastered knowledge of the basic theory of GIS to carry out topic focused practices, for which the relevant basic principles and other theoretical knowledge can be taught online. The online teaching model enables students to preview the teaching content so that the theory can be well mastered to guide the subsequent computer-based practice. However, the online teaching model has poor interactivity and with it, it is difficult to provide face-to-face guidance for students. Consequently, it is difficult for students to seek help and find solutions in the first place when encountering operational problems. In contrast, the classroom- or computer room-based offline teaching models can provide better answers for students and achieve higher teaching efficiency. Therefore, the innovation of teaching methodology should be teaching content-oriented, and the teaching method may come in a different form, while the relationship between teaching content and teaching method should remain unchanged.

3.4 "Changing" and "unchanging" in assessment

The dialectical relationship between "changing" and "unchanging" in the GIS practice course is also reflected in the final assessment scheme. Assessment, as a tool for evaluating teaching effectiveness and student learning performance, provides an important basis for reflecting on and improving teaching practice. Traditional assessment is mainly in the form of examinations (closed-book examinations/open-book examinations), practice reports, and classroom defense, which are mainly intended to examine students' mastery of basic theory and fail to effectively track and assess their practical hands-on ability. As mentioned above, the teaching content of GIS practice courses should address new problems encountered in social development and foster students' practical ability to use GIS theories and technologies for identifying, analyzing, and solving problems. Therefore, the assessment of GIS practice teaching should cover the key teaching processes and links, while traditional test papers, practice reports, and classroom defenses are only one aspect of assessment and fail to effectively track and assess the intermediate process of student practice. For this reason, it is necessary to make appropriate changes to the traditional assessment methods, to record the students' practice sessions at any time through classroom inspections and questions, and to encourage students to form atlases of the intermediate processes as an important basis for process assessment. The students' mastery of the teaching content can be objectively determined by combining the above assessment results with the final practice reports. The online or hybrid teaching (particularly of the virtual simulation experiment platform) provides an effective way for training and assessing the students' practical abilities, which is expected to be widely promoted in future GIS practice teaching[21-23]. However, regardless of the form of assessment, its fundamental purpose is to evaluate the learning performance of students objectively, and it is necessary to examine accurately students' mastery of knowledge points as well as their practice skills in the OBE framework with a student-centered educational philosophy. Therefore, the assessment of GIS practice teaching should reflect students' mastery of the course in all aspects, and the assessment method is allowed to change suitably to reflect students' individual differences while always serving the purpose of inspecting and reflecting on the teaching quality as well as continuously improving the teaching practice.

In short, the elements of "changing" and "unchanging" in GIS practice teaching are present throughout the teaching process. Identification of the

types, interactions, and roles of the two elements in GIS practice teaching is an important prerequisite for ensuring teaching quality. GIS practice teaching should be based on the fundamental philosophies and theories of GIS and should be constantly updated in terms of educational philosophy, teaching content, teaching methodology, and assessment in alignment with the current social needs and cutting-edge academic progress. This is to ensure that the GIS course can constantly meet social development needs while maintaining the essential characteristics of GIS.

4 Case Study: Taking the Course of "GIS Practice Design" in Central South University as an Example

"GIS Practice Design" ("GIS 课程设计" in Chinese) is a core intensive practice course (2 weeks) of the majors of "Surveying and Mapping Engineering" and "Remote Sensing Science and Technology" at the Central South University. It aims to aid students in mastering the basic operation and practical application of GIS software and foster students' comprehensive analysis and problem-solving abilities based on their previous learning in "GIS Principles and Applications" and other courses. This course is focused on the basic principles and methods of GIS and aligned with the national strategic needs and cutting-edge technologies, providing a systematic analysis of the dialectic relationship between "changing" and "unchanging" in the whole teaching process and key links from the aspects of educational philosophy, teaching content, teaching methodology, and assessment. The findings lay a solid foundation for the design of the GIS course.

4.1 Improvement of the CDIO-OBE teaching philosophy

In view of the national strategic planning objectives in the social transition period and the differentiated needs of different industrial sectors (such as those in the fields of natural resources, ecology and environment, urban planning, and agriculture and rural affairs) for the training of GIS professionals, the course team was student-centered and underpinned by the OBE teaching philosophy. Through literature review, expert interviews, questionnaire surveys, industry visits, and other forms, the course team systematically identified the business needs of various industrial sectors for GIS technology. The identified business needs were set as the goals to meet by the course of "GIS Practice Design". Given these goals, the course team, by means of the CDIO teaching philosophy, designed specific teaching content with specific themes in alignment with the national and industrial needs in the syllabus. The students' innovation ability in the whole process of engineering practice, such as project conception, design, development, and implementation, was fostered through the designing of typical engineering projects such as natural resources monitoring and analysis, environmental pollution monitoring and mapping, and sustainable development analysis and evaluation. Moreover, hybrid teaching combining both online and offline teaching models was conducted to provide theoretical knowledge and practice guidance throughout the process, which comprehensively enhanced students' practical ability and sense of responsibility in using professional GIS knowledge to meet industrial needs.

4.2 Designment of the practice teaching content

Given the strategic initiatives of national/industrial sectors for dealing with major ecological and environmental problems and considering the international cutting-edge progress in GIS and remote sensing, the course team designed a number of thematic topics including "remote sensing monitoring and mapping of air pollution," "remote sensing monitoring and evaluation of ecosystem service value," "characterization of urban heat island response during urban expansion," and "remote sensing monitoring and analysis of vegetation

productivity." By addressing the geographical characteristics and principles relevant to each topic, students were guided to think about the philosophical and theoretical basis for using GIS and remote sensing technology to solve practical problems, and were inspired to use appropriate methods for GIS practice. For example, when addressing the topic of "remote sensing monitoring and mapping of air pollution," the teacher started from the law of formation and evolution of air pollution. The teacher then introduced the primary influential factors of the spatio-temporal processes of air pollution and the principles of remote sensing monitoring, and then introduced the characteristics and shortcomings of the current main GIS spatio-temporal models of air pollution. The teaching content was presented to the students systematically with the difficulty and complexity increasing at each step, which guided the students to conduct systematic thinking and understand the topic comprehensively. In GIS practice, the teaching content such as data downloading and collection, data processing and analysis, and result discussion was systematically presented to the students, thereby enabling them to become fully familiar with the basic process of using GIS and remote sensing technology to carry out remote sensing monitoring, analysis, and evaluation of the ecological environment based on geospatial data analysis. Moreover, the students were provided with an operational manual to master the whole process of practice.

4.3 Hybrid teaching with the cooperation of multiple education providers

The teaching team of "GIS Practice Design" of Central South University of China adopted a combination of online and offline teaching models to instruct GIS practice. For GIS theories, online teaching mainly relied on the teaching visualization platform of Central South University while leveraging the online teaching resources "GIS Principles and Applications" (see in http://lms.csu.edu.cn/course/19682/content#/) and "Remote Sensing Applications and Thematic Mapping" (see in http://lms.csu.edu.cn/course/19682/content#/) developed by the team members. Classroom teaching was mainly carried out in the computer room based on the combined use of problem-oriented and task-driven methods as the teaching approach. The students were allowed to independently choose a topic, carry out GIS practice, and complete the whole process with the help of the practice guide. Based on this, students were allowed to expand the scope and depth of the practice appropriately. The teacher was mainly responsible for providing support and guidance, and was ready to answer all kinds of questions in the process of practice in a timely manner. In addition, in view of the intensive engineering practice of the course, relevant teachers inside and outside the school were organized to collaboratively form a team of practice teaching mentors while inviting well-known experts from the Chinese Academy of Surveying and Mapping and other industrial institutions to present academic reports. Meanwhile, enterprise mentors were invited to participate in classroom teaching. All these measures finally led to the establishment of a multi-party, collaborative education community with deep integration of industry and education. By leveraging the rich experience of enterprise mentors in engineering practice and using the online/offline lecturing approach, the students further understood the important role of GIS technology in the monitoring and analysis of natural resources, ecological civilization, sustainable development, and other major national engineering practices and strategic planning. As a result, the students not only expanded their professional knowledge, but also strengthened their sense of responsibility in using professional knowledge to serve the society.

4.4 Personalized assessment in accordance with the contents and the students' abilities

The "GIS Practice Design" course was aimed at

fostering students' practical hands-on ability in using GIS expertise to solve practical problems, so the assessment could not be conducted in the form of paper examinations. The traditional assessment mainly requires students to prepare experimental reports after completion of the practice and it comes in a single form, which makes it difficult to achieve personalized assessment of the students. Moreover, the limited number of topics in the course practice leads to possible plagiarism among some students who choose similar topics, and thus provides a condition for promoting students' bad learning attitudes and habits. For this reason, the course team conducted a question-answer session and on-site discussions on occasion when guiding students' practice to effectively understand the degree of students' mastery of GIS knowledge and skills in practice, and include this in the final grade. Different levels (basic and advanced) of extension training projects were set according to the difficulty of the tasks, and the final grades of projects of varying difficulties were multiplied by certain weighting coefficients to motivate students to further challenge higher-difficulty tasks after completing the basic tasks. When presenting the outcome, the course team encouraged students to use project reports, scientific research papers, atlas, computer programming, and other forms according to the practice content and results combined with their own understanding and interests rather than use project reports alone. The outcome of each student was quantitatively evaluated by comprehen sively scoring both the work and defense. Through the above-mentioned forms of assessment, students could carry out personalized learning and receive personalized assessment according to their own interests and abilities, thereby leading to an objective and accurate evaluation of their learning performance.

Based on the above-mentioned systematic thinking and innovative exploration, this course has achieved a good teaching performance. It has enabled students to further understand and master the basic principles and practical applications of GIS in the process of reform and inheritance, strengthened their theoretical and practical cognition in a systematic manner, and stimulated their strong sense of responsibility in using professional knowledge to serve societal needs. With the support of this course, undergraduates have applied for more than 10 provincial and university-level projects such as the "Student Innovation and Entrepreneurship Project," and have developed a set of applications on smart phone for health path planning under air pollution. Moreover, some undergraduates have published (under supervision) numerous academic papers in journals such as *Environmental Pollution*[24], *Journal of Environmental Science*[25] and *Journal of Ecology*[26]. In short, the performance of classroom teaching and undergraduate training has been improved significantly.

5 Conclusion

Proper handling of the dialectical relationship between "changing" and "unchanging" in practice teaching during the social transition period is an important prerequisite for ensuring the quality of the "GIS Practice Design" course. With continuous social development and technological progress, GIS practice teaching should keep up with or lead the social development trend in order to ensure that the trained talents can adapt to the social and industrial needs. Meanwhile, the teaching process must comply with the most basic educational philosophies and principles to avoid an excessive pursuit of changes in teaching form to ensure the original purpose of education is not disregarded.

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