The Application of Hybrid Instruction Mode in the Course of Geographic Information System Principles

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Abstract

Geographic Information System Principles is one of the professional core courses for the students majoring in Geographic Information Science. It plays an important role in providing a theoretical foundation and technical support for subsequent professional courses. The course is offered in the second semester of the freshman year and is the first professional core course for students. There are four key issues that need to be addressed. Firstly, the main content of this course is extensive and the difficulty level is relatively high. Secondly,theory and software operation are disconnected in traditional classes. Thirdly, the traditional teaching mode can not well stimulate students' interest. Fourthly, the traditional teaching and learning evaluation method focuses on results but not process. Hence, we rely on the online teaching platform of our school to carry out Hybrid Instruction Mode, hoping to improve students' learning effect and improve teaching quality. Based on the outcome-based education (OBE) concept, we refine the teaching objectives, and subsequently enhance the teaching materials. Then, we have built a blended teaching mode. The whole teaching process is divided into four parts including "course guidance", "pre-class self-study", "in-class practice", and "post-class research". Online and offline teaching are connected with various activities. Discussions, exercises, reflections, assessments, critical thinking, paper reading and homework are online activities. Guidance, analysis and practice are offline activities. During the teaching process, we also reformed teaching method and carried out ecological civilization and scientific spirit education.We optimized the assessment method using the formative evaluation. The course objectives are almost achieved.

1. Introduction

Geographic Information System Principles is one of the professional core courses for the students majoring in Geographic Information Science. Through the study of this course, students will master the basic theories and methods of Geographic Information Systems (GIS), understand the principles and methods of spatial analysis, and comprehend the applications of GIS in related fields. Also, they will possess the ability of spatial data acquisition, analysis, and visualization using GIS software. Hence, this course plays an important role in providing a theoretical foundation and technical support for subsequent professional courses.

In the teaching process, there are four key challenges that need to be addressed.

Firstly, the main content of this course is extensive and the difficulty level is relatively high, resulting in difficulty to grasp the theoretical knowledge for students. The course is offered in the second semester of the freshman year and is the first professional core course for students, with a total of 12 teaching units. The contents such as spatial reference system and map projection, spatial data model, spatial data structure, spatial data organization and management, are called for strong mathematical thinking ability and some basic knowledge of computer and information. They are also the foundation of GIS related courses of this major. However, they are very difficult for students to understand. If they are not thoroughly learned, students will not be able to understand the subsequent software operation, or to carry out comprehensive analysis and application, which will directly affect the learning of core courses of this major.

Secondly, theory and software operation are disconnected in traditional classes. This is a course that combines theory with practice. In learning spatial data acquisition and spatial analysis, students are required to know how to carry out applications according to the related principles. The reality is that many students can only operate the software, and is lack of ability to clarify why to do it and to interpret the results.

Thirdly, the traditional teaching mode can not well stimulate students' interest. The typical characteristic of traditional teaching and learning mode is active teaching and passive learning. Most students have no motivation to devote themselves to learning and is easy to lose their mind in class.

Fourthly, the traditional teaching and learning evaluation method focuses on results but not process. The assessment method are lack of the evaluation of the learning process, and can not comprehensively investigate the learning effect of students. Thus, the evaluation results can not effectively motivate students to study hard.

Hence, we rely on the online teaching platform of our school to carry out Hybrid Instruction Mode, hoping to improve students' learning effect and improve teaching quality.

2. Course Overview

2.1 Introduction of the Course

Geographic Information System Principles is a compulsory core course for students majoring in geographic information science. The course is offered in the second semester of the freshman year and is the first professional core course for students. In the Spring semester of 2023-2024 school year, we offered this course for two classes.

2.2 Objective of the Course

Knowledge objectives of this course are as below.

(1) To explain the basic concepts of GIS; to enumerate the types, functions and research contents of GIS; to briefly describe the development history of GIS; to be able to open software and point out the location of some basic commands independently.

(2) To explain the meaning of map projection and why to use map projection; to enumerate and explain commonly used map projections; to explain the principle of Gauss Kruger projection; to calculate the projected zone number and central longitude of a certain point on the earth according to the formula of different zoning types.

(3) To use GIS software to create files of different element types, add projection, digitize spatial data and assign attributes; to edit shapes and attributes according to different requirements; to explain the source of spatial data error and evaluate the data quality.

(4) To explain the difference and connection between vector data and raster data; to use GIS software to complete projection transformation, data format transformation and data structure transformation independently.

(5) To enumerate and distinguish different map symbols; to remember the three elements of a map; to use GIS software to independently produce thematic maps and export them as pictures in the specified format and resolution according to the given data and requirements; to cultivate students' scientific attitude and good aesthetic concept.

(6) To be able to list and explain typical spatial analysis methods for vector and raster data respectively; to be able to use GIS software to complete spatial analysis operations independently; to describe and explain spatial analysis results reasonably.

(7) To explain the concept of digital terrain model (DTM) and digital elevation model (DEM); to generate DEM by GIS software; to use GIS software to complete surface analysis, three-dimensional spatial analysis, and realize three-dimensional visualization.

(8) To explain the concepts of WebGIS and mobile GIS and give examples respectively.

(9) To briefly describe the concept, basic features, design principles and life cycle stages of geographic information engineering.

(10) To enumerate typical GIS application cases and explain the corresponding principles and methods.

There are three typical capabilities to be cultivated in this course.

(1) Ability to collect and process spatial information and draw various types of thematic maps independently by using GIS software.

(2) Ability to use geographical method to solve practical problems in the field of natural science and social science.

(3) Ability to write reports, statements and to communicate with different people.

We also want to impart values to the students.

(1) By learning basic theories, methods and applications of GIS and cartography, students can develop scientific attitude and patriotic feelings.

(2) By carrying out spatial data digitalization in designated areas, we can cultivate the students to be patient, careful, meticulous and diligent.

(3)By systematically learning GIS theories, methods and application examples, the students will face up to the advantages and disadvantages of the current development of GIS industry in China, pay attention to social development and scientific and technological progress, actively explore the application of new technologies in this major, and explore the possibility of applying relevant knowledge, theories, technologies and methods to different fields.

2.3 Key Issues to be Solved

As are referred in section 1, there are four main challenges in traditional class. Hence, the key issues to be solved in this course are as below.

(1)How to strengthen students' understanding of basic theory?

(2)How to make students reasonably and comprehensively analyze the results of software operation?

(3)How to reform the assessment?

3. Blended Learning Design

3.1 Optimize the Teaching Content

The teaching content is refined based on the outcome-based education (OBE) concept (Spady,1994). The American scholar Spady has conducted in-depth research on the mode in the book of *Outcome-Based Education: Critical Issues And Answers*. We have to optimize the teaching content according to the need of students’ future work and life. And we also have to coordinate the content with the development of technology and society.

Hence, we have specified the professional goal of GIS major according to the need of future work in GIS industry. Then, we refined the teaching objectives based on the professional goal, and subsequently enhance the teaching materials. Also, the new technologies, methods, and knowledge such as AI are introduced into teaching and learning process in accordance with social development. The practical teaching cases and software operation videos are carefully selected and made for all practical sessions. In addition, videos of National Refined Courses and recommend papers are introduced to enrich the learning resources. We hope to ensure the integrity and advancement of the learning content through taking these measures.

3.2 Blended Learning Design

This is accomplished using Beijing City University online education platform. Basic information, unit studies and activities are three main columns for this course. It also has other functions such as learning data analysis.

The whole teaching process is divided into four parts including "course guidance", "pre-class self-study", "in-class practice", and "post-class research". Online and offline teaching are connected with various activities. Discussions, exercises, reflections, assessments, critical thinking, paper reading and homework are online activities. Guidance, analysis and practice are offline activities.

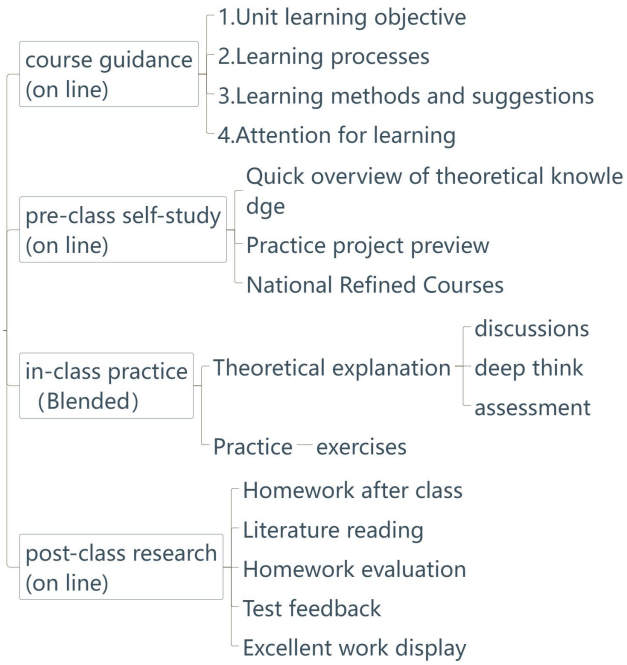

Figure 1. The frame of teaching mode

Course guidance serves as a guide for students self-learning, which provides instructions on the teaching content, objectives, learning methods and pre-class preparations for each unit. Students can learn by themselves by using this guidance.

Pre-class self-study includes three components which are course quick overview of theoretical knowledge, practice project preview and videos of National Refined Courses. PowerPoint presentations, practice data and operation videos by teachers will be uploaded to the platform. The National Refined Course is from Sun Yat-sen University(Zhang, 2024). It allows students to study the materials and operate the software before class and review afterwards.

In-class practice involves interactive sessions between teachers and students. Problem discussions (including two activities of discussions and deep think), in-class exercises (with the activity of exercise) and in-class tests (assessments) are incorporated to engage students in active learning during class time for theory teaching and practice.

Post-class research aims at consolidating and elevating what has been taught. This is realized by assigning post-class homework, answering open-ended questions, and reading academic papers. This helps students solidify their knowledge and enhance their perspectives and critical thinking abilities. Excellent homework will be displayed in this module to encourage the students.

3.3 Teaching Method Reform

During the teaching process, innovative teaching methods are employed.

In terms of theoretical teaching, case method, research teaching method, and heuristic modes of teaching are adopted for different teaching units respectively, which facilitates students' understanding of theoretical knowledge.

For the practical content, we developed a teaching organization method of "positive - inverse- positive", so that students can understand the process of software operation and know how to explain the results. Let’s take spatial interpolation for example.

"Positive" : This is the introduction of spatial interpolation principle. Formula derivation will be generated in this part. It helps to understand the logical thinking process of this practice and the meanings of the results.

"Inverse" : Lead the students to view the module of spatial interpolation in the software, understand the design of the tool, and make the students fully understand what the inputs and outputs are in order to complete spatial interpolation. Thus, the students can find the connections between the formulas and the software.

"Positive" : Combined with the analysis of the first two steps, the students are guided to complete the spatial interpolation according to the technical process, get the spatial interpolation results, describe and interpret the results.

The learning results of this course can be used to support the data requirements in the fields of territorial spatial planning and urban management. In students’ spare time, then are encouraged to take part in competitions inside and outside our school. For example, at least two groups will attend the Innovation and entrepreneurship training program for college students every year. Extracurricular practice has greatly enhanced the professional ability.

3.4 Optimize the Assessment Methods

This course is closely related with theory and practice. We tend to emphasize the entire study proceeding. We have carried out the course evaluation using the formative evaluation. There are several parts of the evaluation.

(1) Performance in class. The attendance and participation are both inspected.

(2) The stage assessment. It includes four questions, which are from the teacher's scientific research projects and professional competitions focusing on cultivating the students' basic GIS skills and teamwork ability.

(3) The final examination. It is a closed-book examination, which examines the students' understanding and application ability of GIS theory.

(4) Online and offline studies. Every student is encouraged to complete all online and offline activities. The activity completion, homework and video viewing time are main indicators to comprehensively assess student learning process. Additionally, students are encouraged to take part in subject competitions to enhance their professional abilities through competitive experiences.

3.5 Ecological Civilization and Scientific Spirit Education

The most important research object of GIS is the earth. The use of GIS can monitor the earth's mountains, forests, fields, lakes,

grasses, sand and cities. It makes us treasure the gift of nature. During the classroom teaching, territorial spatial planning, the third National Land Survey and other related major projects are introduced to the students. In the stage assessment, there are two questions related to ecological civilization for the world earth day propaganda. One is about physical regionalization of China, the other one is about Shunyi District Planning (2017-2035).

The practice of GIS is the realization of a certain method or an analysis of geographic data. Different methods have their applicable scope and characteristics. Students should not modify the data or adjust the process parameters arbitrarily when the result doesn’t meet expectation. They should seek truth from facts. Besides, the practice of GIS also needs experience and patience because of the large workload of data processing. Only through practice can we deeply understand what academic norms and scientific spirits are.

4. Resource Construction and Application

4.1 Online Resources

Basic information, unit learning, course resources, course activities and other columns are set up on the platform. The construction resources in each column are shown in Table 1.

Column	Resources/Activities		Quantities
Basic information	1.Course introduction		1
	2.Teaching syllabus		1
	3.Teaching calendar		1
	4.Teacher introduction		1
Unit learing	Course guidance	Course guidance	12
	Pre-class self-study	Quick overview of theoretical knowledge	12
		Practice project preview	7
		National Refined Courses	42
	In-class	Discussions	46
		Deep think	5
		Assessment	6
		Exercises	22
	Post-class	Homework after class	16
		Literature reading	43
		Extension	6
	Course questionnaire		1

Table 1. List of online resources

In the practice project preview module, I have made totally 42 software operation videos by myself for all practice projects with 1546255061B. All the resources are 6694.79 MB.

4.2 Statistics of Online Study Data

To analysis the study situation, a simple statistics is generated according to the online study data. The data are exported from the platform.

Statistic indices	Class 1	Class 2	Average
Average frequency of logins to the online course platform(/person)	115	94	104.5
Average duration of online (minute/person)	1014	920	967
Frequency of reading resources (/person)	126	108	117
Frequency of replies to the course discussion area(/person)	53	44	48.5
Frequency of participating in the test(/person)	5	4	4.5

Table 2. Statistics of online study data

It shows that average frequency of logins to the online course platform is 104.5 for each student. This means that one student will login to the platform more than 25 times a month from March to June. It indicates that the students use this platform very frequently. In terms of duration of online, each student stay on line for 967 minutes as an average. The longest duration is 4011 minutes. The statistics data show that the student of the two classes are very diligent to make good use of the platform. However, it is clearly shown from the statistics that the exhibition of class 1 is better than that of class 2. The results are consistent with offline study situation.

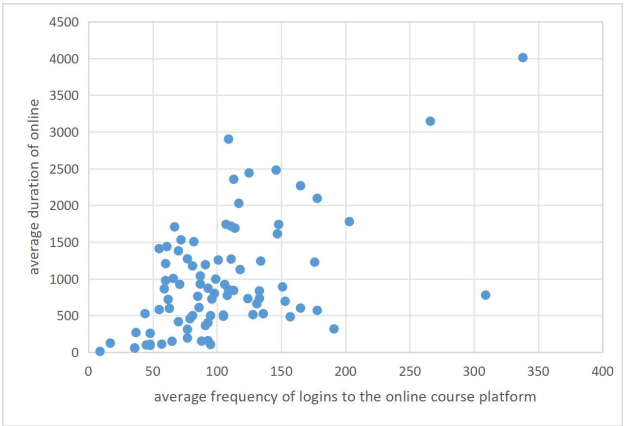

Figure 2. The relationship between average frequency of logins to the online course platform and average duration of online

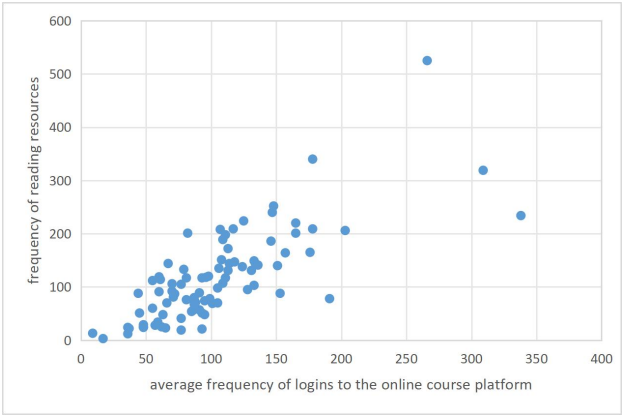

Figure 3. The relationship between average frequency of logins to the online course platform and frequency of reading resources

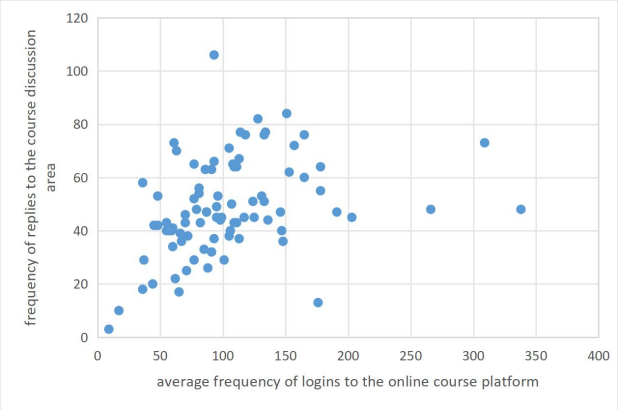

Figure 4. The relationship between average frequency of logins to the online course platform and frequency of replies to the course discussion area

We also try to explore the relationships between different parameters of the statistics. Figure 2-4 show that average duration of online, frequency of reading resources and frequency of replies to the course discussion area are approximately positively related to average frequency of logins to the online course platform. This might indicate that the students having higher frequency of logins are inclined with full use of the platform.

5. Teaching Effect

5.1 Questionnaire Survey

Questionnaire survey is one of the most common methods of investigation. The questionnaire consist of 19 questions and mainly includes three parts: students' self-evaluation of learning effect, students' satisfaction with blended teaching, and students' achievement after blended teaching(Chen, 2018). Through the analysis of these three parts, the learning effect of blended teaching can be investigated from the subjective level of students.

The questionnaire was accomplished on the platform anonymously towards all the students from class1 and class 2. About 60% of the students attended the questionnaire.

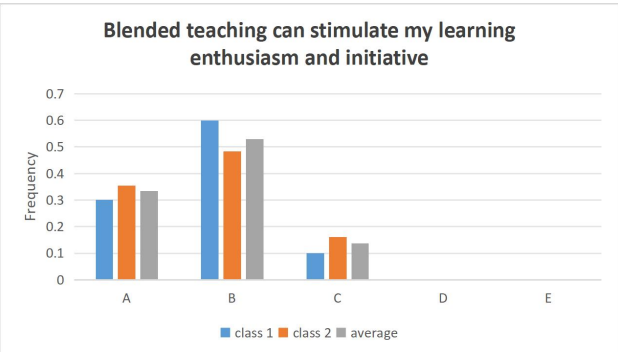

Figure 5. Blended teaching can stimulate my learning enthusiasm and initiative
(A:Strongly agree; B:Agree; C: Neither agree nor disagree; D: Disagree; E: Strongly disagree)

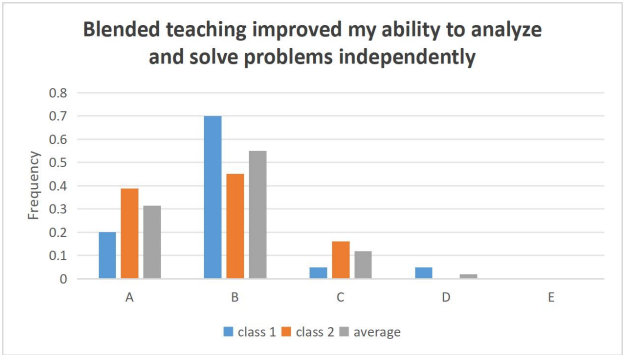

Figure 6. Blended teaching improved my ability to analyze and solve problems independently
(A:Strongly agree; B:Agree; C: Neither agree nor disagree; D: Disagree; E: Strongly disagree)

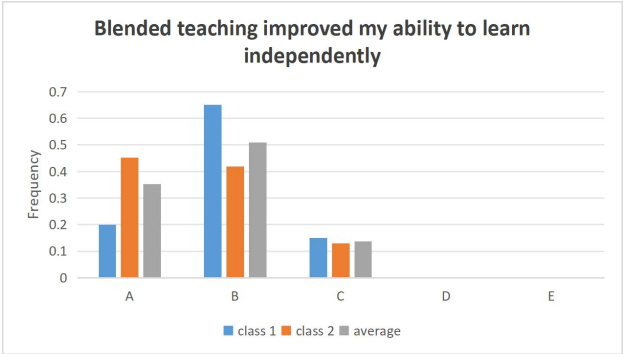

Figure 7. Blended teaching improved my ability to learn independently
(A:Strongly agree; B:Agree; C: Neither agree nor disagree; D: Disagree; E: Strongly disagree)

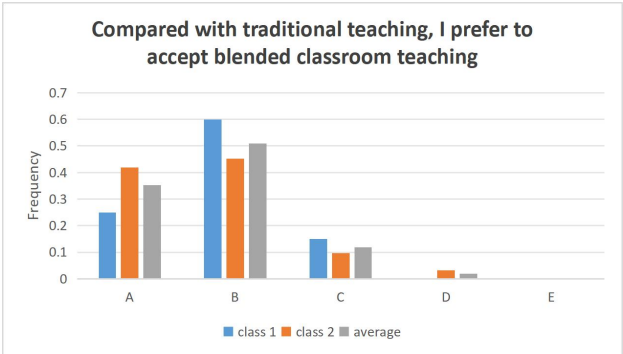

Figure 8. Compared with traditional teaching, I prefer to accept blended classroom teaching
(A:Strongly agree; B:Agree; C: Neither agree nor disagree; D: Disagree; E: Strongly disagree)

Figure 5 shows that about 86% students agree or strongly agree that blended teaching can stimulate their learning enthusiasm and initiative. About 14% students selected “Neither agree nor disagree”. The value of agree and strongly agree for class 1 is 90%, which is higher than that of class 2.

From Figure 6, we can see that about 86% students agree or strongly agree that blended teaching improved their ability to analyze and solve problems independently. Different from Figure 5, there are nearly 2% students disagree the opinion.

Figure 7 shows the result about students’ opinion on whether blended teaching improved their ability to learn independently.

It shows that about 86% students agree or strongly agree this opinion.

Compared with traditional teaching, 86% students prefer to accept blended classroom teaching(Figure 8).

The results above indicate that the students are satisfied with blended teaching.

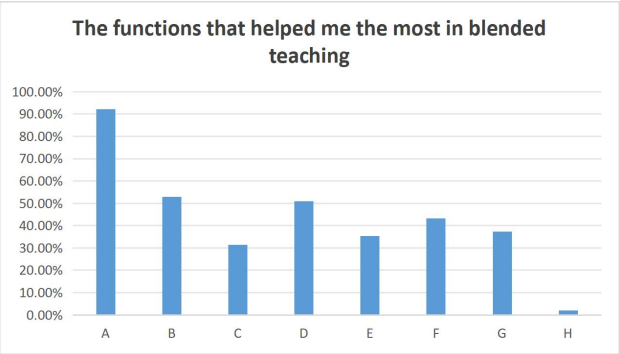

Figure 9. The functions that helped me the most in blended teaching
(A:software operation; B:knowledge review; C:National Refined Courses study; D: homework and exercise; E: test; F: discussion; G:excellent homework; H:other)

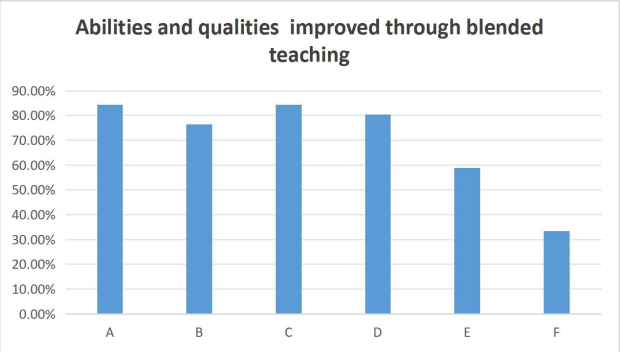

Figure 10. Abilities and qualities improved through blended teaching
(A: ability of software operation; B: knowledge of basic GIS theory; C: ability of GIS application; D: ability of drawing; E:team-work ability; F: text writing ability)

Figure 11. Improvement besides professional abilities
(A: industry development;B: professional quality; C: sense of confidentiality; D: consciousness of national territory; E: teamwork awareness; F: ecological civilization;G: red cultural resources; H: history of the university; I: independent thinking ability)

Fiture9-11 show that after blended teaching, the students’ abilities have been improved. Software operation, knowledge review, and homework and exercise are the most satisfied functions for students. About 92% students consider that software operation function helped them the most in blended teaching.

Though blended teaching, ability of software operation, knowledge of basic GIS theory, ability of GIS application, ability of drawing and team-work ability have proportions higher than 60%, especially team-work ability, ability of GIS application and ability of drawing. However, the improvement of text writing ability is not obvious.

5.2 Students Outcomes

The course construction leads to an improvement in learning outcomes of students. In recent three years, 12 Innovation and entrepreneurship training program for college students have been approved for students in GIS major. They focus on serving related problems using GIS method independently. This proves that students are well cultivated through blended teaching.

6. Summary

In this paper, we have proposed a mode of blending teaching according to current challenges and have evaluated the teaching effect. The course objectives are almost achieved.However, there are still some problems to be solved in the future.

Communication between courses needs to be strengthened. Geographic Information System Principles can provide knowledge and skills support for multiple courses and majors. We will make further efforts to promote the communication between relevant disciplines and relevant courses, so as to better realize the integration and collaboration between majors.

The construction of online resources need to be further improved. The selection and setting of online learning resources for courses should be further optimized and refined. Clearer guidance and corresponding feedback mechanisms should be set up for students' online learning to ensure the effective use of online resources and timely feedback of students' learning effects. And thus, it will ensure that students' problems can be timely and targeted solved.

From the investigation, it shows that text writing ability is not well developed. However, text writing ability is a necessary ability for students in the future work. We will pay more attention to text writing ability cultivation.

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