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Effect of Flipped Teaching on Learning Efficiency of 3D Software Courses

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ABSTRACT

The purpose of this research is to explore the impact of flipped teaching on the learning efficiency of 3D space software courses. Statistical analysis is conducted through a network interface, and the main research objects are full-time students in Department of Environmental Design of some university. In the questionnaire, learning efficiency is divided into three dimensions of "learning interest attitude", "group learning efficiency", and "knowledge internalization absorption". The purpose of this article is to explore and compare the effects of different grades on the learning efficiency of flipped teaching in software courses. The research results show that: first, there is a significant difference in the "enhancement of learning interest in the Internet" in the interest dimension. In the topic selection of this direction, it is obvious that the interest in online learning in lower grades is better than that in upper grades. Second, "self-learning software grouping in the website" has obvious differences. It shows that lower students are more accustomed to digital knowledge and are more able to accept flipped teaching. Third, the options of "knowledge internalization" are significantly different for each grade. Flipped classroom teaching is not only attractive for students, but also helpful for autonomous learning.

Keywords: *flipped teaching, curriculum learning efficiency, learning interest attitude, group learning efficiency, knowledge internalization absorption*

I. INTRODUCTION

At present, three-dimensional space software teaching methods still focus on teaching, and it is also the most common teaching model. The lecture method is mainly teacher-centered, and the teaching method is mainly lecture. The learning method lacks initiative, and the homework exercises in class are mainly copy and observation. In each teaching link, students with strong learning abilities are more efficient, and students with poor abilities gradually lose their enthusiasm and initiative in learning. There is less interaction between students with strong or poor learning abilities, and the phenomenon of these two polarizations is not conducive to the development of holistic learning. Students lack active thinking and must simultaneously receive knowledge in the classroom. Therefore, students who are interested in this course tend to be more efficient, and the learning efficiency of the course is generally low. To sum up, if the learning process is divided into two steps: "knowledge transfer" and "knowledge absorption and internalization", the passive learning method of students will be transformed into active, while the teaching method focuses on knowledge transfer and ignores its absorption and internalization.

To solve this problem, the flipped classroom proposed by Bergmann Sams (2012) has become a new way of reforming teaching in recent years. The flipped classroom allows and encourages students to regard learning as an activity and socialization process, and constructs knowledge through pre-class self-study and in-depth discussions in the classroom. In social learning theory, results are more important to affect learning. factor. In recent years, flipped teaching has also enabled students to receive new information at any time due to the development of the digital age. In the age of technology, the learning work of passively transferring knowledge has gradually been separated from formal courses. Due to the popularization of computer, network and cloud technology, classrooms have also become a non-only or necessary place for "teaching" and "learning".

II. LITERATURE DISCUSSION

In recent years, the development of digital knowledge has enabled students to obtain information quickly, and electronic communication has become the

norm in the Internet age. Therefore, the use of network technology has gradually become a learning tool for transferring knowledge. In the advent of the digital age, "flipped teaching" is bound to become the mainstream. Students learn course knowledge in the digital age, and in formal courses, students construct the concept of learning work more actively through active learning (Davies et al., 2013; Flumerfelt & Green, 2013). In flipped teaching, students are positioned to control their own learning speed, progress, and learning steps based on individual needs. In this teaching, teachers can achieve meaningful learning through observation, guidance, comment and assistance without restriction. Although flipped teaching can be regarded as a variation of the hybrid teaching model, the network teaching and classroom teaching that this model takes into account basically still teach in the order of traditional teaching methods. However, flipped teaching implements actual teaching activities through the network platform teaching method before class. The focus of traditional teaching is not on teaching, but on activities such as joint discussion, answering doubts, or guiding further thinking. Although flipped teaching is a simple "flip" in the order of teaching, the core value is to give students the initiative of learning.

Flipped teaching is changing the way of traditional teaching, and the way of learning attempts to transform the more passive into autonomous learning. Teachers move the time for knowledge transfer outside of the formal classroom, and in the classroom, students are allowed to actively construct knowledge through extensive interaction with peers and teachers. The learning environment is transformed from teacher to student-centered. The same course in flipped teaching allows students to spontaneously preview through the Internet. Teaching videos are important in this process. Teachers can make videos and upload them to the website, or find suitable videos from the website. There are many ways for teachers to use flipped teaching, but the basic concepts are the same. Students can adjust the learning progress according to their own needs. And they are expected to be responsible for their own learning. The role of the teacher in the curriculum has been changed from being a lecturer to a provider of asynchronous learning resources. Teachers provide learning-centered opportunities in the classroom, allowing students and teachers to increase interaction opportunities, and there is a space for cooperative learning between students, so that learning methods become active.

This teaching is not a new idea, but recently, because of the development of digital technology, students can receive information ubiquitously and connect with peers, making flipped teaching gain attention. In the digital age, flipped teaching includes a blended learning design. The use of digital technology makes the learning work of passive knowledge transfer beyond the formal curriculum. In the formal curriculum, students can construct the concept of learning work more actively through active learning. Students are positioned in flipped teaching to control their own learning speed, progress, and learning steps based on individual needs. In flipped teaching, teachers can achieve meaningful learning through observation, guidance, comment and assistance without restriction. Many studies have pointed out that flipped teaching can improve the learning efficiency of students. This learning method can provide more group discussion time to promote the development of multiple abilities. However, most of the research is applied in theoretical classrooms, and less applied to computer software courses.

In response to the advent of the digital age, the relative design education must also be adapted. The role of teachers in the future must consider the following points:

- Teachers can understand the nature of digital technology and design teaching on this premise.
- Teachers adjust teaching content in response to digital teaching trends.
- Teachers must understand the application of flipped teaching courses in order to provide students with interest in learning.
- In the future, teachers must be encouraged to use their creativity to establish new models for teaching materials and teaching methods in the network environment.

The application of flipped teaching is mostly based on theoretical teaching, and less research on 3D courses. It is necessary in response to the advent of the network technology era and the background of the future teaching environment. Therefore, this research hopes to investigate whether flipped teaching can improve learning efficiency or interest in 3D software courses.

III. RESEARCH METHOD

A. Research framework

This research mainly uses SPSS 2.0 software as the calculation tool; and the data statistics are based on the analysis of single factor variance analysis. The research performs statistical analysis through a network interface, and fills out the questionnaire with full-time students in the Department of Environmental Design of some university as the sample object. The questionnaire was designed with a Likert Scale, and different grades were given according to the tendency of the statement. And this research is exploring the impact of flipped teaching on the learning efficiency of 3D software courses. The questionnaire is divided into three levels

based on learning efficiency, which are divided into "learning interest attitude", "group learning efficiency", and "knowledge internalization absorption" . The purpose is to explore and compare the effects of flipped teaching on the learning efficiency of software courses among different grades.

1) Independent variables: The independent variables of this study are "gender" and "grade", which are explained as follows:

- Gender: The students who participated in the survey in this study filled out questionnaires online and were divided into two ethnic groups: an independent sample of male college students and an independent sample of female college students.
- Grades: This study is divided into four grades and four classes for teaching experiments. They are Class 1 of the Department of Environmental Design of Grade 19, Class 3 of the Department of Environmental Design of Grade 18, Class 2 of the Department of Environmental Design of Grade 17 and Class 1 of the Department of Environmental Design of Grade 16 .

2) Control variables: The control variables of this study are "teaching content", "student level", and "teachers", which are explained as follows:

- Teaching content: The teacher mainly focuses on 3D computer software teaching courses, with a total of 5 unit courses, and the teaching is based on course cases.
- Student level: The research objects are students in 4 classes from freshman to senior in the environmental design department of a university. Among them, the second to fourth grades have taken a 3D simulation software teaching course, while the first grade has taken a computer software course; therefore, there is little difference in software application ability among students.
- Teachers: The teachers in this study are all the same person who has been teaching at the university for 8 years.

3) Dependent variables: The dependent variables of this research are "learning interest attitude", "group learning efficiency", and "knowledge internalization absorption", which are explained as follows:

- Learning interest attitude: The learning interest attitude of this research refers to the scores obtained by students on the flipped teaching network questionnaire in the "Sketch up" course. The purpose of this questionnaire is to try to investigate the influence of flipped classrooms on students' interest in learning.
- Group learning efficiency: The group learning efficiency in this study refers to the scores obtained by students on the flipped teaching network questionnaire in the "Sketch up" course. It is an attempt to investigate the willingness of flipped classrooms for students to learn in groups via the Internet.
- Knowledge internalization and absorption: The internalization and absorption of knowledge in this study refers to the scores obtained by students on the flipped teaching network questionnaire in the "Sketch up" course. The purpose of this questionnaire is to investigate the internalization and absorption of knowledge by students through online learning.

B. Research objects

The objects of this research are the full-time college students from the Department of Environmental Design of some university. Among them, the second grade took the "Sketch up modeling" course in the last semester of 2019, and the sample number was 46. The third grade took the "Sketch up modeling" course in the second semester of 2018, with a sample size of 34, and the fourth grade students took the "3Ds max" course in the second semester of 2018 with a sample size of 31. And first-year students have taken computer software courses (Photo shop). The total sample objects were 161 people.

C. Computer software courses

The 3D space software course of this research focuses on cultivating students' expressive ability in space simulation design. The "Sketch up modeling" course is a compulsory course for the Department of Environmental Design ("Table I"). The purpose is to cultivate 3D design thinking and strengthen the multi-media expression method. In this course, an integrated and systematic presentation of the software is made, so that students can fully grasp the method, and can transform the learned instructions into design ideas and express them in the work in. The "3Ds max" course is also one of the compulsory courses of the department, and this course is to guide the interior simulation design, using software to express the designer's thinking ("Table II"). Students will familiarize and refine the instructions one by one through continuous course training. The teaching simulation is mainly based on furniture and interior design, which also improves students' artistic quality. This can enable them to have strong practical and innovative abilities after graduation, so as to meet the basic requirements of professional learning and meet the needs of market and social development.

TABLE I. DESCRIPTION OF THE MODELING COURSE OF SKETCH UP

Unit	Subject	Teaching content	Case	Time
1	Preliminary stage of modeling	Explanation of drawing and editing tools / straight line, rectangle, circle / push, pull, move tool / basic drawing and editing tools explanation / circle, arc, polygon, freehand curve / path following, rotation / offset, zoom, scale / tape measure, protractor, coordinate axis / text, size / positioning camera, rotating around axis, roaming.	Classic chair TV wall Wardrobe design	12 lessons
2	Advanced stage of modeling	Explanation of advanced drawing and editing tools / group tools, layer / scene, section / solid tools, shadow, sandbox / softening, fog / advanced drawing and editing tools explanation / component tools / material mapping.	Landscape lamppost indoor case	12 lessons
3	Material plug-in rendering	Application drawing and editing tool explanation / building plug-in use / Lay out application / vray for Sketch up rendering performance	Nordic house design	12 lessons
4	Design application	Interior design / Villa design / Landscape design	Space case	12 lessons

TABLE II. 3DS MAX PRACTICAL COURSE DESCRIPTION

Unit	Subject	Teaching content	Case	Time
1	Modeling	Basic instruction explanation operation / deformation instruction operation / movemen / rotation / zoom / lock point instruction operation / lock point / lock angle / lock ratio	Classic chair, teapot cup group, wine cup tower	12 lessons
2	Materials	Material instruction explanation / create panel / SU material and V-Ray material / reflection and diffuse material / bump material / common material	Desk and chair, indoor case.	12 lessons
3	Light	Light instruction explanation / georeference setting / V-Ray rendering scene / point light source / spotlight / photometric network (IES) light source	Nordic style, residential design	12 lessons
4	Application	Interior design case / architectural design case / landscape garden case	Space case	12 lessons

D. Experimental courses

The computer software courses in this experimental study are divided into "Sketch up modeling" and "3Ds max practical" courses. This course is 3 credits and a total of 48 hours of study time. These two courses are taught twice a week, each of which is four lessons and one lesson is 45 minutes. Therefore, one course can be completed in 6 weeks in total. In this experiment, the second-year students' SU (Sketch up) courses are arranged in the first semester of the second year, while the third-year students' SU courses are arranged in the second semester of the third year. The 3D course for fourth grade students will be taught in the second semester of third grade. The questionnaire survey is conducted after the end of all courses, using the time of the last lesson, in which scales such as learning interest attitude, group learning efficiency, and knowledge internalization absorption are measured.

E. Test tool

The test tool is the survey scale for the impact of flipped courses on learning efficiency.

The questionnaire scale used in this study was designed by the author. This scale adopts Likert's five-point scoring, "strongly disagree" scores 1 point, "disagree" scores 2 points, "uncertain" scores 3 points, "agree" scores 4 points, and "strongly agree" scores 5 points. The learning efficiency questionnaire is divided into three dimensions: "learning interest attitude", "group learning efficiency", and "knowledge internalization absorption". The Cronbach's α coefficient of 161 students in four classes in the overall 13 projects survey is .870, which shows that the scale has good reliability.

IV. RESEARCH RESULTS

In order to understand the impact of flipped teaching on students' interest in the course, the questionnaire is divided into three dimensions: they are "learning interest attitude", "group learning efficiency", and "knowledge internalization absorption". This study uses independent sample t-tests to examine and analyze the differences in learning interest of gender in flipped courses. And it uses one-way variance analysis to test the differences among the three dimensions.

A. Analysis of t-test data for independent samples of flipped teaching

Using independent samples to test the differences in the learning efficiency of gender in the flipped course, from "Table III", it can be seen that there is no significant difference in the topics of learning interest attitude, network group learning, and self-study knowledge internalization. This should reflect that male and female students have reservations about flipped

teaching. On the other hand, it may also reflect that male and female students are accustomed to traditional teaching.

TABLE III. ANALYSIS RESULTS OF GENDER IN INDEPENDENT SAMPLE T TEST

	Topic	Male (58)	Female (103)	Assume equal variances Significance (two-tailed)	Do not assume equal variances Significance (two-tailed)
Interest in the network	1	3.52	3.63	.553	.581
	2	3.48	3.70	.194	.227
	3	3.40	3.39	.960	.963
	4	3.50	3.64	.441	.483
	5	3.41	3.64	.180	.223
	6	3.36	3.20	.374	.391
	7	3.47	3.31	.393	.386
Group learning	1	3.69	3.54	.399	.432
	2	3.67	3.61	.725	.725
	3	3.66	3.51	.413	.431
Knowledge internalization	1	3.47	3.59	.463	.484
	2	3.45	3.63	.318	.327
	3	3.48	3.48	.967	.970

B. Analysis of the one-way anova of the class in the "self-study software interest in the website'"

In the one-way anova analysis Scheffe method, after comparison, there is a significant difference in the interest aspect of "enhancing learning interest in the Internet"; and in all topics, it is obvious that the lower grades are better than the upper grades in online learning interests. The author believes that this is related to the higher level of reception of digital information in the lower grades, which can be shown that low-level students are accustomed to network information and are more able to accept flipped teaching, and higher grades are more accustomed to traditional teaching.

C. Analysis of the one-way anova of the class in the "self-study software grouping on the website"

The "self-study software grouping on the website" in the interest dimension has obvious differences after the Scheffe method of one-way anova analysis; and in all the topics, it is obvious that the interest of the lower grades of online learning grouping is better than that of the upper grades. Continuing from the previous learning aspect (self-study software interest in the website), the lower grades have a high degree of acceptance of digital information. Whether it is "discussing and learning in groups", or "actively helping students with difficulties in learning", or "using video to group learning", they all have the courage to try. It can be shown that lower students are accustomed to network information and are more able to accept flipped teaching. Compared to them, the higher grades are still accustomed to traditional teaching.

D. The analysis of the one-way anova of the class in the "flipped classroom learning knowledge internalization"

In order to further clarify the optional part of the "knowledge internalization" in the learning efficiency questionnaire, the results of the one-way anova analysis were used. The results show that there are significant differences in the selection of "learning software on the website, I think it is better to absorb and apply learning knowledge" except for the second-year students. This shows that the flipped classroom has no difference in the internalization and absorption of learning efficiency and knowledge, which may reflect the autonomous performance of each class in the learning atmosphere. In the option of "learning through the Internet and absorbing the knowledge in class and then practicing the case, the learning efficiency will be higher", except for the fourth grade, there are significant differences in other grades. This result reflects that the fourth grade is slightly exhausted in terms of learning efficiency. After 3 years of learning experience, whether it is classroom or trying new teaching methods, they feel that there is no new idea. In the last option, "it is better to absorb the difficult instruction knowledge by continuously watching videos on the Internet, and then apply it", there are significant differences in each class. This result can show that traditional learning has a

knowledge of students Internalization and absorption are not effective. In addition to being attractive to students, flipped classroom teaching is also very helpful for the internalization and absorption of independent learning knowledge. ("Table IV")

TABLE IV. ARITHMETIC MEAN AND STATISTICAL RESULTS OF ONE-WAY ANOVA OF THE CLASS IN "FLIPPED CLASSROOM LEARNING EFFICIENCY"

		Arithmetic mean		Analysis of one-way anova		
	Topic	***Average***	***Standard deviation***	***F***	***Significance***	***Post hoc***
Interest in the network	1	3.59	1.164	17.360	.000	A＞C, A＞D, B＞C
	2	3.62	1.012	13.035	.000	A＞C, B＞C, D＞C
	3	3.39	.995	10.442	.000	A＞C, A＞D, B＞C, B＞D
	4	3.59	1.109	5.842	.001	A＞C, B＞C
	5	3.56	1.030	14.571	.000	A＞C, B＞C, D＞C
	6	3.26	1.081	9.514	.000	A＞C, A＞D, B＞C, B＞D
	7	3.37	1.099	15.731	.000	A＞C, B＞C, D＞C
Group learning	1	3.60	1.051	7.716	.000	A＞C, A＞D, B＞C
	2	3.63	1.047	8.088	.000	A＞C, A＞D, B＞C
	3	3.57	1.042	7.825	.000	A＞C, B＞C
Knowledge internalization	1	3.55	1.049	6.530	.000	A＞C, A＞D
	2	3.57	1.111	9.878	.000	A＞C, B＞C
	3	3.48	1.025	11.741	.000	A＞C, A＞D, B＞C

V. CONCLUSION

In recent years, the development of digital knowledge has enabled students to quickly obtain information, and the advent of the Internet age has made classrooms a non-only or necessary teaching field. This also makes "flipped teaching" gradually form a popular new teaching method. However, because this teaching method requires online videos to be produced in advance, it consumes a lot of time and labor costs. This research suggests that if teachers can support each other to record instructional videos, the time for lesson preparation can be reduced. The main purpose of this research is to investigate whether students can improve the efficiency and interest of 3D computer design courses in flipped classroom teaching. From the results of the survey, analysis and comparison, it can be known that the lower grades have more reactions than the upper grades. This can also anticipate the possibility of the implementation of the flipped classroom (teaching) in the future. In traditional teaching methods, there are many shortcomings. However, passive learning by students cannot internalize knowledge. In the author's own curriculum teaching experience, students have major differences in knowledge, literacy and attitudes. The application of flipped classroom teaching method is to improve students' problem analysis ability, while improving the learning process and thinking ability.

And this pedagogy requires education researchers to continuously explore and analyze, pay attention to link connection problems in continuous teaching, and provide guidance for more teachers to promote learners' learning. In the follow-up research, software teaching courses will be incorporated into the teaching method, and online cooperative learning will be used to continue relevant research.

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