Creative Education, 2024, 15, 591-600
https://www.scirp.org/journal/ce
ISSN Online: 2151-4771
ISSN Print: 2151-4755

Comparing Effects of Large-Class Teaching and Small-Class Teaching on the Course Objectives of Physics Courses Based on Blended Learning

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How to cite this paper: Wang, X. L., & Gao, H. Y. (2024). Comparing Effects of Large-Class Teaching and Small-Class Teaching on the Course Objectives of Physics Courses Based on Blended Learning. *Creative Education, 15,* 591-600.
https://doi.org/10.4236/ce.2024.154036

Received: February 21, 2024
Accepted: April 20, 2024
Published: April 23, 2024

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Abstract

On the basis of the blended learning mode, a comparative analysis of the formative assessment, summative assessment and degree of course objectives achievement of curriculum evaluation in the large-class and small-class teaching process of college physics in local universities is carried out. Furthermore, it demonstrates that small-class teaching is easier to achieve the transformation of the "student-centred" teaching mode, the effective achievement of the teaching goals of knowledge inquiry and ability building in college physics, and the diversification of teaching evaluation methods. The experiments show that the percentage of students in the small classes (31%) within the 90 to 100 points range is much higher than that in the large classes (18%) in terms of formative assessments. Meanwhile, the proportion of over passing grades (>60) in small classes is 19% higher than in large classes on summative assessments. Finally, the overall achievement degree in small-class teaching has a 5% higher achievement than in large-class teaching.

Keywords

Blended Learning, Large-Class Teaching, College Physics, Course Objectives, Degree of Achievement

1. Introduction

College physics courses are important compulsory basic courses for science and

engineering majors in colleges and universities of China. The basic concepts, basic theories, and basic methods they cover are important parts of the scientific literacy essential for scientific and technological talents. And they are an important foundation for cultivating and improving the ability to analyze and solve problems. College physics can effectively improve students' scientific thinking and preliminary ability to use physical methods to solve the practical problems. It plays a very important role in talent cultivation and cannot be replaced by other courses in terms of cultivating students' knowledge, abilities, and quality (Wang et al., 2016).

When it comes to college courses, the learning mode of them is still an active field for global educational industry and the development of universities. As we know, each college course will present distinct teaching pattern, especially college physics aims to guide students' scientific thinking to overcome difficulties. To reduce students' misconceptions, Kesuma et al. (2020) studied the effect of blended learning model of physics for higher education in a developing country, where the blended learning model adopted online learning and face-to-face learning. Meanwhile, Bazelais & Doleck (2018a) gave a proof of blended learning to create an active learning environment, and they addressed the gap between blended learning and face-to-face learning. Worth to mention, Alsalhi et al. (2021) thought that the blended learning has an impact on the achievement of college physics course, and they made a conclusion that the number and gender of students are important factors. However, there may exist various teaching or learning patterns, and Hrastinski (2019) addressed that the meaning of blended learning should be specifically explained as a scientific term. Obtained from practical university program, Heinze & Procter (2004) found that the transparent communication is important to blended learning according to the experience of a university program. From another sight, Brenya explored the strong connection between educators' perceptions and teaching approaches for higher education in a developing country (Brenya, 2024). Sawaftah & Aljeraiwi (2018) investigated the influential factors of students' perceptions of the blended learning in teaching physics, and they found that the gender is not an influential factor. Amenduni & Ligorio (2022) introduced the difference between online learning and the blended learning, and pointed that there need more combinations among media, methods and learning contexts. Differing from above, Bazelais & Doleck (2018b) considered the missing of comparisons among different instructional approaches, and they found that the blended classroom can activate students' motivations. To further study the effect, Moskal et al. (2013) thought that the institution, faculty and student goals are key factors for a successful blended learning program, and proved the blended learning can make a positive institutional transformation. In order to examine the effectiveness of the blended learning model, Herayanti et al. (2020) developed a collaborative scheme into the blended learning model, and inquiry-based model can improve problem-solving skills effectively. As a special case, Malsakpak & Pourteimour (2024) put the comprehensive study on electronic learning, collaborative learning and lecture-based teaching, and they first paid

concentration to undergraduate nursing students. In term of educational environment in China, Zhi & Thoe (2024) investigated the impact of blended learning in Chinese primary and secondary music education.

In recent years, the "double first-class" construction and newly engineering disciplines construction have put forward more specific and higher standard requirements for talent cultivation, bringing new opportunities and challenges to university physics teaching. At present, local colleges mostly adopt the traditional "teacher-dominated" large class teaching. So, how to evaluate the effect of blended learning model in China is a tough challenge. The problems of large teaching capacity, wide coverage, highly abstract content, and relatively few classroom hours have caused many students to reflect that physics is obscure and difficult to learn, with little harvest and even losing interest in learning (Qin, 2017). Some scholars in China have compared the influence of mathematical learning achievements of college students' mathematical learning achievements on small class teaching and large class teaching (Chen & Niu, 2017; Chen et al., 2020). And some have also studied the practical effects of blended learning models (Sun et al., 2021), reflecting the common problems in teaching such as the need for student learning mode transformation and the difficulties of large class teaching. But, there still lacks the research on college students' physical learning achievements on small-class teaching and large-class teaching.

To investigate the effect of blended learning on college physics in China, this paper takes three classes offering university physics courses at local universities as research samples, and these three classes belong to the same department have comparable student demographics. All three classes employ a blended teaching model (comprising 148 students at class of 2021), with two classes are combined with a total enrollment of 99 students and the other class teaching in a small class with a total enrollment of 49 students. As we know, it's the first attempt to consider the class scale, blended learning and students' learning achievements on college physics teaching. On the basis of blended teaching mode, we plan to explore the following four aspects: first, the teaching mode, methods, and evaluation methods for achievement degree of teaching objectives after the reform of blended learning; The second is to compare and analyze the evaluation results of the achievement degree of teaching objectives in college physics courses before and after the reform; The third is to compare and analyze the evaluation results of the achievement degree of teaching objectives for college physics courses in large and small classes based on a blended learning model; The fourth is to propose specific measures and suggestions related to teaching strategies.

2. Method

To ensure the effectiveness of data analysis on the research samples and further comprehensively improve teaching outcomes, teachers have adopted the same teaching mode, methods, and assessment methods for teaching objectives for both selected large and small classes. Both classes use identical textbooks, teaching aids, and have similar teaching requirements with keeping a consistent

teaching progress. Based on the flipped classroom mode, the teaching mode of both large and small classes develops the blended teaching mode progressively in three stages: "pre-class", "in-class", and "post-class".

The teaching method for both large and small classes mainly contains a simplified form of within-class division called "within-class grouping". A 50-minute class is divided into two parts: the first part involves the teacher's focused lecture. The teacher gives a 30-minutes lecture and the lecture is conducted in a guided and structured manner, explaining the logical structure of learning objectives, the content of the chapters, their connections and relationship with other content, and their position within the entire course. The main focus is on teaching students what to learn, why to learn, and how to learn. The second part involves class discussions, which are carried out in four stages: group discussions, teacher spot checks, free questioning, and teacher summaries. Teachers provide relevant discussion questions or exercises, asking students to discuss and learn from each other collaboratively solving problems around their assignments and addressing their gains, confusions, and difficulties. Subsequently, the teacher checks randomly select groups, and each group selects a student to share the essence of their discussion or present unresolved issues. The teacher then invites the entire class to freely express their thoughts and provides answers to any remaining questions. Finally, the teacher spends a few minutes summarizing the class, and re-explaining the contents easily overlooked, requiring further deepening and improving, and summarize the lesson to conclude the entire process.

The assessment methods for teaching objectives in both large and small classes are the same, primarily consisting of two parts: formative assessment and summative assessment, each accounting for 50%. Formative assessment evaluates from three aspects: learning attitudes (e.g., attendance), self-learning abilities (e.g., in-class exercises, spontaneous responses, homework, unit tests, midterm exams, online self-study, etc.), and other aspects of ideological and political content in the course (e.g., theme discussions, course essays, etc.). Summative assessment primarily evaluates students' grasp of basic knowledge and concepts, computational skills, comprehensive analysis, application abilities, and self-learning capabilities.

3. Results and Discussion

This work presents the four types of assessment results to demonstrate the effect of blended learning in the followings.

1) Comparisons and analysis of formative assessment results

In the formative assessment statistics for large and small classes, the average score for the small classes is 85 points, while for the large classes is 82. The performance of the small classes is significantly better than that of large classes. As shown in **Figure 1**, within the range of 0 - 69 points, the percentage of students in the small classes is lower than that in the large classes. In the 70 to 89 points range, there is not much difference in the proportion of students in different classes. Within the 90 to 100 points range, the percentage of students in the

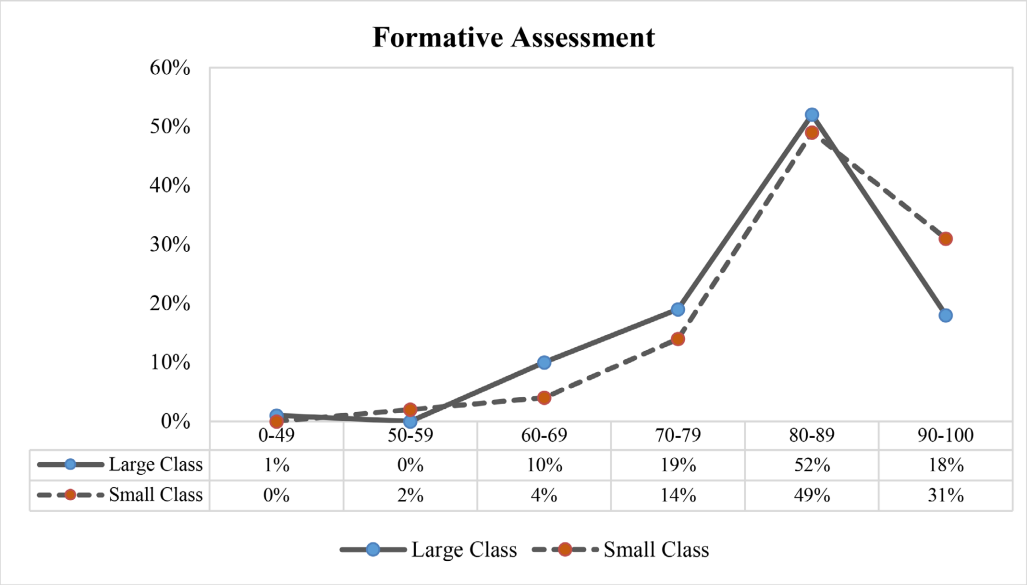

Figure 1. Statistics results of formative assessment of students in large and small classes.

small classes (31%) is much higher than that in the large classes, indicating that the proportion of students with low scores in the small classes is lower than the large classes, while the proportion of students with high scores is higher. This suggests that, compared to the large classes, students in the small class generally perform better, and it contributes more to the improvement of students' learning abilities. The main reasons for this are reflected in the following aspects. First, in small class teaching, teachers can adopt various teaching modes to emphasize more on teacher-student and student-student communication and interaction. In contrast, large class teaching can only achieve interaction and individual student presentations through regular Q&A sessions. Second, teachers have higher expectations for the capability cultivation of students in small classes. They pay more attention to and promptly evaluate students' learning outcomes. Students in small classes need to prepare diligently in advance, think about the questions raised by the teacher before class, and strive to grasp the teaching content to avoid awkward situations during class discussions. On the other hand, in large classes, many students have a roughly preview of the course contents, and some students may not even prepare in advance. After all, students have low participation levels during class.

2) Comparisons and analysis of summative assessment results

Through an analysis of the summative assessment results for large and small classes in Figure 2, it reveals significant differences between both large and small classes. The proportion of failing grades (below 60) in small classes is noticeably lower than that in large classes. Moreover, the proportion of passing grades (60 - 69) and good grades (70 - 89) in small classes is higher than in large classes. Several factors contribute to these differences. Firstly, the level of student engagement in small class teaching is higher than in large classes. The teaching process in small classes emphasizes both teacher-student and student-student interactions.

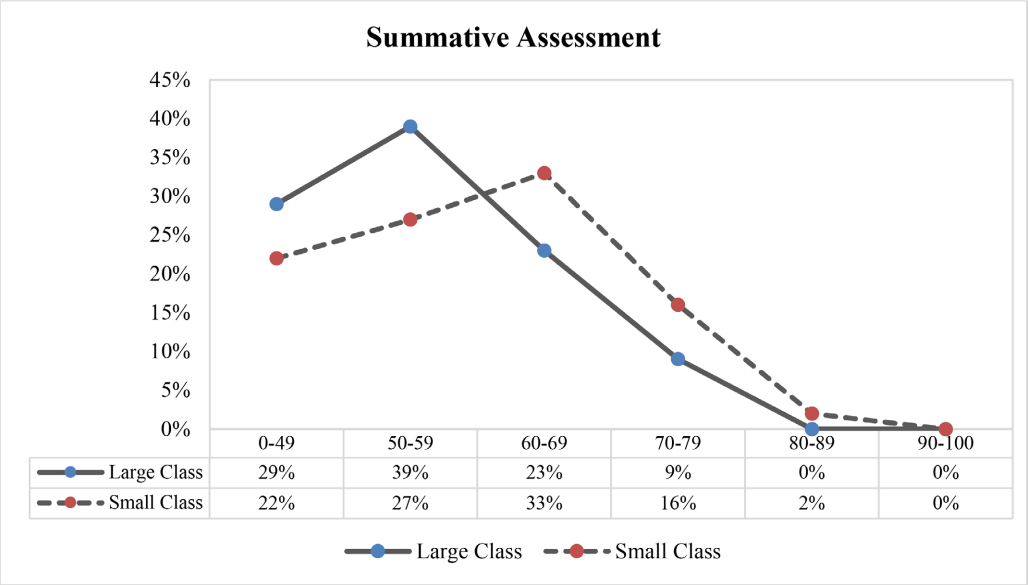

Figure 2. Statistics results of summative assessment of students in large and small classes.

However, large class teaching, due to the large size of the class, relies on regular Q&A sessions for teacher-student interaction and individual student presentations, limiting opportunities for student interaction and thereby reducing their participation in discussions. Secondly, small class teaching effectively stimulates students' subjective initiative. Small class teaching requires students to thoroughly preview before class, actively participate in group activities during class, and focus on expanding and improving after class. In contrast, the large class teaching makes it challenging to ensure the quality of discussions with numerous group members and ensure the assessment of discussions with a high number of groups. Moreover, not every class can adopt interactive methods, leading to a sense of complacency among many students who believe they are not being asked questions in class or less likely to be questioned. Consequently, the frequency of student interactions is limited, diminishing the importance students attach to discussions. Therefore, students in small classes tend to achieve significantly higher final grades compared to their counterparts in large classes.

3) Comparisons of students' total scores

The analysis of the total scores for large and small classes in **Figure 3** reveals that the failure rate among students in the large classes is 27%, significantly higher than that in the small classes. In the range of 60 to 79 points, the percentage of students in both large and small classes is comparable. However, in the 80 - 100 points range, the percentage of students in the small class is 26%, much higher than that in the large classes. This indicates that total scores for small class students are generally superior to those of large class students, contributing more to the improvement of students' learning abilities. The main reasons for this are twofold: firstly, in small class teaching, teachers can comprehensively monitor and adjust classroom instruction in real-time; secondly, small class teaching can effectively improve the information flow between teachers and students, ulti-

mately facilitating the transition from a "teacher-centred" to a "student-centred" teaching approach.

4) Overall analysis of the achievement degree of courses teaching objective

According to the assessment method of achieving course objectives, an overall statistical analysis of the achievement degree of course objectives is conducted for both large and small classes.

The objectives 1, 2, and 3 of both classes have been achieved, but the achievement levels for the three-dimensional objectives in small class teaching are higher than those in large class teaching, as illustrated in Figure 4. For course objective 1,

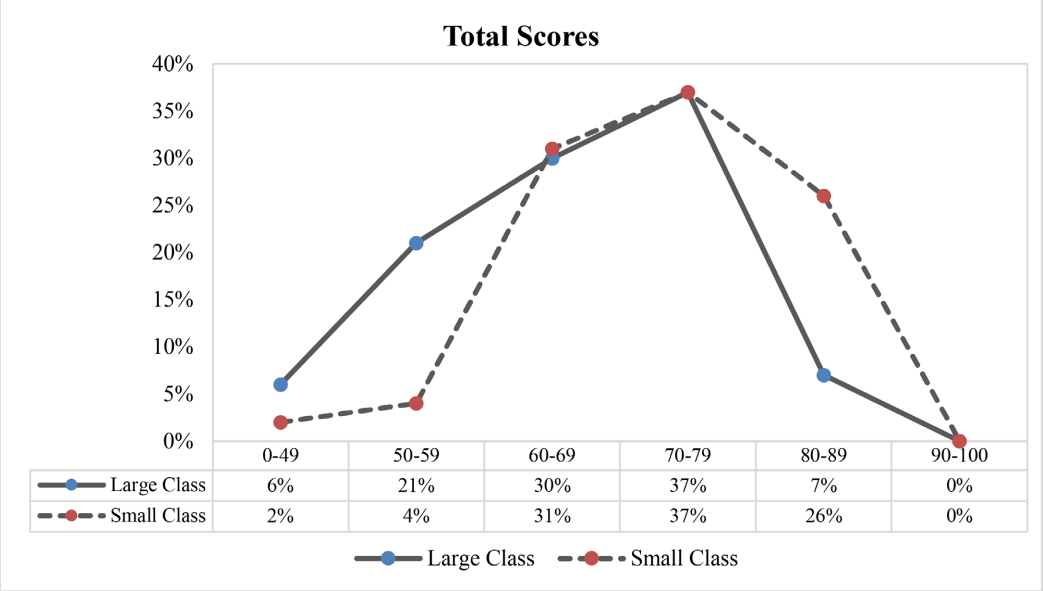

Figure 3. Statistics results of students' total scores for large and small classes.

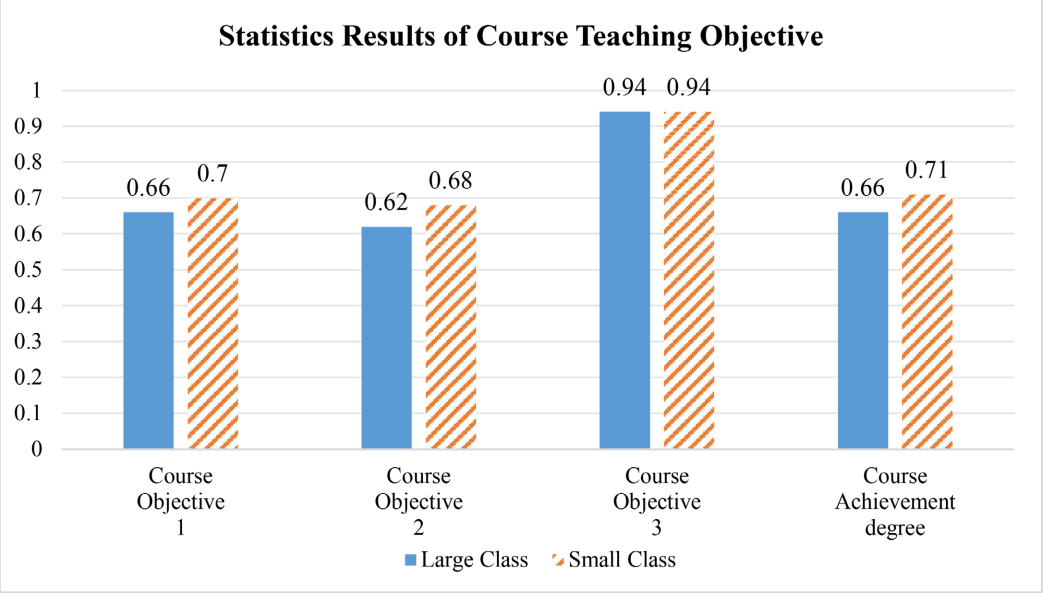

Figure 4. Statistics results on the achievement degree of course teaching objectives for large and small Classes.

i.e. knowledge exploration ability, the achievement degree in small classes is 0.7, while 0.66 in large classes. The higher achievement degree in small classes suggests that the teaching effectiveness in small classes surpasses that in large classes in establishing the basic physical image of material movement and understanding fundamental concepts in classical physics such as particles, rigid bodies, mechanical waves, electromagnetic fields, etc. For objective 2, i.e. ability development, the achievement degree in small classes is 0.68, compared to 0.62 in large classes. This significant difference indicates that small class teaching excels in enhancing students' abilities in scientific computation, logical reasoning, complex problem solving, and independent learning compared to large class teaching. As for objective 3, i.e. values shaping, the teaching effectiveness is comparable between large and small classes. This suggests that in college physics teaching, the fundamental mission of moral education has been effectively implemented, and both have well achieved the ideological and political education goals of the course. The overall achievement degree for the course is 0.71 in small class teaching and 0.66 in large class teaching, with a 5% higher achievement in small classes. This implies that, the teaching effectiveness in small classes is totally superior to that in large classes, regardless of knowledge exploration or ability development, small class teaching has a slight edge.

5) Discussions of results and suggestions

From the teachers' point of view: Firstly, compared to large class teaching, small class teaching is more conducive to enriching course content, facilitating the information transmission and interaction of teaching content, implementing various new teaching concepts and methods, achieving diversified assessment methods, and realizing its expected effects. The same situation can be observed in math course achievements (Chen & Niu, 2017). Secondly, compared to large class teaching, small class teaching is more favorable for demonstrating educational fairness, enabling comprehensive real-time monitoring and adjustment of classroom teaching, and practicing differentiated teaching focusing on individual student differences. Thirdly, small class teaching is beneficial for improving the information flow between teachers and students, forming a positive teacher-student and peer relationships, and facilitating the transition from a "teacher-centred" to a "student-centred" teaching approach.

From the perspective of students: Firstly, compared to large class teaching, small class teaching is more easily to achieve the transformation to a "student-centred" teaching approach, enabling students to change from "passive learning" to "active learning". Although "online-offline" course teaching mode may bring some improvements (Sun et al., 2021), this small class teaching enhances their attention, interest, and overall quality of learning, leading to comprehensive improvements in knowledge, skills, and qualities. Secondly, small class teaching facilitates personalized development for students easily, providing the most suitable education for each student, allowing their individuality to flourish. Thirdly, small class teaching is more conducive to improving students' academic performance, learning abilities, and capabilities for application and innovation, enabling stu-

dents to transform their acquired knowledge from input type to output type.

Given the advantages of both "teaching" and "learning" in small class teaching, it is advisable to actively implement small class teaching when conditions permit. This approach can better embody the teaching philosophy of "student-centred" and achieve better teaching results. In large class teaching, there should be a greater emphasis on improving the information flow between teachers and students, increasing the frequency of monitoring and adjusting students' classroom learning, highlighting the "student-centered" teaching philosophy, and focusing more on students' personalized development and the enhancement of their learning and application capabilities.

4. Conclusion

College physics courses based on blended learning mode are still an active research field due to its cultivating interest of university students' thinking. This paper investigates the effect of blended learning on students' course achievements in small-class learning and large-class learning innovatively. Obtained from several assessments, small-class learning can provide more promising perspective on "student-centered" teaching to improve the quality of college physics teaching. Through the comparable results, we suggest that small-class learning can replace the partial large-class learning in a reasonable way. And, we will pay more concentration on the other factors which may have a significant influence on college course teaching in the future.

Acknowledgements

This project was supported by the Teaching Content and Curriculum System Reform Project of Guizhou Provincial Higher Education (No. 2021294, No. 2021297).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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