The Practice of Information System Analysis and Design Based on Flipped-Classroom Model

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Abstract. This article discusses the necessity and implementation of the Flipped-Classroom Model for Information System Analysis and Design. It addresses challenges of the traditional classroom model, such as educational differences, slow updates, and expanding higher education. The Flipped-Classroom Model combines extracurricular learning and in-class practice, fostering independent learning and critical thinking skills. Results show that the experimental group outperformed the control group in final exam scores and lab grades. The model enhances learning outcomes and develops comprehensive abilities and innovation consciousness. This research highlights the importance of the Flipped-Classroom Model, providing valuable references for educational reforms and cultivating student abilities.

1. Introduction

With the rapid development of information technology and the wide application of information systems in various industries, Information System Analysis and Design has become one of the core courses in computer majors and has gained significant attention and utilization in higher education\(^1\)[2]. Information System Analysis and Design is an emerging foundational discipline that intersects computer science and information systems. Its theoretical and practical applications are of great significance for the comprehensive development and employment enhancement of students. As the demand for professionals in the field of Information System Analysis and Design continues to grow, this poses challenges to educational institutions in terms of how to effectively nurture talent in this area and improve teaching quality\(^3\).

However, during many years of course teaching, some issues have gradually been noticed in the teaching of Information System Analysis and Design courses. Firstly, there are significant differences in students' educational backgrounds and disciplinary foundations. The Information System Analysis and Design major requires students to have a solid foundation in computer science and logical thinking abilities. However, there are significant differences in students' preliminary knowledge, and some students lack relevant theoretical and technical foundations, especially those from humanities backgrounds. Additionally, regional distribution differences among students also result in disparities in learning abilities. Therefore, the traditional uniform classroom teaching model is difficult to meet the learning needs of students with different educational backgrounds.

Secondly, due to the rapid development in the field of Information System Analysis and Design, the update speed of the education system lags behind industry advancements. The continuous innovation in information technology and the evolving industry demand educational institutions to quickly adjust course content and teaching strategies to meet the new industry requirements and trends. However, because the education system’s response rate to industry dynamics is slower than the industry’s development speed, students often lack enthusiasm and application awareness for the learned content in the classroom. This undoubtedly makes it difficult for them to effectively meet industry demands.

Lastly, the expansion of higher education and the challenges in talent cultivation also pose difficulties in teaching Information System Analysis and Design courses. China has a large scale of higher education, but there is a relative shortage of teaching resources in geographical specialties. This limited attention received by students in the classroom prevents them from receiving personalized teaching guidance. In addition, in the traditional classroom model, students lack autonomy and opportunities for active learning, resulting in a lack of depth in course learning and practical application abilities\(^4\).

Therefore, to address the aforementioned issues, this study plans to explore and apply the Flipped-Classroom Model in the Information System Analysis and Design courses. This teaching model emphasizes students' active learning and active participation. Through a combination of pre-class readings, in-class discussions, and post-class practices, the model aims to cultivate students' critical thinking, problem-solving abilities, and practical skills. The main objective of this study is to evaluate the actual...
2. The Concept of Flipped-Classroom.

The concept of the Flipped-Classroom has been widely applied in the practice of Information System Analysis and Design courses. This concept originated from Jonathan Bergmann and Aaron Sams, chemistry teachers in Woodland Park High School, Colorado, USA, who first proposed it in 2007. They recorded classroom lectures as videos and encouraged students to learn independently at home, which was warmly welcomed by students\(^5\).

The fundamental idea of the Flipped-Classroom is to "deliver knowledge outside of class and internalize knowledge in class." Students autonomously learn basic knowledge through activities like watching micro-videos, effectively accumulating new knowledge\(^6\). When they return to the classroom, the teacher guides students in collaborative inquiry activities and answers their questions face-to-face to promote a deeper understanding of the subject\(^7\)^\(^8\)^\(^9\). Compared to traditional teaching methods, the Flipped-Classroom has the following advantages:

1. Guiding student autonomy in learning: In the flipped classroom, students have the freedom to control the time, location, pace, and frequency of learning videos based on their own learning conditions and preferences. This allows for meeting the learning needs of students from different backgrounds, improving learning outcomes, and nurturing students' self-directed learning abilities\(^10\).

2. Enhancing interaction between teachers and students: In a traditional classroom setting, students often passively receive knowledge. As they are just introduced to new information, they may not engage in deep thinking, resulting in limited interaction between teachers and students. However, the Flipped-Classroom changes the roles of teachers and students. Students first study on their own outside of class, grasp the foundational knowledge, and then participate in classroom activities together with the teacher. Through communication and interaction, the teacher helps students internalize the knowledge\(^11\).

3. Making full use of online resources: In the context of current knowledge-sharing, the Flipped-Classroom allows teachers to utilize various teaching resources available on the internet and integrate them into resources suitable for students in their specific field. By providing learning materials such as micro-videos, teachers can focus more on designing and organizing classroom activities, paying attention to the absorption and internalization of knowledge by students, thus enhancing the depth of learning\(^12\)^\(^\text{[13]}\).

In conclusion, the concept of the Flipped-Classroom holds significant importance in the practice of Information System Analysis courses. It provides students with a higher quality learning experience and outcome through guiding student autonomy, enhancing interaction between teachers and students, and making full use of online resources. In future teaching practices, there are plans to further deepen the application of the Flipped-Classroom, continuously optimize course design, cultivate students' practical skills and innovative thinking, and contribute to the professional development of Information System Analysis field\(^14\).

3. The practice of Flipped-Classroom Model in ISAD course.

The Information System Analysis and Design course holds a significant position in the field of computer science, with its main objective being to enhance students' practical skills in information system analysis and design. This course covers key topics such as spatial data fundamentals, input and processing, spatial analysis, and spatial data visualization. To optimize students' learning experience and improve their practical skills, this research adopts the Flipped-Classroom instructional model, which delves into the course content through the following four phases\(^15\).

3.1. Instructional Preparation Phase.

During the instructional preparation phase, teachers need to develop corresponding instructional designs, organize learning resources and materials, and create the necessary environment for implementing the course. The tasks involved in instructional preparation include:

1. Designing instructional guidelines that clearly define the teaching objectives, task requirements, and content arrangement.

2. Enhancing learning resources, including courseware, e-books, case studies, and online materials.

3. Setting up the experimental environment and software tools to ensure that students can smoothly carry out practical operations.

3.2. Information Transmission Phase.

The information transmission phase primarily occurs outside of the classroom setting, where students engage in self-directed learning and knowledge acquisition to prepare for discussions and practical activities in the classroom. The tasks involved in the information transmission phase include:

1. Students autonomously select learning materials, which may include video presentations, online resources, and other study materials.

2. Students acquire necessary project background, theoretical knowledge, and methodologies through activities such as watching videos, reading literature, and participating in online discussions.

3. Students engage in self-assessment and practice to reinforce and assess their preliminary grasp and understanding of the knowledge.
3.3. Application Digestion Phase

The application digestion phase primarily takes place in the classroom, where students apply their acquired knowledge to practical scenarios through project-based activities and discussions. They engage in in-depth analysis and application of the knowledge. The tasks involved in the application digestion phase include:

1. Students individually or in groups complete practical projects in information system analysis and design, applying their learned knowledge to solve relevant problems.
2. Students participate in classroom discussions and group projects, collaborating with peers to solve real-world issues, share knowledge, and exchange experiences.
3. Teachers provide guidance and feedback, guiding students to deepen their understanding and analysis of the practical process, enhancing the application and digestion of their learning.

3.4. Comprehensive Evaluation Phase

The comprehensive evaluation phase evaluates and provides feedback on students’ learning and practical abilities, thereby promoting the improvement of their learning outcomes. The tasks involved in the comprehensive evaluation phase include:

1. Students submit individual reports or group project summaries, describing the practical process, results, and reflections.
2. Teachers assess and provide feedback, offering guidance and suggestions based on students' learning performance and practical abilities.
3. Students participate in peer evaluation and course feedback, summarizing and evaluating the Flipped-Classroom teaching method, and providing suggestions for improvement and enhancement.

3.5. Teaching effect

Through the well-designed four stage tasks, the Flipped-Classroom teaching mode can effectively promote the cultivation of students’ learning and practical ability in the experimental course of information system analysis and design. Students obtain the required resources in the teaching preparation stage, carry out autonomous learning in the information transmission stage, carry out practical projects and discussions in the application digestion stage, and receive feedback and guidance in the comprehensive evaluation stage, to obtain more in-depth learning experience and ability improvement in the course. At the same time, teachers’ guidance and feedback will help students’ comprehensive ability development and continuously improve the teaching effect of the course[16][17].

4. Effectiveness of Flipped-Classroom Implementation in Information Systems Analysis and Design

In a certain semester, a pilot study on instructional reform was conducted. Two classes in the same major were selected for a comparative experiment, with consistent basic characteristics such as class size, gender ratio, and student background. One class followed the traditional lecture-based approach, referred to as the control class, while the other class implemented the Flipped-Classroom Model, referred to as the experimental class. After a semester of traditional instruction and Flipped-Classroom experimentation, the final exam scores of both classes were subjected to statistical analysis.

According to the statistical data, the experimental class achieved significantly higher average scores compared to the control class. Specifically, in the tests on the fundamentals of Information Systems Analysis and Design, the control class obtained an average score of 76.89, while the experimental class achieved a significantly higher average score of 79.30, surpassing the control class by 2.41 points. Additionally, in the practical lab tests on Information Systems Analysis and Design, the control class achieved an average score of 86.48, whereas the experimental class achieved a notably higher average score of 88.97, exceeding the control class by 2.49 points. A detailed comparison of the distribution of students in different score ranges was conducted to provide a more intuitive comparison between the two classes. Please refer to Table 1 for further details.

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Theoretical test</th>
<th>Practical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>60-69</td>
<td>14.4%</td>
<td>9.9%</td>
</tr>
<tr>
<td>70-79</td>
<td>20.2%</td>
<td>14.1%</td>
</tr>
<tr>
<td>80-89</td>
<td>50.8%</td>
<td>51.0%</td>
</tr>
<tr>
<td>90-99</td>
<td>14.9%</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

From the data in the table, it can be observed that in each score range, the experimental class has a higher proportion of students compared to the control class. In the high score range (≥90), the experimental class has 10.1% more students than the control class (in the theoretical test) and 12.9% more students (in the practical test). Similarly, in the excellent score range (≥80), the experimental class has 10.3% more students than the control class (in the theoretical test) and 6.2% more students (in the practical test). These data demonstrate that the students in the experimental class have a better grasp of knowledge depth compared to the
students in the control class, and high-performing students are able to improve their grades to higher score ranges through the Flipped-Classroom learning approach. However, it is worth noting that in the low score range (≤69), the experimental class has 4.5% fewer students than the control class (in the theoretical test) and 1.9% fewer students (in the practical test). This indicates that even under the Flipped-Classroom Model, students in the lower score range can still benefit from it.

After analyzing the assignments submitted by students and the final Information Systems Analysis and Design reports, it was found that students in the experimental class demonstrated a stronger sense of innovation when designing project proposals. They have a deeper understanding of the entire field of information systems and are able to analyze and evaluate various industry companies in a more objective and comprehensive manner, showcasing their abilities in critical thinking and comprehensive analysis.

Significant achievements have been made in the Information Systems Analysis and Design experimental course following the implementation of the Flipped-Classroom instructional reform. Students, through active participation in the Flipped-Classroom Model, have not only outperformed the traditional lecture-based approach in grades but have also made significant progress in the development of comprehensive abilities and innovation awareness. These achievements fully demonstrate the effectiveness and importance of the Flipped-Classroom Model in enhancing the teaching quality of the Information Systems Analysis experiment course.

5. Conclusion

The implementation of Flipped-Classroom in the Information Systems Analysis experiment course has yielded encouraging results. This innovative teaching approach has completely transformed traditional instructional methods, effectively stimulating students' motivation and engagement, thereby enhancing their learning outcomes and comprehensive abilities.

Firstly, the Flipped-Classroom Model empowers students to take control of their learning. This approach encourages students to engage in independent learning outside of the classroom, providing them with more time to delve deeper into and digest course content. They can personalize their learning based on their own progress and level of ability, further exploring and deepening their understanding of areas that interest them, thus improving learning autonomy and flexibility.

Secondly, the Flipped-Classroom Model promotes collaboration and interaction among students. In the classroom, students can engage in discussions, problem-solving, and sharing experiences based on their independent pre-class learning. This collaborative learning environment fosters teamwork and communication skills, enhancing their learning outcomes and achievements.

Furthermore, the Flipped-Classroom Model encourages active involvement in practical projects and application activities. In this teaching model, students have the opportunity to apply their knowledge to real-world problem-solving, thereby enhancing their practical skills and innovative thinking. Simultaneously, guidance and feedback from teachers help students gain a deeper understanding and application of the learned content, strengthening their practical skills and overall competence.

In summary, the Flipped-Classroom Model implemented in the Information Systems Analysis experiment course has significantly improved students' learning outcomes and comprehensive abilities. This teaching approach provides students with more opportunities for independent learning, promotes collaboration and interaction, and encourages active involvement in practical projects. However, it is important to recognize that the Flipped-Classroom is not applicable to all courses and student populations, requiring reasonable selection and adjustments based on specific circumstances.

In future curriculum reforms, strategies for implementing the Flipped-Classroom will be further optimized, and the design of course content and practical projects will be deepened. Monitoring and feedback on students' learning processes will be strengthened, aiming to continuously enhance learning outcomes and skill development. Additionally, further research will be conducted to explore the applicability and effectiveness of the Flipped-Classroom Model in different subject areas, making more contributions to the innovation and development of education and teaching.

References


12. Xi Chen, Peiyin Deng. Design of teaching mode based on information technology [J]. Electronic Technology, 2023, 52 (06): 112-113


