Flipped Classroom Instructional Model and Its Empirical Study in Information Literacy Education: Postprint

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Abstract

[Purpose/Significance] Addressing the current research status of flipped classroom, this study constructs a flipped classroom teaching model based on instructional objective classification theory, verifies the credibility of the model through empirical research, and summarizes successful teaching experiences to provide reference for peers.

[Method/Process] Taking the course "Medical Literature Management and Information Analysis" as an example, the teaching model is validated, and the implementation key points at each stage are elaborated and summarized from both teacher and student perspectives.

[Results/Conclusion] The study finds that the flipped classroom yields significant teaching effects, with the main factors for successful teaching including support from instructional theory, learner-centered instructional design, carefully prepared micro-lecture resources, application of educational technology, and a fully functional teaching platform.

Full Text

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Abstract

[Purpose/Significance] In response to the current state of flipped classroom research, this study constructs a flipped classroom teaching model based on

instructional objective classification theory. Through empirical research, the model's credibility is verified and successful teaching experiences are summarized to provide reference for peers in the field. [**Method/Process**] Taking the course "Medical Literature Management and Information Analysis" as an example, the teaching model is validated and the implementation points of each stage are elaborated and summarized from both teacher and student perspectives. [**Result/Conclusion**] The research finds that the flipped classroom approach yields significant teaching effects. The main factors contributing to successful implementation include support from teaching theory, learner-centered instructional design, carefully prepared micro-lesson resources, application of educational technology, and a fully functional teaching platform.

Keywords: flipped classroom; teaching model; information literacy education

Introduction

With the development of information technology and the open educational resources movement, the flipped classroom has become a hot topic in education. The emergence of MOOC video resources such as Khan Academy, Coursera, Udacity, and edX has provided resource support for flipped classrooms. The flipped classroom approach involves students engaging in autonomous learning through instructional videos before class, then participating in collaborative learning under teacher guidance during class to achieve knowledge internalization and expansion [1].

International research has primarily focused on the theoretical foundations of flipped classrooms, factors affecting teaching effectiveness, and instructional design and implementation strategies. In 2013, the Center for Digital Education conducted a national survey of university teachers in the United States, revealing that many had begun adopting flipped classroom methods with positive results [2]. The flipped classroom was introduced to China in 2011, and research has since concentrated on overviews, models, implementation, conditions, applications, and prospects. In 2015, Miao Jingmin and Wang Qiong surveyed 165 teachers practicing flipped classrooms, with most reporting positive impacts on "enhancing student interest and initiative," "promoting mastery of knowledge and skills," and "improving student confidence" [2].

With the development of information technology, information literacy MOOC courses have emerged, such as "How to Use Twitter" and "Information Literacy" offered by Wake Forest University in the United States [3], as well as "Literature Management and Information Analysis" by the University of Science and Technology of China, "Information Retrieval" by Wuhan University, and "Essential Course for Digital Survival" by Sun Yat-sen University in China [4]. Information literacy teachers have conducted related research on flipped classrooms with certain achievements. For example, Jiang Lili and Chen Youhua proposed a theoretical framework for information literacy flipped classroom design based on process elements, explaining each 环节 from the instructor's perspective and

validating it through specific course practice [5]. Zhang Jie, Wang Ying, and Yang Xinye designed a flipped classroom teaching model suitable for information literacy education based on the current status of library user education, and implemented it in library orientation education with certain effects [6]. Long Xi conducted a comparative empirical study on flipped classroom teaching models based on constructivist learning theory, concluding that flipped classrooms can improve student achievement and learning interest [7]. Chen Xiaohong, Gao Fan, and He Xuemei integrated the conceptual advantages of MOOCs and flipped classrooms to construct a diversified information literacy teaching model, demonstrating through practice that this model significantly cultivates students' abilities in information acquisition, independent thinking, and knowledge innovation [8]. Liu Xiang and Qi Haijing conducted instructional design for literature retrieval courses guided by flipped classroom concepts, using "CNKI" as a specific case study for practical validation, concluding that it effectively improved learning efficiency [9]. Zhang Jinlei identified that constructing learning environments, designing instructional videos, and classroom activities are key factors in flipped classroom teaching models. Based on constructivist learning theory, he constructed a teaching model (see Figure 1 [Figure 1: see original paper]) consisting primarily of pre-class and in-class components, where information technology support and smooth learning activities ensure the construction of a personalized collaborative learning environment [10].

In summary, the flipped classroom approach indeed enhances student learning interest, cultivates comprehensive abilities, and improves learning efficiency. However, existing flipped classroom teaching models for information literacy education still have several shortcomings: insufficient theoretical support, with few models combining the educational theories underlying flipped classrooms; lack of holistic design thinking, with few designs addressing both teacher and student perspectives; and few teaching models covering the complete process including pre-class, in-class, and post-class stages. This study draws on Bloom's Taxonomy of Educational Objectives in the cognitive domain, combined with learning pyramid theory, ARCS motivation theory, and peer instruction theory, to construct a complete pre-class, in-class, and post-class teaching model from both teacher and student perspectives. Using an information literacy education course as an example, this study explains the implementation points of each stage across both dimensions, verifies the model's credibility, and analyzes the factors contributing to the success of this course experiment, aiming to provide reference for related teaching reforms and research.

3. Flipped Classroom Teaching Model

Instructional design is a systematic activity that, under the guidance of teaching theory, establishes teaching objectives, prepares teaching content, designs teaching activities, and constructs teaching environments to support specific learners in achieving teaching objectives [1]. Flipped classroom instructional design emphasizes holistic thinking, requiring teachers to consider not only in-class content

design but also students' thought processes and learning theories as autonomous learners. This study argues that effective flipped classroom implementation requires advanced educational concepts, micro-video-based teaching resources, interactive teaching platforms, and learner-centered instructional design. Among these elements, practically instructive instructional design is crucial, as it guides learners' autonomous inquiry learning before class and knowledge internalization during class. This study combines Benjamin Bloom's Taxonomy of Educational Objectives in the cognitive domain to construct a flipped classroom teaching model as shown in Figure 2 [Figure 2: see original paper].

3.1 Pre-class Teaching Preparation Teaching preparation primarily includes the design of teaching objectives, content, environment, and classroom activities, which ensures smooth course implementation. In terms of teaching objective design, based on Bloom's Taxonomy, objectives are categorized into remembering, understanding, applying, analyzing, evaluating, and creating. In traditional teaching, the less challenging "remembering" and "understanding" stages typically occur in class with substantial teacher assistance, while the more challenging "applying," "analyzing," and "evaluating" stages are completed after class with minimal teacher support. In flipped classrooms, teachers create micro-videos for the less challenging "remembering" and "understanding" content for students to complete through autonomous learning before class, enabling online communication with teachers and peers. The more challenging components are then addressed in class with greater teacher and peer assistance [11] (see Figure 3 [Figure 3: see original paper]). In this information literacy course study, content aimed at comprehension and memorization—such as literature management tools, mind mapping, and database introductions—was completed before class, while class time focused on homework completion, seminars, collaborative exchanges, and presentations under teacher guidance.

3.1.1 Establishing Teaching Objectives. Teaching objectives define the standards and tasks expected from teaching activities. In flipped classrooms, teaching objectives should follow the learner-centered philosophy of "determining teaching based on learning," where learning objectives determine teaching objectives [12]. Objectives should closely align with the "Framework for Information Literacy for Higher Education" issued by the Association of College and Research Libraries (ACRL) in 2015, emphasizing research and design on diverse information resources, information value assessment, information dissemination, and information analysis [13]. Specifically, this involves cultivating students' information ethics, information acquisition ability, information management ability, information analysis ability, and collaborative sharing ability to enhance their problem-solving capabilities. For graduate students, the focus should also include cultivating scientific foresight, academic ability, and academic ethics standards.

3.1.2 Preparing Teaching Content. The course content covers familiarization with retrieval methods for various domestic and international databases,

tracking the latest research information, mastering literature management tools, learning to use various information analysis tools to quickly locate core literature, applying mind mapping and cloud tools for academic sharing and collaboration, and following academic standards in academic writing. Teaching content arrangement must break away from the long-standing practice of focusing database-centered literature retrieval courses and instead center on competency cultivation. To verify the necessity of teaching content and understand students' information literacy status, this study designed a questionnaire to assess students' information literacy from perspectives including their understanding of flipped classrooms, information awareness, information knowledge, and information ethics. Survey results showed that 40% of students had never received training in literature retrieval courses, and 79% reported no understanding of MOOCs or flipped classrooms. Based on these results, "course introduction" content was added in the first class to help students understand and accept the new teaching method. Some survey results were also surprising: 88% of students chose "heard of but never used" when asked about familiarity with research software such as Xmind, EndNote, and HistCite; and 53% selected "according to my own habits, depending on the situation, or no citation" when asked about reference formatting in papers. These results indicated that students were unfamiliar with literature management and analysis software, had no different understanding of information sources compared to undergraduates, and lacked awareness of academic standards, particularly regarding reference formatting.

3.1.3 Designing Teaching Activities. Teaching activities are designed to enable more effective student learning. According to the Learning Pyramid theory [14], learning methods with retention rates below 30% are individual or passive learning with low student participation, while those above 50% involve team or active learning. "Teaching others" yields the best results, achieving 90% retention (see Figure 4 [Figure 4: see original paper]). In this course's activity design, students collaboratively completed assignments through group discussions. During this process, students engaged in 充分的 group discussions and practice. In the presentation 环节, students not only applied learned knowledge but also demonstrated clear logical thinking and expression abilities.

3.1.4 Constructing the Learning Environment. The learning environment must support autonomous learning, team learning, research, presentation, and assessment. Flipped classrooms require both autonomous and classroom learning environments. The autonomous learning environment depends on an information technology platform that includes modules for content uploading, teacher-student communication, online testing and evaluation, student information management, assignment distribution and collection, discussion forums, student work presentation, and notification distribution. Before class, students complete pre-class learning tasks according to their own pace through the online platform and communicate with classmates and teachers online. The classroom learning environment requires reconfiguring traditional classrooms to create a harmonious, equal, and collaborative atmosphere suitable for group work.

In this course, the autonomous learning environment was built using the university's MOOC teaching platform, which is fully functional and directly integrated with the academic management system. Additionally, some open learning platforms are very useful for flipped classroom teaching. For example, China's University MOOC platform includes all functions of a virtual learning environment, including announcements, grading standards, courseware, quizzes and assignments, exams, and discussion areas. The classroom learning environment was constructed through an information commons space equipped with combined computer desks, computers installed with various research software, a presentation stage suitable for reporting and scoring, and related projection and audio equipment.

3.2 Pre-class Knowledge Learning Stage According to John Keller's ARCS motivation model from the University of Florida, an effective pre-class task sheet should include four elements: Attention, Relevance, Confidence, and Satisfaction [16]. In this course study, pre-class task sheets were designed based on the ARCS model. For example, the third class's pre-class task was "Use mind mapping learned in the second class to present the information scope, retrieval methods, result presentation formats, and features of 3-5 Chinese and foreign databases." The "Attention" element was captured by using the newly learned "mind mapping" technique. "Relevance" connected to students' existing knowledge. "Confidence" was built by ensuring the assignment was not overly difficult and could be easily completed after watching the video resources. "Satisfaction" came from thoroughly understanding the learned knowledge through mind mapping organization.

3.2.1 Preparation of Micro-lesson Resources. In this course study, micro-lesson resources (including micro-videos and online tests) primarily utilized MOOC resources. After comparative analysis, Luo Zhaofeng's course "Literature Management and Information Analysis" was selected for its clear teaching objectives, reasonable structure, exquisite video production, and good user experience. Due to limited class hours, selected content from this course was used as flipped classroom teaching resources based on this course's teaching objectives, including "Mind Mapping and Its Application in Research," "Search Engines and Online Learning," "Chinese Literature Databases," and "Foreign Literature Databases."

3.2.2 Design of Pre-class Task Sheets. Completing pre-class tasks not only improves learning efficiency but also reveals learning deficiencies, providing important early feedback for subsequent classroom teaching. Jiao Jianli points out that pre-class learning tasks should be closely integrated with micro-lessons, detectable and evaluable (to facilitate teachers' timely grasp of student status), serve classroom teaching, and meet learners' individualized development needs [15]. The biggest difference between pre-class tasks and traditional preview lies in their guidance. Traditional preview is task-free, and teachers still deliver new knowledge according to their own logic in class. In flipped classrooms, students

learn new knowledge from videos with specific tasks, and teachers understand existing problems through submitted assignments. Class time is no longer used for delivering new knowledge but for concentrated problem feedback.

Under teacher guidance, students independently watch micro-videos to complete pre-class task sheets. Teachers need to prepare micro-video resources, test questions, design learning task sheets, supervise online learning, communicate with students through the platform, and answer questions promptly.

3.3 In-class Knowledge Internalization Stage In flipped classrooms, class time is primarily used for knowledge internalization and ability expansion. According to Bloom's Taxonomy, in-class instructional design should focus on achieving knowledge application, analysis, evaluation, and creation through classroom activities. During this stage, students complete knowledge internalization through exercises, group projects, and interactive exchanges under teacher guidance.

Teachers need to provide feedback on problems identified in pre-class assignments and promptly address common issues. Instructional methods should emphasize cultivating students' independent thinking and collaborative learning abilities. Problem-centered teaching and peer instruction are commonly used methods in flipped classrooms. Existing research shows that peer instruction promotes learners' conceptual understanding, facilitates long-term knowledge retention, improves student satisfaction with classes and creates deeper impressions, and enhances student participation [17].

This study uses "information resource acquisition" as an example to illustrate the teaching process. The third class's activity flow consists of problem feedback, supplementary teaching, collaborative learning, just-in-time teaching, and assignment summarization. Problem feedback is based on pre-class task sheet completion. Supplementary teaching addresses issues in MOOC resources and common problems in pre-class assignments, such as updated database retrieval interfaces and incomplete mastery of PubMed database analysis functions. Collaborative learning primarily trains students in scientific methods through project-based research. First, students are grouped into teams of 6-8 with designated leaders. Second, groups determine research topics based on majors or interests (which could come from supervisors' research directions, academic conferences, or clinical cases). Third, after thorough discussion, the leader assigns tasks to each member, who complete them independently. Fourth, the group collectively organizes and completes a retrieval assignment report. Finally, group results are presented in PPT format. During collaborative learning, teachers serve as facilitators and scaffolds, providing individual guidance based on each group's situation. In this study, it was found that groups could not quickly identify research hotspots in topics using analysis tools. In response, the teacher conducted 15 minutes of just-in-time teaching, focusing on techniques for using search engines and databases to analyze popular topics.

3.4 In-class Knowledge Expansion Stage In this stage, the teacher's role is no longer an authority but a classroom facilitator. Teachers need to establish group scoring criteria, determine evaluators, and identify content for classroom commentary. Students primarily engage in achievement presentation and exchange, self-evaluation, intra-group evaluation, and inter-group evaluation activities. In this study, group evaluations included dimensions such as presenter performance, PPT production, retrieval topics, topic analysis, retrieval tools, retrieval steps, key information sources, retrieval results, teamwork, and topic summary. The scoring weight was distributed as: self-assessment 10%, peer group assessment 40%, and teacher assessment 50%. To motivate group leaders, leaders received 5% higher scores than members, while all members received the same score.

3.5 Post-class Knowledge Consolidation Stage At this stage, students need to complete online tests, questionnaires, summary reflections, and submit comprehensive reports. In this project, students were required to independently complete a comprehensive report after the course, including topic introduction, literature retrieval process, material reading, material summary, thesis outline drafting, establishment of a topic-related database, supervisor comments, and summary reflection. The comprehensive report was evaluated across multiple dimensions including topic selection, retrieval, analysis, and management.

Teachers need to complete feedback provision, lesson plan reflection, and evaluation activities. First, teachers should collect student feedback on the course through multiple online and offline channels. Second, lesson plans should be reflected upon and adjusted based on student pre-class feedback, group work, achievement exchanges, and comprehensive reports. Finally, a diversified evaluation system should be established. In this project, students' final evaluation included pre-class online tests (30%), online discussions and classroom performance (5%), in-class exercises (35%), and comprehensive reports (30%) (see Table 1), with evaluation 贯穿 the entire pre-class, in-class, and post-class process.

To understand teaching effectiveness, this study conducted a survey across three dimensions: teaching effectiveness, learning attitude, and teaching methods, with 20 items total. Results showed that 93% of students mastered basic methods for Chinese literature retrieval, 82% mastered basic methods for foreign literature retrieval, and 90% mastered commonly used research software such as mind mapping tools, EndNote, and RSS, basically achieving teaching objectives with good results. Regarding teaching methods, 99% of students believed group learning could improve learning effectiveness and team cohesion, 92% believed flipped classrooms could improve teaching effectiveness, 70% were willing to choose flipped classroom teaching methods, and 90% expressed high satisfaction with the course. However, survey results also revealed some problems: 49% of students believed the biggest problem in peer collaborative learning was that "team members' contributions were not reflected in grades," 47% believed it was

"unclear division of labor and responsibilities among team members," and some students complained about heavy workload with different tasks at each stage.

4. Conclusions and Implications

The 2013 Flipped Classroom White Paper identified four key elements affecting flipped classroom effectiveness: flexible learning environments, transformed learning culture, carefully planned teaching content, and professional teachers. Through practice in information literacy teaching, this study demonstrates that the teaching model in Figure 2 [Figure 2: see original paper] is feasible and can improve teaching effectiveness to achieve expected objectives. The main implications for peer reference are as follows.

4.1 Teaching Theory Support Flipped classrooms are built upon theories such as mastery learning, constructivism, cognitive load, and effective teaching. Their instructional design is based on self-directed learning theory, Bloom's Taxonomy, the ARCS motivation model, and the Learning Pyramid theory. Without support from these educational theories, systematic instructional design would be difficult, like water without a source or a tree without roots. Although the author has taught literature retrieval courses for many years, she lacked formal teacher education and systematic training in educational theory and instructional design. To compensate, she obtained certificates for "Flipped Classroom Teaching Methods" and "Instructional Design Principles and Methods" through self-study on China's University MOOC platform, which also offers other pedagogy courses such as "Pedagogy" and "Toward Deep Cooperative Learning." Continuous learning through MOOCs not only compensates for deficiencies in foundational educational theory knowledge and quickly grasps relevant research trends but also provides expert guidance and peer support. The empirical research on the teaching model in this study was implemented following the five-step method from the "Flipped Classroom Teaching Methods" course.

4.2 Learner-centered Instructional Design This study's teaching model was constructed under the guidance of Bloom's Taxonomy, dividing teaching objectives into four sub-objectives: memory and understanding, application and analysis, comprehensive evaluation, and summary improvement, with carefully planned teaching content 围绕 these sub-objectives. The classroom teaching process is divided into pre-class (teaching preparation), pre-class (knowledge learning), in-class (knowledge internalization), in-class (knowledge expansion), and post-class (knowledge consolidation) stages. To enable learners to successfully complete tasks at different stages, the teacher's role continuously changes from designer in the teaching preparation stage, to learning resource provider, pre-class assignment feedback provider, classroom facilitator, diversified evaluation designer, and learning scaffold. Teachers are no longer authoritative classroom figures but facilitators and assistants to student learning.

4.3 Carefully Prepared Micro-lesson Resources Micro-lessons are online teaching videos aimed at explaining specific knowledge points for learning or teaching purposes. Instructional videos should be concise, clear, comprehensive, focused, and highly engaging. Video production is a complex process involving segmentation, script writing, filming, post-production, and platform publishing. Through practice in creating micro-videos in MOOC courses, the author believes that micro-lesson video production requires teamwork, and independent production presents certain difficulties. Therefore, this course selected high-quality MOOC resources as pre-class teaching materials. Selection of MOOC resources depends on accumulated experience. The author is very familiar with the teaching plans, grading standards, courseware resources, quizzes and assignments, and teaching platforms of "Literature Management and Information Analysis" and "Information Retrieval" courses on China's University MOOC platform. After comparison, the former was deemed more aligned with this empirical study's teaching objectives. Having followed and studied this course multiple times, the author had thorough knowledge of its structure, strengths, and weaknesses, enabling informed decisions about which content required supplementary lecturing, which could be learned independently before class, and which was suitable for collaborative learning. The selected MOOC resources also had issues: lack of introduction to the PubMed database essential for medical majors, no separate demonstration of database analysis functions, outdated retrieval interfaces, and absence of academic standards content. These issues were addressed as priorities in face-to-face teaching during course design. When selecting MOOC resources, alignment with teaching objectives should be considered alongside reasonable knowledge point segmentation, video production quality, platform interface friendliness, and video playback smoothness.

4.4 Application of Educational Technology The flipped classroom model involves instructional video production, course resource distribution, student assignment submission, problem feedback and exchange, and grade management—all inseparable from modern educational technology application. The author has experience filming micro-videos for freshman library orientation education, using screen recording software to produce micro-videos on specific knowledge points, and using LibGuides to create online teaching platforms for literature retrieval courses. This experience with course website construction and teaching tools facilitated the smooth progress of this study. Flipped classroom application in information literacy education is a beneficial attempt, though challenges inevitably arise, particularly in instructional design, which requires teachers to invest more effort in continuously improving pre-class, in-class, and post-class teaching activities. However, the teaching effects are evident, with good student acceptance and outstanding classroom performance. This study is a single-group experiment and exploratory teaching practice research, hoping to provide reference for related teaching reforms.

4.5 Fully Functional Teaching Platform The teaching platform should preferably be the university's own MOOC platform for convenience in learning, management, and grade entry. In this study, since selected resources came from "China University MOOC," the author could not operate its backend to supervise students' pre-class learning and testing. The MOOC resources were embedded into the university's platform as web links, with discussion questions and pre-class task sheets published on the platform. Student pre-class learning was supervised through discussion participation and task sheet submission. In addition to platform-provided interactive software, social software such as QQ and WeChat were also used for communication.

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Note: Figure translations are in progress. See original paper for figures.