Embedded Disciplinary Teaching Service Based on Precise Integration of Teaching Resources—A Case Study of the "Mechanisms of Cell Senescence" Micro-lecture Postprint

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Abstract

[Purpose/Significance] The American Center for Teaching Quality and the "2030 Teacher Solutions" group predict that teaching will evolve into a hybrid profession, wherein team members perform specialized roles to deliver customized and meaningful learning solutions for students. Subject librarians should actively explore opportunities to become integral members of these teaching teams. This study proposes an embedded subject service model grounded in library resource organization, drawing upon the professional knowledge and skills of subject librarians.

[Method/Process] Employing a case analysis methodology and using university micro-lectures as an exemplar, this research constructs a framework for organizing micro-lecture teaching resources based on fragmented knowledge units, and implements it on the Chaoxing Xuexitong platform.

[Results/Conclusion] The findings demonstrate that grounding services in subject information resources constitutes the fundamental basis and starting point for subject librarians to deliver subject services. Through efficient resource organization, discovery, and presentation, subject librarians can achieve precision services oriented toward specific disciplines, thereby becoming organic components of university teaching and research teams. This study provides a novel attempt at precision embedded subject services by subject librarians.

Full Text

Preamble

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Embedded Subject Teaching Service Based on Precise Integration of Teaching Resources: A Case Study of the Micro-Lesson "Mechanism of Cell Senescence"

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Abstract

[**Purpose/Significance**] The Center for Teaching Quality and the "Teacher Solutions 2030" team in the United States predict that teaching will become a hybrid profession in the future, with teaching team members providing customized, meaningful learning solutions for students through division of labor. Subject librarians should actively explore ways to become members of teaching teams. This study proposes an embedded subject service model based on library resource organization, starting from the professional knowledge and skills of subject librarians. [**Method/Process**] Using case analysis and taking a university micro-lesson as an example, this study focuses on constructing a micro-lesson teaching resource organization framework based on fragmented knowledge units, presented on the Superstar Learning platform. [**Result/Conclusion**] Research shows that subject information resources are the fundamental basis and foothold for subject librarians to conduct subject services. Through efficient resource organization, discovery, and presentation, subject librarians can achieve precision services oriented toward specific disciplines, thereby becoming an organic component of university teaching and research teams. This study provides a new attempt at precise embedded subject services by subject librarians.

Classification Number: G252, G434
Keywords: knowledge unit, resource organization, fragmentation, subject service, precision, Superstar Learning

Since Tsinghua University first introduced "subject service" in 1998, Chinese universities have successively launched various subject services covering information literacy education, citation verification, scientific novelty retrieval, departmental lectures, and subject analysis. In summary, university subject services basically support three aspects: teaching, research, and decision-making. Regarding teaching support, university libraries currently offer various forms of information retrieval courses and information literacy training, provide embedded teaching services, teaching reference resources, multimedia database services, and network resource navigation, as well as learning spaces and facilities [1]. Although university subject services have achieved some results, they also exhibit shortcomings such as broad and unfocused service content with weak directionality and interactivity [2], simple stacking of resource content, and superficial service depth [3], causing subject service development to encounter bottlenecks. Correspondingly, Chen Yuanfang et al. investigated the current status of subject services in 50 domestic universities, including responsibilities and service content, finding that subject services currently exist at multidimensional boundaries

[4].

In light of this, this study begins with the most common teaching support in subject services, selecting the smallest-scale micro-lesson to explore how subject services should be embedded in teaching and where the entry point for teaching support should lie. Micro-lessons are chosen because blended online-offline teaching has become a trend in university education, and currently, all universities are actively experimenting with MOOCs and micro-lessons. Supporting online courses will also become an important component of university library subject services. However, there is widespread confusion among subject librarians, especially those without library and information science backgrounds, about their professional growth bottlenecks. On one hand, their original professional abilities cannot keep pace with disciplinary research; on the other hand, their library and information science capabilities have limited growth, making it difficult to conduct high-quality research. This phenomenon is quite common among academic librarians in Chinese university libraries.

2. Issues in University Micro-Lesson Teaching and Resource Organization

Micro-lessons feature "diverse forms, prominent themes, and short, interesting formats," representing a fragmented teaching model. In autumn 2008, David Penrose, a senior instructional designer and online services manager at San Juan College in New Mexico, USA, first proposed the concept of "micro-lecture." Subsequently, Salman Khan founded Khan Academy, demonstrating teaching content through effective and convenient methods. Thereafter, Oxford University in the UK also launched a series of micro-courses.

In November 2012, the National University Teachers Network Training Center of the Ministry of Education defined "micro-lesson" [5]: a short, complete teaching activity recorded in video format, focusing on a specific knowledge point or teaching segment. The connotation of "micro-lesson" includes three meanings: "micro-lecture," "micro-course" (or "mini-course"), and "micro-teaching." Different types of micro-lessons reveal knowledge at different depths and granularities, requiring different teaching support materials (in terms of material type, breadth, depth, and granularity). To promote and develop micro-lessons, the Ministry of Education's National University Teachers Network Training Center launched the National University Micro-Lesson Teaching Competition. Through this competition, micro-lessons rapidly gained popularity in higher education.

The main difference between micro-lessons and traditional courses lies in their starting point: micro-lessons fragment systematic knowledge in a field, explaining a knowledge "point" clearly in a short time, whereas traditional courses focus on "surfaces," emphasizing learning systems and knowledge systems. Micro-lessons rely only on networks without requiring classrooms, while traditional courses require face-to-face instruction with immediate classroom interaction and feedback.

Currently, all universities are developing micro-lessons, but the actual results are not outstanding. Apart from the quality of the micro-lessons themselves, a prominent shortcoming lies in post-class learning management, particularly regarding homework and self-study consolidation. The root cause of poor post-class learning management lies in the lack of accessibility and relevance of post-class teaching support resources, which do not correspond to the micro-lesson teaching model, resulting in insufficient post-class evaluation and monitoring.

2.1 Current Status of Micro-Lesson Teaching Resource Organization in Domestic Universities

Domestic research on micro-lessons mainly focuses on: design and development of micro-lesson plans, micro-courseware, micro-exercises, and other resources [6]; construction of micro-lesson teaching resource libraries and management systems for materials and exercises [7-8]; design and development of micro-lesson autonomous learning resource platforms, including micro-lesson videos and teaching assistance systems [9], etc. At the practical level, currently influential micro-lesson platforms in China include the National University Teacher Development Center Teaching Website [10], whose main functions include micro-lesson videos, teaching courseware, instructional design, evaluation and communication, and collection/sharing to social media modules.

As a student-centered autonomous learning teaching model, micro-lesson resource construction should be closely integrated with teaching and mutually reinforcing. To ensure learning effectiveness, relevant teaching support resource packages must be provided. These micro-lesson support resources should be dynamically growing and continuously improving. Hu Tiesheng et al. proposed the "Very 6+1" micro-course framework, which includes "1" 5-8 minute micro-video as the core, integrating "6" supporting resources: micro-lesson plans, micro-courseware, micro-exercises, micro-reflections, micro-reviews, and micro-feedback. Among them, "micro-reflections" are generated by teachers themselves, "micro-reviews" are comments and messages from the public, and "micro-feedback" represents user feedback after learning. All are generative and expandable resources that participate in improving original lesson plans and courseware. The "6" resources can be individually split or arbitrarily combined according to practical applications to meet personalized teaching and learning needs [5].

The National University Micro-Lesson Teaching Competition, guided by the Higher Education Department and Teacher Work Department of the Ministry of Education, is a top-down national university competition. The "Work Display" section of the National University Teacher Development Center Teaching Website platform aggregates numerous high-level micro-lesson entries across diverse disciplines, representing the best current standards of micro-lesson production in Chinese universities. Accordingly, this study investigated micro-lessons on this platform. Given that the author is a biomedical subject librarian, to facilitate research-practice integration, the analysis focused on 23

major micro-lesson works in the biomedical field, including micro-lesson videos, teaching courseware, instructional design, evaluation and communication, and collection/sharing modules. The investigation revealed that auxiliary materials related to micro-lesson content knowledge points mainly exist in micro-lesson videos, teaching courseware, and instructional design modules, including reference books, discussion questions, exercises, or practice problems. Table 1 shows the types of teaching support resources for biomedical micro-lessons.

2.2 Analysis of Problems in Micro-Lesson Teaching Resource Organization in Domestic Universities

As shown in Table 1, the 23 micro-lessons exhibit several main problems:

(1) **Insufficient resource support**: Five micro-lessons present only knowledge points without any supporting materials. Fifteen micro-lessons only provide reference books related to knowledge points, ten provide discussion questions, and five provide exercises. Only one micro-lesson simultaneously provides reference books, discussion questions, and exercises.

(2) **Overly coarse resource granularity**: These micro-lesson resources mostly provide literature-level rather than knowledge-level support, with large granularity that does not match the fragmented knowledge explanation of micro-lessons. They cannot directly point to the knowledge point content itself and thus cannot effectively support students' consolidation and review of "knowledge point" content. Only a few micro-lessons provide English vocabulary related to knowledge points, research frontiers, and relevant website links, such as the micro-lesson "Mechanism of Cell Senescence" by Zhang Xiaoyi from Beijing University of Technology.

(3) **Non-intuitive resource presentation**: Even when micro-lessons provide relatively complete types of teaching resources, the presentation methods are relatively obscure, often hidden in instructional design or teaching courseware, not intuitive or user-friendly, and not presented from the learner's perspective.

The above investigation indicates that micro-lessons have problems in teaching resource organization. Although research involves micro-lesson teaching resources and auxiliary materials, resource organization basically stops at the reference book level rather than delving into knowledge points and knowledge units. There is no organization of teaching auxiliary materials targeting knowledge units, especially directed, user-friendly resource packages pointing to small-granularity knowledge points. To some extent, the unreasonable organization of micro-lesson teaching reference support materials directly affects teaching effectiveness and student learning efficiency, hindering learners' self-study and knowledge consolidation. Due to insufficient attention to post-class learning resource construction and organization in Chinese university micro-lessons, the vast majority basically stop at reference book provision, exhibiting form over content.

3. Precise Organization of University Micro-Lesson Teaching Resources Oriented Toward Knowledge Units: The Case of "Mechanism of Cell Senescence"

For the organization of micro-lesson teaching support resources, it may be more appropriate for university library subject librarians to collaborate with teachers. As the main body of micro-lesson teaching support reference resource construction, university libraries can cooperate with teachers to collect, organize, and cluster literature according to knowledge point carrier forms for different types of micro-lessons, forming many-to-one and one-to-many teaching reference resource organization patterns. Truly embedding libraries into micro-lesson teaching services will help improve and optimize teaching auxiliary resource organization. In fact, the medical subject librarians at the author's library have successfully embedded into PBL (Problem-Based Learning) teaching at the medical school, fragmenting and reorganizing teaching content-related subject resources around problems, deeply embedding into curriculum teaching with satisfactory feedback. The exploration and attempt in this study have certain practical foundations.

3.1 Instructional Design of the Micro-Lesson "Mechanism of Cell Senescence"

Each micro-lesson is not an isolated entity but a part or segment of a complete knowledge system. The micro-lesson "Mechanism of Cell Senescence" is a knowledge unit within the chapter "Cells and Cellular Activities" in the "Introduction to Life Sciences" course, as shown in Figure 1 [Figure 1: see original paper]. Correspondingly, the author believes that a knowledge system can be divided into different knowledge units, with micro-lessons presenting these units. Like Khan Academy's knowledge map, these knowledge units are organized together through a knowledge map, facilitating learners' navigational learning—learners can understand the entire knowledge system, know where they are within it, and select needed knowledge units for study. Therefore, only when every necessary knowledge point is made into a micro-lesson can students fully comprehend the content of "Introduction to Life Sciences" and form a knowledge map of the course in their minds. Thus, the production of single-knowledge-point micro-lessons and resource organization becomes necessary. The following focuses on researching the teaching organization construction of a single knowledge unit.

The micro-lesson "Mechanism of Cell Senescence" targets first-year undergraduates. The courseware contains rich animations and intuitive, interesting video demonstrations with clear identification of key and difficult teaching content. The teaching objectives require students to: master the concepts of "telomere and telomerase"; understand the relationship between "telomeres and cell senescence" and "telomeres, telomerase, and cancer"; and learn about research progress and main existing problems in telomerase. Additionally, this micro-lesson provides relatively complete auxiliary materials including: references,

including books, online textbooks, and journal articles published in *Nature*, *Science*, and *Cell*; names of related advances; foreign language vocabulary; and homework assignments requiring students to review literature and summarize the regulatory mechanisms of telomerase activity after class [12].

Regarding the micro-lesson "Mechanism of Cell Senescence," the biggest shortcoming in its instructional design framework is the teaching auxiliary resource module. Although it provides literature-level knowledge clues, it does not refine them to the knowledge unit level. Due to platform limitations, these materials exist only as documents without intuitive presentation. Consequently, students rarely download central auxiliary materials for post-class learning during micro-lesson study, resulting in superficial learning effects and difficulty obtaining deep understanding. The root cause lies largely in the fact that, on one hand, teachers do not consider or realize that organizing and collecting teaching support resources is part of their teaching tasks and instructional design. In traditional teaching, teachers are accustomed to providing reference books after class, but when teaching shifts to fragmented micro-lesson formats online, continuing the reference book model is clearly inappropriate. On the other hand, sources of teaching resources for micro-lessons are extremely broad—content on the same knowledge point can be widely distributed across various resources including books, journal articles, conference papers, and special literature, and can also appear in videos, texts, audio, and other carriers. Moreover, due to different learning objects, the breadth, depth, and granularity of micro-lesson teaching support resources also vary. Teachers may not necessarily be competent in collecting and organizing micro-lesson support resources.

3.2 Organization of Teaching Auxiliary Reference Resources for the Micro-Lesson "Mechanism of Cell Senescence"

Therefore, based on the instructional design and teaching objectives of the micro-lesson "Mechanism of Cell Senescence," this study screened and clarified main knowledge points, using subject terms related to knowledge units as search entry points to retrieve relevant books, journals, dissertations, standards, patents, research reports, academic communities, and other network and library academic resources, with particular emphasis on searching professional databases such as the JOVE video journal to obtain various types of resources including videos and experimental operations. Targeted and precise collection of resources for knowledge points was conducted.

3.2.1 Hierarchical Organization of Micro-Lesson Teaching Unit Resources As is well known, micro-lessons feature "short, small, refined, and powerful" characteristics, primarily targeting single knowledge points, key points, doubtful points, and difficult points as online courses. Therefore, teaching reference and auxiliary resources provided by micro-lessons should not be lengthy reference books or exercise collections but should instead be chapters in reference books related to knowledge points, targeted exercises

with explanations, providing granularity that reveals more detailed content. Only in this way can they truly serve teaching support and reference functions, supporting students' autonomous learning, inquiry, and expansion around knowledge points. Based on knowledge units for micro-lesson teaching resource organization, connecting teaching resources related to micro-lesson content and providing learners with pathways deep into resource content can truly support students' post-class learning consolidation [13].

Micro-lesson-related resources include books, journals, special literature, etc. Different publication types involve knowledge content of varying depth and granularity. For example, textbook and book content forms the foundational content of teaching systems; journal and conference articles mostly involve research frontiers; dissertations cover a knowledge theme from basics to frontiers; web news reports only provide updates on knowledge developments; and learning communities aggregate subject-related knowledge including basics, specific learning questions, experimental problem-solving, learning methods, and research frontiers.

By forming corresponding teaching resource modules from various publication types collected around a knowledge unit, teachers and students can arbitrarily select and assemble teaching resource modules of different depths and granularities according to teaching needs, providing precise resources based on different levels of demand.

For the micro-lesson "Mechanism of Cell Senescence" in "Introduction to Life Sciences," based on the teacher's instructional design sorting out of course knowledge objectives, it can be decomposed into the following knowledge points: telomere concept; telomerase concept; relationship between telomeres and cell senescence; relationship between telomeres and cancer; relationship between telomerase and cancer; and research progress in telomerase (actually included in the previous five knowledge points). Subject librarians can collect, organize, process, and reveal teaching auxiliary resources for this micro-lesson around these knowledge points and related themes. The following uses one finer knowledge point (relationship between telomerase and cancer) as an example for auxiliary resource organization.

First, based on the disciplinary nature of "relationship between telomerase and cancer" and the teacher's instructional design, modules were selected including books, online academic communities, journal/conference papers, video journals, and patents. Figure 3 [Figure 3: see original paper] shows the teaching resource organization framework for a minimum knowledge unit "relationship between telomerase and cancer" within the micro-lesson "Mechanism of Cell Senescence."

As shown in Figure 3, surrounding the minimum knowledge point "relationship between telomerase and cancer" in the micro-lesson "Mechanism of Cell Senescence," various teaching resources in books, online academic communities, journal/conference papers, JOVE video journals, and patents can be revealed, delving into resource interiors to expose small-granularity teaching resources

that facilitate students' post-class self-study and autonomous learning. Due to space limitations, Figure 3 cannot list all resources completely, requiring either packaging resources into a document or presenting these module details on an appropriate platform.

The above course resource organization around the micro-lesson "Mechanism of Cell Senescence" starts from knowledge points in knowledge units, organizing relevant content from books, journals, conference papers, reports, etc., around knowledge points. Through fragmentation deconstruction, reorganization, and integration of course knowledge content in the form of knowledge clues, the depth of revelation has reached the specific subject content level, representing subject content-based analysis, reorganization, and integration.

3.2.2 Presentation Methods for Micro-Lesson Teaching Resources
For presenting micro-lesson teaching resources, integration into micro-lesson teaching platforms using course management systems can manage the entire course and micro-lessons with their supporting teaching resources, achieving synchronous presentation of micro-lesson resources while managing micro-lesson teaching, student usage, and feedback. Currently, university libraries have two platforms capable of presenting micro-lesson teaching support resources: LibGuides [14] and Superstar Learning.

LibGuides, as a library knowledge guidance system, serves as course guides. In comparison, Superstar Learning has a more aesthetically pleasing resource display interface, with directory-level displays showing relationships between resources more clearly at a glance. Additionally, Superstar Learning has powerful social functions with good interactivity. Its "Group" function serves as a learning community where notifications can be sent and topics discussed. More conveniently, Superstar Learning has both mobile and computer cloud versions, usable on both computers and mobile phones, especially enabling mobile learning anytime, anywhere on mobile devices.

After comparing LibGuides and Superstar Learning for presenting micro-lesson teaching resources, this study adopted Superstar Learning due to its powerful resource sharing, social interaction, and aesthetically friendly resource display interface. The teaching resources for "Mechanism of Cell Senescence" were presented using Superstar Learning (e.g., Figure 4 [Figure 4: see original paper], Figure 5 [Figure 5: see original paper]).

Students use Superstar Learning to study the micro-lesson "Mechanism of Cell Senescence," while teachers or students can use the "Group" function for discussion and interaction. Subject librarians can also join, embedding into micro-lesson teaching to provide course-related information retrieval services and personalized precision information services for teachers and students in need. Students can use these functions not only on computers but also on mobile phones via the Superstar Learning APP anytime, anywhere. Through Superstar Learning, teachers, librarians, and students are organically connected, forming a small

learning community where all three parties have mutual needs and benefits.

3.3 Effect Feedback on Precise Integration of Micro-Lesson Teaching Resources into Teaching

The "Introduction to Life Sciences" course at the author's university originally used traditional classroom teaching, with after-class support recommending students to use "China University MOOC" and independently search for relevant resources online, yielding unsatisfactory teaching results. Therefore, after communicating with the instructor, online course assistance was added. By pushing the integrated teaching resources for the micro-lesson "Mechanism of Cell Senescence" built on Superstar Learning to the instructor (as shown in Figures 4 and 5), the integrated resources not only included the micro-lesson video and teaching auxiliary resources for "Mechanism of Cell Senescence" but also clearly and intuitively presented other units in the "Introduction to Life Sciences" curriculum system and their related knowledge points.

The instructor's post-class feedback indicated that this integrated micro-lesson auxiliary teaching resource could help students study effectively, compensating for the problem that the vast life sciences system and rich knowledge points cannot be effectively connected and integrated through classroom teaching and textbook support materials. Meanwhile, the instructor also suggested that screening should be strengthened to provide more targeted teaching support reference resources, as the materials retrieved around knowledge points are numerous. Resource screening and organization need to consider students' acceptance levels and comprehension abilities. Student feedback indicated that packaging videos and related auxiliary resources on the aesthetically interactive Superstar Learning platform could provide precise and intuitive knowledge point-related resources, offering not only an additional learning path but also saving much time in searching for materials, facilitating better, faster, and more comprehensive mastery of learning content and improving learning efficiency.

Therefore, practical application requires in-depth communication and collaboration with professional instructors for appropriate resource screening and teaching module selection based on teaching objects. Teachers and students can select teaching resource modules of different depths and granularities according to actual teaching and learning needs for assembly and real-time embedding into shared interactive teaching platforms such as Superstar Learning.

4. Discussion and Reflection

As the university's teaching resource guarantee center, subject librarians' organization of micro-lesson teaching reference and learning auxiliary materials should not stop at large-granularity literature units but should target knowledge units, delving into textbooks, monographs, and papers to organize and reveal knowledge in small-granularity content organization methods.

This study takes the micro-lesson "Mechanism of Cell Senescence" as an example, analyzing and constructing a knowledge unit-based teaching resource organization framework from a subject librarian's perspective. The framework includes: using knowledge maps to present the entire knowledge system context, organically connecting knowledge points, with interface links at each knowledge node to corresponding teaching auxiliary resource modules. Additionally, it focuses on constructing a teaching resource organization framework for a basic unit within the micro-lesson and presents it on the Superstar Learning platform.

In summary, through precise resource organization, micro-lesson teaching resources can be organized in classified and hierarchical ways according to teachers' teaching needs and students' learning needs, promoting teaching based on student demand levels and facilitating self-study according to individual student needs. Research shows that basing services on resources is the fundamental foothold for subject librarians to conduct subject services. Discussing subject services supporting teaching without resource collection, selection, evaluation, and organization is likely putting the cart before the horse. Only by closely following teaching and research changes and developments, and conducting organic resource organization, discovery, and presentation starting from academic and teaching resources, can precise subject services be achieved, truly embedding into research and teaching support services and becoming an organic component of university teaching and research teams.

The Center for Teaching Quality and the "Teacher Solutions 2030" team in the United States jointly developed the report *Teaching 2030: What We Must Do for Our Students and Our Public Schools—Now and in the Future* (referred to as *Teaching 2030*), which predicts [15] that teachers will become a mixed profession, becoming teacher-entrepreneurs who spend part of their time teaching and part serving as student guidance experts, teacher educators, community organizers, learning designers, policy researchers, and online virtual tutors. The teacher professional structure in 2030 should be a grid-like "lattice" rather than hierarchical "ladder."

Therefore, perhaps it is time to redefine the teacher's role. Teachers will no longer have a single identity as instructors but will cooperate with other teachers to create stable, interlocking teaching teams. Consequently, cooperation between teachers and subject librarians will become increasingly close. "Teaching quality" assessment may no longer measure only teaching effectiveness in isolated classrooms but could comprehensively judge from students' learning efficiency—whether students can most effectively allocate attention and ultimately master knowledge in the least time.

The exploration of precise embedded subject services by subject librarians based on resource support for teaching is an attempt by libraries to keep pace with the times in supporting new teaching models. Although this study uses micro-lessons as a case, completing subject services in the teaching support direction based on resources—the library's foundation—is undoubtedly the direction of university library resource services and subject services. All services provided

by subject librarians, whether information literacy education or subject competitiveness analysis, are based on subject resources, and the foundation of subject resource revelation and analysis is the collection and organization of information resources. Without the identification, screening, and organization of subject information resources, subject services can only degenerate into promotion of database products and simple data listing. It is precisely based on this understanding that this study emphasizes that returning to resources is not only the starting point of subject services but also the foundation for subject librarians' professional standing.

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Author Contributions:
Yang Mingfang: Completed data collection, teaching reference resource organization, resource revelation platform construction, and paper writing.
Yuan Xilin: Proposed research ideas and revised the paper.

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