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Research on the Consistency Practice of "Teaching-Learning-Assessment" Closed Loop in Hybrid Courses Enabled by FD-QM Standards

-- Taking Information Security Courses as an Example

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Abstract: In the digital age, network security is the core support for safeguarding national sovereignty, economic development, and social stability. The quality of network security talent training is related to the implementation of national security strategies. However, there is a serious disconnect between teaching, learning, and evaluation in many current security courses. This article focuses on the empowering value of FD-QM online course quality standards on course closed-loop consistency, explores the path to improving the quality of technical courses, and takes the undergraduate course "Information Security" as the research object. Based on the characteristics of course construction and the design principles of FD-QM standards and closed-loop consistency, a four stage closed-loop model is constructed, including goal anchoring, activity design, dynamic evaluation, and closed-loop optimization. A course optimization solution is proposed.

Keywords: FD-QM Standard; Mixed Type; Consistency.

1. Introduction

The supply-demand imbalance of cybersecurity talents in China is prominent. According to industry reports, the demand for talents will exceed 3 million in 2024, while the annual output from universities is less than 100,000. The shortage of talents has become a key bottleneck restricting the development of the cybersecurity industry. As the main front for talent cultivation, universities urgently need to address this dilemma through the construction of high-quality courses. Hybrid courses, leveraging the advantages of flexible online learning and in-depth offline practice, have become an ideal model for cybersecurity disciplines. This study deeply integrates the FD-QM standard with hybrid courses, focusing on the construction of a closed-loop consistency of teaching, learning, and evaluation, enriching the application research of online course quality standards in technical disciplines.

Research on the consistency between online course quality standards and blended teaching has established a preliminary system both domestically and internationally. The QM (Quality Matters) standard from abroad has been maturely applied in the quality assurance of online courses. The domestic FD-QM higher education blended online course quality standard (second edition) has been applied in over 140 universities across China, covering multiple disciplines such as engineering, agriculture, forestry, and medicine. As of 2024, a total of over 580 courses nationwide has received in-depth guidance, and 66 courses have been selected as national first-class courses, while also being included in provincial teaching evaluation indicators [1].

2. Interpretation of FD-QM Standard and Principle of Consistency

(1) Overview of FD-QM Standards

The FD-QM standard is a localized quality standard for online higher education courses, jointly initiated by the Teaching Development Center of Fudan University and the international online education quality agency QM in 2015 and officially launched in 2021. The standard is centered around the core concept of "learning-centeredness," emphasizing the principle of consistency in the construction of objectives, activities, and assessments. The indicators cover the entire process of course design, implementation, and evaluation. The standard draws on the international QM framework while also incorporating the practical teaching situations of Chinese universities, such as strengthening online and offline interactive design and balancing process and summative evaluations. It is applicable to SPOC, MOOC, and purely face-to-face courses. It won the Global Impact Award from the American Distance Learning Association in 2017 and has become an authoritative quality assurance tool for promoting blended teaching reform.

The FD-QM standard encompasses eight major categories and 33 subcategories, including course overview, learning objectives, learning assessment, teaching materials, course activities, course technology, learning support, and course production. The maximum score for standard evaluation is 80 points. The course being evaluated must also meet two basic requirements. Firstly, the total score must exceed 50 points. Secondly, criteria 2, 3, and 5 within the major categories are key evaluation contents, and the total score for these three items cannot be less than 25 points, approximately 70%. Specifically, criterion 2 (learning objectives) must score more than 9 points, criterion 3 (learning assessment) must score more than 8 points, and criterion 5 (course activities) must score more than 8 points [2]

(2) FD-QM standard consistency course design

Consistent curriculum design is a core principle of the FD-QM standard, which is reflected in the learning objectives (indicators 2.1 and 2.2), learning assessments (indicator 3.1), teaching materials (indicator 4.1), learning activities

(indicator 5.1), and curriculum technology (indicator 6.1) of the FD-QM standard [3]. Focusing on student ability development, the learning objectives, teaching activities, and academic assessments are organically combined. The teaching objectives serve as anchor points, and the learning objectives must be quantifiable. The objectives determine the core direction of the curriculum and clarify the learning outcomes of students. Activities are the path of teaching, employing various teaching activities, including online preview, online content review, offline discussion, offline real-case analysis, joint group tasks, etc. Through these activities, the teaching objectives are achieved from multiple aspects, and students' professional skills, problem-solving abilities, critical thinking skills, and autonomous learning abilities are cultivated in the process. Academic assessments serve as a calibrator, providing real-time feedback on the construction achievements of the curriculum [4].

In the practice of the FD-QM standard, it is often said that objectives determine what to teach, activities determine how to learn, and evaluation determines how to verify. This shifts the focus of curriculum from what teachers teach to what students learn. All curriculum designs start from the students, considering their learning habits, acceptance level, and ultimate outcomes. Before designing a curriculum, teachers should consider which objectives the teaching activity can help students achieve and which quantitative evaluation system can clearly indicate whether the objectives have been achieved. These are the core of consistent design in the FD-QM standard [5].

3. The Foundation and Current Status of Information Security Blended Course Construction

Due to its inherent characteristics, the information security curriculum undergoes rapid knowledge updates and iterations. It requires in-depth cooperation with the industry, relying on both first-class and second-class teaching methods, and combining online and offline resources to achieve blended teaching. Therefore, from the beginning of curriculum development, the concept of industry-education integration, school-enterprise cooperation, and joint development has been adhered to. Relying on online resources, blended and diversified teaching has been achieved.

The course is a key course and a first-class course in Shanghai. It is jointly developed by the course and industry associations and enterprises. Through deep integration of industry and education, it starts from job positions, subdivides job skills, utilizes artificial intelligence technology to assist teaching, incorporates real enterprise cases, aligns with the requirements of professional qualification certificates, and achieves comprehensive design of the course system content. The course has established a related website on the Chaoxing platform, enabling online and offline blended teaching. As of now, the number of students enrolled has reached over 3,700. Due to the continuous reform and innovation of the course, guiding students according to enterprise requirements, and leading students with real cases, it has been recognized by both students and enterprises. However, when benchmarking against the FD-QM standard, there are still certain issues in terms of learning from the perspective of students and constructing a consistent design for the "teaching, learning, and evaluation" closed loop:

(1) The cultivation of students' autonomous learning ability still needs to be strengthened

The effectiveness of course teaching depends on the teacher's design. How to design courses from the learners' perspective, how to guide students to learn independently, and how to facilitate students' learning during the course are all issues that teachers need to consider. However, in the actual course teaching process, students still demonstrate automatic learning based on the teacher's teaching strategies, rather than participating in independent learning of the course according to their own needs. Therefore, it is hoped that the FD-QM standard can be benchmarked during the course design process to achieve further optimization and innovation in course design.

(2) The diversification of the student evaluation system still needs to be strengthened

Student evaluations should adopt various forms, providing diverse and process-oriented feedback on students' learning. Through continuous periodic assessments, teaching methods and modes can be adjusted in real-time. Additionally, assessments allow for a deeper understanding of students' learning situations. Regular analysis of these situations enables the formulation of different teaching methods and the design of various teaching activities, thereby enhancing course participation.

(3) The design of the blended curriculum system still needs to be optimized

The design of blended courses is refined through continuous exploration and optimization. However, in daily teaching, many teachers face confusion in allocating online and offline content. Often, there is overlap between online and offline content, and the arrangement is not appropriate, causing students to experience the frustration of redundant learning. This leads to a situation where the blended approach is not genuine and fails to achieve the desired effect.

4. Instructional Design based on FD-QM Standards and Closed-loop Consistency

To address the aforementioned issues and truly achieve student-centered curriculum design, the curriculum was redesigned based on the FD-QM standards and the concept of closed-loop consistency. This redesign clarified course objectives, optimized the course teaching process, enriched course resources, and strengthened diverse evaluations, thereby achieving innovation in course teaching design.

(1) Focus on the consistency construction of teaching, learning, and evaluation, and optimize the course content

The curriculum objectives are derived from enterprises, which subdivide the job requirements of enterprises to form a systematic curriculum objective system, including overall curriculum objectives, detailed chapter objectives, and task objectives. Through learning, students can assess their own learning outcomes starting from small goals and gradually achieve the overall curriculum teaching objectives through continuous accumulation. The information security curriculum primarily targets two positions: network security operation and maintenance engineer and WEB penetration testing engineer. Through job skill analysis, relevant skill requirements are integrated into the curriculum chapters, and corresponding learning objectives are formulated in each chapter. The relationship between curriculum objectives and teaching activities should be clarified to encourage students to actively participate in various teaching activities.

Additionally, the setting of curriculum objectives should also reflect high-level requirements.

After clarifying learning objectives, it is necessary to design teaching activities. Through various activities, we can subtly enhance students' abilities, strengthen their participation, and promote their autonomous learning abilities. Due to the uniqueness of the information security course, it naturally incorporates ideological and political elements. Therefore, in the course teaching design, diversified activities will also be used to enhance students' patriotism, cultivate their awareness of national security, abide by laws and regulations, professional ethics, and foster teamwork skills.

During the course design process, various activities such as course analysis reports, experiment reports, group defense and offense experiments, personal knowledge summaries, extracurricular learning, poster making, online short video production, and journal paper writing are conducted. Each activity corresponds to a specific teaching objective. For instance, students are required to utilize artificial intelligence technology to create promotional posters based on real-life cybersecurity incidents. Through this activity, students can enhance their application of artificial intelligence technology, increase their participation in teaching activities, and improve their awareness of cybersecurity. It also reinforces cybersecurity awareness and promotes cybersecurity awareness campaigns, thereby enhancing students' ideological and political awareness, professional ethics, and providing early preparation for their future employment.

The course also requires students to condense and summarize their best knowledge through personal knowledge summaries, share and exchange their findings. Students are encouraged to explore new knowledge and skills. Through this activity, on the one hand, it provides a self-summarization process for in-class knowledge. On the other hand, it helps students build the ability of autonomous learning and self-exploration. Through autonomous learning, students can analyze, solve, and summarize problems, and share and exchange their findings within the class. Therefore, such activities can effectively cultivate students' systematic professional abilities and help them quickly transition into the role of a safe enterprise employee.

When designing the curriculum evaluation system, the principle of consistency is also adhered to. Curriculum evaluation relies on teaching activities, which in turn correspond to curriculum objectives. Through multi-level and diversified curriculum evaluations, students' learning outcomes are assessed, and based on quantifiable results, curriculum activities are revised, ultimately achieving the fulfillment of curriculum objectives. According to the requirements of the FD-QM standard, when designing assessments, the following points should be noted: firstly, students need to be clear about the specific requirements of the assessment; secondly, students who pass the assessment will achieve the course objectives; thirdly, multiple forms of assessment should be used to gradually complete the course evaluation; fourthly, students need to be aware of their progress, and teachers need to provide real-time assistance. For example, in the information security course, there is a group attack and defense experiment that adopts the relevant model of CTF competitions, setting attackers and defenders, and judging each group's performance based on the number of levels cleared and the number of defenses made. Using this level-clearing and flag-capturing method can effectively evaluate students' critical thinking skills and their ability to comprehensively apply knowledge content. The related evaluation is also very transparent, allowing students to intuitively see their own shortcomings. After successfully clearing the levels, the requirements of the chapter objectives are also met simultaneously.

By focusing on teaching, learning, and assessment, utilizing online course website resources, achieving consistent course design, optimizing course content, and meeting course teaching objectives.

(2) Design courses from the perspective of learners to enhance their interest in learning

In the process of curriculum design, teachers are required to be student-centered and fully embody the high-level, innovative, and challenging nature of the curriculum. However, in actual teaching, students should first be regarded as learners. From the learners' perspective, it is crucial to explore how to guide students from scratch in their course learning, how to solve the difficulties they encounter during the learning process, and how to provide timely support for answering questions. These are the primary considerations for curriculum designers. Therefore, based on the FD-QM standard, the first section of all chapters in this course website resource includes a "Please read first" section, which introduces how to learn the course, how to take the exam, course teaching norms, introductions to the lead teachers, and classic teaching videos of the course. Through this section, students can understand how to start the course, the overall goal of the course, the learning foundation of the course, the application of AI technology in the course, the course assessment methods, the proportion of assessment scores, the basic information of the lead teachers, office locations, email addresses, phone numbers, and question-answering hours. With these contents, students can embark on their course learning with an exploratory mindset. Only when students are interested can the effectiveness of course learning be improved.

(3) Carry out in-depth blended learning design to accelerate knowledge iteration

What constitutes genuine blended learning? Simply having a course website with course outlines, schedules, lesson plans, instructional videos, etc., does this constitute blended learning? If students watch videos on the course website and submit assignments, does this count as blended learning? Actually, this cannot be considered blended learning at all.

The FD-QM standard provides detailed requirements and instructions for blended teaching. It outlines eight core standards for planning online and offline components to ensure that teaching elements are precisely aligned around learning objectives. In terms of goal design, it clarifies that online learning focuses on knowledge acquisition, while offline learning emphasizes the cultivation of higher-order skills. Through quantified goals, it achieves a dual enhancement of efficiency and depth. In terms of the evaluation system, it emphasizes diversification, taking into account both online knowledge comprehension and offline collaboration, and uses transparent scoring criteria to enhance fairness. Additionally, it underscores structured interaction and full-scenario support to alleviate the learner's isolation effect. Through peer review, learner feedback, and other forms, it continuously improves the closed loop of teaching, learning, and evaluation, promoting blended teaching from potential advantages to actual achievements, and building a sustainable quality improvement ecosystem.

Taking the information security course as an example,

online learning primarily encompasses three aspects: firstly, independent learning of basic theoretical knowledge; secondly, reviewing and addressing key and difficult content; and thirdly, participating in various teaching activities, including questionnaire surveys, forum postings, homework submissions, phase tests, and extended video learning. Offline learning mainly involves analyzing students' learning situations based on online learning, conducting analysis of key and difficult issues, introducing real case libraries in alignment with enterprise needs, communicating, and discussing. In conjunction with course objectives, it introduces advanced course content to enhance students' cognitive level.

5. Optimization Suggestions and Outlook

With the widespread application of artificial intelligence technology and the continuous deepening of the industry-education integration model, through reform and innovation, combined with the FD-QM standard, we will further optimize and enhance the quality of course construction. In subsequent course development, we will carry out course optimization and reform from the following aspects.

(1) Artificial intelligence empowers personalized learning

Relying on the relevant standard system of FD-QM, we systematically organize the knowledge system of professional courses, clarify the logical relationships between knowledge contents, and construct knowledge graphs, problem graphs, and ability graphs related to the courses. Based on these graphs, combined with the individual abilities and learning progress of different students, we design learning paths with a problem-oriented approach to achieve the goal of personalized learning for students. We integrate artificial intelligence technology into the entire process of course learning, establishing a full-process design before, during, and after class. Different learning paths are designed for different students, thereby helping students achieve mastery of knowledge content through the shortest path.

Deeply integrate artificial intelligence technology with the FD-QM standard, capture students' learning data through learning maps, including knowledge completion degree, mastery degree, after-class assessment scores, forum interaction scores, etc. Through analysis of these data, understand students' mastery situation and the effectiveness of course teaching. Align the corresponding data with the course teaching objectives, and use data to measure the achievement level of course evaluation criteria. At the end of each semester, utilize artificial intelligence technology to generate a course achievement report, provide detailed data feedback on course achievement, evaluate the effectiveness of course teaching, and thus facilitate continuous improvement.

(2) Strengthen the construction of hubs for industry-education integration

Due to its unique characteristics, the information security curriculum requires continuous iteration of knowledge content. Therefore, it is necessary to further optimize school-enterprise cooperation, strengthen industry-education integration, jointly build a hub for industry-education integration, turn universities into talent reserve bases for enterprises, turn classrooms into exhibition centers for cutting-edge technologies, turn enterprises into bases for student internships and practical experiences, and include enterprise technical experts as joint members in curriculum co-construction. Through continuous interconnection and interoperability, knowledge can be continuously optimized and iterated, ultimately achieving the goal of gender-inclusive curriculum requirements.

6. Conclusion

Through research on the FD-QM standard, focusing on the current situation and issues of information security blended courses, we concentrate on the consistency of teaching, learning, and assessment. Adopting a student-centered curriculum design, we rely on the FD-QM standard for blended course instructional design. This approach enhances student engagement, improves students' autonomous learning abilities, effectively utilizes online and offline resources, achieves content updates and iterations, optimizes teaching methods, and forms a positive online and offline teaching model. Ultimately, this meets the course construction goals and cultivates qualified talents for industry and enterprises.

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