An Exploration of the Outcome-Based Education Teaching Model Driven by Dual Knowledge and Competency Frameworks

Baojun Fu[*], Yu He, Yingmei Li, Yanxue Yao

College of Computer Science and Technology, Harbin Engineering University, Harbin 150001, China
[*]Corresponding author: teacherfbj@hrbnu.edu.cn

Abstract: *With the increased application of artificial intelligence technology in education, traditional teaching models dominated by knowledge instruction can no longer meet the demands of the information age for cultivating innovative and multidisciplinary talent. Therefore, this paper proposes a novel teaching reform model driven by the Outcome-Based Education (OBE) philosophy, which achieves a deep integration of 'competency maps' and 'knowledge maps'. This educational model first analyses the essence and integration of two frameworks: it demonstrates that the competency framework within this model can establish the objectives and specifications for talent cultivation, defining the competencies and proficiency levels students should attain. Meanwhile, the knowledge framework systematically organises the disciplinary knowledge system under this pedagogical approach, elucidating the intrinsic connections between knowledge points. The integration of these two frameworks enables the formulation of clear educational objectives, thereby providing students with a structured pathway for planning and designing their learning journey. Secondly, it outlines the goal-driven, evaluation-oriented, pathway-planning, and content-precision functions of the dual-map teaching model based on the OBE philosophy, which integrates knowledge and competency frameworks. Finally, the paper focuses on the specific implementation process of this model within the teaching process, detailing the complete implementation pathway from map construction, course design, teaching implementation to dynamic evaluation. The implementation of this teaching model provides a theoretical basis for deepening teaching reform and realising personalised teaching alongside competency-based cultivation.*

Keywords: *Competency Map; Knowledge Map; Teaching Reform; Dual-Core Drive; Personalised Learning*

1. Introduction

With the continuous advancement of society, the cultivation of talent is transitioning from a knowledge-centric to a competency-based model at a crucial juncture. The demands of society and industry for talent increasingly focus on whether individuals possess the comprehensive competencies required to tackle complex problems, construct critical thinking frameworks, and collaborate innovatively.[1] However, the traditional teaching model suffers from vague objectives for talent cultivation, where the content imparted fails to form a coherent knowledge system and lacks connection to practical application. Teaching methods are uniformly applied, unable to meet the needs of students' individualised development. To overcome these challenges, we have introduced two key technical concepts into our teaching process: the "competency map" and the "knowledge map". We have integrated their systematic and visualised thinking into the entire teaching process. Driven by the Outcome-Based Education (OBE) teaching philosophy, this approach has formed a crucial breakthrough point for advancing structural reforms in teaching.

2. The Essence and Integration of the Dual Knowledge-Competency Framework

2.1 Knowledge Graph

The essence of a knowledge graph is a semantic network that reveals the rich semantic relationships between knowledge points within a subject domain.[2] In the teaching process, the primary role of Knowledge Maps is expressed as follows:

Structured knowledge representation: Presenting subject knowledge in a diagrammatic format to aid students in better understanding the connections between knowledge points.

Reasoning and Problem Solving: By leveraging the reasoning capabilities of Knowledge Graphs, students are guided to derive new conclusions from existing information.

Personalised learning: Dynamically adjusting teaching content based on students' learning pathways and knowledge acquisition.[3]

Predicting and Providing Feedback on Learning Behaviour: By analysing learners' behavioural data within the Knowledge Graph, the system can forecast their future learning performance and deliver real-time feedback and recommendations.

Knowledge graphs systematically organise and integrate fragmented knowledge points, while the interconnections between these points clearly illustrate the prerequisite knowledge required for learning a particular concept and its corresponding extensions.[4] With their assistance, the learning process becomes more transparent and teaching content is organised more efficiently. Moreover, Knowledge Graphs provide semantic support for intelligent tutoring systems, thereby enabling them to interpret students' queries with greater precision and deliver tailored responses. This facilitates the generation of personalised learning pathways and resource recommendations for learners.[5]

2.2 Competency Map

The competency map is a diagrammatic tool which visualises the structure of competencies and their interrelationships. It breaks down competencies into specific skills and associated knowledge points.[6] Capability maps enable the systematic and intuitive mapping of core competencies, professional skills, and skill competencies required within a particular professional domain or role. They simultaneously reveal their hierarchical structure and intrinsic connections, thereby enabling precise alignment with the demands of the actual industry. The primary function of the Capability Map is manifested in:

Optimising Instructional Design: Competency Maps transform ambiguous industry requirements into concrete, actionable teaching objectives. Educators can thereby refine curriculum frameworks, design teaching activities and practical projects aligned with competency development needs, thereby enhancing practical content closely linked to industry demands.

Tailored recommendations: By analysing students' performance across various metrics and their developmental trajectories, we dynamically generate capability profiles to provide tailored learning recommendations, thereby establishing a foundation for differentiated instruction.

Career Development Planning: Utilising a competency map to illustrate the required competencies and their hierarchical levels for specific roles, enabling students to clearly understand the practical skills necessary for pursuing particular positions.

The core function of the competency map lies in the construction and refinement of the competency framework.[7] It relies upon the establishment of detailed competency objectives, providing each competency element with clearly defined and multifaceted interrelated content. Whether it be the personalised definition and detailed description of competency names, the formulation of associated questions, or the integration of experimental and practical projects, the Competency Map provides educators with comprehensive and robust support.

2.3 Dual-map integration of Knowledge and Competence

In the course of teaching, constructing knowledge graphs serves as an effective pedagogical strategy. Its core purpose lies in establishing a knowledge framework for students, consolidating fragmented knowledge points into a systematic network by linking core subject knowledge through graph-based connections. The core value of the Competency Map lies in addressing what competencies should be cultivated in students and how these competencies should be developed. Its primary objective is to break down broad and abstract educational goals—such as core competencies, critical thinking, social responsibility, and professional ethics—into specific, definable, observable, measurable, and actionable skill points, while simultaneously clarifying the logical connections between these skill points.

The Competency Map outlines the anticipated outcomes of teaching endeavours, addressing the question of what kind of individuals we aim to cultivate in our students. It serves as the overarching framework for teaching and the benchmark for evaluation. Knowledge maps serve as roadmaps for

learning, addressing both what knowledge students need to acquire and how they should learn to master it. They constitute the specific content and pathways for achieving competency objectives. The integration of dual knowledge and competency maps collectively forms the "strategic blueprint" and "tactical blueprint" for educational reform.

3. The Driving Role of the Dual Knowledge-Competency Framework Based on the OBE Approach

The OBE philosophy is an emerging educational concept that begins with learning outcomes and reverse-engineers the teaching process[8]. It ultimately breaks away from the traditional teacher-centred, textbook-centred, and knowledge-centred approach to instructional design, advocating for student-centred learning through independent study, collaborative learning, and inquiry-based learning. Within the four stages of teaching implementation – goal setting, content organisation, activity delivery, and evaluation feedback – integrating a knowledge-plus-competency framework into the outcomes-based curriculum model enables teachers to better master theoretical knowledge in classroom instruction. This approach enhances students' ability to analyse and resolve problems within predefined application scenarios. Both types of maps can also better play a crucial driving role.

3.1 Goal-driven guidance

During the development of courses or programmes, all teaching activities must be designed to directly address the specific requirements outlined in the competency framework. Competencies guide the direction of teaching, as well as the depth and breadth of knowledge.

3.2 Evaluation-driven function

Teaching assessment no longer focuses solely on the memorisation of isolated knowledge points, but shifts towards evaluating the attainment of competencies[9]. Through diverse assessment methods such as project-based assignments and practical examinations, students' position and progress along the competency spectrum are evaluated, thereby achieving the dual objectives of enhancing teaching through assessment and promoting learning through evaluation.

3.3 Path Planning Function

The introduction of dual diagrams enables students to establish clear developmental objectives while rationally integrating the knowledge systems they require to master, thereby designing optimal learning pathways.

3.4 Precision-targeted recommendations

When the system identifies gaps in a student's understanding of a particular knowledge point, the Knowledge Graph can precisely recommend relevant practice exercises and supplementary reading materials, enabling targeted tutoring and avoiding inefficient learning.

The introduction of a dual-map teaching model integrating knowledge and competency frameworks, grounded in the Outcome-Based Education (OBE) philosophy, has unlocked new possibilities for addressing the needs of both educators and learners for high-quality learning resources and intelligent learning environments. This pedagogical approach has exerted a significant influence on teaching, refining aspects overlooked by traditional experience-based education and providing novel avenues for the implementation of personalised teaching methodologies.

4. Design and Implementation of Teaching Models

The OBE teaching model, which is driven by Knowledge Maps and Competency Maps, is fundamentally aimed at cultivating students' core competencies. On the one hand, it effectively integrates subject knowledge acquired through multiple channels, presenting core knowledge and the interconnections between various knowledge points in the form of a Knowledge Graph. This facilitates students' grasp and mastery of the knowledge system, enabling them to design personalised learning pathways tailored to their own learning patterns.[10] On the other hand, this teaching model conducts capability analysis, distilling the requisite competency indicators from dimensions such as self-directed

learning, practical operations, and corporate research. The formation of a competency map enables the transformation of ambiguous industry, societal, and personal development requirements into concrete, actionable teaching directives, clearly quantifying the capability demands across different positions and hierarchical levels. The OBE-driven teaching model, which operates under the dual-map framework of knowledge and competency, enables the more specific and targeted design and implementation of teaching processes. This pedagogical model primarily encompasses four key components: the refinement of knowledge maps, the construction of competency maps, the design and implementation of an Outcome-Based Education (OBE) teaching model driven by dual maps, and teaching evaluation and feedback.
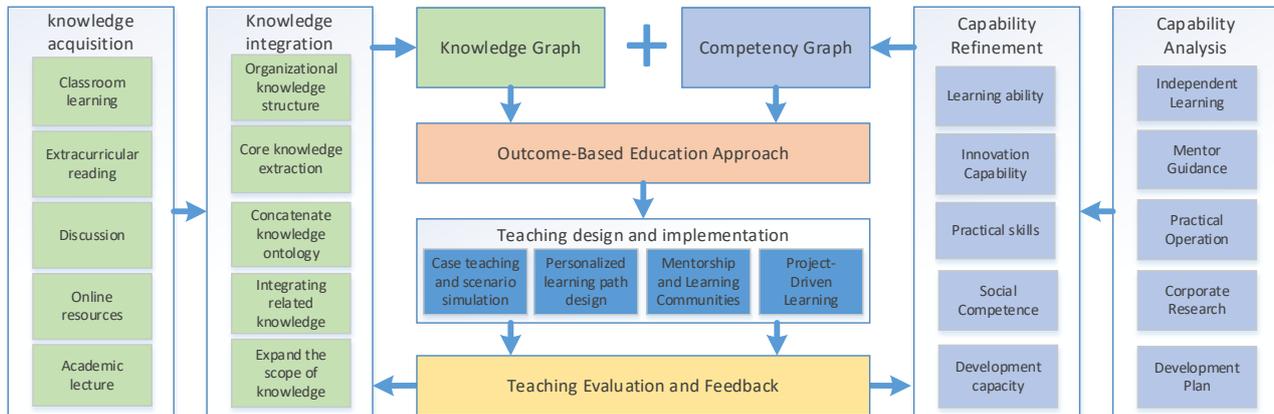

Figure 1: Outcome-Based Education Teaching Model Driven by Knowledge Maps and Competency Maps

4.1 The Condensation of Knowledge Maps and Competency Maps

The construction of Knowledge Maps typically involves the following key steps:

4.1.1 Knowledge acquisition

The knowledge acquisition phase involves structured or semi-structured data resources obtained from multiple channels. These resources encompass learning activities centred around the curriculum, supplementary reading, discussions centred around specific issues, various online resources, and academic lectures. Through techniques such as data mining and natural language processing, specific representative knowledge entities (such as concepts and terminology) are identified from data resources.

4.1.2 Knowledge integration

This stage first requires the expansion and supplementation of knowledge entities formed during the knowledge acquisition phase, exploring their extensions to establish a comprehensive system centred around these knowledge entities, serving as an extension of the knowledge entities themselves. This process effectively broadens students' cognitive horizons, enhances their knowledge base, and lays the foundation for constructing a comprehensive knowledge system. Secondly, integrate related knowledge by merging relevant knowledge with common characteristics to further refine knowledge entities. The next phase involves linking knowledge ontologies to connect disparate, isolated knowledge units, thereby forming a networked knowledge structure. Subsequent work involves identifying core knowledge within existing knowledge networks, clarifying the central objectives of the learning process, and laying the groundwork for planning learning pathways. Finally, the knowledge structure is optimised to form a Knowledge Maps.

4.2 Refining the Competency Map

4.2.1 Competency Analysis

The cultivation of student capabilities is achieved through the process of charting personal development pathways within practical learning and working environments. This typically encompasses a range of activities including independent study, tutor-guided learning, internships and practical placements, corporate research projects, and the setting of learning objectives tailored to individual progress. The competency analysis process guides students in applying relevant knowledge and skills to accomplish tasks, quantifying the sense of responsibility, autonomy, judgement, and decision-making

demonstrated during problem-solving. This approach concretises and visualises abstract learning objectives, thereby significantly enhancing learning efficiency and focus, propelling personalised learning from concept to practice.

4.2.2 Capacity Consolidation

This phase involves deconstructing the competency indicators derived from real-world scenarios into more specific, observable, and measurable dimensions of capability, aligned with job requirements or professional standards. This framework encompasses five key areas: learning ability, innovative capacity, practical skills, social competence, and developmental potential. It propels education towards a systematic shift from knowledge transmission to the cultivation of core competencies, thereby serving as the link between societal demands and teaching objectives. Among these, learning ability serves as the foundation, guiding students to master how to learn and enabling them to become independent learners. It constitutes the fundamental capacity for lifelong learning that students must cultivate to meet the demands of future development. Innovative capability places particular emphasis on shifting thinking paradigms, encouraging students to move beyond a simple pursuit of "standard answers" in their learning approach. Instead, it encourages them to break down mental barriers, dare to pose questions, and be bold in questioning and challenging assumptions. To cultivate the breakthrough thinking and original problem-solving abilities most needed by future society. Practical competence emphasises the transformation and validation of learning, requiring students to learn by doing. This ensures knowledge is not left in abeyance and cultivates students' crucial ability to translate ideas into action and plans into tangible outcomes. Social competence emphasises collaboration and mutual support, educating students to become effective team contributors and responsible members of society. This forms the foundation for organisational success and social harmony. Developing capabilities emphasises cultivating students' growth mindset, effectively integrating societal demands with self-awareness to assist pupils in exploring career pathways and understanding the connection between present learning and future development. This empowers students with the intrinsic motivation and resilience to navigate their own careers, adapt to societal change, and achieve sustainable well-being.

4.3 Design and Implementation of the OBE Teaching Model Under Dual-Map Guidance

Competency Maps and Knowledge Maps, driven by an outcomes-based teaching philosophy, can systematically organise the subject curriculum framework throughout the design and implementation of teaching. It extracts, categorises and correlates knowledge points from textbooks, literature and online resources to provide students with optimal knowledge navigation and learning pathways. By establishing mappings between subject knowledge and skill units, it rationally assesses learning outcomes, diagnoses developmental bottlenecks, and drives personalised interventions and resource recommendations. The ultimate goal is to achieve tailored instruction, thereby enabling each student to efficiently construct their own knowledge framework and transform it into core competencies for tackling future challenges.

The teaching implementation process driven by the OBE philosophy can simulate authentic workplace scenarios in response to societal demands, facilitating project-driven learning. This approach sequentially links the tasks within a project to the requisite knowledge points, ensuring that project-based learning is both challenging and underpinned by knowledge. Moreover, the implementation of this pedagogical model facilitates collaborative inquiry among students organised into learning communities, centred around authentic tasks designed around competency maps. Instructors assume the role of personalised development mentors, providing targeted learning guidance. They employ visualisation tools to help students comprehend knowledge structures and deliver individualised instruction.

4.4 Instructional Evaluation and Feedback

The OBE teaching model, driven by Knowledge Maps and Competency Maps, will comprehensively document students' performance throughout project completion, online assessments, and discussion participation. Based on collected data, visualise students' knowledge acquisition and competency attainment against the competency framework. Then generate formative assessment documentation, reflecting on teaching practices in light of evaluation outcomes. If the majority of students demonstrate substandard performance in a particular target competency, it is necessary to review whether the pathway design within the knowledge map is appropriate and whether the knowledge requirements align with the teaching resources. Accordingly, both maps and the teaching implementation process should undergo dynamic adjustment and optimisation.

5. Conclusions

The integration of OBE-driven teaching processes with the depth of competency and knowledge frameworks constitutes, inherently, an educational reform centred on student capability development. It achieves precision and visualisation in teaching objectives through competency maps, whilst enabling personalised and intelligent learning pathways via knowledge maps. This dual-map driven teaching model, based on the OBE philosophy, not only effectively addresses the shortcomings of traditional teaching but also charts the most suitable developmental pathway for each student. Ultimately, it achieves the organic integration of scaled education with personalised cultivation. In the future, with advancements in artificial intelligence technology, the construction and application of dual-map teaching guided by the OBE philosophy will become increasingly automated and intelligent, thereby reshaping our teaching ecosystem at a deeper level.

Acknowledgments

References

[1] Bilotska L , Lozovenko S , Vodzinska O . Formation of the professional competence of future fashion industry specialists with employers' involvement in the educational process. .Fashion Industry, 2025(2):47-59.

[2] Defang Z , Mengmeng Z , Juan Y .Research on the Construction of Personal Knowledge Representations Integrated with a Cognitive Evaluation Model.Modern Distance Education Research, 2017.

[3] Yao D , Qiu Y , Guo Y ,et al. College Students' Classroom Participation and Learning Outcomes under the Outcome-Based Education: A Case Study of International Logistics Course.Creative Education, 2024, 15(3):15-23.

[4] Jufang M A .Research on Integrating Moral Education Into College English Course on the Basis of Outcomes-Based Teaching Mode.Psychology Research, 2022, 12(10):865-873.

[5﹞Dewen Cao．Research on the Teaching Reform of Radio-Frequency Identification Course Based on the Educational Philosophy of Outcome-Based Education．Journal of Contemporary Educational Reseach,2023,7(4):7-11.

[6] Kaprielian V S , Silberberg M , Mcdonald M A ,et al.Teaching population health: a competency map approach to education..Academic Medicine Journal of the Association of American Medical Colleges, 2013, 88(5).

[7] Jais I R M , Yahaya N , Ghani E K .Higher Education Leadership Competency Framework in Malaysia: A Refinement.Humanities and Social Sciences Letters, 2020, 8.

[8] Willis S, Kissane Barry. Outcome-Based Education: A Review of the literature.Prepared for the Education department of western austral-ia.1995:1-55.

[9] Watkins,David.Learning and Teaching: A cross-cultural perspective.School Leadership & Management, 2000, 20(2):161-173.

[10] Wan Yahaya W A J , Zaini K M .AI and Competency-Based Education: Moving Beyond Traditional Approaches.Springer, Cham, 2025.