

Research on Improving the Course Design of Building Information Modeling (BIM) Courses in Higher Vocational Colleges in China

1. Introduction

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a building, serving as a shared knowledge resource for information about a facility throughout its lifecycle (ISO 19650-1, 2018). BIM+ extends the concept by integrating emerging technologies such as cloud computing, the Internet of Things (IoT), and artificial intelligence (AI) (Wei, 2020) to enhance data management, collaboration, and decision-making in the architecture, engineering, and construction (AEC) industry (Li and Yang, 2017).

In recent years, BIM has gained widespread adoption globally, driven by policies and regulations that mandate its use in public and private construction projects (Heidari, Peyvastehgar, and Amanzadegan, 2024). Countries such as the United Kingdom, the United States, and Singapore have developed national BIM standards and frameworks to promote its implementation. In China, the Ministry of Housing and Urban-Rural Development (MOHURD) has introduced policies to accelerate BIM adoption, including the “14th Five-Year Plan” for the construction industry (Ministry of Housing and Urban-Rural Development, 2022), which emphasises digitalisation and smart construction. Provinces like Jiangsu have actively promoted BIM education and application through school-industry collaborations (Xing et al., 2021).

The development of higher vocational education in China has also been a key focus of educational reforms (Zhang et al., 2024). The government has introduced policies such as the “National Vocational Education Reform Implementation Plan” and the “1+X Certificate System” to enhance the quality of vocational training. The 1+X Certificate System allows students to obtain both an academic diploma and industry-recognised skill certificates, aiming to improve employability and bridge the gap between education and industry needs (Chen, 2023).

This study explores how BIM courses in higher vocational colleges can be improved by examining the perspectives of three key stakeholders: students, teachers, and industry professionals. Understanding students' perceptions of the course can reveal challenges related to engagement, skill development, and career readiness. Teachers' perspectives provide insight into curriculum design, instructional methods, and resource availability (Murillo, 2024). Industry professionals' viewpoints highlight the skills and competencies required for employment (Li, 2015). By analysing these perspectives, the research aims to identify strategies for optimising BIM course design to better align with industry demands and vocational education reforms. The main research question is “How can the design of BIM courses be improved for higher vocational colleges in China?”

2. Research method

2.1 Theoretical Framework

This study adopts a pragmatic research paradigm, which prioritises practical solutions and the application of research findings to real-world problems (Clarke & Visser, 2018). Pragmatism supports the use of multiple research methods to explore complex issues from different perspectives, making it well-suited for educational research that involves diverse stakeholders. Since the research aims to improve the BIM courses in higher vocational colleges, a pragmatic approach enables the integration of both quantitative and qualitative data to gain comprehensive insights into students' learning experiences, teaching practices, and industry expectations.

Pragmatism aligns with the constructivist and interpretivist perspectives in qualitative research, allowing for in-depth exploration of participants' perceptions, while also incorporating post-positivist elements by employing structured quantitative data collection methods such as questionnaires (Kaushik, and Walsh, 2019). This theoretical foundation ensures a balance between objective measurement and subjective interpretation, providing a well-rounded understanding of the research problem.

2.2 Justification for Using the Pragmatic Research Paradigm

The pragmatic paradigm could be effective in vocational education research because it facilitates practical, actionable findings that can directly inform course design and teaching strategies. By focusing on real-world applications, pragmatism bridges the gap between theoretical exploration and practical implementation (Creswell, 2013). This paradigm also allows flexibility in method selection, ensuring that the most suitable techniques are used to address the research objectives.

2.3 Mixed Methods

This study employs a mixed methods research design, integrating both quantitative and qualitative data collection and analysis. This approach is justified based on its ability to capture the complexity of educational experiences and its suitability for studying real-world phenomena in-depth (Creswell, 2015).

2.4 Rationale for Mixed Methods

The rationale for using mixed methods in this study lies in its ability to enhance validity through triangulation, as combining different methods allows for cross-verification of data from multiple sources (Bryman, 2012). It ensures comprehensiveness, with quantitative data offering statistical trends and qualitative data providing deeper explanations, thus ensuring a holistic understanding of BIM courses. Additionally, the approach offers flexibility and depth, as structured questionnaires provide measurable insights, while interviews and focus groups enable participants to describe their experiences in detail, enriching the overall findings.

In this study, the mixed methods approach will involve quantitative data through a structured student questionnaire with 30 participants to capture perceptions of courses' effectiveness and areas for improvement. Qualitative data will be gathered through focus group discussions with students, providing deeper insights into their learning experiences, while teacher interviews will explore instructional challenges. Additionally, industry professional interviews will assess the alignment of the course with industry expectations, helping to identify skill gaps and areas for improvement.

This combination ensures that the study not only measures but also interprets student learning experiences and professional expectations.

2.5 Case Study

The case study approach is justified by its contextual relevance, as it focuses on a vocational college in Jiangsu, a region where industry-education integration policies are actively promoted, making it an ideal setting to examine BIM education. This approach allows for a depth of analysis, enabling a detailed exploration of students' experiences, teachers' challenges, and industry needs within a single institution. While the case study is limited to one college, its findings may be applicable to other vocational institutions with similar educational and industry contexts, offering valuable insights for broader improvements in BIM education.

2.6 Summary

This study follows a pragmatic research paradigm, utilising a mixed methods approach within a case study framework. The pragmatic paradigm ensures a focus on practical applications, while the mixed methods approach enables a thorough understanding by integrating both quantitative and qualitative data. The case study approach allows for an in-depth exploration of a vocational college in Jiangsu, providing insights that may inform broader educational improvements. By adopting this methodology, the research aims to generate actionable recommendations for improving BIM-related vocational education, ensuring that students graduate with skills aligned to industry needs.

3. Sampling

This study employs a purposive sampling strategy to ensure that the selected participants provide relevant insights into the research objectives (Gentles et al.,

2015). The sample includes three key stakeholder groups: students enrolled in BIM courses, teachers responsible for delivering the course, and industry professionals working in the AEC sector. The selection criteria for each group are designed to ensure that the participants have direct experience with BIM education and its industry applications.

The student sample consists of 30 participants who are currently enrolled in BIM courses at the selected vocational college in Jiangsu. These students are chosen based on their direct engagement with the course, allowing them to provide informed perspectives on the curriculum, teaching methodologies, and practical training components. Their input is critical in understanding the strengths and challenges of the course from a learner's perspective. Within this group, a smaller subset of approximately six to eight students will participate in focus group discussions, enabling a more in-depth exploration of their learning experiences.

The teacher sample includes three instructors who are responsible for teaching BIM-related content within BIM courses. These educators are selected based on their teaching experience in higher vocational education, ensuring that they can provide insights into curriculum design, instructional challenges, and student engagement. While they are colleagues of the researcher, they do not belong to the same major, thereby reducing potential biases in their responses. Their participation is essential for evaluating pedagogical effectiveness and identifying potential improvements in course delivery.

The industry professional sample comprises five experts from the construction sector, including construction site engineers, project managers, and enterprise managers. These professionals are chosen based on their expertise in BIM applications and their familiarity with the skill sets required for graduates entering the workforce. Their perspectives help assess the extent to which BIM

courses aligns with industry needs, highlighting any gaps between vocational training and professional expectations. Their feedback is particularly valuable in recommending curriculum modifications that enhance employability.

The sampling strategy ensures that all three groups contribute distinct yet complementary perspectives to the research. Students provide firsthand accounts of their learning experiences, teachers offer insights into instructional challenges, and industry professionals evaluate the course's relevance to real-world demands. By integrating these viewpoints, the study aims to develop a comprehensive understanding of how BIM courses can be improved to better serve both students and industry stakeholders.

4. Ethical Considerations

This study follows ethical research principles to protect the rights and well-being of all participants. Informed consent will be obtained from all individuals before their participation. Students, teachers, and industry professionals will receive detailed information about the research objectives, data collection procedures, and their right to withdraw at any time without consequences. Confidentiality will be maintained by anonymising all personal identifiers in transcripts and reports, ensuring that participants cannot be linked to their responses.

Data security will be ensured through password-protected digital storage and restricted access to research files. Audio recordings from interviews and focus groups will be securely stored and deleted upon completion of data analysis.

Participants' responses will be used solely for research purposes and will not be shared outside the study context.

To prevent conflicts of interest, students involved in the study will not include those taught by the researcher, reducing potential power imbalances and ensuring honest feedback. Teacher and industry professional interviews will be conducted in a neutral setting, emphasising voluntary participation. The study will comply with institutional ethical guidelines and relevant national regulations on research ethics in education.

By adhering to these ethical principles, this study ensures that the research process is conducted with integrity, respecting the rights and dignity of all participants.

5. Research Tools

This study employs a combination of quantitative and qualitative research tools to collect comprehensive data on BIM courses in higher vocational colleges. The selection of research instruments aligns with the pragmatic research paradigm and mixed methods approach, ensuring a holistic understanding of student experiences, teaching effectiveness, and industry alignment (Chan, and Sher, 2014). The primary research tools include student questionnaires, focus group discussions, teacher interviews, and industry professional interviews. Each tool is designed to capture distinct yet interrelated perspectives, facilitating a well-rounded analysis of the course structure, pedagogical practices, and professional expectations.

5.1 Student Questionnaire

The student questionnaire is the primary quantitative instrument used to assess students' perceptions of the BIM courses. It includes a structured format with a mix of multiple-choice and open-ended questions, allowing for both statistical analysis and qualitative insights.

The questionnaire is designed to evaluate several key aspects of BIM courses, including the relevance of course content by assessing whether both theoretical and practical elements align with students' learning needs. It also explores student experiences with different teaching methodologies, such as lectures, hands-on practice, and digital simulations. The questionnaire examines the integration of BIM-related practical training within the curriculum and identifies challenges students face in understanding BIM concepts, using software, and applying industry practices. Additionally, it allows students to provide feedback on areas for improvement, offering insights into how the course could be enhanced.

The questionnaire is distributed electronically or in print, depending on accessibility and convenience. The collected data undergoes descriptive statistical analysis to identify patterns and trends, while open-ended responses are analysed thematically to extract key insights.

5.2 Focus Group Discussions

To gain deeper qualitative insights, focus group discussions are conducted with a subset of student participants. focus group discussions offer an interactive environment where students can share their experiences, discuss common challenges, and propose course improvements (O. Nyumba, et al., 2018). Each session follows a semi-structured format, guided by themes identified from the questionnaire responses.

The key topics discussed in the focus group include students' experiences with BIM learning, focusing on how they engage with the course material and

software applications. Participants will also reflect on the balance between practical and theoretical components, assessing the effectiveness of hands-on activities in developing BIM-related skills. The discussion will explore challenges and knowledge gaps, particularly difficulties in understanding BIM concepts and applying them to real-world scenarios. Additionally, students will share their perceptions of how well the course prepares them for employment in the AEC industry, considering industry expectations.

Each discussion is audio-recorded (with consent) and transcribed for thematic analysis, identifying recurring themes and unique insights from student experiences.

5.3 Teacher Interviews

Teacher interviews serve as a qualitative tool to explore instructors' perspectives on the effectiveness of BIM course delivery. Teachers provide insights into curriculum design, instructional challenges, student engagement, and industry relevance. These interviews follow a semi-structured approach, allowing flexibility while ensuring that key topics are addressed.

The interviews focus on evaluating the curriculum's effectiveness, determining whether the current syllabus meets both educational and industry standards. They also aim to identify instructional challenges, such as difficulties in teaching BIM concepts, softwares, and technical applications. The interviews assess student engagement, exploring participation levels and potential pedagogical strategies to improve motivation. Additionally, they examine the course's industry relevance, considering whether it adequately equips students with the skills necessary for employment in the AEC sector.

The interviews are conducted in person or online, recorded, and transcribed for qualitative thematic analysis, extracting key themes related to teaching effectiveness and areas for course enhancement.

5.4 Industry Professional Interviews

To evaluate the alignment of BIM courses with industry needs, interviews are conducted with five professionals from the construction industry, including construction site engineers, project managers, and enterprise managers. These professionals provide insights into the practical applications of BIM and assess whether vocational education adequately prepares students for the workforce.

The semi-structured interviews cover key areas such as industry requirements, focusing on the essential BIM skills and competencies expected from graduates. They also identify skill gaps, pinpointing areas where students may lack practical expertise or knowledge (Dearnley, 2005). The interviews assess whether the course content accurately reflects real-world industry practices and gather recommendations for improvement, including suggestions for modifying the course structure, adding practical components, or integrating new technologies.

Interviews are conducted in person or online, audio-recorded, and transcribed. Thematic analysis is employed to categorise industry insights into key findings that inform curriculum development.

5.5 Justification of Research Tools

Each research instrument is carefully selected to capture relevant stakeholder perspectives. The student questionnaire provides quantifiable data on BIM course effectiveness, while focus group discussions offer personal insights into learning experiences. Teacher interviews reveal pedagogical challenges and instructional methods, while industry professional interviews assess the course's real-world applicability. This multi-method approach ensures a comprehensive evaluation of BIM courses, leading to actionable recommendations for improvement.

The student questionnaire is effective for gathering standardised, large-scale data. It ensures consistency in responses, allowing statistical analysis to identify patterns in student perceptions. However, it may lack depth, as structured responses often fail to capture the complexity of students' experiences, and the response rate may be biased if only motivated students participate.

Focus group discussions provide rich qualitative data, allowing students to share opinions in an interactive setting. This dynamic approach uncovers points that structured questionnaires may overlook, offering insights into student engagement and expectations. However, focus group discussions may suffer from dominant voices influencing the discussion, and group conformity may hinder honest feedback (O. Nyumba, et al., 2018). Analysing multiple discussions is also a time-consuming work.

Teacher interviews offer expert perspectives on curriculum effectiveness and teaching challenges. Their insights are valuable in identifying pedagogical strengths and weaknesses, as well as constraints in integrating BIM technologies. However, teacher interviews may be biased, as educators might hesitate to critique their methods. The small sample size may not fully represent all instructors' experiences, but triangulation with student and industry feedback balances this limitation.

Industry professional interviews provide insights into the real-world applicability of BIM education and identify potential skill gaps in graduates. These interviews help bridge the gap between education and employment, but industry professionals may not be familiar with the specific curriculum, leading to broad feedback. Variability in industry expectations may also pose a challenge, but interviewing professionals from different roles ensures a comprehensive view.

The integration of multiple research tools enhances the validity and reliability of the study by triangulating data from diverse sources. Each tool's strengths complement the others, providing a well-rounded, actionable understanding of BIM courses in higher vocational colleges.

6. Data Analysis Methods

The data collected from the student questionnaire, focus group discussions, teacher interviews, and industry professional interviews will be primarily analysed using thematic analysis, which is well-suited to this research's focus on understanding stakeholder perspectives in detail. The quantitative data from the student questionnaire will provide contextual background, while the core analysis will focus on the qualitative data collected from the interviews and focus groups.

6.1 Quantitative Data Analysis

The quantitative data from the student questionnaire will be used to gather basic information regarding students' engagement with different course elements. For example, students will be asked about how much time they are willing to dedicate to various online resources related to the course. These responses will be summarised using simple descriptive statistics, such as frequency counts, to provide an overview of students' behaviours and preferences (Hossan, Dato'Mansor, and Jaharuddin, 2023). The quantitative data will help

contextualise the qualitative findings but will not be the primary focus of the analysis.

6.2 Qualitative Data Analysis

The primary focus of the data analysis will be on the qualitative data gathered from the focus group discussions, teacher interviews, and industry professional interviews. Thematic analysis will be employed to identify and interpret patterns or themes across the data. This method allows for a detailed exploration of participants' perspectives on the BIM course, such as their perceptions of course content, teaching methods, and practical applications.

The process will involve several stages, starting with data familiarisation, where all interview and discussion transcripts will be thoroughly reviewed to gain a deep understanding of the data. Significant segments of text will then undergo initial coding, where key ideas or concepts are captured (Vaismoradi, Turunen, and Bondas, 2013). These codes will be grouped into broader themes, such as teaching challenges, alignment with industry needs, and gaps in practical training. Finally, the themes will be refined and reviewed to ensure they accurately reflect the data, ensuring a comprehensive analysis of the findings.

6.3 Strengths and Limitations of Thematic Analysis

Thematic analysis is flexible and allows for a deep, contextualised understanding of participants' experiences, making it ideal for this research. However, its main limitation lies in the subjectivity of theme identification, which can introduce researcher bias (Kushnir, 2025). This will be mitigated through peer review and validation with participants. The method also does not quantify the prevalence of themes but provides rich, qualitative insights into the BIM courses' strengths and areas for improvement.

7. Conclusion

This research aims to enhance the design of BIM courses in higher vocational colleges by exploring students' experiences, teachers' perspectives, and industry professionals' needs. Through a mixed-methods approach, the study will provide valuable insights into course effectiveness, guiding improvements that align with educational goals and industry demands for digital construction skills.

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