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Implementation of Integrated Learning Model in Construction Structure and Construction Management Courses

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ABSTRACT

This study aims to explore the application of an integrated learning model in the Construction Structure and Construction Management course, and examine how the model can improve students' readiness in using real-time data that is relevant to the needs of the construction industry. This study uses a qualitative descriptive approach with an integrated learning study method. The research location is in the Civil Engineering Study Program, Darul 'Ulum Islamic University, Lamongan. The research subjects consisted of lecturers and students who were taking related courses. This learning model was implemented through six main stages: introduction to theory, technology integration, real-time data-based project simulation, cross-disciplinary collaboration, data-based decision making, and evaluation. The results showed that students gained a better understanding of the relationship between theory and practice, and began to get used to processing and analyzing data in the context of project decision making. However, limited access to technology and lack of technical training are major challenges. The implications of these findings emphasize the importance of providing supporting infrastructure and strengthening cooperation with industry so that learning is more contextual and applicable.

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1. INTRODUCTION

In the world of higher education, thorough preparation for students to face future professional challenges is an urgent need (Rieckmann, 2012). One way that can be done is by combining various approaches in the learning process, such as through the application of an integrated learning model. This integrated learning model provides students with the opportunity to integrate various knowledge and skills acquired in various subjects (Harr, Eichler, & Renkl, 2015). In the context of higher education in the field of civil engineering, one of the subjects that has great potential to be applied is the subject of Building Construction Structures and Construction Management (Salmisto & Nokelainen, 2015).

The subjects of Construction Structures and Construction Management not only require a deep understanding of theory, but also practical skills in managing construction projects and understanding complex building structures (Fewings & Henjewele, 2019). Therefore, the application of an integrated learning model is very important to prepare students to face the challenges of the world of work that increasingly relies on the use of real-time data (Syafei & Zam'an, 2024)(Mustikaningsih & Fahrudin, 2024). By integrating concepts from construction structures and construction management in one series of learning, students can better prepare themselves in facing the dynamics of the fast-paced and technology-based construction industry (Carina & Marji, 2024).

Although civil engineering students have been equipped with various theories and practical skills during their studies, in reality many of them are not fully prepared to face the demands of using real-time data when they enter the world of work (Lindsay & Morgan, 2021), (Rendo, Supardi, & Nisanson, 2023). One of the main challenges is the lack of in-depth understanding of how to utilize the latest information technology in the context of construction project management that requires fast and accurate decision-making based on constantly changing data (Camngca, Amoah, & Ayesu-Koranteng, 2024). Most of the learning processes during lectures still focus on case studies or simulations that do not fully reflect the dynamics and complexity of real-world situations (Nazib & Hasanah, 2025). In addition, limitations in mastering software and construction management systems based on real-time data are also factors that hinder student readiness (Omrany et al., 2025). This risks making it difficult for students to adapt quickly when faced with field situations that require them to respond to changes and challenges directly using data that is available instantly (Hanim & Ahlas, 2020).

Several problems that often arise related to students' readiness to use real-time data in the workplace, especially in the construction sector, can be identified in various aspects. First, there is a gap between the theory taught in lectures and real-world practices faced in the field (Yiao, Yokokawa, & Majd, 2024),(Angelita & Sohidin, 2024),(Febriza, 2025). Courses that teach construction structures and construction management often do not cover the use of the latest technology, such as cloud-based project management information systems or real-time project monitoring software that are now widely used in the industry (Matthews et al., 2015). Second, students also tend to be less trained in accessing and analyzing rapidly changing data, as well as in making decisions based on accurate and up-to-date data (Valickas, Valickiene, & Grakauskas, 2015),(Hastini, Fahmi, & Lukito, 2020). In addition, the lack of cross-disciplinary collaboration in lectures makes students unaccustomed to working in teams that integrate various types of data from various sources (Anderson, 2017). As a result, when entering the workforce, students often find it difficult to operate the tools or platforms used in the industry, which has the potential to hinder the effectiveness and efficiency of construction projects (Arham et al., 2024), (Gunawan, Nafisah, Husna, & Mulyanah, 2025).

The selection of the problem studied in this article focuses on the implementation of the Integrated Learning Model in the subjects of Construction Structure and Construction Management, with the aim of improving students' readiness in using real-time data. This problem was chosen because of the significant gap between theoretical learning in college and practical needs in the construction industry which is increasingly dependent on the latest information technology and data. Several studies have raised the issue of the gap between education and the demands of the world of work, such as Pramesti's research (Fajari, Saputra, Berlinson, & Parhusip, 2024) which examines the relevance of informatics-based curriculum by collaborating between universities and the world of work, Azelia's research (Azelia & Azzahra, 2024) examines the gap between university graduates in Indonesia by analyzing the MSIB program, Suryana's research (Suryana, 2024) examines the practical experience of students by presenting industry practitioners in the learning process so that they are better prepared when they graduate from university, Laksmi's research (Laksmi, 2024) examines the obstacles to the gap in legal education in universities by conducting training and professional development, Angelita's research (Angelita & Kuswanto, 2025) examines the gap between higher education and industry needs by conducting internal MBKM. Based on this research, there has been no research that examines integrated learning by combining two subjects as a form of initial implementation of BIM in real time. In the

workplace, the use of real-time data is very important to monitor project progress, identify potential risks, and make timely decisions to ensure the success of construction projects (Rao et al., 2022). By integrating various disciplines in one integrated learning model, it is hoped that students will not only understand the technical aspects of building structures and construction management, but also be able to implement information technology in managing projects efficiently. Therefore, this study aims to explore how an integrated learning model can prepare students to be better prepared to face industry challenges that require skills in using real-time data.

Several previous studies have examined the application of integrated learning models in engineering education, especially in subjects related to construction and project management. Research by Fathoni (Fathoni, Prasodjo, Jhon, & Zulqadri, 2023), for example, found that the application of integrated learning that combines building structure theory and construction management can improve students' understanding of the importance of integration between the two aspects in construction practice. In addition, research by Azmi (Azmi, Mansur, & Utama, 2024) shows that the use of technology in learning, such as real-time data-based simulations, can accelerate the process of students adapting to the needs of the technology-based industry. They found that students involved in learning that integrates real-time data-based project management software are better prepared to face dynamic and complex field situations. The results of this study indicate that learning that integrates theory and technology not only improves knowledge, but also practical skills that are much needed in the world of work, especially in terms of decision making that relies on data available in real time. Based on the background and previous findings, this study specifically aims to explore the effectiveness of integrated learning models in improving the readiness of civil engineering students to use real-time data in the subjects of Construction Structures and Construction Management.

2. METHODS

This study uses a descriptive approach with qualitative methods to explore the implementation of an integrated learning model in the subject of Construction Structure and Management. This approach was chosen because it allows researchers to understand the phenomenon contextually and comprehensively based on the perspective of the subjects involved, especially in the context of students' readiness to face the challenges of the construction industry world based on real-time data.

The subjects of this study were students of the Civil Engineering study program at Darul `Ulum Islamic University Lamongan who were taking the Construction Structure and Construction Management course. In addition to students, the lecturers who teach the course are also important subjects to get the teacher's point of view regarding the implementation of this learning model. In addition, researchers also involved lecturers who teach the course to get perspectives regarding the implementation of this model in class. The object of the study is the implementation of an integrated learning model in the context of using real-time data in the learning process.

The data sources used are primary data and secondary data. Primary data were obtained through in-depth interviews and direct observation. Secondary data were obtained from documentation studies. Data collection techniques were carried out using: (a) interviews, interviews were conducted in a semi-structured manner to provide flexibility in exploring topics. Interviews were conducted directly on campus and recorded with the consent of the informant. In this study, the main informant was 1 lecturer teaching the Construction Structure and Management course, additional informants were 6–8 students selected based on the criteria of active involvement in class, consistent attendance, and participation in tasks related to the use of real-time data; (b) observation, the locus of observation was the classroom of the Faculty of Engineering, Darul `Ulum Islamic University, Lamongan. Observations were conducted during several lecture sessions. The researcher used a structured observation sheet that included several indicators, including the level of student involvement in data-based discussions, the use of real-time data software or technology (BIM devices, spreadsheets, or project management software), interaction between lecturers and students in data-based problem

solving, application of real-time data in assignments or case studies; (c) documentation, documents analyzed include Semester Learning Plans (RPS), teaching materials, and learning evaluation records.

Data obtained from interviews, observations, and documentation studies were analyzed using thematic analysis techniques. The analysis process begins with data reduction, namely sorting and filtering information that is relevant to the focus of the research, especially those related to the implementation of integrated learning models and the use of real-time data in learning. Furthermore, the reduced data is coded or labeled to identify important pieces of information. These codes are then grouped into main categories or themes, such as the effectiveness of the integrated learning model, the level of student readiness in using real-time data, and the challenges or obstacles that arise during the learning process. From the results of this categorization, researchers compile data interpretations and draw conclusions to comprehensively describe the phenomena studied.

To ensure the validity and credibility of the findings, this study applies data triangulation techniques. Triangulation is carried out by combining various data sources, namely from lecturer interviews, student interviews, direct observations in class, and analyzed learning documents. In addition to source triangulation, technical triangulation is also used, namely comparing the results of interviews, observations, and documentation to find the appropriateness and consistency of information. Researchers also carry out additional validation processes through member check techniques, namely by returning a summary of the interview results or initial interpretations to informants to ensure that the information recorded is in accordance with their experiences and views. Through this process, it is hoped that the data produced is valid and can be scientifically accounted for.

3. FINDINGS AND DISCUSSION

Findings

From the results of the research conducted, it was found that the application of classical learning methods often has difficulty in contextualizing the material taught with the conditions of the working world that continue to develop in real time. In the traditional approach, the material is delivered theoretically without providing an opportunity for students to face real situations or rapid changes as they occur in the field. This makes students less prepared to adapt and apply their knowledge when facing the dynamics of the working world which is full of uncertainty and continuous change. Project-based learning or real-time data-based simulations are more relevant solutions, because they allow students to experience firsthand how to manage problems and make decisions based on current information that is similar to the challenges faced by professionals in the industry.

Seeing the challenges faced by classical learning methods in contextualizing material with the increasingly dynamic world of work, lecturers began to consider trying other learning models. The integrated learning model, combining theory with practice more comprehensively, allows students to not only understand basic concepts, but also apply them in real situations. By using an integrated approach, students can collaborate on projects involving various disciplines and real-time data, so that they are better prepared to face real challenges in the industry. Lecturers, as facilitators, can create more relevant and in-depth learning experiences, which directly connect classroom learning with the needs and complexities of the world of work. This is known through interviews with lecturers and students as follows:

> "Integrated learning in class does provide students with a more holistic understanding of the relationship between building structures and project management. However, in terms of using real-time data, we often face limited facilities. Some tools used for real-time data-based project monitoring have not been fully integrated into learning, so some still use manuals such as cloud usage. Students actually understand managerial concepts, but they have not been fully trained to use them in a more practical context in the field. Therefore, a learning stage is needed to introduce students to real-time data-based projects such as those in the real world of work." (Wr-D-A/ PM:1-3/KT-PK).

"Compared to the previous regular learning, this integrated learning provides many benefits, because I can see the direct connection between structural design and how to manage a project properly through the stages guided by our lecturers." (Wr-M-A/ PM:1-3/KAT-SDR).

Figure 1. Implementation of Interviews and Observations with Lecturers and Students

Based on the results of interviews and observations with lecturers and students, it can be concluded that the implementation of the integrated learning model in the Construction Structure and Construction Management subjects includes several stages, including (1) the stage of introducing basic concepts and theories, (2) the stage of integrating technology into learning, (3) the stage of simulating construction projects based on real-time data, (4) the stage of cross-disciplinary collaboration, (5) the stage of making decisions based on data, and (6) the stage of evaluation and feedback.

Introduction to Basic Concepts and Theories

This stage builds the students' basic understanding of the basic concepts in Building Construction Structures and Construction Management, as well as the importance of using data in decision making.

"Understanding the basic concepts in Construction Structures is very important for students because it is the foundation for them to design and manage construction projects well. Basic concepts such as material types, construction methods, and load calculations must be mastered so that students can make the right decisions during the planning and implementation process of the project. Without a solid understanding of structures, construction project management can be hampered and even risky." (Wr-D-A/PM:1-3/TDSK-TDMK).

"Learning these basic concepts is very important because it is the foundation of all further courses. For example, if we do not understand construction design and basic structures well, how can we design safe buildings? Likewise with construction management, if we do not understand the basics of planning and resource management, how can we manage projects well in the future? I think these basic concepts are very crucial to build a deep understanding and so that we are ready to face more complex challenges in the next stage." (Wr-M-B/PM:1-2/TDSK-TDMK).

Based on the results of the researcher's observation study, in the early stages, students were introduced to basic theories related to construction structures and project management. Lecturers delivered materials covering various types of building structures, construction planning and design, and managerial aspects in project management. In addition, students were given an understanding of the importance of real-time data in construction projects, as well as how this data can influence fast and accurate decision making.

Technology Integration in Learning

This stage enhances students' understanding of the use of technology and software to monitor, analyze, and manage construction projects with real-time data.

> "Overall, I found the students very enthusiastic and engaged in the simulation. They started to think more critically about the decisions they made and their impact on the overall project. It gave them a real picture of how the theories they learned in class can be applied in a real-world context. The simulation also helped them understand the importance of communication and teamwork, because in a real construction project, project management involves many parties who must collaborate effectively." (Wr-D-A/PM:1-3/ITP).

> "The biggest challenge for us is how to manage very rapid changes. For example, there are some problems that suddenly appear, such as limited resources or a budget that has increased. We have to immediately respond to these changes and make adjustments, both in terms of budget and time. Using software to monitor real-time data is very helpful, but still, making decisions quickly and accurately is not easy." (Wr-M-A/PM:1-3/ITP).

Based on the results of the researcher's observation study, at this stage, students are taught how to integrate technology into project management. Learning will include an introduction to software used in the construction industry, such as software for project progress monitoring, risk analysis, and real-time data-based resource planning. Students are given practical training to operate devices such as Excel and SAP that are connected to a cloud system, allowing them to access and use current data in project management.

Real-Time Data-Driven Construction Project Simulation

This stage provides students with practical experience in managing construction projects using ever-evolving data.

> "Of course. Real-Time Data-Based Construction Project Simulation is a learning method that aims to provide students with practical experience in managing real construction projects. At this stage, students work in groups to plan and manage construction projects that they have previously studied. Through this system, they can monitor project progress directly, such as budget data, resources, and schedules. Students are then asked to make decisions based on existing data, such as schedule adjustments, budget management, and resource allocation. This reflects the dynamics that occur in the real world, where things can change quickly and require timely responses." (Wr-D-A/PM:1-2/SPK-DRT).

Based on the results of the researcher's observation study, at this stage, students are invited to participate in a construction project simulation that reflects the real situation in the field. In this simulation, they work in groups to plan and manage a construction project, using real-time data obtained through previously taught devices. Students are asked to make decisions based on current data, such as schedule adjustments, budget management, and resource allocation based on project progress monitored in real time.

Cross-Disciplinary Collaboration

This stage develops students' abilities to work collaboratively across multiple disciplines in construction project management.

> "This experience is very valuable because we work in a team consisting of each role, such as project manager and structural engineer. We are asked to manage a construction project. The most

challenging thing is how we have to communicate and collaborate with each other to achieve the same goal, even though we have different perspectives and expertise. For example, structural engineers focus more on the design and strength of the building, while I as a project manager have to think about the budget and time. We have to keep discussing to find the best solution, which does not only pay attention to one aspect, but the entire project." (Wr-M-C/PM:1-2/KLB-MK).

Based on the results of the researcher's observation study, the integrated learning model not only includes technical skills in building structures, but also managerial skills in managing projects. At this stage, students are trained to work in teams consisting of various roles, such as structural engineers, project managers, and information technology experts. Through this collaboration, they learn how to manage projects holistically, use real-time data to communicate with various parties involved, and make appropriate decisions based on available information.

Data-Driven Decision Making

This stage improves students' skills in making quick and accurate decisions based on ever-growing data.

"This experience was very interesting and challenging. We were given a case study where we had to evaluate current project data and make very important decisions. For example, we were given information about a delay in material delivery that would affect the project schedule. We were also given limited budget data and had to make a decision whether to increase costs to speed up material delivery or adjust the schedule with less cost. This process really honed my skills in making quick and accurate decisions, especially considering many interrelated factors." (Wr-M-B/PM:1-2/PK-MK).

Based on the results of the researcher's observation study, students are faced with various situations that require real-time data-based decision making. Lecturers provide case studies or field situations that require students to evaluate current data and make decisions about schedule changes, budget allocations, or resource re-planning. This process teaches students to act responsively and accurately in dealing with problems that arise in construction projects.

Evaluation and Feedback

This stage assesses the extent to which students can apply the knowledge and skills they have learned in real situations and provide feedback for improvement.

"The main focus of this evaluation is the students' ability to integrate real-time data into decision-making. We want to see how they analyze existing data, make decisions based on current facts and data, and how they deal with challenges or problems that arise in the simulation. We also assess their ability to communicate, both through written reports and presentations, to explain the decisions made and the reasons behind them. Lastly, we pay attention to their creativity and ability to think critically in planning efficient solutions." (Wr-D-A/PM:1-3/UB).

Based on the results of the researcher's observation study, at the end of the learning, students are evaluated based on their performance in a project simulation involving the use of real-time data. The evaluation is in the form of an assessment of the project report, presentation of decisions taken during the simulation, and the ability to utilize data to solve problems faced. The lecturer will also provide feedback on the decision making made, as well as provide suggestions to improve students' skills and understanding in using real-time data in the future (Ariarta, Mu'in, Latif, Saadah, & Harini, 2024).

Discussion

The results of this study indicate that the application of an integrated learning model in the Construction Structure and Construction Management course provides a significant contribution to improving students' readiness to face the challenges of the construction industry, especially in terms of using real-time data. This finding supports Vygotsky's (Vygotsky & Cole, 1978) constructivism theory, which emphasizes the importance of learning through direct experience and social interaction in a real-world context. The integration of theory and practice through project simulations and the use of real-time data-based software allows students not only to understand concepts but also to internalize complex decision-making processes based on actual data.

In this context, the use of technology in the learning process has proven to be a factor that strengthens the connection between academic learning and industry needs. This is in line with the results of research by Simic (Simic, Leible, Schmitz, Gücük, & Kučević, 2023), which confirms that the integration of digital technology in engineering education can accelerate the learning process and improve understanding of field practices. However, even though students have shown a fairly good mastery of theory, challenges still arise when they are faced with significant differences between technology systems on campus and in industry (Sari & Priatna, 2020), (Mieslenna & Wibowo, 2019). This indicates the existence of "asynchronous competencies", where the curriculum is not fully responsive to the dynamics of industrial technology. As stated by Roddy (Roddy et al., 2017), this technological gap can hinder the transition of graduates from the classroom to the workplace, if not balanced with adequate practical training.

Furthermore, simulation-based learning that combines real-time data has been shown to provide concrete benefits in building data-driven decision-making skills. Students are trained to evaluate and respond to project scenarios with constantly changing data, reflecting real conditions in the field. However, the effectiveness of this approach is highly dependent on the availability of facilities and access to the latest technological devices. This finding reinforces Collins' (Collins & Halverson, 2018) view that technological infrastructure constraints can be a major obstacle in implementing simulation-based learning, especially in institutions with limited resources.

From a collaborative aspect, this integrated learning model also encourages the formation of cross-disciplinary work skills, which are one of the core competencies in modern construction projects (Satar et al., 2024), (Pare & Sihotang, 2023). Collaboration between students with different interest backgrounds creates a more realistic learning situation, similar to the team structure in complex industrial projects. This is in accordance with the results of the Ananda study (Ananda & Abdillah, 2018), which highlights the importance of integrating cross-disciplinary learning to form graduates who are adaptive and able to work in multidisciplinary teams. Communication, coordination, and conflict management skills are soft skills that are naturally formed in this collaborative learning environment (Aini, 2024), (Caeiro-Rodríguez et al., 2021).

Overall, the results of this study confirm that the integrated learning model is able to bridge the gap between education and the industrial world, especially in the context of utilizing real-time data. However, the positive impact is not maximized if it is not supported by improved technological infrastructure, ongoing technical training, and strategic partnerships between universities and industry. Therefore, there needs to be a reorientation of the curriculum and strengthening of the learning ecosystem that is more responsive to the development of industrial technology, so that graduates are truly ready to enter a data-based and high-tech work environment.

4. CONCLUSION

Based on the results of the research and discussion that has been conducted, it can be concluded that the implementation of an integrated learning model in the subject of Building Construction Structure and Construction Management has a positive impact on students' readiness to face the challenges of the world of work, especially in the use of real-time data. This learning model successfully integrates theoretical and practical concepts, giving students a better understanding of the relationship

between construction structures and data-based project management. However, there are still obstacles in terms of limited technology and adequate technical training, which hinder students' mastery of real-time data-based project management software. Therefore, to improve student readiness, improvements need to be made in terms of providing better technology facilities, intensive training in the use of these devices, and strengthening collaboration with industry so that students can gain real experience in managing construction projects based on real-time data.

As a recommendation for further research, it is suggested that a longitudinal study be conducted to evaluate the long-term impact of the implementation of the integrated learning model on graduate performance in the workplace. In addition, comparative research between educational institutions that have different levels of technology access is also important to identify supporting and inhibiting factors in the implementation of real-time data-based learning. Future research can also focus on the development of technology-based adaptive curricula and studies of the effectiveness of industry-based technical training to maximize student readiness to face the era of digitalization in construction.

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