Project-based Learning in Timber Engineering Education: A Recent Example

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This opinion paper advocates for project-based learning (PBL) and teaching as a way of preserving active learning in timber engineering education. A recent example of using PBL in a timber engineering course is presented. Its strengths and associated challenges are briefly highlighted, and some suggestions are provided for the adoption of such approaches.

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Introduction

Project-based learning (PBL) is a teaching method that enables students to learn new knowledge, practical skills, and concepts by active engagement in a real-world project (see *e.g.*, Frank *et al*. 2003; de Los Rios *et al*. 2010; Guo *et al*. 2020). In the context of timber engineering education, using PBL approaches, students are challenged to apply theoretical concepts to a practical design problem. This can include several components, including structural design analysis, fabrication, mechanical testing, and analyzing test results of various timber building members. Such an experiential learning process can promote creativity and help students to further develop their problem-solving skills. Although PBL is not a new concept, its adoption in certain teaching practices can be challenging, especially in large classes where PBL might, in some cases, be time-consuming and require significant additional effort from the lecturer.

There are various methods by which PBL can be applied in higher education. The outcome of each method could be unique and dependent on several factors, especially on the lecturer's skills and familiarity with PBL. This editorial presents a recent example where PBL has been combined with lectures and tutorials in a timber engineering course. The strengths and associated challenges of this approach are highlighted, and some suggestions are provided for implementation of such approaches.

Example of PBL in a Timber Engineering Course

The overall structure and topics of a recent timber engineering course where PBL is combined with conventional lectures and tutorials is illustrated in Fig. 1. This course, under the title of Wood Design and Structural Analysis, was led by the author at the University of Primorska, Slovenia. The content of this course had to be designed in a way that it can suit master's students from two different curricula, *e.g.*, Civil Engineering and a non-engineering program in Wood Technology.

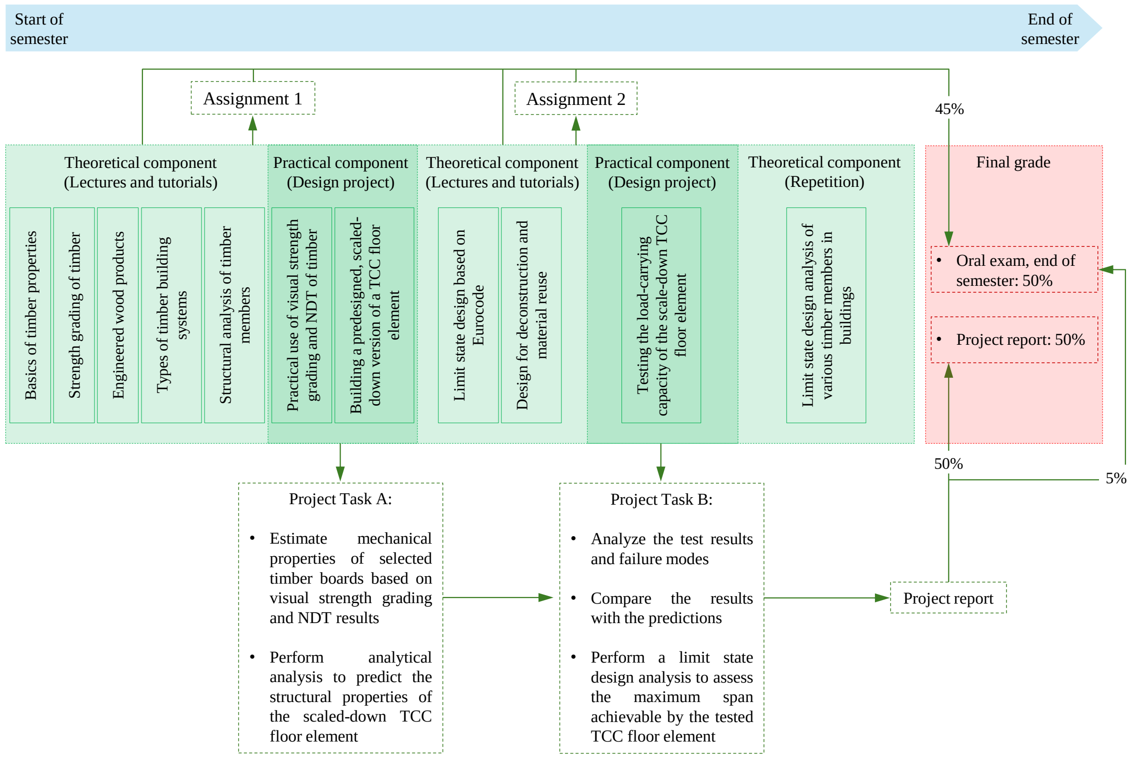

Fig. 1. Details of a timber engineering course in which PBL is implemented

The examination of student learning in this course is comprised of 50% practical project report and 50% oral exam, such that there is no paper-based exam. The lectures and tutorials of the course are aimed to familiarize students with the theories and design concepts around the use of timber in building construction. Two general assignments are given to students during the semester. These assignments cover any topic that is not already included in the practical projects. The assignments are supposed to be solved and then delivered and described in detail by students during the oral exam, which is held individually at the end of semester. During the semester, each student is assigned a unique practical project on a certain subject. The practical project is performed in two steps and each step has its own smaller tasks (Fig. 1). In the example shown in Fig. 1, the practical project is related to material selection, design, fabrication, mechanical testing, and analytical analysis of a timber-concrete composite (TCC) floor element. TCC is chosen here as it not only covers material-related design factors, but also covers factors related to design and structural performance of connection systems. Nevertheless, other structural members or a combination of members can also be used instead of TCC.

To complete the practical project, the students first need to use their knowledge of strength grading and non-destructive testing (NDT) of timber, which they acquire during the lectures and tutorials, to select some timber boards for their projects. They then use these timber boards to produce a scale-down version of a TCC floor element in groups of two or more students (with each group producing one TCC floor element with a unique design). The initial design of the TCC floor element is provided by the lecturer, which intentionally contains some flaws or imperfections (Fig. 2).

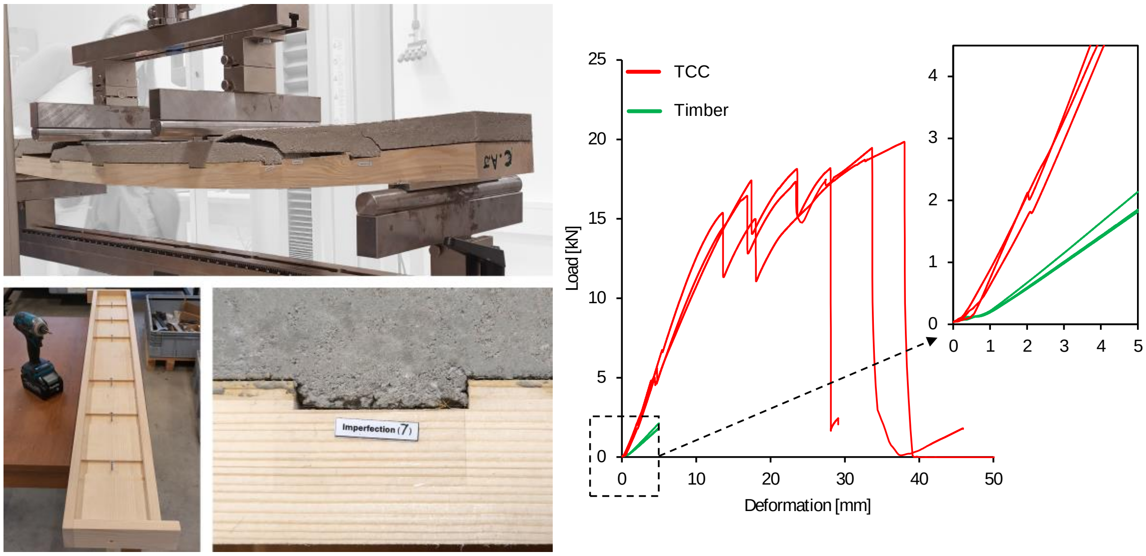

Fig. 2. An example of the scaled-down TCC elements with intentional imperfections (left) and their test results (right) produced and tested by students

After the fabrication of the TCC elements, the students are tasked to estimate the structural properties of the TCC elements by use of analytical methods. In the next step, they test the load-carrying capacity of the TCC elements under bending loads, analyze the effect of flaws and imperfections on the test results, compare the test results with their analytical analysis, analyze and elaborate on the observed failure modes, and perform a complete limit state design analysis to evaluate the maximum span achievable by the tested TCC elements in an office building. Finally, they will write a project report and then deliver and describe the details of their project report during the oral exam.

Strengths and Challenges of PBL

Potential strengths and related challenges of the PBL approach presented in this paper are summarized in Tables 1 and 2. The statements in these tables reflect the author’s viewpoint.

Table 1. Strengths of the Presented PBL Approach

Strengths	Creating an active classroom environment and allowing students to apply theoretical concepts to real-world timber engineering design problems.
	Developing hands-on skills while performing various stages of the practical projects (*e.g.*, how to use NDT equipment or TCC fabrication tools, *etc*.).
	Learning about research methodologies in timber engineering, which might be beneficial for students’ future occupations.
	Enhancing students problem-solving abilities and preparing them for real-world scenarios in timber engineering.
	Reducing students use of AI-generated content and promoting authentic learning experiences and critical thinking skills.
	Enabling the possibility of tailoring practical projects to individual students, or groups of students, which could be specifically useful where students come from various backgrounds and various levels of understanding of engineering concepts.

Table 2. Potential Challenges of the Presented PBL Approach

Challenges	Combining PBL with lectures and tutorials can be time-consuming and demanding. This might be especially challenging when managing laboratory activities as part of the practical projects in large classes.
	Additional resources and equipment will be required for the experiments in the practical projects, which could be challenging in small or resource-constrained institutions.
	It can be challenging to design individualized projects while ensuring fairness in terms of difficulty level and assessment criteria. On the other hand, if practical projects are not individualized, then there might be less confidence in or control over the originality of the project reports.
	If the paper exam is replaced with PBL assessment methods, a high level of consideration is required to ensure comprehensive evaluation of student learning outcomes. *
* PBL assessment methods can also be used without eliminating the paper exam.	

Suggestions

The following suggestions are provided for the implementation of the PBL approach presented in this paper:

- Industry partners can help by allocating materials, equipment, or assistance.
- Lecturers can seek pedagogical assistance to integrate PBL into their teaching.
- Students can be assigned specific tasks within their team activities.
- Optionally, a written exam can be included in the course, or an oral exam can include some items that would have been likely covered in a written exam.

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