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THE CURRENT TRENDS IN CIVIL ENGINEERING EDUCATION

Jelena M. Andrić[1], PhD; Aleksandar Pujović, MSc
[1] Xi'an Jiaotong-Liverpool University, Suzhou, CHINA, Jelena.Andric@xjtlu.edu.cn
[2] Western Serbia Academy of Applied Studies, Užice, SERBIA, aleksandarpujovic@gmail.com

Abstract: *Civil engineering is a specific discipline in education due to the complexity of requirements and the rapid technological changes in practices. The importance of civil engineering education is to provide the well-being of society, socio-economic development and improve the quality of life. On the other hand, programs in civil engineering can be complex and challenging since they require knowledge from many different fields such as mathematics, mechanics, structural analysis and others. As a result, students show less motivation during the class to participate and engage in the learning process. Using Schon's reflection model on teaching experience in civil engineering programs and architecture programs, it can be observed that sometimes there is a lack of student motivation to participate in classes actively. This paper investigates different strategies as a solution to motivate students to engage in class instead of being passive participants in the teaching process. To enhance teaching experience, a review of the current trends in teaching in the civil engineering field is conducted. The results show two different strategies for motivating students to participate in the learning process: problem-solving and gamification. The problem-solving approach is based on solving practical engineering problems with teacher guidance, through which students obtain the necessary skills and knowledge. Gamification can be shown as using game design elements to improve the learning experience.*

Keywords: *reflection, motivation, civil engineering education, problem-solving approach, gamification*

1. INTRODUCTION

Civil engineering is a specific discipline in education due to the complexity of requirements, and it is directly associated with people compared to other engineering disciplines [1]. Specifically, civil engineering is based on the basics of mathematics, mechanics, statics, structural analysis, soil mechanics, geotechnical engineering, fluid mechanics, design, material science, construction methods, planning, cost control, uncertainty and risk, and sustainability [2, 3]. Furthermore, civil engineering education focuses on the entire lifecycle of a construction project [4]. The rapid changes due to the novel technological discoveries and practices add to the complexity of civil engineering education [5].

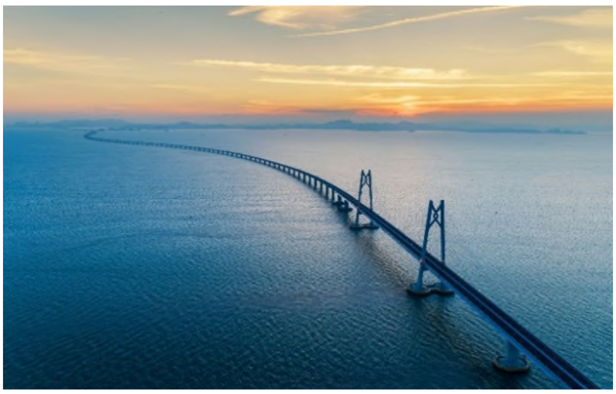

Figure 1: Megaprojects in China (Hong Kong – Zhuahai – Macau bridge on the left and Shanghai Tower on the right)

The current requirement of civil engineering education is to meet the challenges in the 21st century and to prepare graduates for complex mega and giga projects (Figure 1). Overall, the importance of civil engineering and architecture education is to provide society's well-being, contribute to socio-economic development and improve citizens' quality of life. Progressively, the demand for well-educated and well-trained graduates in the construction industry is increasing. Accordingly, graduates must be qualified to become productive workers [4]. Since the construction industry is competitive, it is essential to identify the key skills of graduates to meet the expectations and needs of their employers. After graduation, there are various employment opportunities for civil engineers and architects in contractor companies, designer companies, consulting agencies, contracting agencies, clients, and developers.

For some complex projects, innovative technical and technological solutions would be requested in order to complete the project. Currently, in the construction industry, there is a trend of developing international construction projects that also need the adequate professional skills of team members. Since international projects consist of project teams that are geographically distributed due to the different origins of the owner, designers and contractor companies, their members should be ready for such ventures. Civil engineers, construction managers and architects need to be prepared to work in a multinational team, to develop cross-cultural collaboration and communication skills, multinational team management skills, to overcome difficulties caused by different knowledge and skill levels of team members, to become familiar with construction materials, standards, and construction methods in foreign countries and diverse access to information and technologies and difference in time zones [35].

On the other hand, civil engineering programs can be challenging and complex due to the high requirements of knowledge of mathematics, mechanics, structural analysis and other [6]. Hence, this can be one of the factors that engineering students are usually less motivated in classes [7]. Secondly, students are used to a teacher-centred style of teaching. Also, studies have shown that educators in engineering are more likely to adopt a teacher-oriented style [9, 13].

Therefore, this paper aims to contribute to the pedagogy by reviewing the current trends in civil engineering education in other parts of the World and comparing them with the teaching style in Serbia to find a suitable teaching strategy to enhance students' motivation. In pedagogy, motivation for the study is described as a psychological force that directs behaviour toward effective student learning [8]. By Schon's reflective model in pedagogy, the teaching process in classes for civil engineering and architecture students is reflected, and the issue of students' lack of motivation to be actively involved in the teaching process, especially in teaching Modules like Concrete structures, is detected. Further, a comprehensive literature review is carried out to identify the possible teaching strategies that can contribute to improved motivation during the class.

2. PROBLEM STATEMENT

Generally, lecturers in engineering fields are more likely to choose a teacher-centred approach, which aligns with previous studies' findings [9, 10, 11]. The teacher-centred approach focuses on the teacher's key role in transmitting knowledge and sharing knowledge with their students, who are the passive receivers of teaching content [12]. This style of teaching is common in South-Eastern Europe. For example, the teaching methods at Serbian Universities are focused on the traditional teacher-oriented approach, where the teacher passes knowledge to students, and student participation in the learning process is limited [13]. Also, China is well-known for its traditional style of teaching and learning, which was influenced by the Confucian attitude toward education [14, 15, 16]. According to the Confucian teaching attitude, students are more passive during class and receive the teaching content (Figure 2). As a result of the traditional teaching style, it is noticed that students applied a surface-level process as an approach to learning from the class. The surface-level learning process is shallow since a student directs his attention toward learning content just to memorise it and further reproduce it [17]. This is an issue in the modern education system. To motivate students, the current trends in civil engineering education are reviewed to detect suitable strategies for engaging students in the classroom.

Figure 2: Confucius teaching in China

3. RESEARCH DESIGN AND METHODOLOGY

In this research, the reflection model is applied to reflect and evaluate the teaching strategy to detect possible challenges and make certain changes in the teaching process. Reflection as a teaching practice is an effective way to consider one's own teaching and learn from one's experience [18, 19]. Schon introduced reflective practice in 1983 [20]. Reflection is a continuous process that enables professionals to become aware of their knowledge base. Since Schon's introduction, reflective practice has become a focus of interest and a powerful tool in teachers' education. The reflective practice turns into a fundamental feature of learning from experience. In addition, it represents an efficient tool in a practice-based learning setting that enables practitioners to learn from past experiences instead of formal knowledge transfer. The complex process of teaching involves educators questioning their performance for their own professional development and to improve it. By reflecting on actions that are taken to improve teaching, teachers are getting engaged in a process of continuous learning. The experience from reflective practice does not necessarily lead to learning; however, actions taken to improve the quality of teaching are essential to this process. Practitioners of reflective practice confirmed that it is a crucial professional development source that combines theory and practice [19].

Further, a systematic literature review is carried out through a qualitative analysis. Content analysis is applied for the literature review since the review is focused on the pedagogy papers with the aim of enhancing students' motivation in the civil engineering field. The review process is divided into a few steps: searching for pedagogy papers regarding motivation, limiting the search using keywords, and identifying strategies for increasing student motivation. The search is conducted through Scopus and Web of Science. The literature is limited to peer-reviewed articles. The keywords used for the search are: "*students' motivation*", "*civil engineering education*", "*how to motivate students in the civil engineering program*", "*active learning*", and "*student-centred teaching*". The last step is content analysis and identifying teaching approaches to increase students' motivation.

4. RESULTS

The current trends in civil engineering education show that engineering education is changing from a traditional teacher-based to a problem-solving learning approach [21]. Also, construction education studies focus more on student-centred learning, building information modelling, sustainability, active learning, virtual reality and project management [22]. Considering students' motivation, current teaching trends present problem-solving and gamification strategies. The selected strategies with the corresponding literature are provided in Table 1.

Table 1: Table caption

Teaching strategies	Literature
Problem-solving learning approach	[23, 24, 25, 26, 27, 32]
Gamification	[33, 34, 36, 37, 38]

The first strategy for motivation is the problem-solving learning approach. Generally, the problem-solving approach is a strategy based on the questions or tasks prepared by the teacher related to learning outcomes, and students can solve them by applying their knowledge and analytical skills [23]. A problem-based learning approach is recognised as one of the strategies in which students are given to resolve problems related to the learning content through the guidance of their teacher [24]. This strategy is shown as an efficient tool for motivating students in geography classes [25], in the field of programming [26], language classes [27], and others. Also, this approach can contribute to engaging engineering students in the learning process. The importance of a problem-based learning approach is highlighted in civil engineering education since more students were engaged during the class. In addition, they have developed other skills such as problem-solving skills, independent learning, teamwork, communication and collaboration skills, and critical thinking [28, 29, 30, 31]. Some of the practical examples are Azam et al. [32], who implemented this strategy in a structural analysis course. First, the course teacher designs an example of the problem according to the teaching outcome. Students are asked to work in a group and seek a solution. The structural analysis problem includes the analysis of a single-span truss with one hinge support and one support, and the other one with two hinge supports. It is expected that students engage in a self-learning process in order to solve a problem. Through the process, students search for information by themselves and collaborate with their peers to exchange ideas and information. In the beginning phase, it was difficult for students to solve the problem since they were unfamiliar with the question. However, it was a very efficient method since the results show that students can be motivated by complex challenges. The implemented educational approach has provided students with the opportunity to understand theoretical concepts better and be more confident in solving problems. There were no negative attitudes towards the approach.

Some of the other activities to engage students during the learning process are: discussions, educative games, case studies, role-play activities, and others [22].

Figure 3: Gamification process

The second strategy is gamification, which is becoming a popular trend in higher education. Game-based teaching is based on the gamifying learning procedure [33], and obtaining new knowledge is similar to a game. Gamification is a process based on using game design elements to improve the learning experience. Through a game, there is a goal to be accomplished by following its instructions and rules. Figure 3 depicts the steps in the gamification procedure for motivating students to participate and engage in the teaching process. The steps in the gamification procedure are following: (1) setting the reward of the game; (2) setting the clear goals of the game and identifying the knowledge and skills required; (3) selection of game elements (points, levels, challenges); (4) sense of progression and achievements; and (5) obtaining the required skills. The practical example of a successful game design-based learning method in a civil engineering program is demonstrated in the case of the Geotechnical Engineering course [34]. Principally, students have selected three geotechnical engineering topics, and they have explored these topics beyond textbooks in order to gather information for the game development process. Hence, students developed games for this research. During game development, students were motivated to study and learn more about soil mechanics and geotechnical engineering topics. In addition, the research has shown that students have improved their goal-setting, collaboration, and communication skills. The other application of game-based learning is in the case of sustainable engineering [36]. Besides civil engineering, game-based teaching is a popular trend in different engineering fields, such as building services, computer, mechanical, and industrial engineering [37]. It is noticed that during game-based teaching, learners are encouraged to be more focused on the analysis of the teaching topic in order to play a game.

5. CONCLUSION

By applying Schon's reflective model, the lack of student motivation is detected in teaching students enrolled in civil engineering programs. The lack of student motivation is one of the common issues during the class due to the high level of mathematics and science. To overcome this issue, two strategies have been detected through the literature review: the problem-solving approach and gamification. These strategies have been shown to be beneficial for increasing student motivation towards learning content and engaging them during the class. By implementing this strategy in the class, the results were positive, and students became more interested in participating in the learning process. Also, the learning environment has improved with the change of teaching approach and students' attitude towards class.

REFERENCES

[1] J. M. Hayes, "Civil engineering pedagogy." *Journal of Professional Issues in Engineering*, no. 112, no. 3, pp. 173-177, 1986.

[2] C. Schexnayder, and S. Anderson, "Construction engineering education: History and challenge." *Journal of Construction Engineering and Management*, vol. 137, no. 10, pp. 730-739, 2011.

[3] J. S. Russell, "Shaping the future of the civil engineering profession." *Journal of Construction Engineering and Management*, vol. 139, no. 6, pp. 654-664, 2013.

[4] P. Chinnan, and M. Saranya, "Graduate employability in the field of construction management." *International*

Research Journal of Engineering and Technology, vol. 6 no. 5, pp. 4354-4364. 2019.

[5] K. Froehle, L. Dickman, A. R. Phillips, H. Murzi, and M. Paretti, “Understanding lifelong learning and skills development: Lessons learned from practicing civil engineers.”, *Journal of Civil Engineering Education*, vol. 148, no. 4, pp. 04022007, 2022.

[6] Y. M. Tang, K. Y. Chau, Y. Y. Lau, and G. T. S. Ho, “Impact of mobile learning in engineering mathematics under 4-year undergraduate curriculum.” *Asia Pacific Journal of Education*, vol. 45, no. 1, pp. 147-163. 2025.

[7] C. Baillie, and G. Fitzgerald, “Motivation and attrition in engineering students.” *European Journal of Engineering Education*, vol. 25, no. 2, pp. 145-155. 2000.

[8] K. Y. Chau, K. M. Law, and Y. M. Tang, “Impact of self-directed learning and educational technology readiness on synchronous E-learning.” *Journal of Organizational and End User Computing (JOEUC)*, vol. 33, no. 6, pp. 1-20. 2021.

[9] K. Trigwell, “Approaches to teaching design subjects: a quantitative analysis.” *Art, Design & Communication in Higher Education*, vol. 1, no. 2, pp. 69-80. 2002.

[10] G. R. Lueddeke, “Professionalising teaching practice in higher education: A study of disciplinary variation and teaching-scholarship.” *Studies in higher education*, vol. 28, no. 2, pp. 213-228. 2003.

[11] A. Salmisto, L. Postareff, and P. Nokelainen, “Relationships among Civil Engineering Students’ Approaches to Learning, Perceptions of the Teaching–Learning Environment, and Study Success.” *Journal of Professional Issues in Engineering Education and Practice*, vol. 143, no. 4, pp. 04017010. 2017.

[12] S. Lindblom-Ylänne, K. Trigwell, A. Nevgi, and P. Ashwin, “How approaches to teaching are affected by discipline and teaching context.” *Studies in Higher education*, vol. 31, no. 3, pp. 285-298, 2006.

[13] S. Benkovic, and M. Dobrota, “Application of teaching methods and techniques at Serbian Universities: progress over time.” *Management*, vol. 16, no. 63, pp. 35-43. 2012.

[14] J. Ho, and D. Crookall, “Breaking with Chinese cultural traditions: Learner autonomy in English language teaching.” *System*, vol. 23, no. 2, pp. 235-243. 1995.

[15] W. Littlewood, “Defining and developing autonomy in East Asian contexts.”, *Applied linguistics*, vol. 20, no. 1, pp. 71-94, 1999.

[16] L. Jin, and M. Cortazzi, “Changing practices in Chinese cultures of learning.” *Language, culture and curriculum*, vol. 19, no. 1, pp. 5-20. 2006.

[17] F. Marton, and R. Säljö, “On qualitative differences in learning: I—Outcome and process.” *British journal of educational psychology*, vol. 46, no. 1, pp. 4-11. 1976.

[18] P. Mathew, P. Mathew, and P. J. Peechattu, “Reflective practices: A means to teacher development.” *Asia Pacific Journal of Contemporary Education and Communication Technology*, vol. 3, no. 1, pp. 126-131. 2017.

[19] T. Russell, “A teacher educator’s lessons learned from reflective practice.” *European Journal of Teacher Education*, vol. 41, no. 1, pp. 4-14. 2018.

[20] D. A. Schon, “The reflective practitioner: How professionals think in action”, New York: Basic Books, 1983.

[21] J. L. Kim, “Use of BIM for effective visualization teaching approach in construction education.” *Journal of professional issues in engineering education and practice*, vol. 138, no. 3, pp. 214-223. 2012.

[22] J. Aliu, and C. Aigbavboa, “Reviewing the trends of construction education research in the last decade: a bibliometric analysis.” *International Journal of Construction Management*, vol. 23, no. 9, pp. 1571-1580. 2023.

[23] E. J. Fournier, “World regional geography and problem-based learning: using collaborative learning groups in an introductory-level world geography course.” *The Journal of General Education*, vol. 51, no. 4, pp. 293-305. 2002.

[24] J. Ce, C. Chunhong, G. Rong, and Z. Xiao, “Design of PBL teaching method based on OBE mode.” In *2021 10th*

International Conference on Educational and Information Technology (ICEIT) (pp. 116-119). IEEE. 2021.

[25] A. Golightly, and S. Raath, "Problem-based learning to foster deep learning in preservice geography teacher education." *Journal of Geography*, vol. 114, no. 2, pp. 58-68. 2015.

[26] S. Nikolic, M. Ros, and D. B. Hastie, "Teaching programming in common first year engineering: discipline insights applying a flipped learning problem-solving approach." *Australasian Journal of Engineering Education*, vol. 23, no. 1, pp. 3-14. 2018.

[27] V. V. Dimitrova, S. McKenney, and P. A. Kirschner, "Second and foreign language teachers' problem-solving schemata development through informal problem-solving: the relationship between experience and expertise." *Innovation in Language Learning and Teaching*, vol. 17, no. 2, pp. 202-216. 2023.

[28] K. W. Chau, "Problem-based learning approach in accomplishing innovation and entrepreneurship of civil engineering undergraduates." *International Journal of Engineering Education*, vol. 21, no. 2, pp. 228-232. 2005.

[29] L. R. D. C. Ribeiro, and M. D. G. N. Mizukami, "Student assessment of a problem-based learning experiment in civil engineering education." *Journal of Professional Issues in Engineering Education and Practice*, vol. 131, no. 1, pp. 13-18. 2005.

[30] N. A. Mohd Noor, A. Alias, A., K. Ariffin, N. Mohamad Bhkari, and A. H. Abu Hashim, "Employing the problem-based learning approach in civil engineering education: The highway engineering experience." In *Proceedings of the Second International Conference on the Future of ASEAN (ICoFA) 2017-Volume 1: Business and Social Sciences* (pp. 519-528). Springer Singapore. 2019.

[31] D. D. Kumar, and Y. Woyessa, "Problem based learning for reinforcing civil engineering education in the universities of technologies in South Africa." In *Proc., CSCE Annual Conf., Growing with Youth*, Montreal, 2019.

[32] R. Azam, M. U. Farooq, and M. R. Riaz, "A Case Study of Problem-Based Learning from a Civil Engineering Structural Analysis Course." *Journal of Civil Engineering Education*, vol. 150, no. 3, pp. 05024001. 2024.

[33] A. Kulhanek, B. Butler, and C. A. Bodnar. "Motivating first-year engineering students through gamified homework." *Educational Action Research*, vol. 29, no. 5, pp. 681-706. 2021.

[34] J. Sabrowsky, B. Ajmera, C. Rutherford, A. Poplin, and A. Emery, "Improving Student Engagement, Achievement, and Motivation Using Game Design-Based Learning in Undergraduate Geotechnical Engineering Classes." In *Geo-Congress 2024*, pp. 377-385, 2024.

[35] L. Soibelman, R. Sacks, B. Akinci, I. Dikmen, M. T. Birgonul, and M. Eybpoosh, "Preparing civil engineers for international collaboration in construction management.", *Journal of Professional Issues in Engineering Education and Practice*, vol. 137, no. 3, pp. 141-150, 2011.

[36] R. Clark, A. Spisso, K. J. Ketchman, A. E. Landis, K. Parrish, R. Mohammadiziazi, and M. M. Bilec, "Gamifying sustainable engineering courses: Student and instructor perspectives of community, engagement, learning, and retention." *Journal of Civil Engineering Education*, vol. 147, no. 4, pp. 04021009. 2021.

[37] K. Alanne, "An overview of game-based learning in building services engineering education." *European Journal of Engineering Education*, vol. 41, no. 2, pp. 204-219. 2016.

[38] E. Jacobs, E., O. Garbrecht, R. Kneer, and W. Rohlfs, "Game-based learning apps in engineering education: requirements, design and reception among students." *European Journal of Engineering Education*, vol. 48, no. 3, pp. 448-481. 2023.