

MODERN LEARNING STRATEGY FOR TEACHING ABOUT CONSTRUCTION MANAGEMENT IN POLAND

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Abstract. Today, more and more employees are marked by an increased familiarity with digital solutions. On the other hand, an impact of the information technology on the accuracy of decision making processes is significant. In search of a competitive advantage employers have to learn how to profit from a competence of such people. However, digital natives have to be educated in a correct way, in terms of both hard and soft skills. Unfortunately, education programs, also those related to construction management, not always meet the market requirements. Therefore higher education institutions start to answer the challenge and convert their policies and teaching programs into 21st-century-friendly.

The paper describes a specificity of the teaching about construction management. It explains modern strategies to attract student's attention and to provide him/her necessary capabilities useful in a future job. First, articles indexed by the Web of Science database from 1999 to 2017, were examined in order to verify a specificity of higher education as well as main factors conditioning teaching about construction management. Moreover, a comprehensive analysis of the new program contents and methodologies used was executed. Then a course model was proposed which provides a reconciliation between traditional and unconventional approaches. Whereas that every change requires preparation, some opportunities and threats were explored.

The article refers also to examples of good practice implemented at the UTP University of Science and Technology. Construction management students witness new didactic strategies (blended learning, case studies, site visits, webinars, conferences) as well as learn about innovative solutions useful in construction management: Building Information Modelling (BIM), Unmanned Aerial Vehicles (UAV) or machine learning. Conclusions of the analysis show that the course model can be useful for implementation in the higher education, especially in construction management.

1 INTRODUCTION

The problems of generational diversity of students have been known for a long time. However, at the turn of the 20th and 21st centuries, a new group, particularly different from the previous generations, appeared at universities. It is now known as the Generation Y,

which includes people born in the early eighties. Their specificity is associated with a significant acceleration of globalization processes and the simultaneous development of information technologies and the creation of the *information society*. Young people, almost all over the world, felt to be inhabitants of the global "village", familiar with innovative communication tools from the very beginning of their lives.

Currently, universities should be able to modify curricula, as well as the methodology of education to new realities, so that in modern generations of students arouse the passion of discovering the secrets of science, and a potential hidden in them could be used. It can be claimed that an opportunity for the success of technical universities that offer, among others civil engineering, is to adapt to the requirements of the Generation Y. Young people very often articulate the willingness to participate in some projects. Therefore, it is crucial to include project-based activities in the ways of guiding the students' work during the teaching process. It may become useful in practice, because most of the tasks carried out in the industry are of investment and construction projects.

2 THEORETICAL FRAMEWORK OF CONSTRUCTION MANAGEMENT EDUCATION

2.1 Main challenges in education development

Nowadays, there are more and more modern strategies to attract student's attention and to provide him/her necessary capabilities useful in a future job. In search of the specificity of teaching about construction management, a comprehensive literature analysis was performed in order to verify a specificity of higher education as well as main factors conditioning teaching about construction management. Articles indexed by the Web of Science database were examined. Details of the search are presented in Table 1. Two-step search produces a number of results filtered by the most suitable categories from the initial query (column 9). These articles were taken to further consideration.

Table 1: Search results from the Web of Science queries

No.	Query	Timespan	Number of results	Proceedings paper	Articles	Other	Relevant categories	Number of filtered results
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>
1	"construction management" AND "higher education"	1999-2017	40	29	10	1	<i>Education</i> <i>Educational</i> <i>Research,</i> <i>Construction</i> <i>Building</i> <i>Technology,</i> <i>Engineering</i> <i>Civil and</i> <i>Management</i>	29

where:

No.	Query	Timespan	Number of results	Proceedings paper	Articles	Other	Relevant categories	Number of filtered results
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>
1.1	"construction management" AND "higher education" AND "BIM"	1999-2017	5	4	1	0	<i>See above</i>	3
1.2	"construction management" AND "higher education" AND "UAV"	1999-2017	0	0	0	0	<i>See above</i>	0
1.3	"construction management" AND "higher education" AND "Big Data"	1999-2017	0	0	0	0	<i>See above</i>	0
2	"construction management" AND "teaching"	1999-2017	109	72	36	1	<i>See above</i>	75
<i>where:</i>								
2.1	"construction management" AND "teaching" AND "BIM"	1999-2017	14	8	6	0	<i>See above</i>	11
2.2	"construction management" AND "teaching" AND "UAV"	1999-2017	0	0	0	0	<i>See above</i>	0
2.3	"construction management" AND "teaching" AND "Big Data"	1999-2017	0	0	0	0	<i>See above</i>	0
TOTAL:			149	99	46	2	-	104

The examined queries reveal some significant remarks. There is no shortage of articles describing general background of the construction management teaching problems on the higher education level. Among them there are some manuscripts about specific domain of BIM [1]–[14] whereas there is no papers about unmanned aerial vehicles or the Big Data in

context of the previous search details. These contents are relatively new so therefore there were no examples found in the search. However, they should not be ignored due to their powerful meaning in practice.

Recently, in construction management education, which is under a constant transformation [15], there is an increased interest in games used for didactic purposes [16]–[19]. Moreover, online courses get more and more significant in shaping current teaching programmes [20], [21]. Blended learning models are frequently incorporated to construction management studying strategies [22]. Besides, many new ideas for methodologies used in this specific area are usually consistent with the innovations found in general approach to civil engineering education.

2.2 Specificity in construction management education

Regarding the specific features of construction, it should be pointed out that erected building structures shape the environment, have a long life cycle, are implemented with the participation of a number of specialists from many industries (constructors, electricians, heavy equipment operators) and their work is connected with a special licensure.

All this makes it necessary to educate students who understand not only the structural mechanics, but are sensitive to respecting the formal and legal bases, or are able to respond to environmental problems in each phase of the project life cycle. Graduates must also be orientated in meeting the requirements of investors, and creating customer satisfaction with the products and services provided. It should be remembered that civil engineers play a key role at every stage of the construction life cycle - they design (construction, finish works, equipment), prepare a feasibility study, deal with administrative matters connected with the construction process, undertake construction projects, and participate in operational processes (maintenance of facilities) and their decommissioning (demolition site manager).

Graduates also work in insurance in the construction industry as well as in institutions financing construction projects. They play roles indicated by the construction law (known as independent technical functions in construction), as well as they become project managers or risk managers in the project. Their activities very often require specialized professional knowledge, when they are construction experts or expert witnesses. In conclusion, it should be stated that they are specialists who participate in decision-making at every level of the life cycle of construction works. Therefore, their proper preparation, described in professionally prepared study programs, containing modern and practical content of education, is crucial for the success of construction investment projects.

3 CONTENT ANALYSIS OF MODERN PROGRAMS

3.1 Building Information Modelling (BIM)

BIM is very often treated as the future of construction, because it means having a 3D model with its exact location and all necessary, easily accessible information for both designers, investors and contractors. BIM topics are interdisciplinary, combine technical, legal and organizational elements. The biggest benefits of using BIM include reduction of errors and delays in design, reduction of modification work costs and shorter duration of the project. The use of BIM in order to improve cooperation between design offices and

contractors indicates a trend towards greater integration of team members. New challenges, such as improving safety and shortening the workflow cycles, are constantly emerging.

Discussing the problems of BIM, both in the context of advantages and disadvantages, opportunities and threats resulting from the implementation of such solutions, should take place in the course of developing the competences of young people in the field of construction management. Therefore, in addition to practical activities integrating individual parts of design branches (architecture, construction, installations) what results in mastering the software, there should also be lessons about the use of BIM at the managerial level.

3.2 Unmanned Aerial Vehicles (UAV)

The use of drones in the world has increased significantly in recent years. The drone is not only a toy for mature children, but also a tool for working in the media, sports, agriculture and, more recently, also in the construction industry. Periodic drone flights before, during and after construction work enables for an inspection and a supervision of progress in the project. This allows to avoid delays in performing tasks. It enables for carrying out precise measurements, to detect insulation failures and to create complete project documentation.

Inspections of office buildings and public utility buildings can be carried out with unmanned aerial vehicles. This significantly facilitates *real estate management*. It also enables for quick and efficient thermovision and visual inspection of hard to reach places.

When educating students in the field of construction management, it is necessary to indicate strengths, potential opportunities and the possibility of using unmanned aerial vehicles during construction. In addition, it is also worth to make them aware of weaknesses, limitations and threats resulting from technical and legal conditions.

3.3 Big Data and Industry 4.0

Data in the analogue format at the present time are less and less used, because it can not be managed with by computers. Digital technology is constantly evolving, and the number of digitally recorded data is constantly growing - it has grown to such a large extent that effective data management is becoming more and more difficult. Big Data (BD) is understood as a large, diverse, complex and/or diffused data set generated from instruments, sensors, online transactions, e-mails, videos and/or other digital sources.

The use of BD in construction stimulates the need to manage the risk of construction projects. Generally, the risk can be defined as the difference between predictions and reality. It means the probability of lack of success in terms of undertaken activities [23]. It should be associated primarily with the measure of deviation from the values previously planned. The attempts to parameterize it relate to the estimation of the probability of achieving the objectives of the planned undertakings and the effects of their failure to achieve, expressed in physical or financial units [24].

The Big Data analysis used for risk management can increase the efficiency of management in the construction industry. In the management of investment and construction projects, both physical and virtual data derived from controlling, BIM, tender bids, schedules, data from construction contractors obtained on the construction site should be used. Thanks to the precise analysis of all data sets, the company can discover new characteristics of its customers, partners, markets, costs and operations [25].

However, apart from the significant advantages, there are also some disadvantages of BD. Poor data quality leads to incorrect results of the analysis. A challenge connected with the quality of data is also their non-consistency. In addition, any data breach or leakage is a serious threat to any organization. The breach is treated as the theft of BD's assets as a result of a burglary into the information and communication system at the level of collection, processing, transformation or to the user who stores them. Data leaks can be defined as the total or partial disclosure of BD assets at a given stage of the project life cycle.

Creating coherent systems based on Big Data is yet to come. In principle, everything is uncertain, both in the theoretical sphere as well as in the implementation of BD. Thus, a risk arises, the consequences of which are difficult to predict. However, there is a need to make students aware of both the advantages and disadvantages of implementing in the building sector achievements of the *Industry 4.0* and to teach them so-called *Construction Management Intelligence (CMI)*.

4 MODERN TEACHING MODEL

4.1 Student-oriented methods

Teaching in the field of construction management at the UTP University of Science and Technology in Bydgoszcz has a relatively long tradition. The specialty *Technology and organization of construction* is the oldest of the three currently operating in the field of civil engineering, at the Faculty of Civil and Environmental Engineering and Architecture. It has been present since the very beginning of the Faculty. Its graduates successfully carry out many investment and construction projects carried out in the Kujawsko-Pomorskie region and beyond. The author made effort to establish cooperation with a significant construction company, which has been organizing a series of events dedicated to the management of construction projects and issues connected with occupational safety and health at the construction site. During one series of such meetings, participants had the opportunity to take part in simulations of the implementation of construction projects maintained in the convention of educational games (Figure 1).



Figure 1: Construction project management in educational games

These events enjoyed considerable interest, and apart from fun, students discovered relationships that determine the success of investment and construction projects.

4.2 Site visits

It has to be underlined that thanks to the author, recently many student trips were organized to interesting and spectacular construction sites in Poland. One can mention here the construction of the A1 highway (Figure 2), the tunnel under the Martwa Wisła in Gdańsk, the sports hall in Bydgoszcz, a skyscraper in Warsaw, shopping centers, public facilities, etc. The preparation of this type of events requires not only managerial skills, but also knowledge of industry and having extensive personal contacts. Co-operation with external entities, such as the Polish Association of Construction Engineers and Technicians Office Bydgoszcz, helps in this. The organization integrates civil engineers and enables the exchange of experience between representatives of different generations of construction engineers.



Figure 2: Participants of the site visit, A1 highway, 2010, Nowe Marzy (Poland)

The trips to construction sites are usually quite popular among students. Thanks to such events, a practical point of view of theories taught by the traditional approach can be passed.

4.3 Conferences and webinars

Scientific development of the youth may take place not only thanks to participation in obligatory classes. The University's offer also includes a number of scientific groups. The "COMA" Student Scientific Group of Construction is one of the most thriving organizations. It organizes a series of CEPPIS international scientific conferences (Figure 3) devoted to contemporary construction problems, with particular emphasis on construction project management.

The participants of these events are students and research and teaching staff from Poland and foreign countries. They debate on the experience presented by scientists from around the world.



Figure 3: Participants of the CEPPIS 2017 conference

Furthermore, during the classes, students have an opportunity to participate in webinars devoted to a chosen subject (e.g. computer aided construction management, risk analysis of construction projects). In November 2017, by taking part in this type of event organized by a nationwide journal, the author proposed to students an additional form of education based on participation in a webinar that was broadcast live [26] and online.

4.4 International cooperation

For construction engineers, the awareness of the complexity of problems occurring during the implementation of construction projects should be extremely important. The spectrum of technical and organizational complications related to construction should be explained in the context of global experience. In the era of common mobility of people, education based on local rules is at least impractical, if not incorrect. Responding to this need, scientists from abroad are invited to the Faculty of Civil and Environmental Engineering and Architecture, who, in frames of the Erasmus+ program, arrive to Bydgoszcz and provide English classes for Polish students (Figure 4).



Figure 4: Lesson conducted by foreign teacher

Such exchange is possible thanks to the intense work of the author who, playing a role of the departmental coordinator of the Erasmus + program, encourages foreign scientists to visit the University and to share their knowledge with students. International cooperation in the field of teaching is possible thanks to the mobility of research and teaching staff, who are increasingly representatives of the Generation Y. They become educators for Ys or Zs in the field of construction or construction management.

5 CONCLUSION

Particular definitions of generations are matrices facilitating the characteristics of a certain group of people. Such a generalization turns out to be useful in finding and developing new and more effective ways of teaching a specific subject by analyzing the goals, contents, methods and organizational forms of education.

In search of the teaching model for the Generation Y (and soon Generation Z) in the field of construction management, two approaches can be applied: evolutionary and revolutionary. The evolutionary approach should take into account the existing contents and methods of teaching, and in their search for improvements that update the present state of affairs to new realities. On the other hand, the revolutionary approach requires a thorough reconstruction of the model of functioning of education at universities, in which modern content and innovative methods of education will play the leading role. The choice of the model depends on the degree of the university's organizational maturity, the quality of the teaching staff employed, as well as the market needs with which the closest possible contact should be maintained.

REFERENCES

- [1] J. Ferrandiz, D. Fonseca, and A. Banawi, "Mixed Method Assessment for BIM Implementation in the AEC Curriculum," in *Learning And Collaboration Technologies, LCT 2016*, 2016, vol. 9753, pp. 213–222.
- [2] J. Kang, "Active Learning Pedagogy for Building Information Modeling in Construction," in *EDULEARN13: 5TH International Conference on Education and New Learning Technologies*, 2013, pp. 2557–2563.
- [3] W. Wu and B. Hyatt, "Experiential and project-based learning in BIM for sustainable living with tiny solar houses," in *ICSDEC 2016 - Integrating Data Science, Construction and Sustainability*, 2016, vol. 145, pp. 579–586.
- [4] A. Abbas, Z. U. Din, and R. Farooqui, "Integration of BIM in construction management education: an overview of Pakistani Engineering universities," in *ICSDEC 2016 - Integrating Data Science, Construction and Sustainability*, 2016, vol. 145, pp. 151–157.
- [5] X. Brioso, D. Murguia, and A. Urbina, "Teaching Takt-Time, Flowline, and Point-to-Point Precedence Relations: A Peruvian Case Study," in *Creative Construction Conference 2017, CCC 2017*, 2017, vol. 196, pp. 666–673.
- [6] X. Brioso, D. Murguia, and A. Urbina, "Comparing three scheduling methods using BIM models in the Last Planner System," *Organ. Technol. Manag. Constr.*, vol. 9, no. 1, pp. 1604–1614, 2017.
- [7] C. J. Cimino, "Teaching Comprehensive Building Design Through Building Information Modeling - A Shift in Pedagogy," in *7TH International Technology, Education and Development Conference (INTED2013)*, 2013, pp. 3716–3723.
- [8] C. J. Diederichs, "Development of Housing and Construction, Site Management and Project Management in Teaching and Research since 1985-2015," *Bauingenieur*, vol. 90, pp. 313–319, 2015.
- [9] A. Ghosh, K. Parrish, and A. D. Chasey, "From BIM to Collaboration: A Proposed Integrated Construction curriculum," in *2013 ASEE Annual Conference*, 2013.

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- [10] J.-L. Kim, “Effectiveness of Green-BIM Teaching Method in Construction Education Curriculum,” in *2014 ASEE Annual Conference*, 2014.
- [11] F. Leite, “Project-Based Learning in a Building Information Modeling for Construction Management Course,” *J. Inf. Technol. Constr.*, vol. 21, pp. 164–176, 2016.
- [12] D. Murguia and X. Brioso, “Using ‘Choosing by Advantages’ and 4D Models to Select the Best Construction-Flow Option in a Residential Building,” in *Creative Construction Conference 2017, CCC 2017*, 2017, vol. 196, pp. 470–477.
- [13] A. Woldeesenbet, C. Ahn, H.-J. Kim, and S. Rokooei, “Faculty Learning Community (FLC) for BIM Education in a Multidisciplinary School,” in *AEI 2017: Resilience of the Integrated Building*, 2017, pp. 39–48.
- [14] L. Yan and L. Shirong, “BIM Teaching Strategy for Surveying Students in China,” in *Proceedings of the 2013 Conference on Education Technology and Management Science (ICETMS 2013)*, 2013, pp. 937–940.
- [15] W. W. Badger and K. Robson, “Raising expectations in construction education,” in *Construction Congress VI, Proceeding: Building Together for a Better Tomorrow in an Increasingly Complex World*, 2000, pp. 1151–1164.
- [16] B. L. Oo and B. T.-H. Lim, “Game-based learning in construction management courses: a case of bidding game,” *Eng. Constr. Archit. Manag.*, vol. 23, no. 1, pp. 4–19, 2016.
- [17] R.-J. Dzung and P.-R. Wang, “C-Negotiation Game: An educational game model for construction procurement and negotiation,” *Autom. Constr.*, vol. 75, pp. 10–21, Mar. 2017.
- [18] T. Hartmann, “Serious Gaming in Construction Management Research and Education,” in *Construction Research Congress 2016: Old and New Construction Technologies Converge in Historic San Juan*, 2016, pp. 1948–1957.
- [19] H. Dib and N. Adamo-Villani, “Serious Sustainability Challenge Game to Promote Teaching and Learning of Building Sustainability,” *J. Comput. Civ. Eng.*, vol. 28, no. 5, SI, 2014.
- [20] W. Sher, A. Williams, and T. Gajendran, “Online Construction Management Education: A Discipline-Wide Implementation,” in *Handbook of Research on Humanizing the Distance Learning Experience*, 2017, pp. 132–156.
- [21] W. Sher, A. Williams, and M. Northcote, “The Lived Experience of Online Educators: Insights from Construction Management,” *Constr. Econ. Build.*, vol. 15, no. 2, pp. 49–62, 2015.
- [22] O. Bokor and M. Hajdu, “The use of eLearning in teaching construction management core subjects,” in *Creative Construction Conference 2014*, 2014, vol. 85, pp. 75–83.
- [23] J. Bizon-Górecka and J. Górecki, “Risk of construction investment project in perspective of execution model,” *Stud. Proc. Polish Assoc. Knowl. Manag.*, vol. 74, pp. 4–15, 2015.
- [24] J. Bizon-Górecka and J. Górecki, “Risk of construction investment project in perspective of construction costs,” *Organ. Rev.*, vol. 6, pp. 36–44, 2013.
- [25] A. Labrinidis and H. V. Jagadish, “Challenges and Opportunities with Big Data,” in *Proceedings of the VLDB Endowment 5(12)*, 2012, pp. 2032–2033.
- [26] Rzeczpospolita, “Budget management - planning and control of project costs” 2017. [Online]. Available: <https://konferencje.rp.pl/wydarzenia/7/941-webinarium-zarzadzanie-budzetem-inwestycji/program>.