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MENTORING OF STUDENTS AND EXAMPLES OF MENTORING TASKS RELATED TO TRAFFIC INFRASTRUCTURE

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Abstract

Big challenges have been imposed on education sector which should pursue market development dynamics, because of the development aimed at innovations, business process digitalization, planning based on large amount of data analysis, using extended and virtual reality in business, value creating by means of 3D print, industrialization in building elements production. Civil engineering is affected by new topics such as healthy and eco-friendly lifestyle, which is also an obligation of educational institutions as well as employers to provide students with the appropriate support in development of professional competencies which are based on contemporary educational methods such as cooperative learning or learning through work, most often in a shape of a professional practice. For such learning style to be sustainable, it is necessary to strengthen mentoring capacities on faculties, as well as employer's competencies and competencies of professional practice providers. Additional lifelong learning and professional training are a part of a mentor competence development by means of which students are provided with professional, motivational, and emotional consultation by mentors. Except for the comprehensive support provided throughout professional practice, it is necessary to shape, connect and achieve desirable learning outcomes defined by study programs. Throughout mentoring process, the mentors are enabled with a possibility to revise their own knowledge in practice, as well as to create new values for the employer and business surrounding while interacting with students. Knowledge dissemination and quality of the teaching content are enabled by the cooperation of institutions of higher education and the business community. Further formalization of the relationship between scientific and business community is required by this two-way knowledge acquisition. Research results with respect to mentoring in civil engineering as well as educating mentors and examples of how to shape mentoring tasks in traffic infrastructure will be presented in the paper.

Keywords: professional practice, mentor, mentoring tasks

1 Introduction

Innovation and technology integration in construction industry are measured by review articles as well as original scientific papers through analysis of scientific magazines articles and patent overview. Topics within which the innovations are included are: (1) data acquisition, (2) analytics, (3) visualization, (4) communication and (5) design and construction automation, (5) new materials and systems, (6) digitalization, (7) environmental impact and

(8) novelty/efficiency [1-3]. The development aims at reaching the following goals: (1) digitalization of business processes, planning based on the great amount of data analysis, using of extended and virtual reality in business activity as well as value creation by means of 3D print, (2) industrialization of construction elements and assemblies manufacture, as well as the increase of prefabricated construction in construction phase, (3) interdisciplinary development of new building materials with improved properties which contribute to a healthy and eco-friendly lifestyle, as well as cost reduction in the use and maintenance of a building [1]. Alongside with the development and innovation integration there is a growing need for education related to new jobs which are developed extremely dynamically. Market dynamics is followed by professional competences development, and because of that it is dependent on a strong bond between education and economy by means of student-aimed professional practice. The professional practice goals are drafted around expert and generic knowledge and skills which should be acquired by students prior to market entry (Table 1).

Table 1 The purpose and goal of a professional practice

	fulfil the theoretical knowledge acquired as a part of higher education - synthesize the knowledge on the basis of engineering problem
	understand the work process - surrounding, relations and responsibilities
	understand the meaning of a completed task in the context of a wider engineering problem or a project
	develop a decision-making ability develop negotiating and teamwork skills
	develop critical opinion and expression of attitude with respect to an engineering problem

In order for such learning method to be sustainable, it is necessary to strengthen employer's mentoring competences, as well as those of professional practice providers by means of lifelong learning and professional training by which mentors will be enabled to provide their students with professional, motivational and emotional consultation in practice. One of the main reasons for additional practice mentors education is to ensure the quality of study program whereon learning goals defined by the study programs must be achieved in practice. While mentoring, and in interaction with the students, the practice mentors are enabled with a possibility to revise their own knowledge and to create new values for the employer and business surrounding. Knowledge dissemination and quality of the teaching content are enabled by the cooperation of institutions of higher education and the business community. Further formalization of the relationship between scientific and business community is required by this two-way knowledge acquisition.

The Sustainable Model of Professional Practices project conducted on the Faculty of Civil Engineering and Architecture Osijek - PRAG is financed by the European Social Fund of the European Union, and it is a part of the operational program Efficient Human Potential 2014-2020, priority axis 3: Education and lifelong learning which lasts for 36 months, from 2020 to 2023 [5]. The aim of the project is acquiring work experience for students and enabling the quality of professional practice as a mandatory part of study program, but also insuring strengthen of competences of higher education staff for the purpose of work-based learning model development. The amendments of the Undergraduate Program of Civil Engineering on the Faculty of Civil Engineering and Architecture Osijek are regarded as a specific aim of

the project. The project is based on three premises which are a result of the former project called Development and Implementation of CQF in Higher Education of Civil Engineers - OKVIR, and which was led by the Faculty of Civil Engineering and Architecture Osijek during 2015 and 2016 [6]. Firstly, all students should be provided with the professional practice, and not just those who are interested in it, or the best ones, and it should be conducted in a way that professional practice is integrated as a mandatory subject of certain study programs. Secondly, learning outcomes of professional practice must be defined from the knowledge, skills and principles which are based on the Dublin Descriptors. Thirdly, in eastern Croatia, the area with rather weak economic entities related to construction, it is important to create permanent and sustainable employer's basis which could be operative for every student generation.

2 Research results related to mentoring in construction and mentor education

Mentor's role is directed at achieving goals in student work, and except from expert engineering competences, significant competences are also required from the mentor. Professional knowledge, skills and views, professional ethics, and knowledge and skills as well as to be independent and responsible are at the top of the list to achieve mentoring goals. The role of the mentor is seen as a coach whose mentees are strategically given consultation how to achieve their goals; a leader of a work surrounding in which the students acquire experience; a teacher who transfers the knowledge directly; a provider of safe surrounding in which a student is allowed to make mistakes without losing credibility; advisor who creates student's self-respect by means of supporting discussions which are not judgmental, role model for situational adoption of the views and business behaviour. Possible problems related to mentoring could be found in review articles and original scientific papers, and the reasons include the following: different personalities and the habits of the mentor and the mentee, different values, reactive instead proactive work style, distancing from tasks and neglecting tasks, manipulative behaviour, using the authority or power, inappropriate duty delegation, self-promotion, technical incompetence, lack of expertise, dysfunctional, i.e. bad attitudes, personal issues, e.g. alcohol abuse or family problems, an ethical problem related to telling falsehood, etc. Could we handle with all of that without additional level of knowledge and communication skills to respond to the challenges? A set of additional skills are required from mentors, and some of the more important include the following:

- the ability to listen
- the ability to build a necessary relationship with the mentee
- providing help to the mentees to overcome the problems themselves
- enabling the mentees to achieve long-term growth
- keeping the mentees on the right way with the aim to achieve set goals [7].

Role-model mentor is a person of uniformed knowledge and skills in three key areas: profession, communication, and organization. It means that, within the profession, a good mentor uses theoretical approaches in practice, implements them in engineering problems, knows and chooses the right technical solutions, procedures and methods for engineering problems in unpredictable situations, manages human and material resources in the project, manages and develops a team of associates in the project related to unpredictable situations, manages the process quality, is familiar with the current regulations, is in charge of risk management, and takes the responsibility which is in accordance with the ethical principles of profession. A clear, unambiguous, professional, and empathic language is used by a good mentor in order to achieve a successful communication. Also, a positive atmosphere is set by which a student is easily allowed to turn to mentor for consultation, as well as to

detect unwanted behaviours and change them (conflicts or lack of motivation). Finally, work hours and tasks are efficiently distributed by a good mentor, who also detects their own lack of time, student's alternative support is organized, time necessary for task finalization is rightly estimated, and regular meetings with students are held. The quality of mentoring relationship is dependent on recognizing the benefits for all participants, and on the characteristics of the main actors - a mentor and a mentee, and the characteristics are subjected to improving.

2.1 Mentoring models and mentoring styles

Mentoring is a business relationship which takes place in an organization or outside of it. Basic classification related to the ways of mentoring include formal and informal, as well as internal and external [7]. A mentoring relationship is arranged by procedures and documents of the organization in formal mentoring, while in informal mentoring it is usually spontaneous. The mentees are directed and systematically led towards knowledge according to predefined plan by a formally set mentor. In case of informal mentoring which is a result of association between a mentor and a mentee due to certain common interests, there is a much simpler and more opened relationship between a mentor and a mentee. In practice both approaches often appear simultaneously [8]. Completing the effects of formal and informal mentoring is highly significant. In literature, a slight advantage is given to formal approaches which is supported by an argument that set goals are easily accessible for mentors, although greater work is expected in preliminary phase.

There are four mentoring types in literature. There is an intensive mentoring relationship between a mentor and a mentee in traditional dyad mentoring which includes one-on-one mentoring, and whereby a mentor is an experienced, older person who is a mentee's guide. Dyads are the most traditional mentoring model whose administration and organization is simple. Individual mentoring can create strong relationships between a mentor and mentees. Mutual mentoring or co-mentoring is specific because mutual relationship between a mentor and a student is established what makes them equal. Peer mentoring takes place between peers and is differed from traditional mentoring because both a mentor and a mentee are in a role of a teacher or a student, as well as e-mentoring which is special because it is seen as an indirect education and learning between a mentor and a mentee and is based on the adoption and use of information technology. A communication between a mentor and a mentee is conducted by means of e-mails or on-line meeting platforms. The model is especially useful when mentors and mentees are not at the same place, or where the participants are extremely mobile [9]. Ten mentoring elements have been identified in conducted research related to mentoring of future civil engineers: definitions, mentoring type identification (formal and informal), context, structure and duration, characteristics of a mentor and a mentee, association type between participants of a practice, features of mentoring relationship (function, phases, activities), program support and expected outcomes [10].

A group mentoring is a work of one mentor and several mentees; a multiple mentoring is mentoring in which a student has more mentors; an inverse mentoring is a situation in which an older student is mentored by a younger mentor; a team mentoring includes more mentors and more students which meet in teams and a triad mentoring in which a student is mentored by an older, experienced mentor, as well as a younger one [11]. With respect to mentoring there are the following aspects of learning in literature: sponsored, trainee, protective, learning from examples, setting challenged tasks, adoption, consultation, and friendship [12]. A group mentoring conducted by a mentor, or a mentor who continuously conducts mentoring can adopt several models or more learning styles at the same time if there is space for such conduct [11]. A mentoring should be guided, and a mentor familiarized with current trends in mentoring, and it is supported by a fact that there are several mentoring models, as well as more learning relationships.

A set of lectures related to mentor education took place within PRAG project which was a result of Research group 1 Education, and it was seen as a means of support to the beginning of student's mentoring during professional practice. The lectures have been planned as a pilot test for professional training program and have taken place at the Faculty of Civil Engineering and Architecture Osijek during June 2021. Twenty-two expert attendants participated in it. The first part of education included the concepts of the Croatian Qualifications Framework, learning outcomes, ECTS credits with the aim to be introduced to the experts. The lecture emphasized the learning outcomes, and a suggestion related to professional practice outcomes was presented and discussed. The second part included mentoring knowledge, with the basic definitions in mentoring given in the beginning as well as key mentoring elements and mentoring models (individual, group, multigenerational, team, etc.). Providing practice, drafting tasks and student monitoring, as well as dynamics related to communication with the student while conducting professional training have been discussed, and the issue related to problems during professional practice has been opened. A workshop related to supportive communication has been conducted in the third part of education. Definitions related to supportive communication have been introduced, as well as all positive and negative communication aspects (congruency / non-congruency, descriptive / evaluative, problem-aimed / person-aimed, supporting / criticizing, specific / global, connecting / separating, direct / covered, supportive listening / one-directional message).

Figure 1 Mentor education

3 Preparation related to mentoring and task structuring

Preparation for mentoring begins with the choice of current project based on which it is possible to shape a mentoring task which contributes to achievement of the expected learning outcomes. Risk assessment related to non-compliance of the task is included in the activity, which is why it is important to really estimate the time necessary to create a task in unexpected circumstances (Figure 2).

A sequence of smaller parts of the task as well as planning their solving dynamics is included in task structuring. The tasks could be complemented, or they could be incoherent. It is recommended that the first task is easier and shorter. A planning of communication dynamics is predicted when task structuring - short meeting, question exchange, longer meeting. Three units are included in the structure of a task (1) theory, (2) description, context, parts and deadlines for creating the task and (3) legislative framework which is comprised of the current regulations relevant for the area as well as professional terminology. Organization and the code of conduct are presented in the first meeting. Expectations related to professional practice are exchanged between a mentor and a student in the meeting. The task is presented - context, content, parts of task and enforcement deadlines.

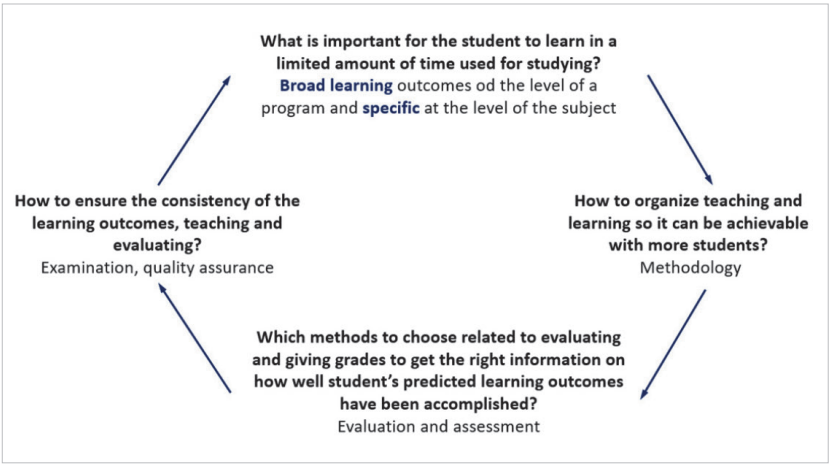

Figure 2 Key questions in preparation of the mentoring task [13]

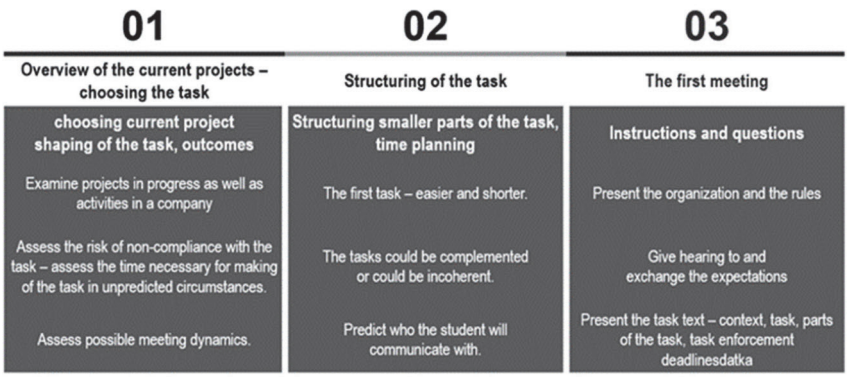

Figure 3 Preparation for mentoring

3.1 Examples related to mentoring tasks design in the area of traffic infrastructure

Example 1

The first example of mentoring task is conceived as monitoring or "shadowing" with respect to creating a concept design for more infrastructural buildings and is an example of the easier task which could be used as a model for a student's first task.

A student is given an insight into the projects which are currently at the stage of making, and he/she is being instructed to conduct documentation overview and analysis. A clear instruction means that a student should systematically monitor the course of making the project documentation with the emphasis on the choice of the adopted conceptual solutions, relevant level of elaboration, attention to details and content. Moreover, it is necessary to understand the importance of legislative framework and regulatory rules, and finally, to be familiarized with software tools which are nowadays used in the process of making the infrastructural projects. Relevant projects must be chosen by a mentor considering the volume, relevance, topicality, as well as certain elements which can actuate student's additional curiosity (e.g. making of the design solution visualizations). Furthermore, it is important

to predict the time to examine student's notes, questions and discussion. Additional time should be predicted for familiarizing with certain possibilities provided by todays' software tools, in this case by means of the BIM approach adoption during the design phase. In this respect, student's attention should be drawn to teamwork, which is always present during the design phase, and to contemporary solutions from this domain such as use of the CDE platforms. A next thing a mentor should do is to organize an interaction for the student to be presented with the way of making documentation needed for getting the location permit, whereby a student should be explained key steps and procedures as well as adopting the correct terminology.

Figure 4 Concept of a task - project monitoring

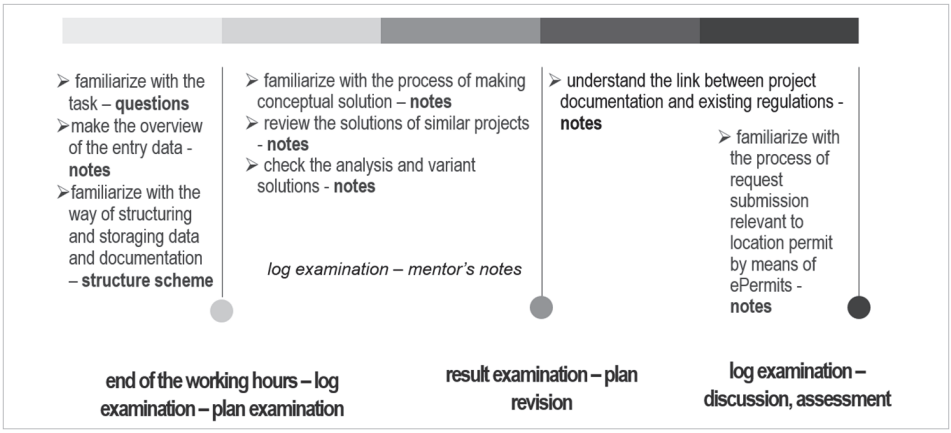

Figure 5 Task dynamics and expected results - project monitoring

A student should be referred to regulatory rules and its correct interpretation so that the link between design process and legislative framework could be adopted by a student. It is important to insist on student taking notes regularly, as well as making drafts and writing questions during the work phase.

In the first task a student should realize the following outcome - familiarizing with the comprehensive making of the project's concept design for an infrastructural building which is compliant with the regulatory rules alongside contemporary technology and partly the BIM approach adoption. The first task which is easier and with lower non-compliance risks should be used for establishing the correct relationship and communication with a student.

Example 2

The second task includes participation in a specific project - precisely, in a railway switch replacement project. Students' knowledge of the railway design as well as railway superstructure will be upgraded by the task.

A student should be presented with a task from the beginning to the end and should be instructed in more detail about the beginning of the task and the results which are expected. In this task it is important for the mentor to have insight into students' notes and drafts since he/she is included into the practical task, and the results are illustrative of student's involvement and adopting the prescribed. In the preparation phase a student is provided with available technical documentation: railway station plan with the exact position and switch type, laying down plan of the switch and laying down plan of the replaced switch (if they are different), requirements of the existing regulations (railway superstructure rulebook). Visiting the location on the terrain is included in the phase, as well as making of the switch replacement plan which includes the overview of all the activities, their order and planned duration, as well as the necessary resources. That is the most important phase. Planned activities with predicted resources (available construction material, workforce, equipment, support provided from other railway sectors) are conducted in the switch replacement phase when the railroad is out of work.

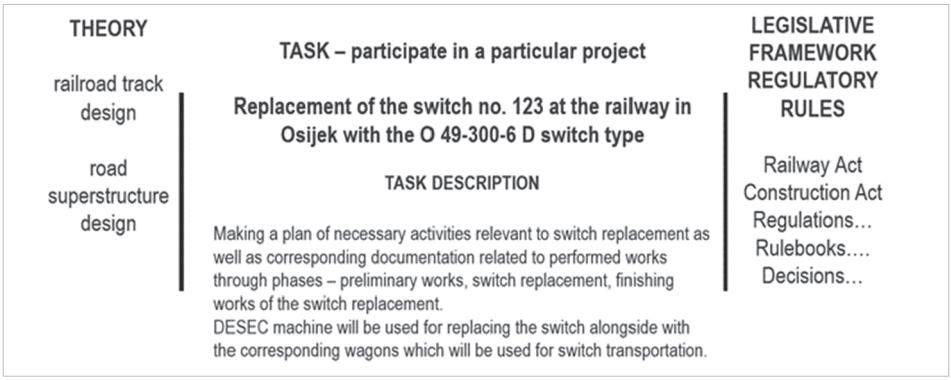

Figure 6 A concept of a task - switch replacement

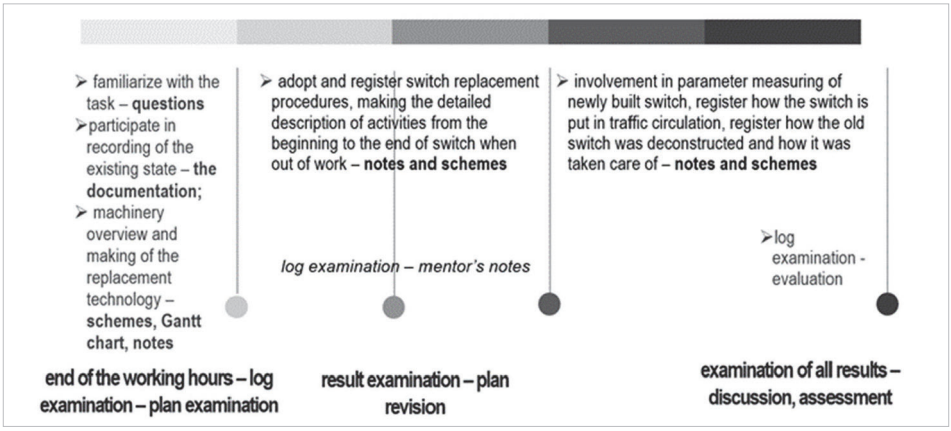

Figure 7 Task dynamics and expected results – switch replacement

Testing related to putting the switch in circulation is conducted in the final phase. The issue of replacement is determined so that the switch of O Xa-200-6 D type is being replaced by a used switch of O 49-300-6 D type. Examination of the areal conditions is one of the first steps in order to see whether it is possible to build the alternative switch into the existing location (presence of the neighbouring switch, connection to tracks one of which is in a concrete plate – a plate used for washing the wagons, installation of the switch of bigger length and bigger radius – ensuring that mathematical centres of the existing and alternative switch are matched, planning related to installation of transitional railways onto access tracks). Deconstruction and relocation of the existing switch on the landfill by means of DESEC is planned, as well as preparing the base for laying down the alternative switch, laying down the alternative switch with DESEC machine according to marking out, connecting the switch to the access tracks, delivery and unloading of the gravel by means of wagons in the switch. Machine regulation of the switch and welding are included in the finishing works.
By this practical task a student is enabled to achieve the outcome with respect to making the activity plan related to with work phases which include switch replacement – preparation, switch replacement and finishing works. Participating in a practical task means that a mentor is expected to prepare more, to monitor student's results more intensively and to have a more intensive communication.

4 Conclusion

A construction market is continuously affected by changes which is why employees with developed skills have become essential. The skills are developed during higher education but are overcome more intensively in practice. Aware of that, a two-day education called Without practice and intended for teaching and non-teaching staff, external participants and students has been organized within the PRAG project entitled Sustainable Model of Professional Practice on the Faculty of Civil Engineering and Architecture Osijek during September 2020 which was conducted by means of lectures and panel discussions. A panel discussion in which representatives of the construction market participated included the following conclusions related to mentors and mentoring:

- a practice is important and necessary
- a professional practice should be at least a month long and should include ECTS credits
- it is essential that the students are proactive as they are the most responsible for acquiring defined learning outcomes
- motivation for accepting students to a professional practice include the opportunity for selecting the best students, new energy and atmosphere, promotion and interest raising of one's own business, helping the community, as well as social responsibility
- there is a need for guidelines related to student mentoring during practice.

The needs and wishes related to professional practice implementation have been confirmed in an open dialog with the representatives of the construction market, as well as the mentor's views regarding benefits, roles and responsibilities which were supported by scientific literature in which the issue has been examined and confirmed. Sources overview regarding mentoring has illustrated the need for structuring how mentoring will be established, what approach will be adopted or a mentoring model, as well as the relationship between a mentor and a mentee, their roles and responsibilities. Finally, it has been confirmed by the literature that for mentoring to be successful, except for professional, mentors are required to have additional knowledge. A lesson and knowledge basis have been drawn regarding establishment of professional development.

The Sustainable Model of Professional Practice at the Faculty of Civil Engineering and Architecture Osijek - PRAG, which was initiated in March 2020 is aimed at implementing a professional practice as a mandatory part of the Undergraduate University Study Program of Civil Engineering. The project is based on three premises - a professional practice is necessary for every student of civil engineering as a preparation for the labor market, and as an incentive for employment, a professional practice has to have clear and verifiable learning outcomes, and must be defined as a collaboration of student, faculty and employer.

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