

DOI: <https://doi.org/10.57125/FED/2022.10.11.31>

How to cite: Almahameed, B., & Al-Saraireh, M. (2022). Preparation of future specialists in civil engineering: innovative standards for future education. *Futurity Education*, 2(3), 25-36.
<https://doi.org/10.57125/FED/2022.10.11.31>

Preparation of Future Specialists in Civil Engineering: Innovative Standards for Future Education

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Received: June 22, 2022 | **Accepted:** August 1, 2022 | **Published:** September 25, 2022.

Abstract: The main vector of professional activity of specialists in the field of civil engineering is the improvement of living conditions in society. Realizing the importance of this sphere. To support the economy and competitive ability of the country, we seek to assess ways to improve the qualification capabilities of future specialists in this field. The actual modernization of the educational process and the use of innovative standards will contribute to the improvement of engineering education and, consequently, the professional activities of the latter. This article presents an analysis of the leading innovative standards in education and their specifics in the context of Jordanian higher education. The deductive-axiomatic method was applied in processing this topic: a fragmentation of the subject under study (the problem of distance learning, analysis of the latest teaching methods, trends in

Europeanization of academic education, the problem of educational institutions management and interdisciplinary training of future specialists) was carried out. Besides, using the methods of abstraction and concretization, it was possible to form a model for improving the efficiency of the educational process for future civil engineering specialists. The empirical component of the study consists of a closed questionnaire survey. The method of student learning assessment (SET) was used. According to the results of the conducted research work, it can be noted that an effective direction of development for engineering education in Jordan is the formation of a new methodological basis and mastering of digital technologies. The European system of academic interaction, according to which decentralization trends are necessary, should serve as a reference point for educators. Recommendations on how to integrate certain elements into the existing system of professional training of civil engineers are presented.

Keywords: civil engineering, educational innovation, learning process, innovation management, student evaluation of teaching (SET).

Introduction

The leading industry in the context of the processes of gradualist development of the state is civil engineering, which determines the possibility of the successful functioning of the overall economic system. It is noteworthy that this movement is significantly transformed in the context of globalization processes. In particular, taking into account the increasing competitiveness in the international market, the spread of modern methods of research and production activities, and the modernization of technical support of engineering as a sphere in general. These changes necessitate a prompt and expedient restructuring of the educational process. As the basic prerequisite for supporting the production process at a proper level, in qualitative and quantitative representation, is the provision of qualification training for professionals of a certain direction. The general paradigm of the education of the future, above all, refers to the necessity to train experts of the future, in particular, in the field of civil engineering. It is noteworthy that both the requirements for the teachers: in terms of acquired skills and knowledge, and for the teaching staff of the higher school are significantly changing. Civil engineering education now follows the general narrative of Jordan's educational system. The commitment of educators to adapt to the current context is quite formalized, but at the level of educational institutions, this need is difficult to realize (Hassan et al., 2021). In particular, this problem acquires clear features in the context of the COVID-19 pandemic, illuminating the failure to prospectively assess the learning process (Zabalawi et al., 2020).

Engineering education is shaping new trends in the preparation of professionals whose competencies align with the demands of the time and correlate with the rapid scientific and technological progress of the present. The revolutionary nature of educational strategies in engineering has taken on a systemic character and is now positioned as a liberal dimension in contemporary education (Cutrer et al., 2019). The active use of multi-criteria approaches is notable (Navarro Martínez et al., 2018).

The primary focus of the scientific-educational discourse in the early 21st century on the issue of preparing professionals in the construction industry is centered around harnessing technological and digital potential, including:

- the multifactorial technological principle of engineering activities (Yepes et al., 2021);
- innovations in theoretical mechanics in construction education through Big Data (Xie et al., 2020);
- the role of Artificial Intelligence in engineering education (Pan & Zhang, 2021);
- engineering education activities based on virtual (Dinis et al., 2017) and augmented reality (Diao & Shih, 2019);
- the use of mobile IoT applications in practical sessions for civil engineering (Chacón et al., 2018);
- information modeling of buildings (Lu et al., 2017).

Research Problem

Developing the potential to implement innovative education standards for Jordanian higher education is a field presented exclusively in the theoretical research dimension. Determining the most feasible innovations and methods of their implementation, as well as the likely effect on civil engineering educators serves as the basis for an overall reform of the higher education system in the state, which is actualized and necessary in the current context.

Research Focus

The study aims to highlight the most expedient ways to improve the quality of qualification training of civil engineers. It is noteworthy that during this study it is important to refer not only to theoretical sources but to take into account the evaluations of the participants in the educational process on this issue. In addition, this approach allows us to assess the likely results of implementing appropriate methods in Jordanian higher education.

Research Aim and Research Questions

The leading task of the work is to determine the field of further development for technical higher education, in particular, in the field of educational and professional support for future civil engineers. Accordingly, we aim to highlight the current needs of the student community, determine the attitude of the teaching staff towards innovative methods of work, and evaluate statistical data on the effectiveness of approaches in the context of the educational process. Thus, it will be possible not only to crystallize the way of gradual updating of education but also to take into account the psychological and pedagogical components of the transition to the educational paradigm of the future.

Research Methodology

General Background

The chosen subject of research requires fragmentation and concretization, given the sufficient breadth of the topic. Accordingly, we use general scientific methods, in particular, deductive-axiomatic, methods of abstraction and concretization. Accordingly, the highlighted components of the process of updating the educational model of Jordan need additional empirical refinement. Thus, such methods were chosen as a closed questionnaire survey according to the Students' evaluation of teaching (SET) methodology, to identify the leading shortcomings and areas of development from the position of higher education applicant (Young et al., 2019); focus group interview method, to establish leading obstacles and advantages considering the activities of teaching staff and method of theoretical processing of predecessor sources, in accordance with the methodological principles given above.

Sample / Participants / Group

The surveys and interviews underlying this work were conducted in the engineering departments of Amman and Irbid institutions of higher education. The respondent groups formed (faculty and students) numbered 93 and 1,012, respectively. The online survey was conducted voluntarily, students were guaranteed confidentiality and anonymity to increase the motivation of the latter. Information about the student body was collected between December 29 and July 23, 2022. The response rate for the survey is 44.2%. Faculty focus group interview sessions were conducted between December 10-14, 2022. All participants expressed an independent desire to join the research program.

Instrument and Procedures

The tools can be differentiated by the type of information obtained: for the qualitative component of the study the method of the focus group was used, and the quantitative representation of the data was formed using a closed questionnaire survey. Accordingly, for the focus group. an interview plan was developed, which included the identification by teachers of the leading criteria for the development of the actual educational process. The second component was the SET questionnaire. A modified form was used, which included the main aspects of the relevant subscales: course evaluation and teaching effectiveness, as well as an assessment on a 6-point Likert scale of the main categories previously identified during the focus group with the teachers. Note that we used the 6-point Likert scale included in the SET form (Işık, 2022) to determine the degree of implementation of trends in educational institutions at the moment, as well as the significance of the latter for students. Accordingly, a percentage representation was formed based on the results obtained. Teachers were evaluated using a similar method. In addition, additional teachers' comments were taken into account when processing the data obtained. Given the length of the text, the questionnaire and plan for the focus group interview are not given but are available upon request. A quantitative representation of the results of the empirical phase of the work was worked out using descriptive statistics and single-factor analysis of variance (ANOVA).

Research Results

Based on the results of data analysis using the descriptive statistics method and taking into account qualitative data, we can provide certain generalizations regarding educational needs and trends in Jordanian civil engineering. Thus, six main vectors of a new educational tradition have been identified, which correspond to an innovative approach and are necessary for engineering education from the perspective of the teaching staff and students of this specialty (Table 1). The teaching staff notes the need to implement such standards as decentralization, recognition of the academic community, modernization of technical support, and dissemination of LMS-systems, as well as the need for interdisciplinary training. At the same time, students emphasize Eurocentrism (the need for international academic interaction), the transformation of educational strategies (the use of the serious game, smart classes), the modernization of LMS-systems. As we see the question of the use of distance learning systems is actualized by the situation of quarantine restrictions due to the COVID-19 pandemic. At the same time, other aspects relate to the procedural characteristics of the educational process and are essential in the context of the effectiveness of the formation of professional competence.

Table 1

Category	The trend in teachers' evaluation	Indicator of importance for students	Implementation rate
Using LMS-systems	0,51	0,73	0,43
Gamification	0,22	0,63	0,18
Eurocentrism	0,43	0,37	0,22
Interdisciplinarity	0,55	0,29	0,78
Decentralization of educational institutions	0,67	0,29	0,54
Transformation of academic community image	0,78	0,20	0,21

Source: author's development.

First of all, let us note that the obtained values reflect the ratio to the conditional unit. Accordingly, we can give prognostic conclusions regarding the pronounced desire of more than half of the students for gamification of the educational process, as well as the use of learning management systems. On the contrary, we can note that teachers tend to rate the use of serious game and digital tools as the least meaningful way to enhance learning. The assessments coincide with the use of LMS-systems as a promising direction in the current limitations, as well as a relatively moderate need to focus on Western educational traditions. Let us also note that the obtained empirical results correspond to the concepts presented in scientific publications of this problem field. A significant exception is the category "Transformation of Academic Community Image", which probably refers to the research aspect of higher education institutions. Therefore, excluding the latter, we will provide specific clarifications on each of the presented categories, taking into account the specifics of Jordanian higher education.

The use of LMS-developments contributes to the adaptation of HEIs to today's challenges, as it implements the principle of accessibility of educational services. At the same time, the use of modern LMS contributes to the formation of a unified "infrastructure" of higher education institutions, which is recognized as one of the significant obstacles at this stage of their development (Zabalawi et al., 2020). The creation of a common information platform for an educational institution will facilitate the organizational components of professional activities and the formation of an academic community, the image of which will have a certain design and commonality. In addition, these systems are informative in the direction of screening the success of students. A recent trend in the use of LMS is the prediction of the effectiveness of mastering the discipline at the initial stage of teaching, which makes it possible to make timely adjustments to curricula. A sustainable channel for student feedback is a promising plane for mastery. Note also that this method is now increasingly available, as access to the log files of most new LMSs is open. Actually, a number of predictive models are presented in research publications, which are actually logs of potential educator outcomes (Riestra-González et al., 2021).

On the contrary, the disadvantages of this innovative method are expressed, in particular, regarding the ability to develop and master the systems by specialists of higher education. Notably, the

common system Moodle LMS, which, in particular, is used at the University of Zarqa, is currently evaluated by educators as insufficiently functional. According to predecessor studies, the desktop and mobile interfaces are used similarly: among the features offered, students refer to 2 resources and note the need to significantly expand the functionality and add fifteen other resources to the system (Hasan, 2019).

The constellation of a large number of factors influences the possibility of widespread use of LMS in the higher education sector in Jordan. To conceptualize this process, let us turn to the technology perception model. Implementing a sustainable LMS requires the creation of an accessible platform and at the same time the accessibility of the technology provision as a whole (Al Amoush&Sandhu, 2019). This requirement challenges higher education professionals to create a unified infrastructure that meets the needs of all participants in the learning process. Moreover, the proposed system needs significant attention to issues of inclusivity. The formation of such a network of provision can be implemented in accordance with the five-year plan for the formation of digital infrastructure for the segment of public education, presented by the Ministry of Education of Jordan. However, the issue of financing in the context of centralized educational management is relevant. The factor of readiness to accept the digital infrastructure by the employees of the education system should also be taken into account. Since the most significant factor for the integration of LMS into the existing interaction paradigm is cultural specificity, a significant effort must also be made to educate on the usefulness of IT tools for the educational process. Thus, there is a significant distance between the necessary components for effective training of civil engineers and the broader field of conditions in which their professional training takes place, requiring a global change to put the highlighted aspiration into practice.

Gamification of the educational process is also an expressed need for civil engineering educators, according to the survey results. This aspiration of students corresponds to the research results of recent years concerning the feasibility of this method (Zainuddin et al., 2020). In particular, the implementation of the serious game approach in the digital space for educational purposes is one of the areas of development of innovative learning. Since it is the educators who play a key role in the gamification process, their evaluation of this category should be taken into account. Note that the results of the presented interview are qualitative and do not indicate statistical trends in the general population. There are findings from a mass survey that Jordanian educators are interested in the use of gaming systems (Assaf et al., 2019). According to the lion's share of respondents, serious games can serve as a tool to establish a finite relationship with students, promote motivation to learn, and act as an independent edutainment technique. Despite the lack of significant experience with this development, educators note that the benefits of game mechanics in the work are significant. On the contrary, the problems described above are actualized: the lack of a unified IT infrastructure, methodological recommendations, and funding limitations. Moreover, the difficulty of evaluating the use of such technology remains unresolved. A key disadvantage is a need to develop new or integrate existing models of serious games in accordance with the educational objectives of a particular curriculum. Note that the measure of the load on the teaching staff of the educational institution in decentralization and implementation of this strategy increases quite significantly. Accordingly, the main place in this initiative should be given to developers, because serious games should realize the possibility of making adjustments by teachers, integration on different devices, being sufficiently inclusive, etc. (Schöbel et al., 2021). Let us also note that the possibility of customizing the game material will contribute to greater adaptability and interdisciplinary application of the latter, which will facilitate the implementation of this product at all levels.

Interdisciplinarity is an important principle for higher education in general, but the specialty of civil engineering requires the ability to interact with the broad architectural and engineering information field (Park et al., 2022). Forming a holistic professional competency requires a future professional to have a sustained understanding of the tangential fields. Moreover, this specialization requires involvement in macrosocial processes: awareness of research achievements at the international level, application of technical innovations, understanding of socio-economic dynamics, etc. Students' satisfaction with the feasibility of the interdisciplinary approach to professional training is now quite high.

Eurocentrism is one of the principles concerning two important aspects of the educational process at the same time. First of all, it is the desire for international cooperation and mobility of the student community. This category is significant, given the socio-economic situation in Jordan: grant support and sponsorship programs will serve as a sustainable and important foundation for higher education to flourish. Also, support for international connections ensures that educators remain included in the current field of information, which encourages Jordanian professionals to make use of current global technical and methodological developments. For Jordan's state economy and culture, heterogeneity and interpenetrating processes in cooperation with other states are an advantage (Hassan et al., 2021). The inclusion of members of other ethnocultural and national groups in the educational system will help to infuse higher education with new traditions and methods. Such divergent thinking among educators will encourage the development of new teaching philosophies and modify the existing standard.

The second aspect of Eurocentricity is the postulation of a humanistic approach to education. Here we address the space of personal growth of future civil engineers. Since higher education serves not only as a platform for professional training but also as a significant institution of socialization, this condition should be taken into account in the development of methodological developments and strategies. As an example, let us note the specificity of the architecture of Jordanian universities: the planning of campuses was intensified and without taking into account the principles of environmentalism, respectively a large part of the cells of civil engineers is an example of the archaic, which makes it impossible to postulate the principles of future education in such a context (Winks et al., 2020).

Summarizing the main categories, we can turn to the need for internal decentralization of educational institutions. First of all, it is an important stage in the realization of the academic autonomy of an institution. In fact, the centralized approach to the management of the educational process quite often makes it impossible to implement innovative developments and slows down the gradualist development of the community. The main difficulty for a fully functioning centralized university is the low expertise of its managers, given the presence of a significant number of fluent processes that cannot be guided by one person. Accordingly, it is much more effective to distribute functions between structural subdivisions and to form responsibility cells within each of the latter. Thus, the functioning of the individual unit of the educational institution will be relatively autonomous and self-sustaining, in the context of management (Elhaija et al., 2021). For the deployment of this scenario of higher school activity organization, we can talk about the possibility of the operational embodiment of student and faculty initiatives, academic community development, and discreteness of units, which will have a unique image reflection. The question of designing strategies for the development of an educational institution remains open. Actually, this direction can be the basis for the professional realization of management.

Based on the results of previous studies, we can assume that it is decentralization that serves as the main method of achieving innovative education. First of all, the formation of an autonomous system at the unit level gives the opportunity to create a common IT infrastructure, which will require much less time and resources, in turn, such a digital substrate opens access to the use of LMS and game technologies. A separate unit has greater opportunities to prepare grants and international endeavors, but also humanistic traditions are more pronounced in a community of a smaller order. Note that the main disadvantage of this strategy is the uneven development of various scientific organizations and institutions, but the competitiveness of educators is greatly enhanced. In addition, corrupt or unbalanced budget distribution between or within units is possible. Moreover, this approach does not solve but also complicates the problem of providing interdisciplinary training for future experts.

It is also important to note that there are significant differences in SET scores for engineering education, established based on a one-factor analysis of variance (ANOVA). In particular, there is a statistical difference between institutions with different degrees of realization of the aspects under study, which provides an opportunity to expand the deductive-axiomatic representation of the problem (Table 2).

Table 2

Significant Differences in Grades for Civil Engineering Students

Grounds	Indicator of significance			<i>p</i>
	<0,25	0,26-0,74	>0,75	
Implementation rate				
Using LMS-systems	0,74	0,66	0,81	0,159
Gamification	0,76	0,55	0,58	0,088
Eurocentrism	0,58	0,14	0,41	0,010
Interdisciplinarity	0,11	0,23	0,55	0,037
Decentralization of educational institutions	0,12	0,64	0,11	0,241
Transformation of academic community image	0,28	0,11	0,23	0,102

Source: author's development.

According to the results, we can testify that students studying at educational institutions with a high or low level of Eurocentricity to a greater extent aspire to embody Western educational traditions in the learning process. Let us preliminarily note that this tendency is due to the desire to modernize and follow modern trends in professional training. At the same time, the level of interest in the European educational-scientific paradigm among other teachers is much lower. An important factor, in this case, is the cultural peculiarities dictated by the geography of the institution. In addition, among the students who are more appreciative of the interdisciplinarity of professional training, the desire to implement this standard of higher education is also higher. First of all, this is due to the difficulty of mastering the value of an interdisciplinary approach, given the specific methodological foundations of this area and

the peculiarities of teaching this material. Let us note that the realization of the didactic value of this category is related to the measure of its realization.

Discussion

As can be seen from the results obtained, the general trend towards the digitalization of the educational process, which is becoming more pronounced due to quarantine restrictions, meets the current needs of the participants in the educational process. Moreover, a significant modernization of technical support is needed, as evidenced by the values of the implementation of relevant educational standards presented above and the results of the evaluation of the functionality of LMS support in Jordan (Al Amoush & Sandhu, 2019). The need to create a unified IT infrastructure in the state, the development of modern educational methods for all public institutions: serious games, LMS-systems, system (interdisciplinary) approach is expressed. It is worth paying attention to the heterogeneity of methodological support of higher education, which is due to the lack of centralized interventions.

Besides, it should be noted that the training of civil engineering specialists should take place in compliance with the modern pedagogical tendencies of the European space. At the same time, it is necessary to maintain the glocalization approach to solve national-level problems, respectively, it is necessary to take into account the specificity of professional training exactly in the Jordanian context presented. To integrate these postulates, it is necessary to follow the concept of gradualist development of higher education: to promote international relations and maintain a moderate Eurocentrism, not embodied in Europeanization. But it is also necessary to promote the development of the educational space and the Jordanian community.

The question of possible ways to integrate the presented model into the existing system of higher education, methods of reconciling the needs of educators and the resource of Jordanian higher education remains relevant. In particular, we have established a significant difference between a certain degree of realization of the main categories and desirability for students and teachers. Now this distance cannot be reduced in the short term, as the current educational reforms are taking place under severe constraints and obstacles (Zabalawi et al., 2020). Nevertheless, the chosen direction corresponds to certain aspirations among educators, indicating a student-centered approach in the transformation of Jordanian higher education.

The limited resources of the education system require considerable plasticity among professionals in this field if the latter are to shape the education of the future. In turn, this makes it impossible to rapidly develop the educational tradition and master innovative approaches. Consequently, the leading issue remains the search for ways to embody certain methods of enhancing the effectiveness of civil engineers' professional training in a situation of constraints. In addition, comparative research to fill existing gaps would be an important addition to this topic. We can emphasize the need to develop a predictive model to assess the prospects for the embodiment of the above principles of innovative education. - Finish the discussion section

The main vectors of the modernization of the educational process in civil engineering are quite significant. At the same time, the possibility of their implementation depends on a significant number of direct and concerning factors, in particular those with socio-economic basis. We were able to identify the main categories that the participants of the educational process consider significant in the context of innovative education. Moreover, we have identified what prospects and obstacles are associated with

the latter. Significant potential for solving these problems has a decentralization strategy - the formation of holistic units that will be able to implement innovative standards of future professional education at the local level, obeying the general principles of the institute.

Conclusions and Implications

Thus, the main principles of future civil engineers' training based on higher education should be interdisciplinarity and Eurocentrism. At this stage, these educational standards are partly implemented and confirm the compliance of the educational paradigm with modern requirements. At the same time, the problem of technical support of educational institutions remains relevant, and at the same time, the need to use LMS-systems and the latest didactic techniques (in particular, gamification in the digital learning space) at the level of structural units is expressed. The issue of management of educational institutions requires reconsideration among specialists because the need for decentralization of institutions is essential, given the obstacles of the distribution of resources in accordance with the needs. All the aforementioned principles of educational process development will reduce the distance between the professional training system for civil engineers and today's challenges. It is important to note that it is for future civil engineers that this problem seems to be significant since this specialty belongs to the category of those in constant transformation and is sensitive to technical and instrumental innovations in the world. Therefore, ensuring that Jordanian engineers are up-to-date with their expertise is the first priority of the educators of today.

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