

## **Innovative methodology techniques in teaching of progressive technologies for architects**

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**ABSTRACT:** The aim of this article is to present innovative techniques, scientific analysis of methodology techniques and to prove the success of the techniques by their impact on students' results. It provides a detailed description of new innovative techniques in the teaching of progressive technologies for architects. Methodology of the new innovative techniques is analysed. The successfulness of the innovative techniques is evaluated in the courses: Technical Equipment of Buildings I, Technical Equipment of Buildings II and Co-ordination of Works in the Architectural Design Process. The evaluation was based on scientific methods of comparison, synthesis and deduction. The results achieved by students in all three courses in individual assignments are introduced in detailed graphs according to the old and new innovative techniques. Scientific analysis of the results achieved in all three courses in individual assignments is introduced according to the old and innovative techniques. The successfulness of the new techniques is proved on the basis of students' results. Recommendations on the application and usage of the innovative techniques are also presented.

### **INTRODUCTION**

Future directions of the building industry and architecture will come from the revised EU directive on the energy performance of buildings directive (EPBD), which states that *...All new buildings in the EU will have to have almost zero energy consumption till 31 December 2020 and this should significantly be met by renewable sources.* To meet the directive, it is necessary to apply modern energy efficient building technology. It is important to find new, efficient, usable and progressive technology in buildings; e.g. the active use of solar energy, a new generation of heat pumps with additional systems, improvement of heat recovery systems, the creation of new efficient ventilation, refrigeration, air conditioning and hot air heating systems, and improved use of biomass.

In Germany and Switzerland, new energy efficient progressive technologies in buildings are now significantly more utilised and incorporated into the architectural design than in Slovakia. The energy efficiency of buildings must be achieved and at the same time the building must provide interior thermal comfort [1]. Interiors of the new buildings are often unnecessarily overheated in the winter and, thus, lose the efficiency of energy-saving technologies of modern buildings. There are many reasons, but the core of the problem is in local thermal discomfort. To remove the local thermal discomfort by overheating the interior is not possible and furthermore it only creates unnecessarily energy loss [2]. A solution of the thermal discomfort problem is topical. The problem of thermal discomfort is nowadays highlighted, so that small interiors are used, architectural and effective. Therefore, the teaching of progressive technologies is very important and is inevitable for architects. Without having knowledge about progressive technologies, zero energy buildings could not be created.

### **RESEARCH ON INNOVATIVE METHODOLOGY TECHNIQUES**

The research on innovative methodology techniques was carried out during the lessons on progressive technologies for architects. Progressive technologies are taught within the Technical Equipment of Buildings I (TEB I), Technical Equipment of Buildings II (TEB II) courses and in Co-ordination of Works at Architectural Design Process (CWADP). For scientific purposes the number of students selected was the same before and after the introduction of the changes in the teaching methodology: TEB I - 120 students, TEB II - 120 students and CWADP - 100 students. These numbers are sufficient for statistical evaluation [3].

### **RESEARCH METHODOLOGY**

The goal of this research is to present innovative techniques, scientific analysis of methodology techniques and to prove the success of the technique based on student results. The following five assignments were researched in the TEB I course:

- Assignment No. 1 - Situation of buildings (public pipes, connections, objects).
- Assignment No. 2 - Architectural design of hygiene centre in buildings (concentrating of installations in vertical direction: installation shaft, installation wall, installation corridor).
- Assignment No. 3 - Architectural location of the main drain and water pipes (main drain of sewage and main drain of rainwater, water system in buildings).
- Assignment No. 4 - Architectural location of an air conditioning room in buildings (ground-plan and location of an air conditioning room).
- Assignment No. 5 - Architectural design of an air conditioning system (location of air pipes, location of vertical ventilation shafts).

The following five assignments were researched in the TEB II course:

- Assignment No. 1 - Energy efficiency of buildings (energy concept of building, progressive technologies, renewable energy sources).
- Assignment No. 2 - Architectural location of a gas boiler room (ground-plan of a gas boiler room, location of a gas boiler room and location of a gas meter room in buildings).
- Assignment No. 3 - Architectural location of a heat exchange station (ground-plan of a heat exchange station, location of a heat exchange station in buildings).
- Assignment No. 4 - Architectural location of heating pipes and heating elements in buildings (location of heating systems in building, location of air pipes, location of convective heating elements, location of a ceiling or floor or wall radiant heating).
- Assignment No. 5 - Architectural concept of lighting and electric installations.

In the CWADP course, one of the four assignments was chosen for research – the application and involvement of the progressive technologies into own solutions of architectural design in the architectural studio.

Each student's assignment was evaluated by the following scale:

- A - excellent (excellent results) = 1;
- B - very good (above-average results) = 1,5;
- C - good (average results) = 2;
- D - satisfactory (acceptable results) = 2,5;
- E - sufficiently (results comply only with minimal criteria) = 3;
- FX - insufficiently (results do not comply with minimal criteria) = 4.

The examination results from the given courses were evaluated according to the same scale.

The new innovative techniques in the lectures on progressive technologies for architects are detailed below:

- new visual form of the lectures;
- many colourful images of technical systems and technical spaces;
- concrete examples of system application in connection to - architecture of building - technical element in it;
- use of colourful deduction tools;
- showcases of positive and negative examples;
- consequences of incorrect solutions in the praxis;
- introduction of an interactivity into the communication between the lecturer and the student;
- appeal of the lecturer for placing questions by the students;
- reduction of students' notes in the lecture - emphasis is placed on understanding the topic of the lecture;
- scripts are available to the students - scientific monographs of the lecturer, where all the basic information is from the lectures.

The new innovative techniques in exercises from teaching of progressive technologies for architects are detailed below:

- new form of the explanation of the assignments;
- emphasis is put on the understanding of the problem and on the application of concrete examples;
- adding new materials to each assignment into the electronic system - where it is accessible for students - they can download and print it;
- new material for each assignment - where the detailed description of solved problems is located;
- new material for each assignment - where it is defined what is necessary to draw and where it is necessary to use dimensions;
- new material for each assignment - principles of solutions;
- new material for each assignment - where the examples of solution are shown;
- new material for each assignment - student examples of solutions;
- new form of consultations of assignments because of the shortness of time for exercises;

- appeal of the exerciser for placing questions by the students;
- interactive solution to students' problems in working with assignments;
- new form of mistake explanation in correcting the assignments.

## RESULTS AND ANALYSIS OF THE RESEARCH

Results of the grades from exercises in the TEB I course from assignment No. 3 before and after the introduction of the new innovative techniques are shown in Figure 1. Exercise results from all five assignments projected into the result grade of all students before and after the introduction of the new innovative techniques are shown in Figure 2. Results of the grades from the examination before and after the introduction of the new innovative techniques are shown in Figure 3.

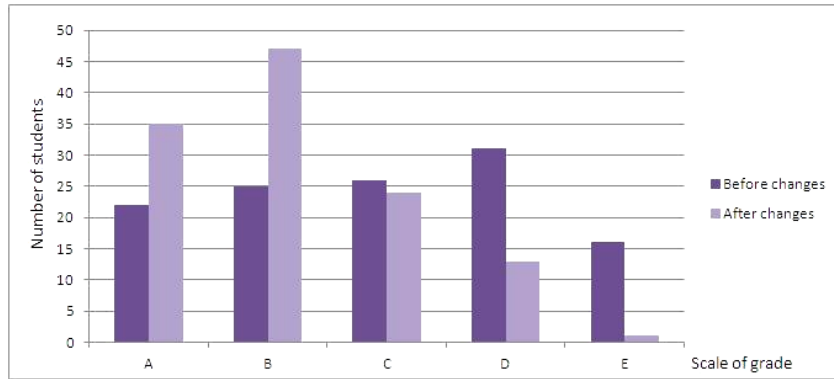


Figure 1: Results of the grades from the exercises in the Technical Equipment of Buildings I (TEB I) course from the chosen assignment No. 3.

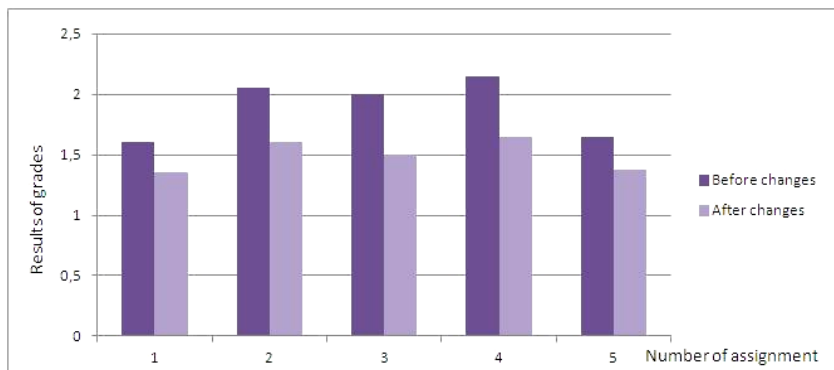


Figure 2: Exercise results from all the five assignments projected to the final grade of all students.

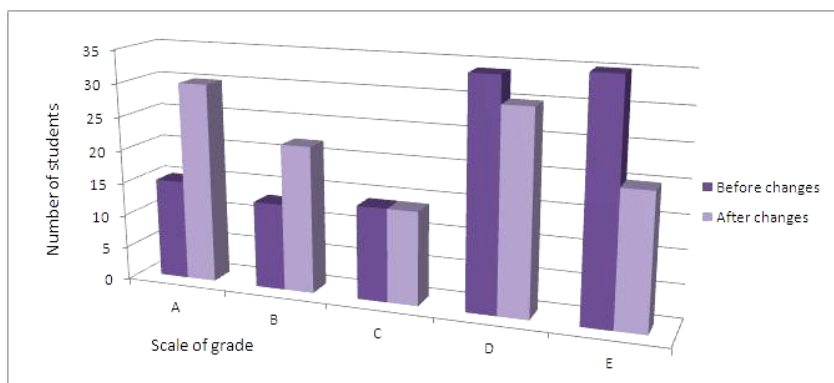


Figure 3: Results of the grades from the examination in the Technical Equipment of Buildings I (TEB I) course.

From Figures 1, 2 and 3, it is obvious that after the introduction of the new innovative techniques into the lectures and in the exercises of the TEB I course, the students' results were significantly improved. From Figure 1, it can be seen how much grades A and B in solving assignment No. 3 increased. Assignment 3 is an application assignment and is one of the more difficult assignments. Furthermore, it can be seen from Figure 1 how much decrease there was in grade D and that grade E disappeared from the results. Figure 2 shows how much the final grades of all students from all five

assignments improved. What is more impressive, the grades from the most difficult assignment No. 2 and more difficult assignments No. 3 and No. 4 were improved. Figure 3 shows a significant improvement of the grades from examinations, where there was an increase in grades A and B, a decrease in the number of grades E. The number of grades C has stayed the same and the number of unsuccessful students has decreased. Finally, it can be concluded that there was a significant improvement in the results from the exercises and from the examination.

Results of the grades from the exercises in the TEB II course from assignment No. 2 before and after the introduction of the new innovative techniques are showed in Figure 4. Exercise results from all five assignments projected into the result grade of all students before and after the introduction of the new innovative techniques are shown in Figure 5. Results of the grades from the examination before and after are shown in Figure 6.

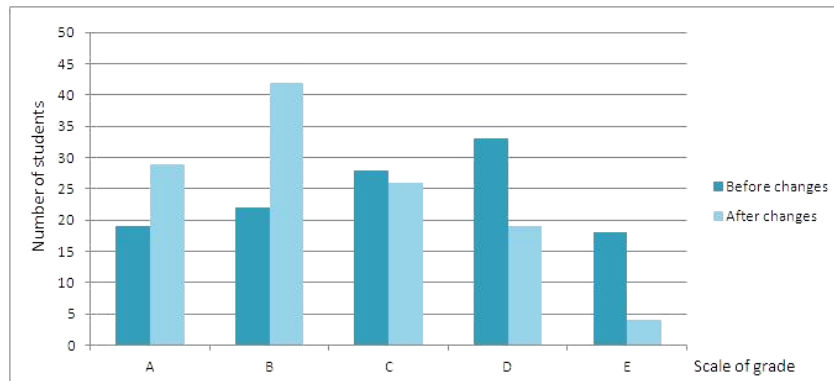


Figure 4: Results of the grades from the exercises in the Technical Equipment of Buildings II (TEB II) course from the chosen assignment No. 2.

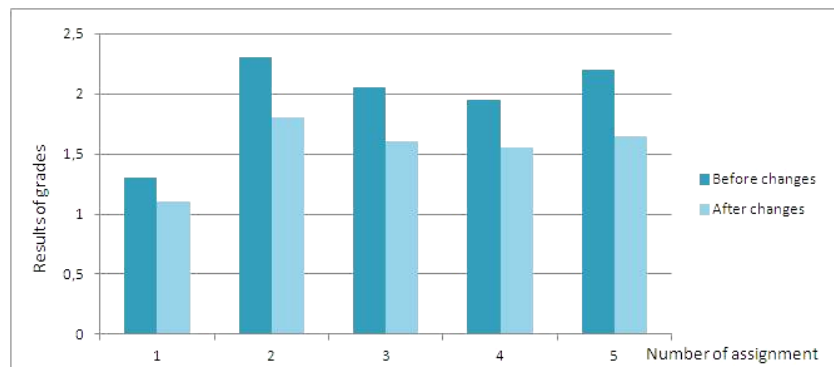


Figure 5: Exercise results from all the five assignments projected to the final grade of all students.

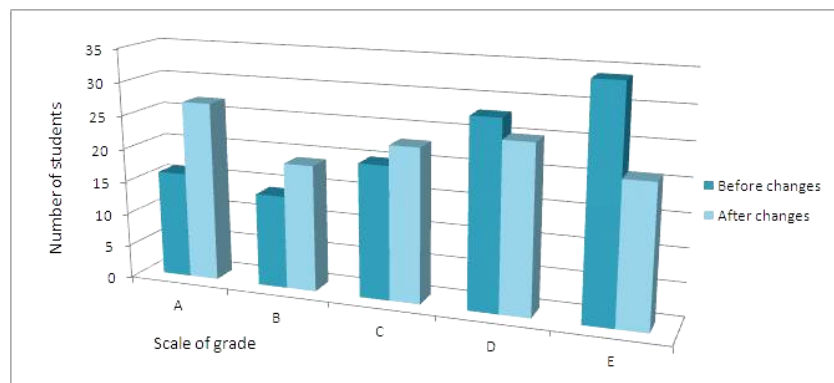


Figure 6: Results of the grades from the examination in the Technical Equipment of Buildings II (TEB II) course.

From Figures 4, 5, 6, it is obvious, that after the introduction of the new innovative techniques in the lectures and in the exercises of the TEB II course, the students' results were significantly improved. From Figure 4, it can be seen how much was the increase in grades A and B in solving assignment No. 2, which is an application assignment and belongs to the more difficult assignments. Furthermore, it can be seen from Figure 4 how much the decrease in grade D was and that grade E disappeared from the results altogether. From Figure 5, it can be seen how much the final grades of all students from all five assignments improved. What is more impressive, the grades from the most difficult assignment No. 2 and more difficult assignments No. 3 and No. 4 were improved. Figure 6 shows a significant improvement of grades from the examination; there was an increase in the number of students receiving grade A and B results,

a decrease in the number of grades E received, and the number of grade C results has stayed the same. Finally, it can be concluded that there has been a significant improvement in the results from the exercises and from the examination. If one compares the TEB I and TEB II courses, one can notice that the results are similar. The number of A and B grades is almost the same, and a slight improvement can be seen in grade D results.

Results of the grades from the exercises in the CWADP course from the chosen assignment before and after the introduction of the new innovative techniques are showed in Figure 7. Results of the grades from the examination before and after the introduction of the new innovative techniques are showed in Figure 8.

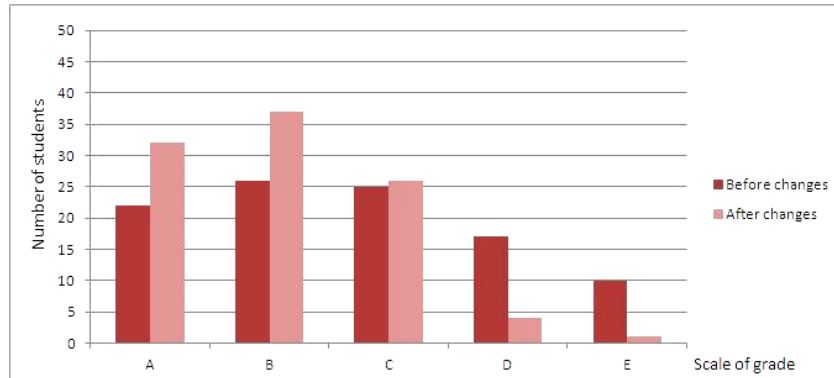


Figure 7: Results of the grades from the exercises in the course Co-ordination of Works at Architectural Design Process (CWADP) from the chosen assignment.

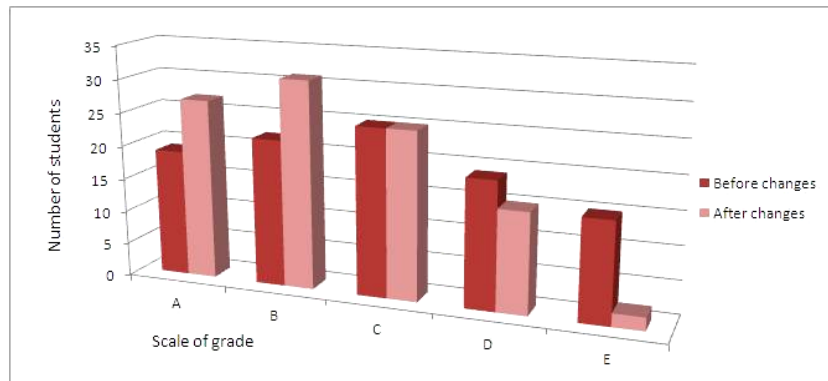


Figure 8: Results of the grades from the examination in the course Co-ordination of Works at Architectural Design Process (CWADP).

It is obvious from Figures 7 and 8 that after the introduction of the new innovative techniques in the lectures and in the exercises of the CWADP course, the students' results were significantly improved. From Figure 7, it can be seen how much the increase in A and B grades was. Furthermore, it can be seen from Figure 7 how much the decrease in grade D results was and the complete disappearance of grade E results. Figure 8 shows a significant improvement of grades from the examination; there was an increase in A and B grades, and a decrease in the number of E grades. Finally, it can be concluded that there was a significant improvement in the results from the exercises and the examination. The average grade from the exercises has demonstrated a trend similar to that of the grades from examination. The results from this course are slightly better than from the previous two courses, something that can be explained by the fact that there were older students involved.

## CONCLUSIONS

The importance of progressive technologies will be constantly increasing, and architects will have to get used to it. Zero energy buildings will soon be a reality and will generally be designed accordingly. Incorporating progressive technologies is required in the first phase of the architectural design. It is very important because an additional forced *inclusion* of progressive technologies into architectural design is not possible, particularly in high buildings. Therefore, the teaching of the Technical Equipment of Buildings I and Technical Equipment of Buildings II and Co-ordination of Works at Architectural Design Process courses for architects is very important.

Progressive technologies for architects were introduced with new innovative techniques in lectures and exercises in teaching, because of better harmonisation of progressive technologies and architectural design. The comparison of the state of knowledge - grades of students was researched systematically before and after the introduction of the new techniques in the three mandatory courses.

Results from the research confirmed the significant improvement of students' achievements. It means that the new innovative techniques in lectures and exercises in teaching of progressive technologies for architects have been successful. The significantly better understanding of progressive technologies by architects and more successful incorporation of progressive technologies into architectural design has, therefore, been achieved. Because of this, it will be possible to prepare high-quality architects for the future, enabling the design of modern buildings for this Century and the design of zero energy buildings.

#### ACKNOWLEDGEMENT

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