EIA in teaching sustainable development and environmental protection in engineering education

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ABSTRACT: A multifaceted approach in teaching the environmental impact assessment (EIA) as a way to stress the role of environmental education in technical sciences is the focus of this article. The EIA is an example of an effective tool that supports spatial planning in implementing sustainable development. The aim is to present the idea and benefits of a facilitative and collaborative approach in teaching the EIA, stressing the role of student co-operation and involvement, as well as a participatory and interdisciplinary approach. Inspiring controversial case studies present different problems and approaches as examples of best practice. The teaching method underlies the necessity of understanding wider processes leading to environmental threats and the ways to prevent them, crossing different disciplines. Such an approach, attractive to students, can present the EIA not only as a formal procedure, but as a useful tool for environmental protection. Consequently, it may strengthen the student's future activities in implementing the idea of sustainable development in practice.

INTRODUCTION

In this article, the idea and benefits are presented of a facilitating and interactive teaching method in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), as part of the specialisation in spatial planning. This method has been applied in teaching the environmental impact assessment (EIA) for urban planners.

The way engineers are taught issues not directly related to the curriculum, beyond the scope of engineering sciences, is extremely important to achieve the intended learning outcomes. Teaching methods need to be adjusted not only to the assumed educational results, but also to the knowledge possessed by the students at a given stage of their education, skills and interests; often focused only on their leading field of study. Sometimes, it becomes a challenge or even a problem that needs to be solved to ensure favourable learning. This requires careful observation of students in terms of their interest in the subject, openness and flexible action to make adjustments to teaching methods.

The aim of the course was to show the possibility of using the EIA - a mandatory procedure under Polish law - to implement sustainable development. In particular, the teaching concerned the protection of the environment and the landscape threatened by new infrastructure investments. This choice resulted from the fact that it is future engineers who will significantly affect the planning, design, implementation, operation and supervision of construction projects, as well as their demolition and utilisation or storage of the demolition materials. Therefore, they will decide on ecological development in many dimensions and on various levels. Their knowledge and competencies, through professional actions and decisions, will translate into increasing or reducing environmental threats. That is why during their studies, they should gain theoretical and practical knowledge in the field of, among others, the EIA, as a tool to prevent environmental degradation.

First, they should understand the idea and message of this tool. They should treat it not only as a burdensome and complicated procedure, but as a fascinating tool with which to understand the implications of environmental decisions regarding the planning and construction of new investments. Thus, the learning objective was to identify and discuss, in an attractive way, the potential of the EIA and to encourage students to use it.

THEORETICAL FRAMEWORK

Engineers participate in various areas, at various stages and levels, in the creation of investments. They plan, design, implement and supervise their functioning, as well as their demolition and the storage or utilisation of the demolition materials. Investments may have numerous negative environmental effects during their implementation, operation and demolition. These include changes in the terrain, flora, soil or water, as well as air pollution, excessive noise, the use of excessive amounts of natural and non-renewable resources, the use of excessive amounts of water and energy,

destruction of the environment, landscape and cultural heritage. Often these are permanent, irreversible changes. As a result, human activity leads to ozone layer depletion, acidification of rainfall, climate change and health problems.

Therefore, engineers should understand well what the environmental implications of their actions may be when they reach the planning, implementation, operation and demolition stages of investments. Help in understanding the environmental effects of human activities is provided by the EIA, which supports spatial planning. It was created in 1969 in the USA and was soon introduced in many countries around the world as an effective and useful tool in implementing sustainable development. It is a mandatory tool in the European Union and in Poland. It is a multistep tool used to determine the potential environmental effects caused by projects and to take them into account, when decisions are made regarding these activities. It is carried out ahead of project implementation, when it is still possible to implement appropriate mitigation measures. Therefore, it plays a preventative role, which makes it an effective tool.

The EIA is a tool for decision-makers, investors, designers and the public to obtain the information necessary to make the best environmental decisions for planned projects. Structured and properly presented information is related to the planned projects, endangered environment and the size and significance of anticipated environmental effects, as well as the possibilities of avoiding or mitigating them. The comprehensive approach and interdisciplinary nature of the research guarantees that knowledge about the potential effects of planned activities is complete and objective. Considering alternatives, this gives the best choices for the environment. Thanks to openness, public participation and the sharing of information, the procedure allows an agreement to be reached by groups with different interests.

All described EIA features should be understood by the student, so that in the future practical activities they can effectively implement sustainable development. That is why various methods were used in teaching, to show not only the methodology and legal requirements of EIA, but also the idea, message and goals of this process.

METHODOLOGY

Sample

Students of semester 7 (engineering degree) of spatial planning, in the FA-GUT, a group of 34 students (23 females and 11 males). Teaching natural science subjects at technical universities brings many problems and challenges. It requires good planning of the classes, selection of theoretical content and appropriate cases, as well as the flexibility to select an alternative teaching method if the teacher notices that students no longer are interested in the topic.

At the FA-GUT, it was decided to teach the EIA as a procedure to define the environmental implications of development. Theoretical knowledge was combined with case studies of controversial activities, to connect the theoretical lectures with practical experience. Lectures were combined with seminars to facilitate interactive and collaborative teaching. A modification of the course content enabled the inclusion of sustainability principles into the teaching process [1]. In addition, students were encouraged to analyse local problems against the backdrop of broader global phenomena. Education requires consideration of globalisation (e.g. climate change, unification of construction systems) and locality (e.g. environmental conditions characteristic of a place) [2].

a) b)

Figure 1: a) Groupwork on a specific task; and b) Result of students' groupwork (Source: Author).

The teaching method was focused on co-operation (students work in pairs or in larger groups); self-education (individual tasks, searching for sources of information, identification of methods of obtaining different data); a participatory approach (engagement and active involvement in the education process: students are encouraged to exchange their thoughts and views, to co-operate, to present their findings, to discuss), interdisciplinary studies in the EIA (stressing the need of interdisciplinary studies during lectures and presenting case studies); and state-of-the-art knowledge (materials from the latest literature and conferences). See Figure 1 and Figure 2.

As examples of best practice, inspiring controversial case studies chosen by the teacher were the vehicle by which different problems and approaches were presented, so as to solve them. Teacher, as *expert*, took part in the presented case studies. Therefore, she could present to students not only theoretical, but also practical knowledge.

a)

b)

Figure 2: Discussions and presentations of students' findings (Source: Author).

Content of the teaching programme:

- Traditional teaching: lectures (theory: idea, aim, history, elements, stages, methodology, potential and shortcomings of the EIA), presentation of selected case studies. During the presentation of case studies various engineering objects were analysed as potential threats to the environment. Positive and negative examples served as supplements to theoretical considerations. Each of the examples presented differing environmental problems and differing ways of solving them. These were, among others: roads, highways, bridges, industrial facilities and other technical facilities. The course ended with an examination.
- Facilitating interactive collaborative teaching: questions/answers, small individual tasks, brainstorming, working in pairs and larger groups of five to six to solve complex tasks, consultations, public presentations, discussions.

Extra Events

In some courses, students are invited to participate in extra events, such as a professional conference (*Landscape protection in the EIA in relation to contemporary legal and methodological circumstances*, GUT, 2018). A multifaceted approach was presented there, and best practices shared, which allowed students to learn new ideas and trends. The opportunity to ask questions, discuss with professionals and exchange thoughts and views was useful to students, as was the occasion to understand the real problems and challenges in practice (see Figure 3).

a)

b)

Figure 3: Participation in a conference on the EIA, FA-GUT, 2018 (Source: Author).

During the course, students acquire the ability to use the EIA tool to protect and shape the environment, in particular to understand and use in practice the relationship between the needs of different users of a space and the characteristics of a place exposed to anthropopressure (especially areas under protection), as well as adequate land use.

Students learn a methodical and comprehensive approach and acquire the ability to perform analytical tasks. They acquire basic knowledge about environmental circumstances and the effects of spatial development on different scales. The students learn to obtain information on spatial management from literature, databases and other sources (see Table 1).

Table 1: EIA teaching methods in engineering studies and results.

	Collaborative methods during teaching	Example tasks	Sample answers	Effects
1.	Teacher asks an open question; each student must give one answer.	What questions does the EIA procedure answer?	What effects will occur as a result of the investment? What will their range be?	Students acquire courage in presenting their answers.
2.	Working in pairs for 2-3 minutes to answer simple question, then presenting findings.	What are the benefits of EIA?	Gaining knowledge about the environmental values and threats.	Students learn to draw conclusions quickly and to present them.
3.	Groups of 4-6 students solve the same complex problem for 15 minutes, write findings on a flipchart and present.	Try to systematise theoretically possible environmental effects.	Negative/positive, long/ short-term, direct/ indirect, on different elements of the environment.	Students learn how to quickly perform specific tasks, publicly present results, compare results and discuss them.
4.	Open discussion. Students answer spontaneously the additional question widening previous task.	Which of the structured effects are the most dangerous? Why?	Synergistic - because are uncertain and difficult to avoid/redirect - because are difficult to predict.	Students learn multifaceted phenomena assessment and make and argue choices.
6.	Groups of 4-6 students solve different complex problems for 20 minutes (playing different roles), write findings on a flipchart. First, the beneficiaries, the investor, then nature conservator present their lists, and finally the residents and radical ecological groups. Students can question the answers of predecessors.	Define environmental threats caused by a specific investment, presented by the teacher (to obtain information, use the professional report EIA provided by the teacher). Feel the role given to you.	The result of the work are lists of environmental hazards (air pollution, water pollution, noise, deforestation, social protests ...) in the eyes of various groups. All the lists are hanging on the wall during presentations.	Students learn to identify methods of obtaining information and materials, to study materials, find specific information, choose data, to share information. Students improve their presentation techniques and learn to understand that different groups can have different opinions.

With the EIA, various teaching methods were used and differing case studies were analysed; a broad spectrum of aspects related to the development and its threats were taken into account; and various scales and levels of activity were referred to. This ensured the integrity of teaching and a holistic approach to the transfer of knowledge, which is considered a requirement of education to shape the professional skills of future engineers [3].

RESULTS AND DISCUSSION

Students in the last class were asked to complete a survey to assess the curriculum of the EIA in engineering studies. They answered a number of questions that were to assess the scope and methods of teaching the subject, ways of acquiring knowledge about environmental protection and the learning outcomes. The answers of 29 students were summarised (Table 2).

Table 2: Questionnaire: students' assessment of the curriculum concerning the EIA.

	Assessment of teaching scope and techniques	Yes	No
1.	Should engineering studies at a technical university be enriched with knowledge about environmental threats and protection?	27	2
2.	Do your studies at the GUT provide the engineer with sufficient knowledge of environmental threats and protection?	19	10
3.	Has the information obtained during the EIA course enriched your existing knowledge about environmental threats and protection?	29	0
4.	Will EIA knowledge be useful for you in the engineering profession?	26	3
5.	Is knowledge of only legal issues related to the EIA sufficient to practise the profession of engineer?	2	27

6.	Does combining theoretical and practical issues in one course support the effectiveness of teaching in the field of environmental protection?	29	0
7.	Were the cases presented during the lectures interesting in terms of expressing environmental problems?	29	0
8.	Has the variety of cases discussed allowed you to understand the variety of environmental threats and possibilities to reduce them?	29	0
9.	Was the approach used during the EIA course, consisting in a combination of different teaching techniques (lectures, seminars, studying professional reports, brainstorming, questions/answers, various tasks to be performed in large and small groups, discussions, presentations) innovative?	14	15
10.	Do interactive activities (engaging the student and forcing them to be active) facilitate the acquisition of knowledge?	28	1
11.	Has working in groups helped you understand other points of view about environmental threats and possibilities to minimise them?	19	10
12.	Were the results of work in student groups satisfactory?	18 + ?	10
13.	Do lectures on threats and environmental protection alone give more complete knowledge than combined techniques?	1	28
14.	Would you recommend using an interactive approach combining different techniques during other classes?	29	0

The results show that students agree that engineering studies at a technical university should be enriched with knowledge of environmental threats and protection which, at present, does not occur in the opinion of half of the students. They agree that the information obtained during the EIA course enriched their knowledge of environmental threats and protection and that this knowledge will be useful for them in the engineering profession.

Most of the students stated that knowledge of just the legal issues related to the EIA is not enough for an engineer. They all positively assessed the combination of theoretical and practical issues in one course, as well as the choice and diversity of case studies, helping to understand environmental problems.

All students assessed combining teaching techniques and believed this facilitated the acquisition of knowledge and would recommend it for other classes. Work in groups was positively assessed by more than half of the students. According to most students, the Internet, university education, conferences and scientific literature are the most effective ways to gain knowledge about the possibilities of environmental protection (see Table 3 below).

Table 3: Students' opinions on the most effective ways to gain knowledge about environmental protection.

	Assessment of ways to acquire knowledge about the environment	0-10 scores for every student
1.	Media	127
2.	Internet	226
3.	Information campaigns at national level	153
4.	Information campaigns at local level	169
5.	Taking part in conferences	204
6.	Participation in protest actions	136
7.	School education	168
8.	University education during studies	221
9.	Scientific literature	204
10.	Popular-science literature	180

Most of the students indicated interactive techniques engaging them, combining lectures, exercises and seminars during the classes and lectures discussing theory and practice are the best way to gain knowledge on environmental protection at university level (Table 4). Most students highly rated interactive teaching methods, because they helped in learning and acquiring new skills useful in professional life (see Table 5).

Table 4: Students' opinions on the most effective ways to gain knowledge about environmental protection at university.

	Assessment of ways to acquire knowledge about the environment at college	0-10 scores for every student
1.	Theoretical lectures	153
2.	Lectures discussing theory and practice	225
3.	Studying legal provisions	120
4.	Studying scientific literature	148
5.	Combining lectures, exercises and seminars during classes	238
6.	Interactive techniques engaging students during exercises/seminars (work in pairs and groups, assignment of simple and more complex tasks, assignment of various roles, presentation of work in the whole group, discussions).	254

Table 5: Assessment of learning outcomes using interactive methods.

	Assessment of learning outcomes using interactive methods	Yes	No
1.	Thanks to interactive teaching methods, students gain courage and confidence in public speaking and in presenting their opinions.	23	6
2.	Interactive teaching methods help you learn to quickly draw conclusions and discuss.	25	4
3.	Thanks to interactive teaching methods, students learn to perform specific tasks quickly.	23	7
4.	Thanks to interactive teaching methods, students learn to publicly present results, compare results and discuss them.	26	3
5.	Thanks to interactive teaching methods, students learn multi-faceted assessment of phenomena.	22	7
6.	Thanks to interactive teaching methods, students learn to make choices and argue for their choices.	25	4
7.	Interactive teaching methods help learn about different methods of obtaining information and argue for the choices.	19	10
8.	Interactive teaching methods help in analysing material, finding specific information, choosing data and sharing information.	24	5
9.	Thanks to interactive teaching methods, students improve their presentation techniques.	25	4
10.	Thanks to interactive teaching methods, students learn to understand that different groups can have different opinions on a given topic.	27	2

Analysis of the questionnaires made it possible to draw more general conclusions about teaching. Combining theoretical knowledge with real case studies during the course on the EIA for urban planners, presenting different problems and challenges, allowed bridging theory and practice. This is one of the most common methods in postgraduate education, next to traditional methods, such as lectures and exercises [4].

Traditional teaching methods also have been enriched by exercises based on a facilitative approach. The teacher limited lectures to a minimum and became a facilitator rather than a lecturer. The teacher facilitated students' tasks, leading to important insights and led discussions. Feedback from the tutor helped to solve problems. These methods belong to research-based learning, where activities undertaken by the students, such as identifying and solving problems, are guided by the lecturer to improve students' knowledge and skills [5].

Students educated in such a way, with competencies, such as creative thinking, active seeking for knowledge, enabling students to solve real problems in the professional sphere, are wanted in the labour market [6]. Another feature sought among graduates is the ability to work in a group. Exercises relied heavily on working in smaller or larger groups, which required the active participation, co-operation and involvement of students. Teamwork, including disagreeing, questioning and clarifying, is universally assessed as one of the key professional skills required by employers [7].

A specific, well-defined problem-solving task to be performed mobilises, engages, activates and stimulates students, helps break student passivity and fosters students' imagination. Another tool helping to prepare students for subsequent professional practice and real life is competition, inseparable from comparison [8]. This involves presenting the results of different tasks and comparing them with results of other groups. Students were enthusiastic and interested in group-working. Groupwork, where students help each other in a relaxed and pleasant atmosphere, is one way to facilitate communications, especially for shy students [9]. The conclusions of the analysis indicate that a multifaceted approach should enrich the curriculum, as it increases the student's competence and value on the labour market.

CONCLUSIONS

A multifaceted teaching approach through the environmental impact assessment was the focus of this study, to stress how important it is to include environmental education in technical science. Knowledge of risks and environmental protection among science students is essential. It is they who will soon face the problem of coping with new, more serious environmental challenges and problems and will have to solve them through responsible actions in professional life. Improving the efficiency of teaching engineers will improve their qualifications. Innovation and best practice in engineering education is necessary.

Modern teaching methods, as bridging theory and practice, collaborative methods, a facilitative and interactive approach, teamwork, and problem-based learning provide this, students' creativity and imagination are developed. They may enhance knowledge of sustainable development and environmental protection in engineering education, for the benefit of the environment and future generations.

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