Environmental impact assessment teaching in environmental engineering

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Abstract – **Environmental studies are conducted by multidisciplinary teams of professionals. Among the desired qualities for a professional working in the environmental impact assessment (EIA) field are: (a) ability to relate concepts deriving from different disciplines; (b) open spirit to understand world visions and rationalities different from one's own, including the technical rationality underlying the environmental impact assessment process; (c) inter-personal relationship and team work ability; and (d) critical thinking. Although such abilities are developed along time and also by professional experience, it is desirable that environmental engineering students perceive that these qualities will help their future professional activities. The environmental engineering course of *Escola Politécnica da Universidade de São Paulo* includes two one-semester assignments on EIA, for which teaching strategies were adopted, such as: (i) traditional lectures; (ii) guided discussions during lecture-type lessons, stimulated by questions proposed by the professor, articulated with the programmatic content of the lesson, so that the exposition only goes on after the students have discussed and advanced a partial solution for the issue proposed; (iii) thematic seminars, when a group presents the review of a scientific paper appointed by the professor; (iv) presentation of the results of guided studies and extra-class activities, which include: (a) a limited number of individual exercises; (b) practical work, which differs from the exercises for being longer and done in group; among the guided works, one is particularly long and challenging: it concerns the critical analysis of an actual and recent environmental impact study.**

Index Terms – Skills, Environmental impact assessment, Teaching strategies.

INTRODUCTION

Environmental impact assessment (EIA) is a multidisciplinary approach to take ecological and social considerations into full account in the decision-making process. EIA can be applied to project planning, product design and to both private and public decision-making. In most countries and in several sub-national jurisdictions, EIA procedures have been legislated and regulated, requiring the preparation and review of an environmental impact study or statement (EIS) prior to project approval and the granting of an environmental license.

Most regulations and indeed international best practice require that such studies be prepared by a team of professionals covering different disciplines in the fields of social and biophysical sciences. On the other hand, a comprehensive analysis of the impacts of a project benefits from the participation of knowledgeable professionals who understand its technical construction and operational aspects and such professionals are usually engineers.

Coordinating that the preparation of an EIS is not only a technical task, as it also requires the build-up of a good relationship with the project owner or its representative, but also to conduct negotiations with government officials and a lot of interaction with the general public, in the form of public hearings and other consultation processes. On the other hand, the coordinator acts as a project manager, who, among other tasks, must keep with budgets and schedules and, not an easier job, to establish a dialogue with specialized professionals and consultants in other to integrate different information and analysis in a coherent product, the EIS, which is, at one time, a technical report and a communication piece.

Effectively and efficiently coordinating the preparation of an EIA requires an unusual combination of skills. Although in principle, a professional of any background could develop such skills, a person featuring a non-specialist or a generalist formation is potentially well-placed to perform such tasks. In many countries, such professionals graduate as geographers, environmental planners, environmental designers, environmental managers or environmental engineers.

Clearly, such skills can only arise from relevant practical experience, but could possibly be developed earlier and to a greater depth if educators instill their seeds in young students.

At the University of São Paulo, environmental engineering is a new career which was set up after a decade of debate among faculty members. It runs in two different campi at two engineering schools. This paper discusses teaching environmental impact assessment at *Escola*

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Politécnica, a 110 year old institution where EIA is a mandatory subject taught in two semesters at the fifth year. The experience reported and discusses here refers to the first time these subjects have been offered, namely in 2006.

TEACHING APPROACH

EIA can be taught to different publics and with different objectives. It can be presented to both public and private decision-makers aiming to show its usefulness as a planning and conflict-resolution tool. On the other hand, it can be introduced to professionals and to students who are or will be its practitioners, be it as members of teams to undertake such studies or as officials in charge of reviewing the studies. The latter is clearly the focus of teaching EIA to environmental engineering students.

Training has traditionally been a favorite means of diffusing EIA in developing countries [1], including in Brazil [2], where there is a vast although largely undocumented experience on EIA training, including one of the authors. EIA education evolved from capacity-building initiatives; training government officials is often a first step in establishing a new EIA system and training is still a key component of capacity building in present days.

However, a clear distinction must be made between introducing new tools or procedures to experienced professionals and training them to make an effective usage of such tools and educating future professionals who are currently following an undergraduate course, for whom "effective teaching" should be sought after [3].

Arguably, introducing a new tool to mid-career professionals could benefit from their experience, but needs to overcome (potentially unsustainable) established practices and prejudices. Conversely, teaching this same subject to young audiences requires a pedagogic approach that considers that the students have probable never been exposed to real life environmental conflicts.

Time schedule is organized in such a way that more than 50% of the total workload comprises extra-class activities. By a combination of theoretical lectures and practical activities (consisting mostly of group work – a situation likely to be found in actual EIA practice), the course aims at:

- strengthening the conceptual understanding of environmental impacts.
- internalizing the idea that EIA is a process designed to anticipate future consequences of present decisions, hence it is not limited to the preparation of an environmental impact study or statement, which is not the purpose of EIA, but a means to achieve its goals; this aspect *has* to be emphasized, since professional practice risks to be reduced to the preparation of a report or the granting of a license or consent [4], whereas the EIA process is about more democratic decision-making.
- introducing tools and procedures to undertake relevant tasks in EIA preparation, especially impact identification and determination of impact significance; a solid understanding of impact identification is of paramount importance, because a common mistake in Brazilian EISs is the confusion between cause (a human action, such as earthmoving) and effect (the environmental impact or the changes – mensurable or perceptible – induced in an environmental receptor [5];
- stimulating awareness of the crucial importance of careful planning *before* starting EIS preparation – e.g. by discussing the role of formulating impact hypothesis *before* engaging in any data collection or field work other than preliminary reconnaissance;
- demonstrating that EIA requires a multidisciplinary team where competencies and skills of each member should be both added and shared;
- strongly suggesting that a competent professional needs to develop his/her own knowledge base which, in turn, benefits from periodical update and recycling; under this perspective, lectures intended to transmit the idea that EIA is an evolving field and that beyond laws and regulations, it responds to societal demands, themselves evolving; students are directed to additional sources of information and stimulated to keep updated on new developments.

A general guideline for the course is that EIA requirements in any jurisdiction are a response to societal needs. This is in contrast with some training schemes based on "how to comply with legal requirements" that market themselves as featuring practical solutions. In fact, this is only part of what is needed from a competent professional who, in order to keep in pace with evolving needs and demands, only benefits from deeply understanding the roots and the evolution of EIA. Thus, a message to be transmitted is that legal requirements and regulation that make laws operational exist only *because* they respond to a need and not that a EIS has to be prepared and filed because the law so requires.

Theoretical lectures follow classical EIA courses whose contents is featured in several English language textbooks, such as [6] and [7], among others, although a local textbook is adopted [8]. Table I outlines the course contents.

TABLE I
ENVIRONMENTAL IMPACT ASSESSMENT COURSE CONTENTS

Terms and concepts
Origins, evolution and international diffusion of EIA
Legal and institutional framework for EIA in Brazil
The EIA process and its purposes
Planning the preparation of an EIA
Tools and techniques for impact identification
Environmental and social baseline studies
Tools and techniques for impact prediction
Methods for impact assessment
Outlining and environmental management plan
Communication requirements and document preparation
EIS review
Public consultation
Decision-making
Monitoring and follow-up
Strategic environmental assessment

In order to stimulate personal reflection and the continuing building of a strong conceptual framework that could underpin future professional practice, each lecture usually starts by asking students how would they solve a problem or state a definition.

As an example, in the first lecture, students are invited to write a short answer to two questions: (i) what is environmental impact, and (ii) what is environmental impact

assessment. A few selected answers are then read and comments on each answer are invited from the "plenary". The goal, not always met, is to reach a consensus about what do these terms really mean, seeking to establish a provisional common understanding to be further explored.

In another lecture, students are shown a map featuring the main elements of a hypothetical project (usually a dam) and key components of the affected environment (such as vegetation stands and human settlements) and then are invited to describe the main tasks to be performed were an EIS to be prepared for this project.

A review of teaching preferences among Brazilian higher education students (not only engineering) found that traditional expositive lectures are especially valued to motivate students, as they can be used to highlight key issues [9].

Lectures are essential to the EIA course, but are limited to approximately 55% of total time spent in class (a total of 72 hours during two semesters). The remaining time is devoted to a series of practical activities (Table II), which have been selected having in mind the need to understand the concepts underlying EIA and the purposes of the EIA process.

At the end of the first semester, a challenge is proposed: students must read and critically evaluate an EIS of a real project. This activity starts during winter vacations and goes through the second semester. This practical task is inspired by the case study approach .At the moment the problem is proposed, they have not yet been introduced to the whole range of issues related to EIS review (a step in the EIA process). Students are challenged to write a consistent, comprehensive and detailed enough review report which can be compared (if the professor wishes!) to the official review report prepared by the governmental agency in charge of managing the EIA process.

Reviewing a 500+ page EIS is not only a lengthy exercise, but one that requires a structured analytical approach and shows the information and cognitive limitations of the students. They are quickly confronted to terms, concepts, tools and issues they are not familiar with, e.g. the biology of estuarine fish or field archeology methods. In the real world, EIS review requires a multidisciplinary team. Hence, in this exercise, the aim is not to identify factual errors (although n attentive and reasonably well-educated reader could typically find some), but to evaluate consistency, articulation among parts and chapters, comprehensiveness and adequacy of project description (a task an engineer should be fit to undertake), robustness and conclusions. The challenge is to devise an analytical framework and to apply it in a consistent manner. It is not difficult to criticize an EIS, to find factual errors or to say that baseline studies should be more detailed, but it is not trivial to determine whether or not deficiencies are *relevant* to decision-making [10].

TABLE II
PRACTICAL ACTIVITIES IN ENVIRONMENTAL IMPACT ASSESSMENT EDUCATION

Activity	Theme	Description	Main Objectives
practical work 1	impact definition	students must read a short newspaper article featuring a controversial opinion	to strengthen the concept of environmental impact
seminar 1	EIA process and its functions	students must read and review a book chapter, presenting a synthesis in class	to strengthen the concept of EIA as a process and to understand the concatenation of parts
exercises 1 and 2	impact identification	students must identify potential impacts of a hypothetical project	to establish reliable cause-effect relationships
practical work 2	impact identification and selection of relevant issues	students must identify potential impacts of a hypothetical project and sort them by class of importance	to introduce the problem of comparing impacts of different types and deciding upon importance
seminar 2	determining impact significance	students must download, read and review a peer-reviewed paper	to strengthen the concept of significance to practice the search of scientific information
seminar 3	follow-up phase	students must download, read and review a peer-reviewed paper	to consolidate the understanding of EIA as a process that does not end with project approval, but extends beyond
practical work 3	EIS review	students must critically review a real case EIS	to expose students to a real-life case to exert critical thinking training to communicate findings

In 2006, students reviewed the EIS of a controversial dredging project that intends to remove sediments (including contaminated sediments) from a navigation canal to restore navigability. A characteristic of most review reports prepared by the groups was a lack of modesty in comments and observations, implying that some groups of students would feel able to prepare a better EIS, which is definitively not possible at their stage of experience.

RESULTS AND EVALUATION

Assessing to what extent the course reached its objectives is no easy task. In a sense, only by delivering technically competent and socially concerned engineers it could be ascertained that the University adequately fulfilled its obligations, but such a measure of success cannot be evaluated at the end of a semester.

Partially aimed at evaluating the results of this teaching approach and at identifying improvement opportunities, a questionnaire was applied to the students inviting them to assign marks to the activities undertook during the course and to its outcomes. Out of its results, it is relevant to notice that students essentially said that practical activities significantly contributed to learning and that such activities should be maintained.

It has also been observed (although no particular procedure was used to evaluate this) that students' understanding of "environmental" impacts and "environmental" impact assessment includes as well categories labeled as "social" and "cultural" impacts. This finding is convergent with the conclusions of a study about the perception of the meaning of sustainable development among a group of engineering students [11], which moved from a predominantly environmental and economic dimension to a wider spectrum to include social and cultural aspects, among others, thus becoming more complex.

CONCLUSIONS

Teaching EIA is challenging under many points of view. One advantageous departure point is that most environmental engineering students acknowledge the importance of this subject for their future professional activity, but EIA is neither technology nor hard science, thus teaching EIA is different from teaching other engineering subjects, in the sense that ethical concerns cannot be ruled out [12].

Unlike other practical subjects, a person who graduates in environmental engineering is not prepared to coordinate the preparation of an environmental impact study or to advise its planning or review. Such skills can only be developed with professional practice. What is expected, however, is that the student could develop a deep sense of the complexities of the task and, more important, develop a solid conceptual understanding to support future practice.

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