

Coaching instead of teaching LCA: 20 Years of experience at universities of applied science

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1. Introduction

This presentation describes how we teach or better coach LCA. We have been using this approach with success since several years in diverse courses at the level of university of applied science. It involves students in active, projectbased learning, fosters their creativity, and enables their learning in context. The exercise lends itself to developing and exercising all levels in Bloom's Taxonomy of Learning - Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation [1].

2. LCA as a student exercise

Teaching LCA normally involves a lot of theory about the LCA methodology. Following the four steps described in the ISO 14040 norm [2], all the relevant aspects are presented and the crucial factors are elaborated such as functional unit, system boundary, allocation, impact evaluation and interpretation. Such a course may be pept up by some smal exercises and normally ends with an exam testing the theoretical knowledge of the students. We soon experienced that this kind of lecturing allows theoretical knowledge transfer but does not allow to address and exercise all the questions and pitfalls that you have to face in real LCA projects. Because in the every day work of a LCA practitioner the problem is not to know what is a FU, to calculate the impacts from the inventory or to know every point of the ISO norm but how to give a reasonable answer to given question despite all the data gaps and other problems like allocation or limits of methods. In other words students have to learn how to do estimations, conclusions, interpretations and deal with uncertainties.

Whenever possible, we reduce the theory to an absolute minimum and allocate most of the lessons to case study like exercises. We provide a professional LCA software and define open-ended problems to be solved. LCA case studies provide a natural playfield for the student to learn not only the technical details, but also to understand the engineered product in its full context including aspects of consumer behavior, industrial decisions about marketing, ethical considerations and public policy aspects such as regulation. The case study facilitates teaching about ill-defined problems and collecting real data. It gives students experience in setting priorities in data collection, making reasonable estimates and identifying uncertainties. The problem is useful for coaching students in a wide range of concepts including systems analysis; setting problem boundaries, data and performance uncertainty, environmental and health risk assessment.

3. Coaching LCA instead of teaching LCA

For serious LCA case studies learning by doing introduction to a LCA software is needed in a first step. The case study then calls for an inventory analysis. The students are encouraged to do the energy and materials inventory in as much detail as feasible. They are faced with the different impact assessment methods and get an idea of the uncertainties involved in assessing the impacts. In many cases, students also propose an improved design. The extent to which details of a new design are emphasized could depend upon whether the course has design or general environmental analysis as its focus.

During the case study the students are free to work how and where they want. We do not teach them what they have to do but offer coaching and moderation during the case study.

4. Results and discussion

Over the last 20 years, we have used LCA case studies on real problems with great student involvement and excitement. Two examples of case studies:

In the year 2006: Improvement potentials of the European football champion ship 2008. This case study was realized for the host city Basel. The students learnt beside the LCA framework how to deal with uncertain data regarding the future, how to find pragmatic solutions for complex problems and how to convince decision makers. Some of their suggestions were implemented.

In the year 2013: Switzerland has decided to shut down the nuclear power plants till 2035 and the case study dealt with the question what will be the environmental impact of this decision. The student learnt how to do scenario analysis, where to find the necessary data and how to deal with uncertainties and discussing the different value systems.

Our observations have highlighted to us numerous features on the value of case study based coaching. These factors of student learning are outlined below:

- Working with ill-defined problems: Real LCA case studies provide an ideal setting for students to learn to draw problem boundaries and structure the various parts of the problem. Students understand the importance and relevance of assumptions and approximations made along the way.
- Handling the unknown: Students are faced with the fact that for some processes there are only unsatisfying data available and that different impact methods lead to different conclusions. They have to deal with such uncertainties and contradictions.
- Asking the right questions: Students are asked to describe the assumptions, data collection methods, uncertainties, and approximations. They have to decide the criteria by which they will judge "environmental friendliness." They have to discover how hard it is to get relevant and useful data.
- Relevance of context in solving problems: Estimating the environmental burdens of a product depends upon the assumptions made about various aspects at the different life cycle stages. These range over diverse aspects such as sources of raw material, context of use, possible health effects, user preferences and habits, institutional constraints, etc.
- Importance of interdisciplinary team work: The interdisciplinary team work requires mutual respect for strength and relevance of other disciplines and develops group process and communication skills.
- Responding to diversity in students: Case studies provide an environment that give students with diverse styles of learning and diverse backgrounds an opportunity to demonstrate their strengths.
- Values and ethics in decision making: Various aspects of values as well as environmental and design ethics are naturally brought into the examinations of decisions in the LCA. The ethical dimensions of awareness (of the engineer, designer, of the consumer, and of society in general), accountability of the various paths involved and autonomy can be invoked and discussed naturally in the project.
- Practical experience: Case studies give students the opportunity to gain experience in practical LCA project work and strengthens the self-confidence.

5. Conclusions

In summary, the didactic method case study presents various facets of environmental science, engineering, and decision making to the student. It develops systemic thinking, technical content knowledge, interdisciplinary knowledge, decision making skills, and group interaction and communication skills. Pedagogical and motivational factors such as teaching knowledge in context, learning through trial and error, extended periods of observation, seeing the use of the material learned attract and retain all students. The case study setting also lends itself to modification for different levels and stages of students. In general, LCA provides a fertile ground for investigations of this type ranging from semester-long project or design courses to homework assignments in a general education course.

6. References

- [1] Bloom B. S. and Engelhart M. D. (1974). Taxonomy of educational objectives. 5th edition, Weinheim, Basel: Beltz
- [2] ISO 14'040 (2006). Environmental management - Life cycle assessment - Principles and framework: Geneva.