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Increasing the Perspectives of Engineering Undergraduates on Societal Issues through an Interdisciplinary Program*

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To tackle the challenges of the 21st century, future scientists and engineers have to understand the interplay between societal challenges and technical solutions as early as possible in their education. They also have to develop the communication and the teamwork skills required to be effective professionals. To address this issue, the Ecole Polytechnique Fédérale de Lausanne (EPFL) introduced a new Global Issues program to all 1800 first year engineering students. In this paper, we present this novel program and reflect on our experience. Our results suggest that student who showed positive attitude towards teamwork, benefited the most from the course and increase their perspectives on societal issues as measured by their moral reasoning after the course.

Keywords: engineering education; soft skills; global issues; interdisciplinary approach; teamwork; communication; climate; food; energy; health; mobility

1. Introduction

In today's world, challenges transcend disciplinary boundaries: population ageing and growth, food supply, energy consumption, growing cities, social inequalities, climate change, water and waste management all require contributions of resources and knowledge from technological, social science and humanities fields. It is crucial that the next generation of scientists and engineers becomes aware of them in order to build tomorrow's technology [1]. For this reason, so-called *soft skill* courses are gaining traction in engineering curricula [2]. This paper contributes to the literature on engineering education by presenting an innovative teaching program for first year engineering students, which bridges social sciences and engineering based around Global Issues and attempts to answer the following research question:

The research question is: Can an interdisciplinary program for engineering undergraduates including soft skills increase students' perspective on societal issues?

To do so, this article will present an overview of the Global Issues program (Section 2), related work (Section 3), the content of the interdisciplinary lectures (Section 4) and group work (Section 5). To test the effect interdisciplinary teaching on social students' social perspectives, this paper uses a test of reasoning in the context of engineering ethical dilemmas and analyzed student feedback on lectures and group work collected from 1800 students (Section 6). Finally, this paper discusses open issues and adaptations for the subsequent years (Section 7) and wraps up with a conclusion (Section 8).

2. Global issues

At the Ecole Polytechnique Fédérale de Lausanne (EPFL), engineering curricula include social science and humanities courses to broaden the perspectives of Bachelor and Master students from the second year on. To introduce these issues earlier, EPFL introduced an innovative first year program called Global Issues. It presents a thematic approach to major global challenges such as, communication, climate, and food. Its particularity is that it is taught by a pair of teachers, one from social and human sciences and one from science and technology in order to offer students a view of global challenges in an interdisciplinary way (both engineering/science and human and social science). In addition, the development of transversal skills such as teamwork, oral presentation, library research and ethical engagement were also part of the objectives of the program.

As illustrated in Table 1, the Global Issues program for all first year students at EPFL is divided into 6 themes: Climate, Communication, Energy, Food, Health, and Mobility. In order to accommo-

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Table 1. The Global Issues program overview

Global Issues											
Climate		Communication		Energy		Food		Health		Mobility	
ClimateA	ClimateB	ComA	ComB	EnergyA	EnergyB	FoodA	FoodB	HealthA	HealthB	MobA	MobB

Table 2. The Global Issues' course outline

	Part 1 - Theory	
Week	**Lectures**	**Online activities**
1	Course-specific content	How to form a group
2		How to find information
3		How to plan a project
4		How to manage references
5		How to cite
6		How to solve conflicts
7		How to style a poster
	Part 2 - Practice	
8	Group project preparation	
9		
10		
11		
12	Group project presentation	
13		

date 1800 students, each theme is split in two courses over a 13-week period (4 ECTS). Students select one course on a first-come first-served basis. The first part of the course consists of a series of lectures, which addresses the theme in an integrated way (social and technical). It also consists of online activities: students can watch short video sequences and complete application exercises exploring bibliographical research, reference management, teamwork and conflict resolution. In the second part students work in interdisciplinary teams (they could be architects, chemists, mathematicians, etc.) to complete a project and make a poster presentation related to their chosen theme (Table 2).

3. Related work

There are different models for the trajectory of engineering education. Some schools are continuing to favor a "foundations" model in which students begin with a thorough grounding in basic sciences before moving on to study more applied and professional aspects in the subsequent years. Other schools introduce professional engineering-type courses early in the curricula (see [3–5]). Crawley et al. [4] have argued that engineering education requires an "introductory course that provides the framework for engineering practice in product, process, and system building, and introduces essential personal and interpersonal skills". As such, a course provides the scaffolding, which allows for students to integrate and make meaningful the scientific, disciplinary and capstone courses, which will follow in their program.

Educational research [4] and the ABET (www.abet.org) accreditation process argue that engineering students need to learn to work as part of groups. However, simply assigning group projects is insufficient and evidence collected by Colbeck et al. [3] led them to conclude, that without "faculty guidance, it seemed that only a few student teams developed positive goal or role interdependence" [3, 6]. Students struggle with questions of leadership, dealing with free riders [3], and dealing with conflicts and with the egos of group members [3, p. 75]. And, in the context of "students already struggling with the pressures of university life in general, the added burden of trying to work within a seemingly dysfunctional team was often the last straw" [6].

Part of the challenge with working in group is recognizing that others may have different perspectives and disciplinary knowledge. This raises questions as to the role of social and human science disciplines in engineering education. The place of such subjects in engineering education has long been recognized and many engineering schools—particularly in the US—have had mandatory social and human sciences content since the early 1900s [7]. One of the roles sometimes attributed to social and human sciences in engineering education is the development of students' moral reasoning. The development of students' moral reasoning has previously been studied using the Defining Issues Test (DIT) (e.g. [8, 9]). However, the DIT has been criticized as providing only an assessment of general moral reasoning, rather than engineering specific moral reasoning. To address this concern an engineering specific version of the test, called the Engineering and Sciences Issues Test (ESIT) has been developed. Nevertheless, it seems that social and human sciences and ethical issues continue to be seen as add-ons to already crowded curricula rather than substantively integrated components [4, 7, 10].

Yet, it is also important to recognize that alongside the distinctions between hard sciences and social and human sciences, there are also distinctions within hard sciences. As Sørensen [11] has noted, engineering is also, in practice, divided into a range of different specialisms each of which uses different languages, methods and concepts. The question of interdisciplinarity in engineering education should then, perhaps, be thought of as a kind of double interdisciplinarity. Along that line, Ertas et al. [12] argue for the need to integrate approaches (methods, tools, concepts, theories) from multiple disciplines in a holistic manner to reach an understanding of complex issues.

While there is an extensive normative literature which provides arguments as to why and how social and human sciences should be integrated into engineering education, it is notable that there is little descriptive literature on how social and human sciences is actually experienced by engineering students: "little if any empirical research that actually examines efforts [to integrate social science and engineering perspectives] and investigates the role of social science with respect to engineering and the design and development of technology more generally" ([11] p. 111).

In summary, the broader literature shows (a) the value of engineering project work at the early stage of training, (b) the importance of supporting students in learning how to work in groups, and (c) a need for empirical research on how models of integrating social and human sciences in engineering education, and the interdisciplinarity (and double interdisciplinarity) which this brings, are experienced by engineering students. These are the questions that this paper will address.

4. Interdisciplinary lectures

The objectives of the lectures of the courses in the Global Issues program are the following: (1) show the links between technological solutions and societal issues in each of the topics. (2) Guide future scientists and engineers to become responsible citizens, and develop critical thinking around global issues. Hereafter, we present courses covering every topic, namely Climate, Communication, Energy, Food, Health, and Mobility.

4.1 Climate

The four lecturers had expertise in various domains related to climate, covering specifically ecological philosophy, modeling and assessing of environmental policies, plant ecology, and hydrometeorology and remote sensing. Taking into account the specific competences of each lecturer, it was decided to provide the same content for both climate courses (i.e., Climate A and Climate B). A single lecturer gave each lecture, and the interdisciplinarity was promoted and reflected in the set of lectures taken as a whole, not within lectures.

The content of the course covered the following four topics. To start with the physical bases, the first set of lectures were entitled climate system and predictions, and focused on three aspects. First, the main components of the climate system, as well as its natural and anthropogenic forcing were presented. Then, the current changes in a variety of climate variables and the predicted climate changes in the near/far future were discussed. Finally, the anatomy of a climate model, the way to obtain predictions and the associated uncertainties were detailed. To illustrate the possible ecological effects, the second set of lectures dealt with the impact of climate change on ecosystems and biodiversity, the responses of the main biomes and agro-ecosystems, and the role of green areas to improve the quality of life in urban areas. From a more societal viewpoint, the third set of lectures aimed at providing a historical and philosophical perspective by presenting the historic frame and public debate. Various aspects were covered from the definition of the Anthropocene related to climate change, to the societal impacts of the explosion of energy consumption, to the public debate about climate change. Finally, the fourth topic provided an economic and political perspective to the questions raised by climate change for the human societies, by focusing on climate targets and policies. In particular, the lectures presented the dilemma induced by the necessity to reduce greenhouse gas emissions (e.g., costs vs. benefits, present and future generations), the economic and the political ways to reduce these emissions.

4.2 Communication

Conversely to the climate courses, the lecturers of the two communication courses worked on different content for their courses. Here, we detail the content of one of the course (Com A), which was taught by three lecturers covering expertise in behavioral economics, leadership, information system, human computer interaction, social media, and mobile and ad hoc computing. In order to change the rhythm and keep students interested, the lecturers, who jointly taught most lectures, frequently alternated between speakers and perspectives. In order to increase the interactivity during the lectures, SpeakUp, a temporary social media application for mobiles, which allowed students to post anonymous questions was used [13].

The course covered different subjects from communication content, social media, leadership, to the future of communication technologies. Before talking about tools, the first lectures discussed communication content. To start the course with a memorable experience, pseudoscience and urban legends were presented as fact during a full hour. Then, for two hours the lecturers presented ways to evaluate information critically. In the lectures on social media, a historical perspective was adopted, which allowed tackling issues such as freedom of speech and censorship. Then, different privacy issues were presented using social media privacy policies as examples (e.g., SnapChat, Facebook.). The usage of social media in education was also discussed (e.g. MOOCs). The lecture on leadership explained how leader distance can influence the nature of motivation and collective action [14], and how technology can mediate the relationship between leaders and followers. Furthermore, this lecture presented the way motivation works, by making the difference between intrinsic and extrinsic motivation. Finally, some potential future paths in communication technology were presented. For instance several technical communication challenges linked to ad hoc networking [15] and social challenges of advances in technology were presented. In particular the advances of skill biased technology that can lead to greater inequality [16] and innovations in GreenIS or JustIS [17] (systems that aim at reducing ecological and social footprints) were discussed.

4.3 Energy

Energy involves scientific, technological and societal issues. In this course, all of these aspects were treated in an intertwined way, from the basic concepts to the needs and resources, as well as societal and political implications. The goal was to provide the students with quantitative tools and to present a global overview of the issue, to form a sufficient background enabling them to discuss in an informed way, and possibly contribute to, various aspects of the energy problem. The spectrum of the lecturers and assistants of the course reflected that of the topics, and included physicists, engineers, economists and social scientists. The lecturers of the two courses collaborated on the preparation of the content and the same lecturers gave some lectures in both courses.

The chosen topics included reminders of the basic concepts related to energy, such as measurement units and scales, a discussion on the world's energy needs and re- sources, a macro-economic perspective on the relation between energy and society, a survey of the presently available energy sources (gas, oil, carbon, nuclear fission, etc.), and a discussion of the sources that are under development for both the near and long term future, such as renewables and nuclear fusion, of climate change and of the energy infrastructures. All topics were treated in scientific and technological terms as well as from the point of view of economy and society. The idea of sustainable development, which is commonly perceived as a prime example of a global issue, was present as a common thread throughout the course.

4.4 Food

Both courses on food (Food A and Food B) were jointly prepared by four lecturers with a diverse background in social and political sciences, ethics, food security management in non-governmental organizations and biological sciences related to nutrition, metabolism and aging. Two interdisciplinary lecturers were present at each course to address the issues discussed with complementary and sometimes conflicting visions, and thus to generate interactive discussions both between the lecturers themselves and between the lecturers and the students. Finally the lecturers used clickers to facilitate interaction with students.

The course started with a general introduction on Global Issues and specifically on food. It was structured around the following five main pillars: food security, food safety, functional food, instrumental food, and the pleasure of food. Food security exists "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" [18]. Food security is therefore the most crucial issue related to food. It is a difficult issue to solve because it involves multiple stakeholders. The lectures on food safety focused on challenges linked to both microbiological and chemical contamination all along the food supply chain. While a balanced nutrition is intimately linked to health, the concept of using specific types of food to prevent or cure chronic diseases (functional food) was discussed and the course demonstrated that is very difficult to prove the health benefits for a particular food. The lecture on instrumental food exemplified the use of food for other purposes than consumption. Two areas were developed: bio-fuels and food speculation. Bio-fuels are being produced and utilized all over the world and divert agricultural production from its primary purpose to feed a given population, thereby representing a threat for food security. The course ended with a lecture on ethical and pleasure aspects of food. The lecture explained the scientific basis to perception of the 5 different tastes through neuronal wiring from the mouth to the brain. It also highlighted the importance of culture in developing taste and eating habits by treating diverse examples such as molecular cuisine and the use of novel ingredients to dissociate taste from appearance or the use of insects as a sustainable source of protein.

4.5 Health

The four lecturers had strong expertise in microbiology, neurosciences, psychology and history. To take advantage of the complementary competences of the lecturers to cover global aspects implicated in health, the same content was taught in both courses (Health A and Health B). The lectures were always in pairs during the course and were also present during all sessions of project preparations to ensure an interdisciplinary follow up of the projects.

The course covered two main fundamental aspects of health, namely infectious diseases and mental health. The lectures on infectious disease discussed the challenges of disease propagation (i.e. SRAS, H5N1. . .). Propagation of infectious diseases is a serious challenge that could result in thousands of deaths in the case of pandemics. Its prevention relies on the one hand on the development of technologies and medical interventions to diagnose, cure or prevent diseases but should also include a better comprehension of social factors contributing to propagation of infections. These factors include poverty, nutritional deficiencies, inequity between rich and poor countries, life style factors or the strong increase of travel. Thus, both biological aspects and sociological/political issues linked to prevention policies of international organization like the World Health Organization (WHO) were presented. In the lectures on mental health, psychiatric disorders (including depression, schizophrenia and drug abuse) were discussed as they have been recognized by the WHO to contribute to a significant proportion of disability-adjusted life years (DALYs) and represent a major health cost [19]. Mental diseases are linked with strong inequity in medical support and social stigmatization. Psychiatric and brain disease are considered to result from an interaction of genetic and environmental factors. In the course, we considered two categories of diseases, including psychiatric diseases with an onset during young adulthood, such as schizophrenia, and neuro-degenerative diseases, including Alzheimer disease. These latter diseases represent a growing challenge given the increase in the aging population. Biological and technological approaches to develop new treatments and their social/psychological implications were covered in this part. Moreover, an interactive approach was used wherein students had the opportunity to test themselves using neuropsychological tests commonly used to evaluate cognitive functions in patients.

4.6 Mobility

Both mobility courses (Mobility A and Mobility B) were prepared and taught together by two professors and their teams, postdocs and PhD students, covering expertise in sociology, mathematics, statistics, socio-economics, environmental engineering, public administration and geography. Lecturers used clickers to interact with students.

The course was divided in three themes: speed in mobility (time), mobility pricing (cost), and mobility and territory (space). Each theme was subdivided into two parts: first examples, and then theory. The goal was to start with real-life examples, to which the students could relate. The examples showed them the complexity of the issue and how intuition can be misleading. The theory gave them methodological tools to understand and analyze the examples. In the lectures on speed in mobility, examples introduced Braess's paradox (i.e., adding network capacity can reduce overall performance), travel time enhancement through Wi-Fi in trains (questioning travel time minimization), and telecommuting (zero travel time). Examples were followed by an introduction to behavioral models, utility maximization (individual level), Nash equilibrium, social optimum (altruistic for the community), and cost-benefit analysis, as an introduction to the second theme. The lectures on mobility pricing began with a provoking question: what if travel cost was zero? Different towns with free public transport were presented. Then, demand management through pricing was presented with examples of parking and congestion charges. Theoretical elements about discrete choice models and in particular mode choice models, individual and public funding of infrastructure and social justice helped students to think about the examples. In the lectures on territory, examples showed the link between territory and mobility through highly mobile people, the barbecue effect (i.e., the large mobility needs of urban people for leisure), and walkability. The reflection was further extended with Zahavi's conjecture (i.e., daily travels have a constant travel time budget, and an increase in speed does not correspond to a decrease in time, but in an increase in travel) and the link between transport and urbanism.

5. Group projects

The group activities in the second part of the course are aimed at providing students with a space for actively putting in practice the knowledge that they acquired in the first part and developing their soft skills. During this part students working in groups of five prepare and present a poster. First, each group chooses a topic related to one of the six global issues. In order to be accepted by the lecturer the topic has to (1) affect a large amount of people internationally, (2) require a coordinated action from several stakeholders, (3) be related to the global issues studied in the class activities, and (4) include a technological and a societal dimension. As an example of a group project, one group of students chose to discuss how a greater access to network infrastructures could improve education and potentially lead to more inclusive political and economical structures in places that are currently not covered.

Then, the group work together during four weeks to create a poster and prepare a presentation. Each week students have to hand in a brief group report as a self-reflexion exercise. The reports summarize the work done by each member during the previous week and assigned tasks for the upcoming week. Thus, these reports also help lecturers to assess the progress of the projects, but also identify potential conflicts within groups.

Finally, the posters are evaluated based on (1) their interdisciplinary, showing at least one social aspect and one technical aspect of the chosen topic, (2) the relevance and coherence of their content, (3) the quality of their references, and (4) their visual aspect. To end the group activities, students have to give a five-minute presentation of their posters followed by five minutes of questions by the lecturers. During the presentation, the groups are requested to sketch potential solutions to the issue that they chose and identify some consequences. The presentations are evaluated on (1) the clarity with which the project was presented, (2) the originality of the solutions, and (4) the timing of the presentation. In order for every group member to be involved, two group members are in charge of the presentation, while the remaining three members are in charge of answering the questions.

6. Teaching evaluation

The Global Issues program was evaluated following the two existing *ways to judge teaching through the medium of students* [20], namely (1) students' evaluation of teaching, which consists mainly of appreciation ratings or scores, and (2) student outcomes, which consist in finding out how well students actually learned what they were supposed to learn.

Student evaluation of teaching. Despite its subjective components [21], student evaluation of teaching (SET) remains the most used method to learn about student's experience in a course. It is a source of information aimed to improve teaching [22, 23]. A SET of the Global Issues courses was thus performed at the end of the semester to assess general satisfaction, satisfaction towards the interdisciplinary aspects of the courses and satisfaction about project topics. The anonymous SET questionnaire was a combined open-closed instrument, consisting of 26 closed questions with a 4-scale answer (agree—somewhat agree—somewhat disagree—disagree) and a no opinion choice, one overall rating question ranging from 1 (bad) to 6 (excellent), and an open section for comments (positive/negative aspects, and suggestions). Fig. 1 shows the evaluation results for five relevant questions as an aggregation of the 1078 STE results (7 of the 13 courses) corresponding to courses for which teachers agreed to publish results.

The results show that a majority of students (52%) expressed a positive overall appreciation of the course. This figure, while not overly positive, is in line with other social science and humanities courses taught to engineering undergraduates at EPFL. It is worth noting that the differences in overall evaluation between the twelve courses were small and not statistically significant, despite important variation in teaching methods and course content. In terms of project topic choice, about three quarters of the students (78%) were able to choose a topic that which interested them. In terms of the interdisciplinary approaches, over two thirds of students (73%) agreed that the courses were presented with an interdisciplinary way and they agreed that the course was a good introduction to both technical (59%) and social aspects of the Global Issues courses (66%). As summarized in Fig. 2, in the open comments, students provided more details about the strengths and weaknesses of the program. In these comments, the main strengths were the topics and the content of the lectures as well as the interest students had for the group work. However, they regretted that the course content was not evaluated directly, and that there was too little guidance for the group work. Finally, they also regretted that there was a lack of integration between the different parts of the course.

Student outcomes. As mentioned above, one of the objectives of the program was to develop the students' understanding of the impact of engineering solutions on global societal issues and attempting to answer the question: *can an interdisciplinary program for engineering undergraduates including*

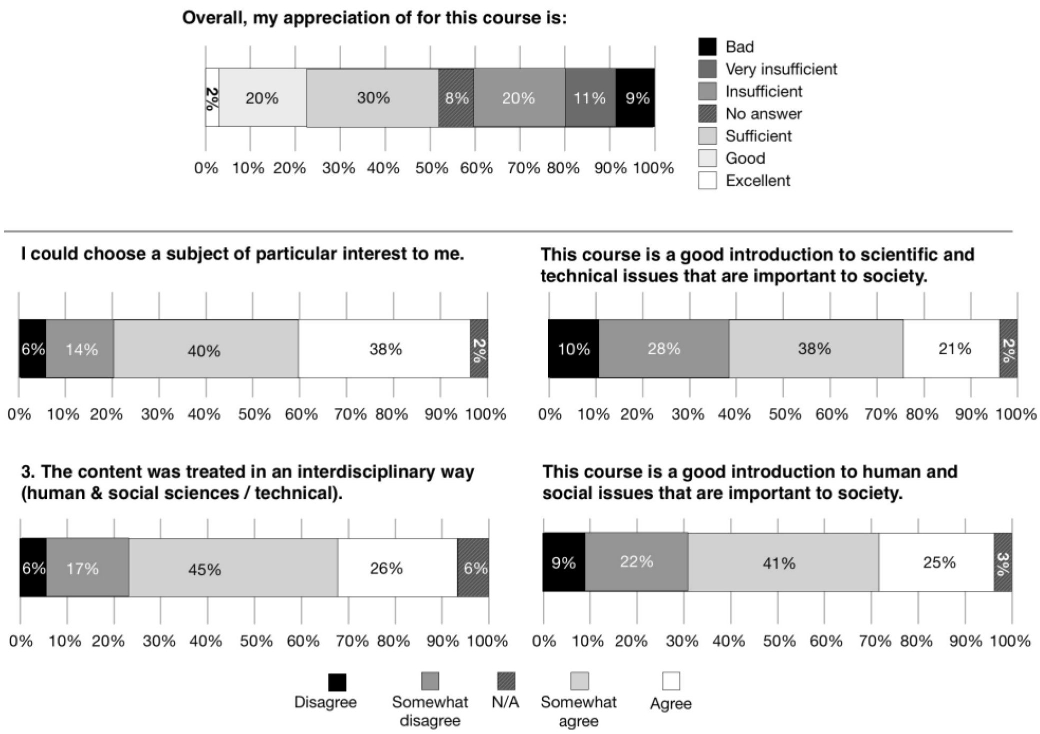

Fig. 1. Student evaluation of teaching (SET) $N = 1078$.

	Strengths	Weaknesses
Lectures	**Interesting content** (e.g., "the diversity of topics, the interdisciplinary", "I found the content of the lectures very interesting", "being able to see another less technical subject", "The topics discussed. Professors. Good explanations")	**No evaluation** (e.g., "It is a pity that we were not quizzed on the content of the course", "The course content must be evaluated!")
Group project	**Enriching activity** (e.g., "The group work, it was fun", "A project with other students from [the institution]", "The freedom to choose a subject for the project")	**Too little guidance** (e.g., "improve the instructions for the project", "being more guided for the project", "the instructions for the project were not sufficient")
Online activities		**Lack of integration** (e.g., "useless online videos", "not interesting videos, no link with the course", "a great lack of coherence between the common activities [i.e., online activities] and the lectures")

Fig. 2. Overview of strengths and weaknesses, with examples of comments from students.

soft skills increase students' perspective on societal issues? To answer this question, the moral reasoning of students and their attitudes toward group work were measured at the beginning ($t = 0$) and at the end of the semester ($t = 1$). A French version of the Engineering and Science Issues Test (ESIT) test was developed for that purpose. ESIT is a test of reasoning in the context of engineering ethical dilemmas. It is based on the Defining Issues Test (DIT), which is the most widely used research instrument for assessing ethical reasoning and it is has been thoroughly validated [5, 24]. In the evaluation, the number of cases was reduced to 4 instead of 6. For each of the 4 cases that involved a moral dilemma, participants had to make a choice. More importantly, they had to rate 12 possible reasons that would explain why they made the choice. Among the 12 possible reasons, some were reasons that underlie pre-conventional reasoning, some involved conventional reasoning, and some post-conventional reasoning. Furthermore, a few of the reasons were nonsensical and were used as a control values. As participants had to rate all motivations for their decisions, it was possible to compute a score for each participant based on the average score achieved on each of the four dimension: pre-conventional, conventional, post-conventional and nonsensical. Additionally, students filled a Readiness for Inter-Professional Learning Scale (RIPLS) questionnaire, measuring their attitude towards group work and interdisciplinary work at $t = 0$. The RIPLS instrument has 19 items and 3 sub scales. Since the focus here was on students in life sciences, science, engineering and architecture (rather than health care disciplines,

Post-Conventional Reasoning (t=1)	Coefficient	Std. Error
Post-Conventional Reasoning (t=0)	0.97***	0.20
RIPLS Scale (t=0)	0.47*	0.19
Interaction	-0.11*	0.051
Intercept	-1.68^{ns}	0.73
Observations	1031	
DF	3	

Fig. 3. The results of the multiple regressions.

which was the original focus of the RIPLS instrument) the questions were adapted to the changed context. The questions were also translated into French. Only one of the three revised sub-scales of RIPLS identified in [24] was used. The disposition towards interdisciplinary and teamwork was computed as the average of the 13 items of the questionnaire, achieving good reliability (Cronbach's $\alpha = 0.85$). The data was analyzed in order to determine if there was an evolution in the post-conventional reasoning of the participants between $t = 0$ and $t = 1$ depending on their initial attitude towards interdisciplinary work and group work. To that end, multiple moderated regression were run and included the initial level of post-conventional reasoning, the RIPLS scale value and the interaction between these two values (see Fig. 3).

As expected the results show that the strongest predictor of their moral reasoning at time $t = 1$ is their moral reasoning level at time $t = 0$. Furthermore, students with better attitude towards interdisciplinary work showed a significant increase of their post-conventional reasoning. There is also a significant interaction between the initial level of post-conventional reasoning and the RIPLS scale, indicating that the effect of attitude towards interdisciplinary work has a stronger effect for those

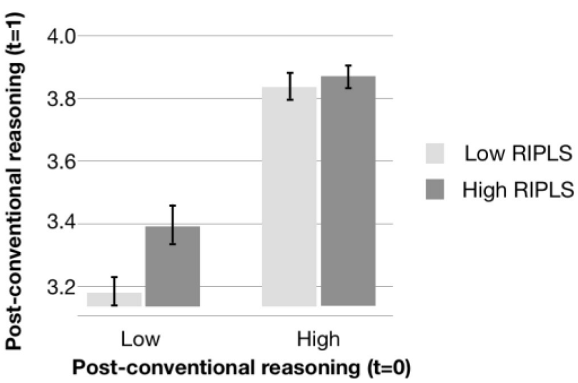

Fig. 4. Post conventional level at $t = 1$, depending on level of post-conventional reasoning at $t = 0$, and RIPLS results. Continuous data was used for regression estimates, but for visual purposes graphs show levels of actual data using top-tier and bottom-tier of data based on a percentile split. Error bars represent standard error of the mean.

students who displayed lower levels of post-conventional reasoning at $t = 0$. Fig. 4 gives a visual representation of the interaction between the RIPLS Scale and the Post-conventional reasoning scale. It shows that there was no difference between groups for students who already had high levels of post-conventional reasoning at $t = 0$, but a strong increase of post-conventional reasoning for those with lower levels at $t = 0$. The effect dampening could be due to a ceiling effect. These results provide an answer to the above research question. Indeed, they show that an interdisciplinary program for engineering undergraduates including soft skills can increase students' perspective on societal issues as measured by the ESIT. Especially when they show a positive attitude towards group work as measured by RIPLS and especially if they have a low ESIT at the start.

7. Discussion and lessons learnt

The evaluation results of the program are promising and show that a majority of students appreciated the course and almost 80% found the topic of their group work interesting. Taking into account the evaluation results presented in the above section, the lecturers have decided to make the following changes for the next edition of the Global Issues program. The lectures keep the same format, but a compulsory midterm quiz is added. The project has the same overall approach, while improving the guidance and the assistance for the projects. The online activities are optional. Furthermore, the online resources for library and group work skills have been redesigned to support the project more closely, and theoretical models of group work have been eliminated.

The findings also suggest that where students have a positive attitude towards group work at the beginning of the course, there are greater gains in post-conventional reasoning during the course. This is especially true for students with the lowest levels of post-conventional reasoning at the outset. This finding provides an answer to our research question whether *an interdisciplinary program for* *engineering undergraduates including soft skills could increase students' perspective on societal issues* If these findings are confirmed, then one should strive to find ways to improve the attitude of students before group work.

Limitations. Even if our sample is quite large (1800 students in 12 different courses) our findings cannot be generalized. The research has been conducted in a specific cultural context for a particular educational context. Furthermore, we mainly rely on self-reporting data from students, which can include biases.

8. Conclusion

Educating young engineering undergraduates to become global citizens with sensibilities that go beyond their technical field of expertise and increase their perspectives on societal issues is a challenging task. This paper presented a novel education program on Global Issues that addresses this challenge through interdisciplinary courses and group work. The positive results show that despite many challenges, the Global Issues program was able to successfully bridge social sciences and engineering for both students and lecturers. Following this experience, the Global Issues Program can serve as useful canvas for other Institutions interested in addressing today's Global Issues by transcending disciplinary boundaries.

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Appendix—Student evaluation of teaching (SET) questionnaire for the Global Issues course

Unless mentioned otherwise, Indicate if you disagree, somewhat disagree, somewhat agree, agree or have no opinion about the following statements:

Global appreciation

1. This course is a good introduction to human and social issues that are important to society.
2. This course is a good introduction to scientific and technical issues that are important to society.
3. The content was treated in an interdisciplinary way (human & social sciences / technical).

4. I was encouraged to reflect.
5. The key notions were sufficiently developed.
6. The examination procedure is appropriate (poster + presentation + MCQ).
7. The various components of the course (lectures, project, presentation, on-line activities) are coherently linked.

The lectures

8. The teachers' explanations are clear to me.
9. The lectures are well structured.
10. There are enough illustrations (examples, cases, experiments, etc.).
11. The coordination between lecturers is good.
12. The course is well documented (bibliography, reference literature)
13. I got a lot of the global witness (Pascal Lamy).
14. I regularly attend the course.

Answer questions 15 and 16 only if you used clickers

15. I appreciated having the opportunity to participate in class and share my opinion.
16. The use of (clicker) technology was appropriate.

The project

17. I could choose a subject of particular interest to me.
18. The guidelines for the project are sufficient.
19. (Teaching) Assistants play an important role in supervision the projects.
20. (Teaching) Assistants are well prepared.
21. The group work experience is rewarding.
22. The total estimated number of hours devoted to the project is: (write a number of hours)

Group and documentary research – second part of the course

23. The skills and knowledge I learned from the on-line activities are useful for the project (documentary research, group work, project creation).
24. The on-line videos and documents are useful.
25. The on-line exercises are useful.
26. The MCQ exam is coherent with the content of the on-line resources.

Overall, my appreciation of for this course is:
(6—excellent, 5—good, 4—sufficient, 3—insufficient, 2—very insufficient, 1—bad)

What are according to you, the strong points of the course ? (open question)

Which elements would you suggest need improvement? (open question)

Additional remarks, precisions and suggestions : (open question)

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