Developing a Sustainability Mindset in Management Engineering Students

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Synthetic description of the initiative

The latest report of the Intergovernmental Panel for Climate Change (IPCC, 2022) indicates that current efforts to reduce human-caused impact on climate change fall short. This is just one example of increasing evidence that anthropogenic activities are increasingly endangering the planet's natural balance. Of course, frameworks to counter this development exist. Polman and Winston (2021) suggest a new business dogma, "net positive", and argue that businesses must give more to the world than they take. The United Nations (UN) 2030 Agenda for Sustainability formulates seventeen Sustainable Development Goals (SDGs) that formalize targets that governments, organizations and individuals can pursue. Such profound transformations require a change in mindset for leaders and clear public commitment (Davis-Peccour et al., 2017). Rimanoczy and Llamazares (2021) advance a needed paradigm shift away from rationalism and competitive individualism, a new mindset as a prerequisite for leaders and individuals to leave anthropogenic views behind and to develop into caretakers of the planet and our societies (Rimanoczy, 2021a). Resulting from studying leaders that advanced their organizations towards sustainability, the Sustainability Mindset and its twelve principles (further explained in the Appendix 1), represents a framework that allows for the intentional development of a mindset for sustainability in education and training (Rimanoczy, 2010 and 2021b). Recently, the Sustainability Mindset Indicator (SMI®; Rimanoczy and Klingenberg, 2021) was added as an assessment tool that maps an individual's pathway towards such a mindset and explores in pre-post comparison how teaching or training may contribute to the development of the mindset. Similarly, this need for a paradigm shift is reflected in teaching by the experiential learning theory developed by Kolb (1976, 1984), which challenges the traditional teaching and learning methods.

These concepts were the foundations for the design of the "Sustainable and Global Supply Management" course, offered to the students of the Management Engineering Master's program at the University of Bergamo. The course recognizes to the students 6 ECTS upon completion of the final exam that can be taken in two modes: as attending student, which means following 48 hours of in-class activities, delivering all the intermediate assignments, and participating in two group projects; or as non-attending student, which means taking an oral exam by preparing all the material provided

in-class plus additional readings. The course was delivered for the first time in October-December 2022 and three educators were involved in the teaching activities, as well as in the evaluation of the students.

The objective of this course is to present a comprehensive overview of the main topics related to the management of sustainability within the firm and its supply chain, considering its interaction in a global context. In particular, the course provided an overall understanding of the concept of sustainability in all its three dimensions (environmental, social and economic). Cutting edge theories, academic research, practical tools and frameworks in the topics of sustainable operations and supply chain management were introduced and analyzed, to provide a basis for improving practical skills and establishing an understanding concerning these topics. Upon completing the course, the students had developed a more profound sustainability mindset, which hopefully will be then transferred to the organizations in which they will be working in the future. As such, the course contributes to the educational objectives of the economic-management area of study. In particular it contributes in developing the ability to solve complex organizational and managerial problems, and to analyze the dynamics of companies in achieving sustainability.

Innovative elements

The initiative showed how it is possible to design a course to teach sustainable development-related topics covering all the phases of Kolb's experiential learning cycle, contributing to creating multiple types of knowledge. Besides recognizing and applying the four phases of the cycle proposed by Kolb, the literature lacks ways of assessing the knowledge students need the most, leaving room to adapt the teaching tools and methods applied. To the best of our knowledge, this course was the first attempt into the use of the SMI® as an assessment tool to study the effectiveness of intentional teaching approaches towards developing a Sustainability Mindset.

The course was designed in terms of general contents and modules by one of the instructors, with the support and feedback of other colleagues, starting almost one year before the course delivery. This period was needed to identify potential tools, educational instruments and artefacts to be used along the course by participating in teaching sessions at conferences and benchmarking similar courses. Moreover, all the teachers had the chance to train themselves with the tools that were planned to be used along the course. For example, two of the educators received training for the simulation tool that was then used to teach the students the systemic view behind the circular economy. Other two educators instead received the training to understand the Sustainability Mindset Principles. Finally, one of the educators was the ideator of the SMI®, to make sure that a complete and rigorous interpretation could have been given real time to the students. This process of continuous learning

and improvement enacted by the three educators involved in the course design resulted in an initial course structure that included the following modules[1]:

1) Introduction to sustainability and sustainable supply chain management;
2) The internal perspective of the company;
3) The Sustainability Mindset Principles;
4) The upstream perspective of the supply chain;
5) The circular economy;
6) Global supply chain management;
7) The social side of sustainability.

All the modules were designed to include multiple teaching approaches and, when possible, all four phases of Kolb's experiential learning cycle to support the creation of all four types of knowledge.

Table 1 reports the eight modules and the tools used to contribute to the four phases of the experiential learning cycle. The table also summarises how we aimed at assessing all four types of knowledge acquired.

Table 1: Details of the course modules and relation with Kolb's experiential learning cycle

	Experiencing (assimilative knowledge)	**Reflecting (accomodative knowledge)**	**Thinking (convergent knowledge)**	**Acting (divergent knowledge)**
1) Introduction to sustainability and SSCM	Taking the SMI®	Looking at the results from the report	Lectures on sustainability and SSCM	
2) The internal perspective of the company	Reporting recent news on the topics of the lectures	Writing an individual essay including the topic of the module	Lectures on reporting, CSR, SDGs, Change management	Development of a group project work by interacting with a real company
3) The Sustainability Mindset principles	Various experiential exercises	Stop-Reflect approach	Lecture on the Sustainability Mindset principles	Retaking the SMI® and reflecting on the changes
4) The upstream perspective of the supply chain	Reporting recent news on the topics of the lectures	Writing an individual essay including the topic of the module	Lectures on supply chain design, traceability, codes of conduct	Development of a group project work by interacting with a real company
5) The circular economy	Simulation on circular economy (The Blue	Writing a group report explaining the results	Lectures on circular economy	Development of a group project work

[1] The slides of introduction to the course with the explanation of the modules and of the teaching approach are provided among the initiative materials (file "SGSM00_Intro to the course")

	Connection by Inchainge)	obtained from the simulation		by interacting with a real company
6) Global supply chain management	Reporting recent news on the topics of the lectures	Writing an individual essay including the topic of the module	Lecture on global supply chain management	In-class debate on why a global supply chain can be considered sustainable or not
7) The social side of sustainability	Showing videos of modern slavery cases (e.g., Shein, Leicester)	Writing an individual essay including the topic of the module	Seminar on social sustainability and modern slavery	
Evaluation of the acquired knowledge	Results of the circular economy simulation	Group report of the circular economy simulation; Individual essay (to include all the modules topics)	In-class participation (as a bonus)	Group project work with companies

Following Kolb's experiential learning cycle, the intent was to start the course with a concrete experience that triggers assimilative learning. The SMI® was chosen[2]: taking into consideration that the students participating in the course had no prior, formal introduction to the concept of sustainability, and given the thought-provoking nature of the thirty-six contrary statements, the instructors deemed the administering of this tool to have the potential of being a "pure" experience James (1977) called for. Considering the statement pairs and finding the one that reflects a person's current state of mind requires by itself a deeper questioning and reflection of self and one's values[3].

While the general flow of topics covered in the course was set upfront, the instructors then considered the results provided by the instructor report[4] to dynamically choose interventions that would result in reflection, thinking, acting, and again experiencing, following Kolb's learning cycle.

Initiative effectiveness

A very first measure of the initiative effectiveness was the distribution of the students between attending and non-attending, as attendance to the course was their free choice. In particular, 33 out of 37 students (89.2%) chose the attending mode. Considering the effort requested of the attending students throughout the course, this choice was not obvious, showing the great interest of the students towards the teaching approach, already at the beginning of the course. Moreover, all the attending students were also assessed in terms of proactiveness during the lectures, with just three students

[2] The description of the SMI® can be found at https://smindicator.com/ (the cost per student in 2022 was equal to 30 €/student including the pre- and post-assessment and the instructor report)

[3] An example of individual report obtained through the SMI® is provided among the initiative materials (file "SMIReport_teacher")

[4] An example of instructor report (with the data obtained from the assessment at the beginning of the course) is provided among the initiative materials (file "Pre-Data Repot_UofBergamo_22_10_14")

showing only limited in-class participation. Figure 1 shows the students distribution in terms of proactiveness.

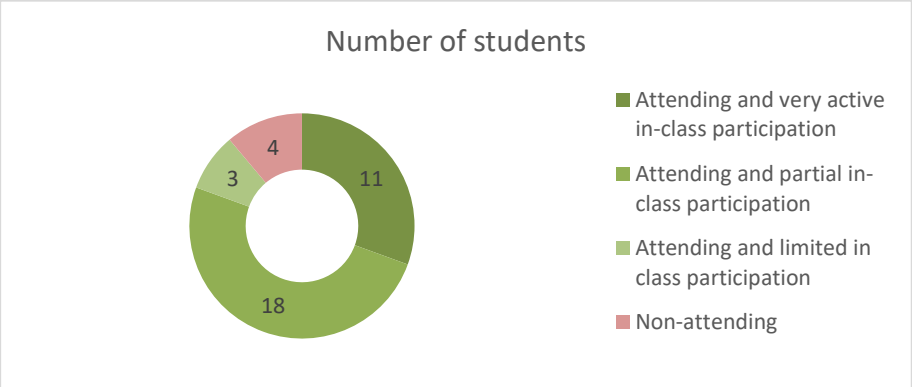

Figure 1: Distribution of the students in terms of participation in the course

As stated in the previous section, all the types of knowledge the course aimed to generate were assessed in different ways, as follows:

- Assimilative knowledge: to assess the acquisition of the knowledge gained through experiencing, the final ranking resulting from The Blue Connection simulation by Inchainge[5] was considered. In particular, the students had to work in groups of 4 or 5 and they were left free to create their own groups, being aware of what tasks would have been requested of them during the simulation. After playing the simulation the obtained ranking translated in a grade from 30 (assigned to the best group) to 27 (assigned to the worst group). Moreover, all the groups had the possibility to submit a non-mandatory assignment, a presentation explaining an example of a circular strategy implemented by a real company. All the groups decided to submit the assignment and proactively participated in the simulation.
- Accomodative knowledge: to assess the knowledge gained through reflecting, we asked the teams to also produce a report explaining the choices made during the simulation and their reasoning. Moreover, each student individually had to produce an essay covering all the modules of the course[6]. The evaluation criteria for these essays were shared upfront and included topics comprehension, the presence of real cases or experiences, the adherence of what was reported with the topics, the effectiveness of written communication, the reliability and traceability of sources and the innovativeness. The students had also the opportunity to

[5] The description of the simulation can be found at https://inchainge.com/business-games/tbc/ (the cost per student for a class up to 50 students in 2022 was equal to 55 $/student)

[6] The details of the individual assignment are provided among the initiative materials (file "SGSM_Individual assignment")

submit a draft of their essay twice during the course to gain preliminary feedback. Most of the students (84.8%) took the opportunity to gain intermediate feedback at least once.

- Convergent knowledge: to assess the knowledge gained through thinking, we evaluated the students' participation, which was not mandatory even in case they were attending, in fact they were considered as bonus points. As a way to gain the participation points (up to 3), students could also submit a reflective essay after having experienced the "One hour in nature" activity (as described in Appendix 2). Again, 84.8% of the students also submitted this non-mandatory reflective essay, sharing profound reflections (some examples are reported in Appendix 2 as well).
- Divergent knowledge: to assess the knowledge gained through acting, the students were asked to interact with real companies provided by the teachers to develop a group project work. In this case, the groups were created by the teachers, both to make the students work with people they were not used to work with and to make sure that all the groups had at least one member fluent in Italian, as all the companies were local and some of the managers involved preferred to interact in Italian. The students had to manage themselves the interaction with the companies, working on a problem related to the course topics they had[7]. The managers were of course instructed upfront and the potential problems were validated with the teacher[8]. Another important indicator of the initiative effectiveness is related to the proactivity and availability of the companies, which replied enthusiastically in less than one day to the invitation to participate in the proposed activity and invited the students over to visit their premises multiple times during the activity.

Finally, a last measure of the initiative effectiveness, was gained thanks to the SMI®, which was evaluated at the beginning of the course on the very first lecture, and again at the end of the course. This double assessment enabled the instructors to gain knowledge about the immediate impact of their teaching on the Sustainability Mindset of the students. Figure 2 shows a graph from pre-post instructor report[9].

[7] The details of the project work shared with the students are provided among the initiative materials (file "SGSM_Project Work")

[8] The instructions sent to the potential companies identified are provided among the initiative materials (file "Invito Aziende per Project Work")

[9] An example of the pre-post instructor report is provided among the initiative materials (file "Pre-PostComparison")

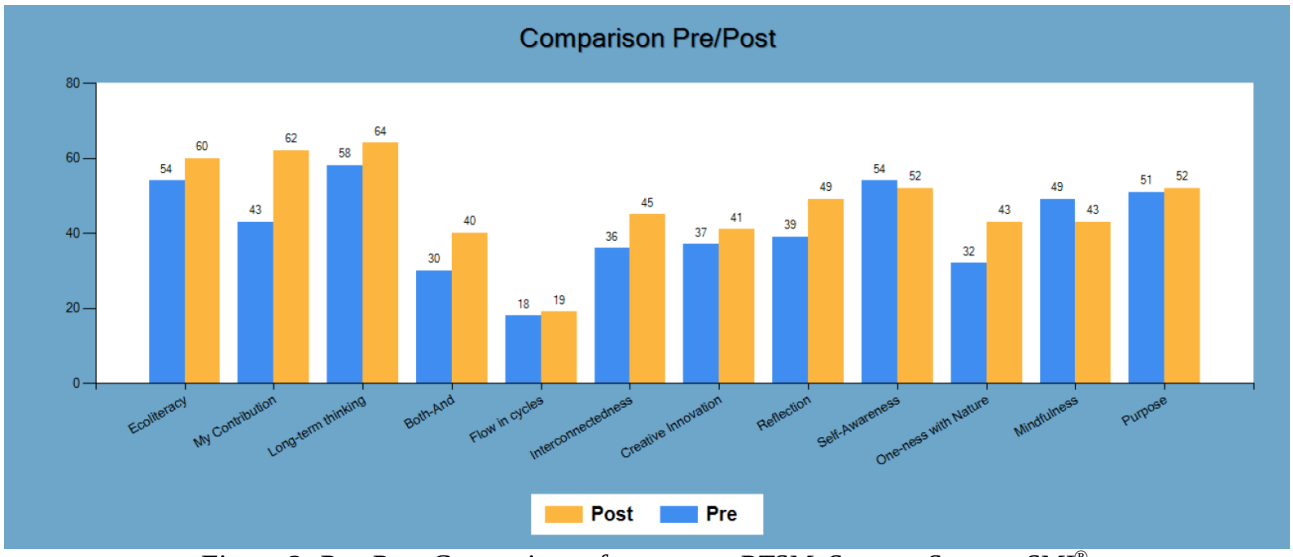

Figure 2: Pre-Post Comparison of aggregate PTSM. Source: Source: SMI®.

The graph shows that PTSM (Points Towards the Sustainability Mindset) increased for most principles, with the highest increase happening on "My contribution" (+44%) and "One-ness with Nature" (+34%). Figure 2 is testimony to a nascent mindset change that the instructors believe the course contributed to.

We were aware that teaching sustainability challenges educators on several levels, given the interdisciplinary content, the systemic and sometimes even paradoxical nature of sustainability concepts, and the urgency with which multiple ecological and social crisis need to be addressed, which calls for a paradigm shift in our thinking, doing, and business models (Rimanoczy and Llamazares, 2021). This initiative was designed using the Sustainability Mindset Principles as a frame to encourage thinking processes that explore an ecological worldview, systems thinking, and emotional as well as spiritual intelligence as a guidance towards understanding what sustainability is and how it can be incorporated into business, and specifically, supply chain management solutions. Experiential learning, as introduced by Kolb (1976), was chosen as the pedagogical approach. Experiential exercises and activities were purposely chosen based on the aggregate group results of the SMI® that allows for identifying aspects of the Sustainability Mindset that may need further development. Completing the SMI® by itself and reflecting on the individual report is a new and profound experience that allowed the students to begin with Kolb's learning cycle's assimilative or experiencing phases.

Encouraging reflective practices throughout the course allowed to continuously inspire moving from the experiencing to the reflecting, and then thinking and acting phase. Looking at the pre-post results of the SMI® assessment, it appears that overall, the course contributed to further the intentional development of the Sustainability Mindset for the students.

The instructors experienced their own learning cycle by accompanying the students in theirs: observing what happened during exercises, listening to or reading reflections and observing how learning of traditional material together with the personal growth offered by the course shaped new ways of thinking and innovative ideas on the side of the students provided a rich experience in itself, as well as reflective moments to observe the impact of the teaching method. Continuously observing the course and adapting teaching to how the group developed, enforced and re-enforced the joint learning of the Sustainability Mindset.

In summary, we believe that the unique and, to the best of our knowledge, new combination of Kolb's experiential learning method and the Sustainability Mindset, together with the specific results of the SMI®, enabled the creation of a rich and inspirational learning environment that furthers learning of and about sustainability, its implications, and applications.

Main results

The initiative was considered overall successful from many viewpoints.

First, all the attending students managed to pass the exam at the first attempt, reaching satisfactory results (the average grade was 29.7). Also the three non-attending students passed the exam at the first attempt, even if the average grade was lower in their case (24.3). In addition, the students who authored the most promising individual essays (graded with 30 or 30 cum laude) were proposed to develop a divulgative article for an Italian journal (e.g., Sistemi & Impresa, Logistica Management, Chimica Management); all of them (8 students out of 33) accepted the proposal. Moreover, the students' evaluations were extremely positive, with the course scoring well above the Management Engineering Program average in all the evaluation dimensions[10].

As a sign of excellence and international recognition, the paper describing the initiative was selected among the nominees for the teaching innovation award (Nigel Slack award) at the 30th EurOMA Annual Conference[11].

Finally, the University of Bergamo recognized the course among the Innovative Teaching initiatives funded through the Teaching Quality Program, granting 5.752 € to this and other two courses to actively involve companies within the teaching and learning activities[12].

[10] See the files "Students evaluation" provided among the main results

[11] The evidence of the presentation at the EurOMA session as nominees for the teaching innovation award is provided among the main results (file "Selection among nominees of the Nigel Slack Award at EurOMA 2023")

[12] The description of the initiative presented is provided among the main results (file "Scheda_presentazione_progetti_didattica_innovativa")

Appendix 1 – The Sustainability Mindset

The Sustainability Mindset is a framework introduced by Rimanoczy (2010, 2021b). Rimanoczy´s research intended to learn from these leaders' successes, with the objective to develop a framework for higher education to intentionally develop environmentally and socially responsible global citizen (Rimanoczy, 2010). Key components were the consideration of which information changed leaders' behavior, how they analyzed it and what motivated unusual steps to change their businesses. This work allowed describing how a mindset for sustainability could look like: a way of thinking and being, as a result of understanding of the ecosystem, developing social sensitivity, and an introspective view on purpose and personal values. The Sustainability Mindset comprises four content areas: ecological worldview, systems thinking, spiritual and emotional intelligence. These content areas are furthermore divided into what became the twelve Sustainability Mindset Principles, see Table A1.

Table A1: The Sustainability Mindset and its twelve principles (Rimanoczy, 2021b).

Content Area	**Principles**
Ecological World View	Ecoliteracy, My Contribution
Systems Thinking	Long-term thinking, Both-And, Flow in Cycles, Interconnectedness
Emotional Intelligence	Self-Awareness, Reflection, Creative Innovation
Spiritual Intelligence	Oneness with Nature, Mindfulness, Purpose

Based on this framework, an online-based assessment tool was developed that maps where an individual stands regarding the development of the Sustainability Mindset (Rimanoczy and Klingenberg, 2021). Using Johnson's (1992) framework of polarities as well as Kegan's (1994) framework of stages of human development, a Sustainability Mindset Indicator (SMI®) was created as a personal development tool. Through thirty-six contrary statements, it captures the development of the Sustainability Mindset compared to a conventional mindset of the cognitive, behavioral and affective dimensions of each of the twelve principles (Rimanoczy and Klingenberg, 2021). Participants receive an approximately thirty pages long personal development report. Furthermore, instructors receive an anonymous aggregate report that shows how the Sustainability Mindset is developed across the group. This report allows for identifying weaker developed principles as well as which of the dimensions (cognitive, behavioral or affective) is lacking (Rimanoczy and Klingenberg, 2021). Leveraging this information, educators can then identify specific interventions or exercises that encourage considering these principles with various experiential learning approaches

(Rimanoczy, 2022). Finally, the SMI® allows for a pre-post analysis: participants can re-take the assessment tool, and the instructor receives a comparative report. While this report does not allow for cause-and-effect analysis of interventions taken and mindset changes, as the participants are not isolated from other experiences in their everyday lives, it does provide a picture of personal development within the group during the period of e.g., a course during which the SMI® was used (Rimanoczy and Klingenberg, 2021).

Appendix 2 – Example of intervention "One hour in nature"

The course participants were encouraged to spend one hour in nature (Rimanoczy, 2022), without any distractions, such as a mobile device, notepad, book, etc. The intent is to experience the surrounding "unfiltered" and directly, which has the potential of being a "pure" experience, depending on prior habits. The students had the option to reflect upon their experiences in an essay, and to engage in dialogue with each other during a course session. Depending on personal background, this exercise triggers any of the four parts of the learning cycle. It specifically addresses the cognitive side of this principle, as it may create higher awareness of what nature is and how humans experience it.

Some quotes (a small sample, as they were many) from the reflective essays submitted by the students, showing profound reflections, are the following:

- *"I can certainly say that it was a unique experience in which I heard sounds, noises, and smells that I had never heard before. I had walked this route many times before, but I had never paid attention to the small details around me."*
- *"As a fashion enthusiast, I have always purchased a large number of cheap and unsustainable clothes, not realizing that by doing so, I was stimulating a market trend called Fast Fashion that is accountable for a large part of CO2 emission. However, today I feel guilty about my past actions. The environment is important and must be preserved over time so that even in the future people can enjoy its beauty and uniqueness."*
- *"I believe that this walk has been really useful. For the first time, I devoted time just for myself and was able to look inside myself. I learned to grasp the little things around us and at the same time I tried to understand what emotions were provoking inside me. I will certainly repeat this experience in the future hoping to re-establish this connection with nature."*
- *"From now on I will for sure pay more attention to what I do with respect to the environment, thinking about how I can contribute to make the world a more sustainable place for everyone."*
- *"This experience allowed me to experience pleasant feelings created by being in contact with nature; colours, smells, noises surrounded me while I appreciated every details. Not only*

positive feelings arose during walk, but negative feelings developed, in fact the thought that mankind is ruining these ecosystems and is compromising future generations created in me a state of anxiety. But I am aware that it is necessary to be optimistic to be able to solve problems effectively, and often crisis situations also conceal great opportunities; in fact, it is in times of crisis that mankind makes great progresses."

- *"This made me think that today's world is looking for very complex leisure activities but that in reality, something as simple as a walk in the woods can give its benefits. What if that's the problem? Is that why we're talking about sustainability right now? If our desires have led us to have all these environmental problems maybe it is also our fault, our selfishness, and our search for a new way to feel emotions. We should learn to be happy with what we have and make the most of it so as not to worsen the environmental situation that we have already caused."*

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