Challenge4Impact

Outcomes and impact of international virtual student business challenges in sustainable entrepreneurship

Research report

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INVENTORY

LIST OF ABBREVIATIONS

C4I	Challenge4Impact project
HEIs	Higher Education Institutions
SBSC	Student-Business Sustainability Challenge

TARGET GROUPS

1. Teaching personnel of HEIs
2. Decision makers of HEIs
3. Transfer and sustainability managers of HEIs

1 Introduction

This research report presents the evaluation results of the teaching and learning formats of student business challenges in sustainable entrepreneurship that were carried out as part of the Challenge4Impact project. The evaluation is based on the evaluation approach "From Output to Impact in Entrepreneurship and Sustainability Education: Guidelines for Evaluating and Improving Student-Business-Challenges" developed in the project (Fichter & Seela 2024).

The development and testing of transnational and virtual formats of student business sustainability challenges (SBSC) in the Challenge4Impact project was based on the following understanding:

> *A Student Business Sustainability Challenge is a specific format of Challenge-based Learning in which a business partner provides a real-world, innovation-related problem or question (the challenge), which is then worked on by student teams. Multidisciplinary student teams attempt to develop a solution or answer to the challenge, coached by their lecturers and supported by different stakeholders. By its definition, these innovations should contribute to a sustainable development (in line with the Sustainable Development Goals). In the best case, the business partners implements this solution in its business development.*

The approach of SBSC goes beyond teaching for sustainable entrepreneurship skills and combines learning with innovation and transfer in businesses. Generally speaking SBSC are mostly impact-driven. Finding suitable business partners as challenge providers, defining appropriate challenges, matching students into functional teams, teaching, coaching and supporting the projects needs etc. - all of this not only requires a new self-concept of teaching and an evolving role of teachers but also a high level of resources: from teachers, students, challenge providers and other supporters.[1] Thus, besides learning success and competence development of students, the SBSC approaches intend to create a medium and long-term effect not only on human resource development but also on tangible innovation results or contribution to transformation in business and society.

Due to the different character and duration of the various SBSC formats, it was necessary to use different forms of data collection for the evaluation. In this respect, it was necessary to deviate methodically from the approach described in the funding application. The respective evaluation methods are presented in the relevant chapters.

The three-year time frame of the project allowed us to examine short- and medium-term effects. However, we were also interested in the longer-term systemic effects of the SBSC formats. In addition to the investigation of the formats developed and tested within the framework of Challenge4Impact, Madeleine Larsson, Olof Hjelm, Karl Eldebo and Dzamila Bienkowska from the Swedish team also conducted a unique long-term study. The subject of the study was the project module offered in the third year of the Energy - Environment - Management engineering program (Master of Science in Engineering, 300 ECTS) at Linköping University, Sweden. We report on the outputs, outcomes, and impacts, and based on the learning outcomes we provide practical implications for teachers interested in conducting similar assessments of their teaching activities (see Chapter 6).

[1] For more information and guidance, we have published Project Result 1: Eldebo, K. & Hjelm, O. (2023) Handbook for Codesigning Student-Business Sustainability Challenges – Setup, Digitalization, and Internationalization, Linköping: Linköping University.

2 Learning formats of Challenge4Impact

During the project, we have conducted two full-term Student Business Sustainability Challenges (SBSC) as well as three special topic challenge formats. Our experiences with these formats led to Project Result 4 and Project Result 5. Table 1 and Table 2 are showing the different formats which we have provided in the project.

Table 1: Full-term SBSC formats, conducted in C4I

Johnson & Johnson FUTURE OF HEALTHCARE CHALLENGE					
	Number of universities	Number of participants	Number of coaches	International (Number of nationalities)	Virtual
Future of Healthcare Challenge 2023	4	33	7	6	yes
Future of Healthcare Challenge 2024	6	30	10	7	yes
STUDENT FORUM FOR SUSTAINABLE ENTREPRENEURSHIP					
How to work with a real company successfully	2	15	4	2	yes
Impact Forecasting of SBSC – Can your project make a difference	2	37	4	2	yes

Source: (Stel, 2025b)

Table 2: Special Topics SBSC formats conducted in C4I

			Relevant dimensions		
	No. of games	No. of participants	Inter-national	Virtual	Sustainability topics
Creativity games	4	190	++	-	++
Negotiation games	6	157	++	++	+
Cross-cultural games	4	176	++	-	+

Notes: ++ strong focus | + some focus | - on campus

Source: (Stel, 2025a).

For a better understanding, we provide factsheets for each challenge format in section 2.1 and 2.2. For further information, please refer to the playbooks mentioned above.

2.1 Factsheets of special topic challenges

2.1.1 Creativity Games

Conductor:	Vennebroek Academic Services
Business Partner:	none

2.1.2 Negotiation Games

Conductor:	Vennebroek Academic Services
Business Partner:	none
Content/ Overall schedule:	Dyadic negotiation game Multiplayer negotiation game Connor's paradise

2.1.3 Cross-cultural Games

Conductor:	Vennebroek Academic Services
Business Partner:	none

2.2 Factsheets of full-term challenges

2.2.1 Future of Healthcare Challenge

History	The program was initiated in 2016 at the start of the Fujifilm Open Innovation Hub in Tilburg, The Netherlands. It was a co-creation between the staff of Fujifilm and Avans University of Applied Sciences / Vennebroek Academic Services (VAS) and addressed mainly Dutch universities. In the period 2016-2022, the program evaluated and expanded. In 2023, the new business partner Johnson & Johnson (J & J) came in and the program was revised totally. The new topic focusses the

	pharmaceutical and health tech branch and addresses new ideas for circularity of J & J products. The challenge now addresses universities in Europe and Asia mainly. Students work in teams of mixed nationalities and mixed origin and are coached by coaches of the participating universities. Collaboration takes place online and is supported with a collection of tools on a designed collaboration board.
Conductor	Vennebroek Academic Services
Business partner	Johnson & Johnson, Sustainable Solutions
Participating institutions	Glasgow Caledonian University (United Kingdom) Nelson Mandela University (South Africa) Pasundan University (Indonesia), Telkom University (Indonesia) Tokyo University of Science / Sanyo Onoda City University (Japan) Twente University, Enschede (The Netherlands) University of Linköping (Sweden) University of Oldenburg (Germany) University of Ulm (Germany)
Content/ overall schedule	Purpose of the Future of Healthcare Challenge is to develop new circular business models for Johnson & Johnson to increase their impact on circularity of medical products See playbook PR4: (1) ideation: problem & solution; (2) validation & feasibility; (3) pitching.

2.2.2 Student Forum for Sustainable Entrepreneurship

History:	Linköping University and University of Oldenburg are project partner of Challenge4Impact and have been collaborating for more than 10 years. Both partners are conducting teaching modules which are based on an innovation-oriented Challenge-based Learning approach. Students are working in so-called “innovation sprints” on innovation-related challenges with different companies. This is a collaborative innovation approach (co-innovation). Due to underlying conditions of deviating schedules and examination regulations, it was not possible to integrate these modules into the Future of healthcare challenge.

	Nevertheless, we develop an innovative approach to pair both modules. Against this background, the Student Forum for Sustainable Entrepreneurship was developed. The suggested online format brings together students from both universities to reflect about different issues and learnings from their individual full-term challenge program.
Conductor	Linköping University & University of Oldenburg
Business partner	None in the Forum, but several business partners were involved in the university-led modules.
Participating institutions	Linköping University & University of Oldenburg
Content/ overall schedule	Two variants had been developed and tested: 2023: Two online meetings: "How to work with a real company successfully" & "Talking about the learning journey" 2024: One online meeting: "Impact forecasting of Student-Business Challenges"

3 Classification of the evaluations in this report

The starting point for the development of the evaluation methodology was the development of a generic logic model. Figure 1 shows the Input-Output-Outcome-Impact (IOOI) model as basis for the evaluation.

Our aim was and is to go beyond traditional course evaluation and to analyse effects on the target group as well as effects beyond the target group. The methodology required for this was developed during the course of the project and could therefore not yet be tested in all the formats offered.

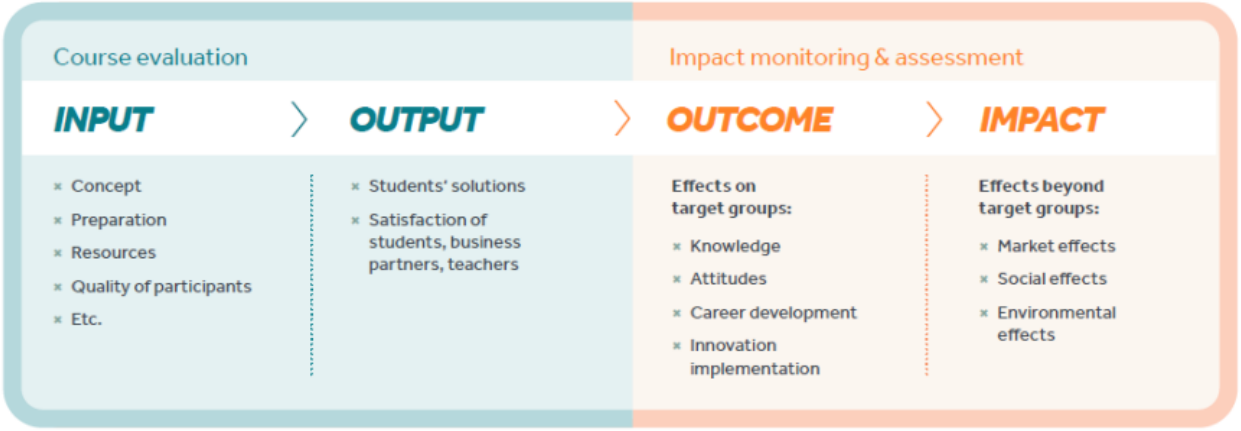


Figure 1: Logic Model of Impact Monitoring of SBSCs

In the following, we present the evaluation results of for the SBSC formats developed and tested in the Challenge4Impact project (see Chapter 4 and 5). The three-year time frame of the project allowed us to examine short- and medium-term effects. However, we were also interested in the longer-term systemic effects of the SBSC formats. In addition to the investigation of the formats developed and tested within the framework of Challenge4Impact, the Swedish team also conducted a unique long-term study which is presented in Chapter 6.

4 Evaluation of Special Topic Student Business Challenges

The Special Topic Challenges had started early in the project. They had been conducted at several universities on campus as well as a virtual format. Duration of these type of challenge was 0,5 to 1 day.

The evaluation was done by online surveys, with regard to the limited time span as retrospective questionnaire only. The questionnaire was constructed as qualitative assessment. The most addressed topics in the questionnaires refer to the “Output” and “Outcome” dimension. Participants had been asked to refer to satisfaction of the event as such and experiences in learning and team processes in detail. Reflecting upon different factors that are relevant for learning and success in the teams contribute lead to skills and competence development.

In the following sections we are summarizing the evaluation results of the different Special Topic Challenges. More detailed information about assessment and evaluation of these formats can be find in the playbook of PR 5.

4.1 Evaluation of Creativity Games

The main objective of the Creativity Games was to develop solutions for sustainability challenges using Lego Serious Play. While the first phase of the game focused on developing individual creative ideas, the second phase focused on developing a 'shared model', i.e. a common team solution, using storytelling: explaining the individuals ideas to each other.

After the creativity games, participants gave their feedback via an online questionnaire (in total 421 statements were collected). The key takeaway is that the participants valued open communication, inclusiveness, creativity, and teamwork, fostering a collaborative and respectful environment that helps to achieve shared goals.

The following aspects had been mentioned positively and could lead to stronger skills in collaborating with others:

1. **Collaboration and teamwork:** There is a strong focus on working together, combining ideas, and ensuring that everyone's voice is heard.
2. **Communication:** Clear and open communication is another prevalent theme, often associated with listening, respect, and feedback.
3. **Inclusiveness and respect for opinions**: all team members contributed, were given space to share, and their opinions were valued. The idea of integrating multiple perspectives and making decisions collectively was key.
4. **Idea generation and creativity:** A recurring theme is the generation and combination of ideas to arrive at innovative solutions.
5. **Positive and open atmosphere:** Many statements refer to the importance of a safe, positive, and open environment, which encourages participation, respect, and fun. Phrases like "positive atmosphere, humor, safe atmosphere" suggest a team that thrives on mutual encouragement and respect.
6. **Problem-solving and decision-making:** There is an emphasis on solving problems through teamwork, critical thinking, and collaboration, along with making decisions that reflect everyone's contributions.

4.2 Evaluation of Negotiation Games

Negotiation games had been conducted in two different alternatives: as dyadic games (where negotiation had to be conducted with only one counterpart) and as multi-partner games (where people were negotiating with several other negotiators). Here again, evaluation was done via online questionnaires right after the event. The intention in offering negotiation games was to support entrepreneurship competences and to create awareness for own preferred communication strategies under pressure as well as negotiation strategies with counterparts with different cultural background. The multi-partner games, especially the game "Connors Island" should also demonstrate the "system effects" in well-being: The prosperity of one tribe depends also on the prosperity of others, so it is important to enable win-win situations. In these games, distributive (zero-sum game) negotiations were juxtaposed to integrative negotiations in which long-term integrative results who benefit all and are a basis for solving 'wicked' sustainable problems.

Participants were asked to reflect upon main eye openers and what they would do differently in next negotiations (no categories had been given in the survey). Therefore, the interest of evaluation focused on learnings in negotiation. Students highlighted especially aspects of:

- pricing strategies
- information exchange
- win-win outcomes
- communication, relationship building and trust
- negotiation tactics and compromise / flexibility
- psychological aspects
- time management and patience

In the multi-partner games, aspects of collaboration and competition, negotiation strategy and dynamics as well as trust & distrust played an important role.

Students realized that working together could lead to better results for everyone. They were unexpectedly honest or transparent, which they said, helped to build trust. Some students learnt that more transparency could make negotiations easier. Some of them identified different negotiation styles or approaches based on culture, roles, or personalities. Some had surprising realizations about mistrust or suspicion in the process. Others mentioned shifting trust dynamics: trust can be built over time through shared goals and collaboration.[2]

4.3 Evaluation of Cross-Cultural Games

As the internationalization of the students' business challenges played an important role in the project, it was also important to offer a short program to reflect on cross-cultural skills.

In order to develop cross-cultural competencies, we used the well-known non-digital Ecotonos game, which was developed in 1993 and has been widely used since then (Saphiere, 2016). Ecotonos is a simulation game in which experiential learning is used with game characteristics such as application of rules, and working together in order to achieve a common goal. Ecotonos involves attitudinal aspects (experiencing the emotions involved in working in multicultural groups), behavioral aspects (practicing interacting with people of different cultural backgrounds), and cognitive aspects (gaining a better understanding of the impact of culture on collaboration) (Bücker & Korzilius, 2015). The use of non-existing imaginary cultures in Ecotonos prevents from stereotyping; the game is not about debating cultural characteristics of different groups but about collaboration across differences. Saphire (2016) described the activities, rules and procedures of the game.

After the cross-cultural games, 190 participants gave their feedback via online questionnaires in 411 statements. They were asked to reflect upon their eye-openers regarding developing cross-cultural competencies.

Students commented on

- listening and understanding – the role of cultural norms and values
- benefits of cultural diversity, the importance of open-mindedness and flexibility dealing with cultural adaptation
- teamwork and group dynamics across cultures
- Difficulties in adapting to cultural differences

The realization of the rules of the simulation games was not easy for all of the students. So they missed or wanted to be improved

Structure and Organization, Guidance and Support

- Practical Application and Real-Life Examples
- Room for Creativity
- More emphasis on teamwork, collaboration, a larger range of cultures & perspectives in activities.

[2] For more in-depth discussion of these evaluation results, see the playbooks of PR5 of C4I.

5 Assessment and evaluation of full-term Student-Business Challenges

As reported before, we had conducted two different types of full-term challenges. The Future of Healthcare Challenge (FHC) and the Student Forum for Sustainable Entrepreneurship.

5.1 Future of Healthcare Challenge

As the first run of the had to be stopped before the midterm session, no evaluation was made. Students instead had the chance to participate in the Special Topic Challenges. Therefore, only 2024 data was collected. Evaluation of FHC was conducted in two different ways. As basis we had used pre- and post-questionnaires and a so-called progress monitor. The results will be summarized in this section. Information that is more detailed is shown in the guidelines and playbook of PR 4[3].

In addition, we had the chance to test the "Guidelines for Evaluating and Improving Student-Business-Challenges" (Fichter & Seela 2024), developed in PR 3. The application and a reflection will be shown in section 6.1.

5.1.1 Quantitative feedback

Overall satisfaction rate

The overall satisfaction rate of the participants was 84%, which was 5% higher than the average score of comparable programs in the period 2016-2022, see Table 3.

[3] Stel, Frans G. (2025): Innovating together globally, Playbooks of Student-Innovating together globally. Playbooks for Student Business Sustainability Challenges. Insights, Reflections, and Roadmaps for Impact. Zuidlaren.

Table 3: Satisfaction by category of the Future of Healthcare Challenge 2024

	adequate responses of organizers	adequate responses of J&J	meetings with coaches useful	enough time	FHC well organized	overall rating FHC
FHC2024	86	88	83	76	86	84
avg 2016-22	77	82 (Fujifilm)	75	70	74	79

Satisfaction with the used tools

In the Future of Healthcare Challenge, we used the Solution Explorer (SE), a digital brainstorm and project management tool based on Muralboard (www.mural.co). With the Solution Explorer platform, the participants discussed digitally with each other team members. SE integrates methodologies as Design Thinking, and Lean Startup, aiming to simplify, and promote interactivity of innovation processes.

The satisfaction of the used tools varied; the video tutorials concerning aims, deliverables, and tools per phase as well were used often (82.9%), whereas the digital tools were considered useful at a rate of 81.4%. In comparison, the ideation and project management tool "Solution Explorer" was used less frequently (65.0%) and was considered easy to use and useful a bit lower (72.9 and 72.4%, respectively), see Table 4. Solution Explorer was considered to be a little complex, while other possible easier software tools could be used in next editions, according to a female student from Germany. Female students from Indonesia, Japan and Italy suggested to provide fewer course materials.

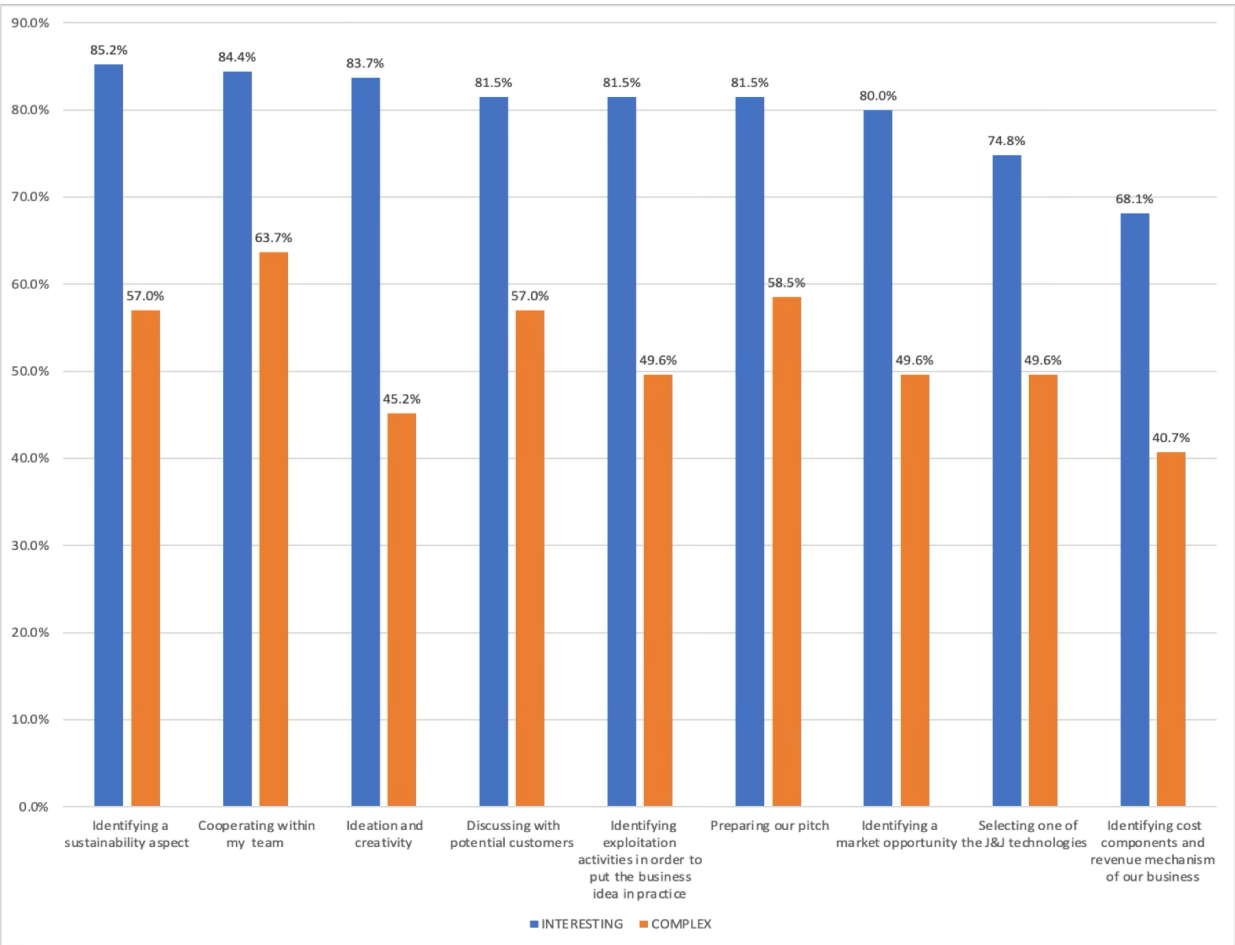
Table 4: Satisfaction of the tools used in the Future of Healthcare Challenge 2024

Used video tutorials (aims, deliverables, and tools per phase)	Digital tools were useful (YouTube and templates)	We used the Solution Explorer (SE) frequently	The SE was easy to use	SE was useful to organize our tasks
82.9%	81.4%	65.0%	72.9%	71.4%

Interest and complexity

We evaluated the extent to which several components of the FHC 2024 were considered to be interesting and complex. The top 3 most interesting aspects were: identifying a sustainability aspect (85.2%), cooperating within my team (84.4%), and ideation and creativity (83.7%), while the top 3 most complex aspects were: cooperating within my team (63.7%), preparing our pitch (58.5%), and identifying a sustainability aspect & discussing with potential customers (both 57.0%), see Figure 2.

Figure 2: Interest and complexity



These ratings are higher than the perceived complexity. With the help of some creativity tools, weekly coaching sessions and technological support, students can find and test possible solutions to wicked sustainability problems. Afterward, due to their real experience with a high-tech company, students feel more confident in innovative entrepreneurship. As examples of learnings from the Future of Healthcare challenge could be mentioned that commitment and team processes are the strongest predictors of new venture performance.

Progress of the teams

Weekly, the participants and their coaches reported the commitment and progress of the teams.

This progress monitor of the FHC 2024 was a strong predictor of the performance of the teams: the more committed teams performed better. In addition, with the progress monitor we could predict problems within teams resulting in drop-out of some participants. We noticed lower commitment halfway the challenge (when the participants were struggling with the creative problem solving), followed by higher commitment and progress in the final phases (when they tested their initial solutions). The progress monitor served as well as agenda for the collegiate meetings of the coaches where they discuss the coaching processes and progress of all teams.

The coaches advised their teams to broaden the scope by diving into the related problems, empathizing with important users and stakeholders. In many cases, the teams focused too much on the solution in the diverge stadium of creativity, phase 2 (problem). Some coaches advised the teams to develop more idea's while avoiding a premature selection of ideas. Explore some 'more funny' creative ideas. The coaches spent much attention on team processes: they urged them not to work individually, but work together, interact and communicate more! They advised them to give more room to the different people in the team, with different interests and expertise. Involve all team members! The coaches advised the teams to communicate more effectively (and frequently) with the staff from Johnson & Johnson.

Recommendation of the challenge

We asked the participants whether they would recommend the challenge to others. In the FHC 2024, 91.4% responded “yes” while 8.6% “no”. In comparison with the previous editions, the non-recommendation rate was a bit higher: in the period 2016-2022, the average score was 5.4%. Three German participants would not recommend, stating that “Other team members don't receive a grade for the project which creates different incentives; progress strongly depends on the team” and “Too much stress with communication and commitment in the group” while “it was too much workload”.

Entrepreneurial intentions

Before and after the challenge we asked the participants: Have you ever seriously considered becoming an entrepreneur? In this year’s edition, the score for entrepreneurial intent increased from 79.3 to 82.1%, which is slightly higher compared to the period 2016 to 2022; in this period, the score for entrepreneurial intent increased from 66.2% to 74.5%. Afterwards, the participants responded to “Participating in this contest has made it MORE likely that I will become an entrepreneur or start my own business”. The same pattern can be observed: slightly higher entrepreneurial intent.

5.1.2 Qualitative feedback

For this evaluation, we used evaluation essays as well as a questionnaire from all our participants in the FHC 2024. The key themes from the participants' experiences, highlighted their take aways Waste, Sustainability, and Circular Business, Cross-Cultural and Cross-Disciplinary Teamwork and Personal Entrepreneurial Growth.

New insights

Participants gained insights on waste issues ("Recycling unused medications could reduce waste, save resources, and promote responsibility among consumers."). Some take aways on awareness and addressing of healthcare were mentioned: “This challenge opened my eyes to the big problem of unused and expired medications harming the environment and public health. It showed me how important it is to find ways to recycle these medications to reduce waste and save resources. "The challenge revealed the importance of global awareness of circular economy and sustainability:" I've gained a deeper understanding of the circular economy, its principles, and its potential to address environmental and social challenges.") Regarding the most important personal learnings in the challenge, participants emphasized the value of cross-cultural and cross-disciplinary collaboration in generating innovative solutions. Empathy and adaptability were considered crucial in cross-cultural teamwork: “I learned to listen actively and appreciate diverse perspectives, which enriched our discussions.” Although it was not easy: "How difficult it is to communicate with those who have totally different backgrounds properly via Zoom and text”, many participants valued their cross-cultural collaboration experience: "Our team’s diversity brought richness to our discussions, with members contributing unique insights from their

country." In the evaluation essays, the participants described their teamwork including some concrete examples of the cross-cultural communication in their teams and their own roles. Teams benefited from diverse perspectives, despite initial challenges. Teams found cultural diversity both enriching and challenging, emphasizing the need for adaptability: "Our Japanese teammate emphasized simplicity, while the German teammate proposed highly technical solutions—balancing these perspectives was key which enriched our solutions." Overcoming language barriers and cultural differences was a key learning: "Language barriers, like understanding accents, initially slowed discussions but ultimately improved our intercultural communication skills.". Flexibility and compromise strengthened collaboration. Participants overcame hurdles like time zone differences: "Coordinating meetings across time zones required careful planning and mutual respect." Participants often took on facilitative and creative roles, ensuring team cohesion and output: "I acted as a moderator during discussions, facilitated meetings, and ensured deadlines were met."

What would you do differently next time?

We asked the participants to reflect what would they do differently after having experienced the challenge: Many participants noted the need for better role clarity. Feedback indicated participants were se as reliable and resourceful, with room for growth in task delegation: "While teammates appreciated my organizational skills, some felt I should delegate more to empower others" and "I would establish clear roles and expectations at the start to avoid confusion and delays." Acknowledging the importance of time management and project planning: "I underestimated the time required for thorough research, which led to rushed decisions."; Seeking early feedback was another key lesson: "I would have started more regular feedback cycles to address friction points sooner. Addressing conflicts with assertiveness and diplomacy was highlighted several times: "When friction arose due to differing priorities, I hesitated to intervene, which I now see as a missed opportunity."

Comfort levels

The participants reflected upon whether they felt comfort in this very self-reliant way of working and whether their comfort level changed during the course. Participants found the self-reliant structure challenging but rewarding. Many participants initially struggled but grew to appreciate the independence and ownership: "At first, I felt uneasy without constant supervision, but I grew more comfortable as the project progressed" and "By the end, I appreciated the autonomy and felt more confident in my decision-making skills." Some found comfort in their team's support despite the independent nature of the challenge: "Balancing individual contributions with team collaboration became a key learning point for me."

Lasting effects

The participants gave examples of how they would apply their learnings of the challenge in their future personal or professional life. Participants planned to implement global collaboration and project management skills: "I'll apply the tools we used, like shared task boards, feedback sessions and structured workflows, task boards, and I will carry forward these to future projects." The participants expected that their sustainability skills will last: "Sustainability and empathy will guide personal and professional choices." Confidence in tackling new challenges was a recurring theme. Participants gained self-confidence through resilience and risk-taking was a recurring theme. Participants gained in entrepreneurial confidence with remarks like: "This challenge has inspired me to explore entrepreneurship", "Stepping out of my comfort zone expanded my knowledge." And "I realized that we can develop a great idea if we work on it together as a team." And "Making a business idea and model is quite difficult but fun."

Suggestions for improvement

Although many participants expressed satisfaction, stating "none," "no suggestions," or "it's already good." the following suggestions for improvement were made:

1. Tools and Resources (7 statements):

- Simplify tools for better usability (e.g., "Solution Explorer is a little complex").
- Provide a clearer structure and reduce overload of materials.
- Include other possible software or tools to enhance usability.
- Use more data-driven insights, particularly customer behavior and preferences.
- Reduce the volume of emails, reminders and materials
- Provide fewer but more focused resources.
- Focus on tools that align closely with project needs.

2. Teamwork and Communication (6 statements):

- Address free-rider issues in team dynamics.
- Better control to ensure all team members are contributing equally.
- Agreement from students for full commitment to the project.
- Improve communication and team adaptation strategies.
- Provide more help and training for international teams.
- Emphasize local teams for enhanced collaboration.

3. Innovation and Novelty (4 statements):

- Refine the personalization aspect with partnerships and scaling roadmaps.
- Be clearer and more detailed about expectations and future ideas.
- Make ideas more feasible and aligned with real-world implementation.
- Eliminate ideas that follow existing models to foster novelty.

4. Time Management (3 statements):

- Provide more overall time for the pitch and project phases.
- Allow better allocation of time to improve the process.
- Ensure a smoother timeline for submission and completion.

5. Participant Criteria (3 statements):

- Accept only master's or advanced bachelor's students.
- Restrict participation to extracurricular participants for better focus.
- Ensure commitment levels are explicitly agreed upon by participants.

5.2 Student Forum Sustainable Entrepreneurship

5.2.1 Evaluation of first Student Forum in 2023

The Student Forum was planned as part of the modules at the University of Oldenburg and at Linköping University and was integrated into the course schedule accordingly. Nevertheless, the students saw the event as an "extra" appointment, which prevented some students from attending (difficulties in scheduling).

The module at Linköping University includes a reflection essay as part of the examination. The Student Forum was intended to prepare this essay. This is not the case in the module at the University of Oldenburg. Here, the students were asked for oral feedback in the next course.

Feedback from students

In the following session, students were asked to give their fellow students who were not present at the forum a brief overview of the activities and to provide feedback on the event. Here is a summary of the feedback:

- It was interesting to meet students from another university with similar teaching offers (student business collaboration) and see similarities and differences.
- I got some good tips for project work and communication with business partner/ challenge provider.
- It was fun.
- The Forum took place at an early stage of our project work. It would have been interesting to discuss all the questions at a later point in the term.
- The meeting focusing on skills was more interesting than the first meeting. More personal and developing for me.

Feedback from lecturers/facilitators

The workshop setting worked well (questions, playbook/method as well as facilitation online). We could see a lively discussion although students didn't know each other before.

The value of self-reflection was recognized and strengthened by the students. This type of reflection has so far been neglected in both modules offered separately and should therefore be integrated more strongly in the future.

The networking of independent teaching modules from two different European universities was easy to realize and required little preparation. The benefit for the students lies in familiarizing themselves with similar teaching concepts, their conditions and implementation and thus gaining a "broader perspective".

It was harder to integrate the subject of the modules (entrepreneurship and innovation) into the exchanges. As the German semester started later than the Swedish, the progression of the projects were constantly misaligned. Interactions which would have benefited one module were either too early or too late for the other module. This we could see on the student feedback of the first meeting, where German students found it interesting, but would rather have had the meeting later on in the module.

5.2.2 Evaluation on second Student Forum in 2024

Feedback from students

Students from the University of Oldenburg were asked to give feedback via the survey tool mentimeter.com. They were asked to

- Rate on a scale from 1 (not interesting at all and very useless) to 10 (very interesting and useful): 13 students participated in the poll and answered with 6.1 average. Answers were spread from 4 to 10, so the benefit was assessed different.

- State what they liked: Answers are concentrating on the aspect of meeting and discussing with Swedish students and getting to know their projects as well as different views on outcome and impact of projects. It was also mentioned, that content wise the Student Forum did not help to move on within the project challenges, because the represented projects in the group had been so different.
- Give ideas for improvements: some ideas have been mentioned that are worthwhile to consider: Introducing the method of impact forecasting beforehand so everybody would be prepared; more time to discuss or changing of groups to get to know also other projects; trying to match students from groups with similar content to learn more from each other.

Students from Linköping filled in a Forms document after the meetup with the same questions and scales as the German students.

- Only 5 students answered the poll. We assume the low attendance was due to the poll being sent out after and not being part of a lecture. The students were content with the meetup, on an average of 7,2 (two rating it 6 and three 8).
- Students liked meeting other students and thought it to be “fun” to engage with students from a different country. One student liked the format of the workshop, with short breakouts and clear tasks to be done. Only one student mentioned the content as something she/he found interesting.
- Ideas for improvements were: More clear instructions in the Mural, not only in the meeting. Somewhat inconsistent time management for the different tasks – some needed more time and some less.

Feedback from lecturers/facilitators

The workshop worked well, as last time the engagement was high among the students and discussions seemed lively. Although the number of students were higher this year, the workshop setting worked well and although some students did not show up, and yet other ones had not done the preparations, the forming of groups went well. The setup was easier to be agile in than in prior workshops, as the students could move themselves into breakout rooms when needed.

The content of impact assessment seemingly engaged the students. The theories were new for both student groups and the timing were good for both groups which was a good prerequisite for discussions.

6 First applications of impact assessment

The development of a methodology for impact monitoring and assessment that includes medium-and long-term systemic effects (impacts) was an important part of the Challenge4Impact project. We discussed the approach proposed in the PR 3 both within the project and at various workshops and conferences. Due to the time lag necessary to capture systematic effects, we were not able to examine all the challenges carried out for their medium and long-term impacts. Nevertheless, we were able to apply our impact monitoring methodology to two cases.

In Chapter 6.1, the team from Linköping University applies the framework for impact assessment of PR 3 on a curricular project module offered in the third year of the Energy - Environment - Management engineering program (Master of Science in Engineering, 300 ECTS) at Linköping University, Sweden.

In Chapter 6.2, we describe and reflect on the application of the framework to the Future of Healthcare Challenge 2024.

6.1 Investigating Impact of Student-Business Sustainability Challenges in Engineering Education

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6.1.1 Introduction

In this chapter, we present the modification and application of the impact assessment framework developed by Fichter and Seela (2024) on a curricular project module offered in the third year of the Energy - Environment - Management engineering program (Master of Science in Engineering, 300 ECTS) at Linköping University, Sweden. We report on the outputs, outcomes, and impacts, and based on our learning outcomes we provide practical implications for teachers interested in conducting similar assessments of their teaching activities.

6.1.2 Methodological approach

To assess the impact of the project module, we use parts of the model presented by Fichter and Seela (2024), inspired by the work of McLaughlin and Jordan (1999) and Fichter et al. (2020). The McLaughlin and Jordan model aims to help managers describe and evaluate different programs. It follows a linear

logic where different forms of input are compiled, followed by a description of activities implemented to generate specific outputs. This is followed by mapping outcomes from different time perspectives and scopes. Fichter and Seela (2024) applied and adjusted this to educational activities, focusing on three main categories of actors: students, teachers, and external actors. Further emphasis was placed on outputs, outcomes, and impacts. In this chapter, we mainly focus on the external actors in their role as challenge providers, leaving out the perspectives of student learning and satisfaction. Furthermore, given the focus of the module, impacts were limited to environmental effects, excluding impacts on the market and customers

The logic model applied in this chapter is described in Table 5 giving examples of information gathered for each step. The data gathering focused input in forms of different types of challenge providers and challenges, outputs, and outcomes. Other input variables and the different activities were regarded as static in this case and will not be included in the rest of the chapter. Impacts were measured as anticipated effects, and no direct emission data etcetera was collected or calculated.

Table 5: Overview of the logic model applied in this chapter with the main focus on the challenge provider (external actor). Developed from Fichter and Seela (2024).

Input	Activities	Outputs	Outcomes	Impacts
Size of module (ECTS) No. of students Student background and competencies Teachers Challenge providers and their resources Project framework Challenges	Lectures Workshops Coaching Feedback Investigations connected to challenge Development of measures	Measures proposed by students to challenge provider Measures labelled as Strategic, Tactic or Operational	Degree of implementation of proposed measures	Anticipated sustainability effects in the form of e.g. reduced emissions or increased resource efficiency

Module description

Our case is a project module offered during the third year of the Energy - Environment - Management engineering program (Master of Science in Engineering) at Linköping University, Sweden. The project focus within the fields of energy and environmental technology is determined by the syllabus of an 18 ECTS project course, which also includes writing a bachelor thesis. The bachelor thesis is not included in this chapter. Furthermore, the project is supported by a fully integrated module in project management worth six ECTS. By combining these two modules, nine ECTS are allocated for the challenge-based project. Over 13 years, a total of 662 students have been enrolled in 109 challenges involving 97 different organizations acting as challenge providers.

Several challenge providers have participated for more than one year. Initially, five challenge providers participated each year, and due to an increase in students, the number is now around ten, with a maximum of eleven. Participating challenge providers are mainly from the region of Östergötland, Sweden, or neighboring regions, and vary in size and industry. More than 50% of the challenge providers are manufacturing firms. The other organizations are found in the following sectors (listed in order of

frequency, starting with the most represented): Construction and real estate, Service, Hotels and restaurants, Food industry, Public sector, Trade, Recycling and waste management, Energy, Transportation, and Agriculture. The authors of this paper have had different roles in the module over the years, such as finding and formulating challenges and organizing the learning activities. Students were responsible for identifying and formulating recommendations to the challenge providers, and teachers supported and checked recommendations for accuracy. Thus, we have indirectly influenced the suggested measures.

The learning objectives related to the project have been constant over the years and are as follows:

- Formulate and carry out an organisation-oriented investigation in a group, including pre-study, project planning, data collection, and analysis. Individually report on the group's work and conclusions.
- In a group, suggest, motivate, and evaluate technical and organisational solutions aimed at improving the organisation's energy, environmental, and sustainability performance. Perform analyses of uncertainties and individually describe the group's work and conclusions.
- Apply and integrate knowledge acquired during previous courses both in the group and in the individual work.
- In group, and individually, apply methods and knowledge within the main subject Energy and environmental technology.

For each challenge, students formulated project goals describing the deliverables to be achieved during the challenge, process goals on work procedures, and effect goals clarifying the intended long-term effects on the challenge provider's activities. These goals were defined in close collaboration with the challenge providers.

Data gathering and analysis

The outputs of the project are concrete measures suggested to the challenge providers for implementation. These were documented by the student groups in a report produced during the project. For this chapter, we have collected all those reports and started to extract all suggested measures. So far, 45 reports from the period 2013-2023 have been analyzed, leading to the identification of more than 420 measures. Of the sectors represented within the course, all were included in this sample of 45 reports except for Transportation and Agriculture. All measures were coded using two sets of codes. First, each measure was labeled as either environment, energy, or others (general measures or measures with a broad sustainability focus). Further, they were labeled as strategic, tactical, or operational. For the coding of strategic, tactic, and operational levels, we used categories suggested by Ackoff (1990). The strategic level typically has a long-term focus and includes, for example, vision, mission, policy development, and activities at the top management levels. The tactic level applies to a shorter time horizon and is more at the middle-management level, typically focusing on planning activities to achieve strategic policies and long-term goals. The operational level deals with concrete everyday activities. Additionally, the specific measures were grouped according to themes that emerged during the analysis.

To operationalize the outcomes, we have chosen to focus on the degree to which the proposed measures have been implemented by challenge providers. To study this, we conducted systematic follow-up by contacting a selection of challenge providers and interviewing them using the student reports as a starting point. In addition to following up on the suggested measures, we also asked about the organization's sustainability work in general, as well as their experience and interest in collaboration with students and the university at large (see the list of questions in Figure 3). Interviews were performed via Microsoft

Teams and documented in writing. The results from the interviews have been anonymized when presented in this report. Of the 45 reports analyzed, ten have been further assessed via interviews.

1. What is the status of your sustainability work today?
2. How would you describe your progress from when the students were with you until today?
3. Based on the students' suggested measures - what have you implemented? How and with what effect?
4. In the short term after the project, have you hired any student to work on related issues?
5. Have you continued to work with students in the sustainability area or other areas?
6. Have you continued to collaborate with universities in the sustainability area or other areas?

Figure 3: Interview questions used during the systemic follow-up.

Interviews were analyzed using a matrix built in Microsoft Excel. The suggested measures were followed up and categorized as implemented, partly implemented, or not implemented. Measures labeled as partly implemented were those still under implementation, those which had been reformulated before implementation, or those implemented in other areas. The results of this labeling are found in Section "Degree of implementation of proposed measures (Outcomes)". The rest of the results were thematically analyzed, identifying similarities and differences between cases. These results are presented in Section "Indirect outcomes" in the next Chapter.

Based on the results from studying outcomes, we can discuss the potential sustainability impact, even though this impact can hardly be measured directly or solely assigned to the suggested measures

6.1.3 Results and Discussion

Measures proposed to the challenge providers (Outputs)

The more than 420 measures that were suggested by the students in the 45 reports have been clustered (similar measures have been clustered under themes) and categorised (level and focus) and in Table 6 we present the themes of the measures. Most measures are on the operational level, followed by tactical and strategical. This observation can both be linked to the academic level of the students (bachelor) and the courses they have taken before the project but also to the needs (and expressed requests) of the challenge providers. As the category *Others* focuses on general or broad sustainability measures there were per default no measures on the operational level. When comparing the categories *Environment* and *Energy* we observe fewer energy-related measures on the strategic and tactic level whereas for the operational measures the overall picture is more evenly distributed. In general, the suggested measures on strategic level can be considered to imply more radical change to challenge provider than most operational measures.

Table 6: Areas of measures listed in the 45 analysed projects. The measures have been clustered into areas and then categorised based on level (strategic, tactical, and operational) and focus (environment, energy and others).

	Environment	Energy	Others
Strategic	Environmental policy Environmental management system Environmental goals and strategy Management engagement	Management engagement	Alignment with the global sustainability goals Increased transparency Strategic market expansion
Tactical	Conducting investigations/ assessments Assigning roles / Distributing responsibilities Development and implementation of procedures Training Collaboration	Conducting investigations/ assessments Assigning roles / Distributing responsibilities Development and implementation of procedures Production planning	Implementation of goals/ requirements and follow-up Development and implementation of procedures Communication Other
Operational	Material and resource usage Transportation Handling of residual products, waste and emissions Calculation of environmental and climate impact Influencing customers and suppliers	Energy supply Energy usage in production processes Energy usage in support processes Other electrical measures Product development Follow-up	-

The suggested measures on the strategic level include development and implementation of an environmental management system and environmental policy, as well as the establishment of environmental goals and development of a long-term strategy. The need for increased engagement from the management is suggested both in relation to environment and energy, and this is the only measure connected to energy on the strategic level. In terms of the broader, more general measures (Others), the measures pointed out alignment with the global sustainability goals, increased internal/external transparency and to make strategic market expansions important for the organization's development.

Looking at the proposed measures at the tactical level three main themes can be observed for both environment and energy: conduct investigations/assessments, assign roles and distribute responsibilities and develop and implement procedures. The suggested investigations/assessments range from broad and comprehensive (e.g. environmental assessments of the organization and its activities and/or products; conduct an in-depth energy/electricity investigation) to more specific (e.g. investigate the possibility of using alternative raw materials/materials such as recycled or bio-based; investigate alternative waste-based energy supply). Additional themes identified are environmental training for employees, external collaborations (e.g. waste management and construction) and a systematic change in production planning to include more focus on power control. For the broader/more general tactical measures (Others)

increased communication and follow-up are recurring (e.g. increased communication to increase knowledge and set higher requirements on suppliers and sub-suppliers; implement a system for continuous data collection and follow-up; Communicate sustainability efforts both externally and internally).

Finally, there was a long list of operational measures suggested to the challenge providers for both environment and energy. As the energy-related projects mainly were carried out as energy audits, most of the operational measures are technical (e.g. change in energy supply; reduction of energy usage coupled to production processes and support processes) and very detailed (optimize heating/cooling in production processes; replace lighting; add heat exchange to the ventilation etc.). Two themes connected to energy stood out: product development in terms of improved energy efficiency of the sold product to reduce energy usage by customers, and follow-up e.g. by continuously displaying energy usage to employees to encourage energy-efficient practices. Focusing on the environmental measures on the operational level the technical measures are also to be found here (e.g. reduced emissions to water/air connected to handling of residual products, waste, and emissions). In contrast to the energy measures several of the suggested measures are connected to management activities (e.g. use a database for handling of chemicals, implement tools for assessing environmental impact, plan and optimize transportation).

Degree of implementation of proposed measures (Outcomes)

To better understand if and how the challenge-based learning activities have led to real impact we need to first follow-up on the implementation of the suggested measures. The ten projects which we have included in the follow-up together represents the following sectors: Manufacturing, Energy, Public sector (waste and wastewater management), Service and Trade, and the projects were performed in the period of 2016-2021. The ten projects included both energy and environmental issues ranging from technological to management aspects. In total, 58 suggested measures were included, representing all levels (strategic, tactical, and operational) and focus areas (environment, energy and others). Of the suggested measures 24% have been implemented, 47% partially implemented (measures that have been reformulated before implementation, implemented in other areas, or are currently under implementation), and 29% have not been implemented (Table 7).

Table 7: Overview of quantitative follow-up of the suggested measures. Partially implemented measures include those which have been reformulated before implementation, implemented in other areas, or are currently under implementation.

	Total	Implemented	Partially implemented	Not implemented
All levels	58	14	27	17
Strategic	6	2	3	1
Tactical	12	4	6	2
Operational	40	8	18	14

The quantitative follow-up on implementation of measures shows no clear difference between the strategic, tactical and operational levels. Similar measures suggested to different challenge providers don't necessarily have the same implementation rate. This suggests that the context in which the measures are introduced, and likely how they are introduced, plays an important role. This is further supported by the fact that so many measures are reformulated before implementation. For example,

instructions and procedures in management systems are adapted, or identified problems are solved with different technical solutions than suggested. Additionally, some measures are implemented in other areas, such as energy measures integrated into the planning of a new production facility.

For the 14 operational measures that were not implemented, interviewees mention reasons such as awaiting the reconstruction of facilities or the construction of new ones. The non-implementation of strategic and tactical measures was attributed to other company priorities or the focus of current operations. Time is an interesting factor to consider, as our follow-up shows that some measures are implemented immediately, while others take 4-6 years to be put into action after being presented by the students.

Indirect outcomes

Irrespective of the implementation rate of suggested measures, all interviewees stress that student collaboration has increased the organization's general knowledge. This includes a better understanding of their own organization in terms of activities, production systems, premises etc., as well as domain specific knowledge such as the integration of life cycle thinking and assessments, energy management etc. This new or deepened knowledge influenced activities after project finalization such as implementation of management systems, considering energy aspects in new premises, life cycle thinking in product development, and logistics and transport planning. Furthermore, the interviewees report staff´s increased awareness and dedication to reduce environmental and energy footprint.

For some organisations, the role as challenge provider in the course follows a tradition of collaboration with the university. For others, it has been a "door-opener" for subsequent educational activities or research projects together with the university. In addition, some have initiated collaborations with organisations outside academia to get support and expand their knowledge and capacities. For those who have not had any continued collaboration with the academia, it has for example been due to other priorities, focus areas, or a lack of resources. When asked, all interviewees expressed an interest in future collaborations if relevant projects or activities can be identified and resources allocated from their side.

All measures suggested by the students aimed at generating impact by improving the energy and environmental performance of the challenge providers´ internal activities, products, or services. Several operational measures, particularly in the energy field, also included an estimation of savings of energy and cost. Thus, anticipated sustainability effects would be in the form of e.g. reduced emissions or increased resource efficiency. The realized impact, however, is dependent on the degree of implementation of the suggested measures, and as earlier described, the degree of implementation varies a lot and is complex to assess.

Further, evaluating and objectively measuring impact is time consuming and difficult. As a start, a baseline needs to be established before any interventions and recommendations. This is followed by the need to get access to real data, meaning that impacts assessment most likely will rely heavily on the organizations' own routines of follow-up and assessment. From our experience, most companies have not yet established a baseline and have none or rudimental routines for follow-up on environmental or energy performance. The implementation of EU Corporate Sustainability Reporting Directive might improve this in the future.

Another complicating factor is that most challenge providers report outcomes in the form of increased knowledge, awareness and dedication to reduce environmental and energy footprints. Establishing a relation between cause and effect of such outcomes is almost impossible.

6.1.4 Reflections and conclusions

Conducting the impact assessment is a work-intensive but rewarding process. As teachers, you normally do not have time to go back several years after the finalization of teaching activities, but instead base assessments and further development of teaching activities on traditional course evaluations from students and what you instantly hear from challenge providers. Allowing long time between course activities and assessment opened opportunities for other learning outcomes and a deeper understanding of the tentative impact. The long-time perspective also came with challenges since some companies had closed down and, in several cases, the person responsible was no longer employed at the organization.

One important remark is that even if the applied model uses the logic model of input, output, outcome and impact, it is not possible to claim a direct case-effect relationship between input and impact. It is challenging to judge if students identified measures not known to the challenge providers or if other factors lead to the implementation of proposed measures. However, the framework served as a good tool for reflections from both teachers and challenge providers and allowed to get an overview of the diversity of measures suggested and the degree of implementation. Such knowledge could be helpful in designing learning activities in upcoming courses. To increase the quality of assessment of the outcomes, and in the long perspective the impacts, it is recommended to establish a strategy for how this should be done already at the planning and implementation of course activities.

Finally, while doing the interviews with challenge providers they were reminded of the suggested measures and in some cases, we noted a revitalized interest in implementing those not yet implemented. Several also expressed an interest in getting student support in the future. Thus, the activities of the impact assessment could be a way of increasing implementation of already suggested and new measures, leading to more outcomes and long-term impact.

6.2 Testing the Impact Cycle on the Future of Healthcare Challenge 2024

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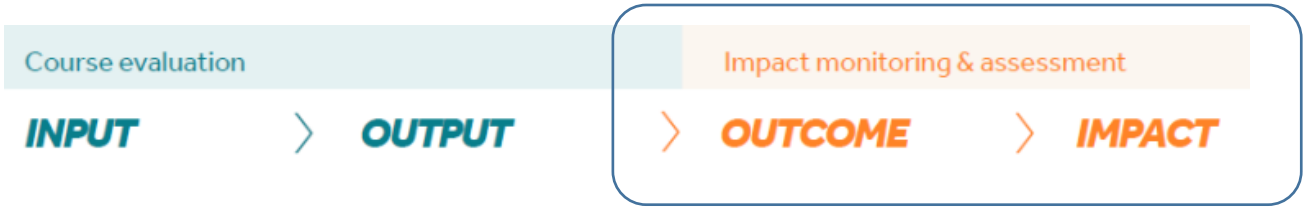

6.2.1 Impact planning

Outcome and impact objectives of the Future of Healthcare Program

Following the method of the Challenge-based Learning (CBL) Impact Cycle, the first step was to define the objectives of the Challenge program on an individual level, business partner level (innovation level) and the system level. Central questions are shown in Figure 4.

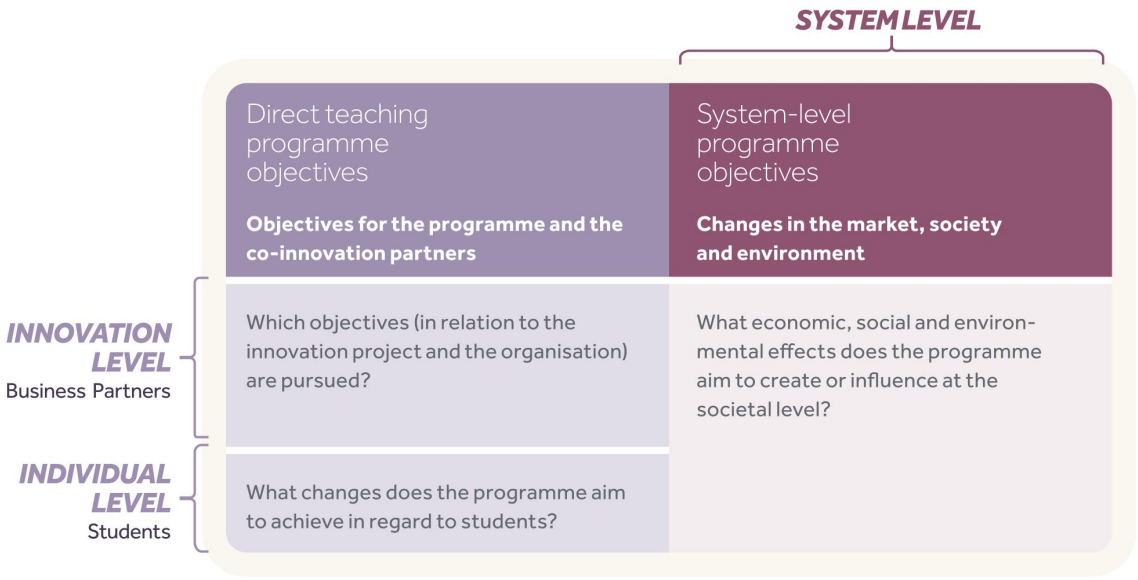

Figure 4: Setting objectives for CBL teaching programme at individual, innovation level and system level (based on Fichter et. al. 2021) (Fichter & Seela, 2024, p. 19)

The following objectives have been relevant for the Johnson & Johnson (J&J) Future of Healthcare Challenge 2024.

Table 8: Objectives of the Future of Healthcare Challenge

Level	**Objectives**
Individual level: What changes does the programme aim to achieve in regard to students and coaches?	
Students	The aim for students is to achieve the following developments in the areas of attitude, behavioral skills and cognition: • raising awareness for sustainability and entrepreneurship, international and trans-sectoral/ trans-functional collaboration They are asked to (1) to develop creative thinking, (2) to innovate and test new business models; (3) to enhance cross-industry multidisciplinary collaboration;

	(4) to develop and implement sustainable healthcare solutions in an international context.
Coaches	Professionalizing the role of 'coach' juxtaposed to 'teacher' by 'learning by doing', intervision and supervision
Innovation Level: Which objectives does the business partner strive to achieve?	
Business Partner Johnson & Johnson	Johnson & Johnson (J&J) aimed *(1) to increase of Knowledge and understanding of Circular business models* *(2) to improve global sustainability ratings of J&J, improve CSR,* (3) *to contribute to circular economy (new implementable ideas for circular business models)*
System level: What economic, social and environmental effects does the program aim to create or influence at the societal level?	
Market, society, environment	The FHC should support transformation of current non-sustainable business models into sustainable business models

Logic Model of the Future of Healthcare Challenge

In impact planning, logic models are a transparent way of illustrating a teaching or transfer program's impact logic and can thus contribute to creating an internal understanding of the intended effects of the support activities.

Based on the planned objectives of the Future of Healthcare Challenge, the inputs and outcomes required to achieve the set objectives need to be planned.

A clear and simple option is to use the impact staircase. The image of the staircase symbolizes that reaching the top step (long-term impact goals) is only possible if the lower steps are achieved.

Planning was done top down and discussed and revised bottom up.

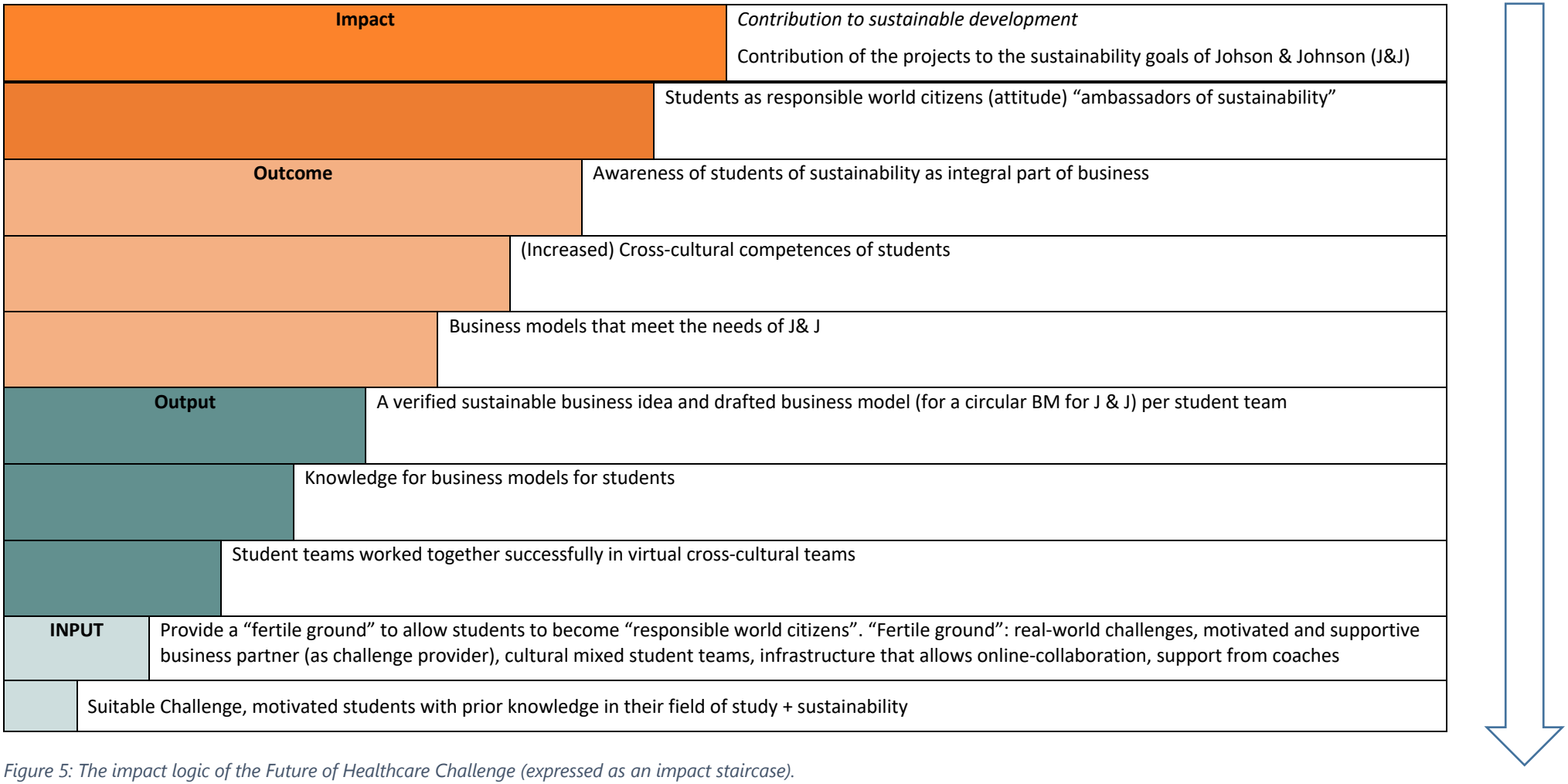

Figure 5: The impact logic of the Future of Healthcare Challenge (expressed as an impact staircase).

6.2.2 Selected indicators and chosen tools to collect data

Next step was to define suitable indicators for each stage of the staircase to assess the effects.

Table 3: Selected indicators to monitor the impact of the Future of Healthcare Challenge

Impact staircase	Indicator	How to evaluate
Suitable Challenge, motivated students with prior knowledge in their field of study + sustainability	Number of students Origin of students Number and origin of participating universities Fields of study	Data from registration
"Fertile ground": real-world challenges, motivated and supportive business partner (as challenge provider), cultural mixed student teams, infrastructure that allows online-collaboration, support from coaches	Team composition (ratio of team members and number of different origins)	Data from team composition list
Student teams worked together successfully	Dropout rate Satisfaction with team	Data from de-registration Student's questionnaire
Knowledge for business models for students	Degree of application of BM-tools/templates	Quality of submitted business models of the team solutions
A verified sustainable business idea and drafted business model (for a circular Business Model for J & J) per student team	Number of submitted business models/ Number of teams	Data from submission
Business models that met the needs of J& J	Feasibility of projects,	jury evaluation
(Increased) cross-cultural competences of students	Satisfaction with progress in intercultural teams	Progress monitor
Awareness of students of sustainability as integral part of business	degree of sustainability of project results	Jury evaluation
Students as responsible world citizens (Atttitude) "ambassadors of sustainability"		Reflection essays
Contribution to sustainable development	Degree of Sustainability/ Follow-up indicator	Feedback from J&J 12 month after completion Impact Forecasting and impact assessment by students (ex-post questionnaire)

6.2.3 Evaluation of data

Input data

INPUT	Provide a "fertile ground" to allow students to become "responsible world citizens" "Fertile ground": real-world challenges, motivated and supportive business partner (as challenge provider), cultural mixed student teams, infrastructure that allows online-collaboration, support from coaches
	Suitable Challenge, motivated students with prior knowledge in their field of study + sustainability

In this section we assess the first two layers of the impact staircase:

- Could we address motivated students with prior knowledge in their field of study + sustainability?
- Could we create a "Fertile ground": real-world challenges, motivated and supportive business partner (as challenge provider), cultural mixed student teams, infrastructure that allows online-collaboration, support from coaches.

In the Future of Healthcare Challenge 2024 (FHC 2024), 30 students from Bangladesh, Germany, India, Indonesia, Iran, Italy, Japan, Nigeria, Pakistan, and South Africa participated. It has been Bachelor and Master students with a background in diverse technical (engineering etc.) or business background ranging from communication science, game design, management & economics, sustainable management to pharmaceuticals. They were recruited by the seven participating universities. The FHC Challenge was (mostly) part of curricular modules. Figure 6 shows, that app. One third of the participating students had an EU-origin. Following universities participated:

- University of Ulm (Germany)
- University of Oldenburg (Germany)
- University of Twente, Enschede (The Netherlands)
- Glasgow Caledonian University (Great Britain)
- Nelson Mandela University, Gqeberha (South Africa)
- Telkom University, Bandung (Indonesia)
- University of Pasundan, Bandung (Indonesia)
- Sanyo-Onada City University (Japan)

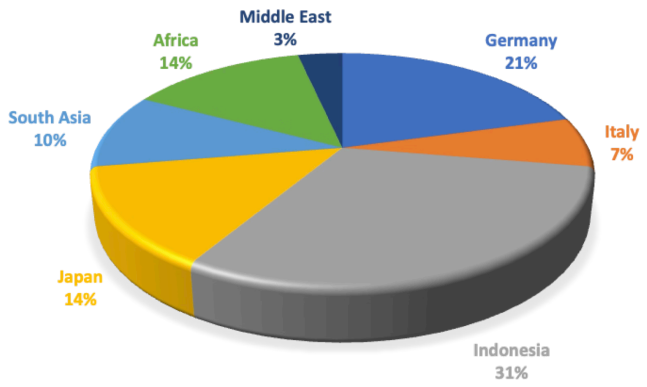

Figure 6: Participants of the Future of Healthcare Challenge by nationality.

Students worked together in seven teams, which consisted at least of four persons. Three teams each had two members with Indonesian origin and from Indonesian Universities, all other team members had a different national background. Ten coaches of different origins had coached teams. So, we could state, that we were able to form truly transnational teams.

The FHC 2024 recorded one drop out during the programme due to family reasons (passing away of mother). No one left the programme because of dissatisfaction.

Satisfaction was measured using the online questionnaires in the final evaluation. The overall satisfaction rate of the participants was 84%. For all criteria, the satisfaction of the participants was relatively high, see Table 9: Satisfaction of participants regarding different categories. The recommendation rate was 91,4 % positive, while 8,6 % of the students stated, that they won't recommend participating the Future of Healthcare Challenge to others.

Table 9: Satisfaction of participants regarding different categories

Satisfaction with	Adequate responses of organizers	Adequate responses of J&J	Usefulness of meetings with coaches	Available time budget	Organization of FHC
FHC 2024	86 %	88 %	83 %	76 %	86 %

The theme of the challenge, provided by Johnson & Johnson was:

"The future of healthcare, circular business models for healthcare and pharmaceutical products"

The challenge was broad in concept but referred to medical devices produced by J & J.

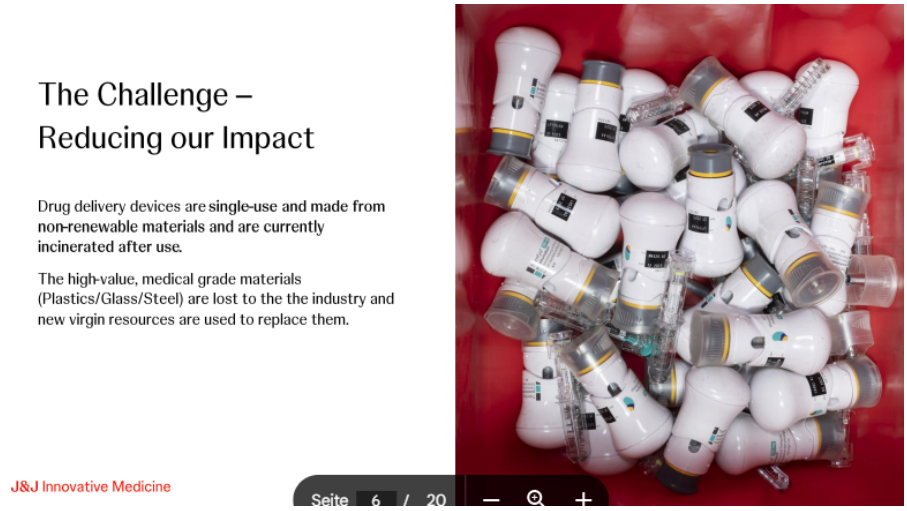

Figure 7: The Challenge, formulated by Johnson & Johnson

VAS has held several preparatory meetings with the contact person of J & J, in which they were able to satisfy themselves of the motivation of the practice partner and to sharpen the challenge topics. J & J provided a permanent point of contact for the challenge, who was not only available at the three scheduled events but was also available to the students for eight Q&A sessions throughout the Challenge.

Output data

Output	A verified sustainable business idea and drafted business model (for a circular BM for J & J) per student team
	Knowledge for business models for students
	Student teams worked together successfully in virtual cross-cultural teams

The following indicators were used to evaluate the output

- Student teams worked together successfully.
- Students gain knowledge for business models.
- Each student team submit a verified sustainable business idea and drafted business model (for a circular Business Model for J & J).

Aspects of *teamwork and collaboration* had been asked continuously via the progress monitor – a monitoring and evaluation survey that students were asked to fill in on a weekly basis. In addition, students were asked to review this issue in a reflection essay. They provided some concrete examples of the cross-cultural communication in their teams and their own roles. Teams benefited from diverse perspectives, despite initial challenges. Teams found cultural diversity both enriching and challenging, emphasizing the need for adaptability. The following quotes stem from the final online survey students filled in after the final session:

"Our team's diversity brought richness to our discussions, with members contributing unique insights from their country".

"Our Japanese teammate emphasized simplicity, while the German teammate proposed highly technical solutions—balancing these perspectives was key which enriched our solutions."

"Initial misunderstandings due to differing communication styles were resolved through active listening and clear guidelines."

Students stated other aspects of skills development a well:

- Overcoming language barriers and cultural differences was a key learning:
  "Language barriers, like understanding accents, initially slowed discussions but ultimately improved our intercultural communication skills."

  "We established communication guidelines and task boards to stay aligned despite time zone challenges."
- Flexibility and compromise strengthened collaboration. Participants overcame hurdles like time zone differences:
  "When discussing project priorities, we negotiated to balance technical feasibility with creative ideas."

  "Adjusting to varying communication styles and approaches enhanced our teamwork."

  "Coordinating meetings across time zones required careful planning and mutual respect."
- Participants often took on **facilitative and creative roles**, ensuring team cohesion and output:
  "I acted as a moderator during discussions, facilitated meetings, and ensured deadlines were met."

  "My role involved creating graphics, multimedia content, and refining our business model canvas."

We could proof, that students gained the knowledge necessary to develop and verify business models for their solution ideas: During the program, a large number of video tutorials and 32 tools for business modeling had been supplied online. Students used these sources to gain or deepen their knowledge about business modelling. In weekly coaching sessions, they could get support from their coaches when needed.

82,9 % of the students made use of video tutorials and tools, but just 65 % used the platform "Solution Explorer" (others concentrated on YouTube tutorials and sources provided via G-drive). 81,4 % assed the tools as useful.

Seven teams submitted a verified business idea in the context of the overarching topic and drafted a business model in phase 2. So all teams finished successfully the challenge program. The quality of the business models have been assessed by the jury. The assessment scheme can be found in PR 4 (playbook of full-term challenges) (Stel, 2025b).

Outcome data

Outcome	Awareness of students of sustainability as integral part of business
	(Increased) Cross-cultural competences of students
	Business models that meet the needs of J& J

The Outcome of the Future of Healthcare Challenge can be assessed with the following indicators:

- Feasibility of the submitted project ideas and their business models
- Satisfaction with the progress in intercultural teams
- Degree of sustainability of the suggested business solutions

Impact data

Impact	Contribution to sustainable development Contribution of the projects to the sustainability goals of J&J
	Students as responsible world citizens (Attitude) "ambassadors of sustainability"

The Impact ambition of the FHC2024 was to educate students as responsible world citizens and contribute to the sustainability goals of Johnson & Johnson and to sustainable development in general. Insights can be drawn from their essays and indicate that the impact ambition was successfully reached.

7 Conclusion and recommendations

This research report presented the evaluation results of the teaching and learning formats of student business challenges in sustainable entrepreneurship that were carried out as part of the Challenge4Impact project. We based the evaluation on the monitoring and evaluation approach developed in PR 3 of the Challenge4Impact project and followed the developed guidelines "From Output to Impact in Entrepreneurship and Sustainability Education: Guidelines for Evaluating and Improving Student-Business-Challenges" (Fichter & Seela 2024).

Two conclusions can be drawn from the evaluation work carried out. The first relates to the suitability of the guidelines developed in PR3 "From Output to Impact in Entrepreneurship and Sustainability Education". The second concerns the effects of the student business sustainability challenges examined.

7.1 Suitability of the guidelines

The guidelines were shown to provide important conceptual and methodological foundations that are very suitable for practical evaluation. These include, for example, the Input-Output-Outcome-Impact (IOOI) scheme, the Challenge-based Learning Impact Cycle and the differentiation of different evaluation levels (individual level, innovation level, system level). The example indicators provided there also support practical evaluation very well. Furthermore, the evaluation tools presented in the guidelines provide important suggestions. At the same time, however, it has also been shown that the Impact Staircase presented in the guide has to be adapted to the situation and has to be understood not as a simple linear sequence but as an interactive and intertwined process. Furthermore, the application of the Impact Staircase implies, that the motivation to create an impact is central to teaching personnel or to the evaluation activity.

Recommendation 1: Support Services are needed and should be used for impact evaluation

The application of the guide and the IOOI concept confirms the underlying assumption of the guide that outcomes and especially medium and long-term impacts are significantly more difficult to capture.

As a recommendation, it can be deduced that the sound recording and evaluation of the outcomes and impacts of practice- and implementation-oriented formats such as the Student Business Sustainability Challenges requires the support of teachers. Just as universities already provide extensive central services for traditional teaching evaluation, the same is needed for impact monitoring and management. Here, the internal and external support services identified in the Challenge4Impact project can be used (see PR 2 and 7).

Recommendation 2: Expansion of traditional teaching evaluation concepts

Practice- and implementation-oriented teaching/learning formats such as Student Business Sustainability Challenges, which claim to achieve impacts on both students and practice partners, require an expansion of traditional teaching evaluation concepts and strategies. In this context, university management and central teaching and evaluation officers should expand university-wide evaluation concepts, infrastructures and services.

7.2 Learnings from observed effects in Challenge4Impact

As the evaluation of the various student business sustainability challenges undertaken in the Challenge4Impact project shows, these challenges supported important skills progress in students and delivered important and innovation-promoting results for the participating practice partners. The effects depend on a large number of configurable factors and differ depending on the duration, type and context of the challenge. The methods and formats suitable for capturing and evaluating outcomes and impacts also depend on this. For example, the tried and tested reflection rounds with students and the “impact forecasting” methodology used in them show very promising results (see PR 3).

Students’ satisfaction with the implemented activities was measured in regular course evaluations and they were in general satisfied but also provided valuable feedback for improvements. For some modules students were also asked to reflect on learning outcomes demonstrating the PR 4 activities helped them in understanding how they had been impacted.

In PR 5 several companies were involved in the modules but not directly involved in PR5 activities. But the second version of Student Forums on Sustainable Entrepreneurship Education had a specific focus on how to make an impact. In this case meaning how to increase the chances that suggested measures developed in the challenges becomes implemented leading to outcomes for the participating companies and impacts in society.

PR4 involved the active participation of one company. The company got direct outcomes in the form of business ideas for further exploration. It is too early to make a full impact assessment, but the company were satisfied with the output and outcomes.

Also, the investigated impact of Student-Business Sustainability Challenges in Engineering Education (see Section 6.1) underlined that conducting an impact assessment is a work-intensive but rewarding process. As teachers, you normally do not have time to go back several years after the finalization of teaching activities, but instead base assessments and further development of teaching activities on traditional course evaluations from students and what you instantly hear from challenge providers. Allowing long time between course activities and assessment opened opportunities for other learning outcomes and a deeper understanding of the tentative impact. The long-time perspective also came with challenges since

some companies had closed down and, in several cases, the responsible person was no longer employed at the organization.

One important remark is that even if the applied model uses the logic model of input, output, outcome and impact, it is not possible to claim a direct case-effect relationship between input and impact. It is challenging to judge if students identified measures not known to the challenge providers or if other factors lead to the implementation of proposed measures. However, the framework served as a good tool for reflections from both teachers and challenge providers and allowed to get an overview of the diversity of measures suggested and the degree of implementation. Such knowledge could be helpful in designing learning activities in upcoming courses.

Finally, while doing the interviews with challenge providers they were reminded of the suggested measures and in some cases, we noted a revitalized interest in implementing those not yet implemented. Several also expressed an interest in getting student support in the future. Thus, the activities of the impact assessment could be a way of increasing implementation of already suggested and new measures, leading to more outcomes and long-term impact.

Recommendation 3: Integrate Outcome- and Impact considerations already in planning courses

To increase the quality of assessment of the outcomes, and in the long perspective the impacts, it is recommended to establish a strategy for how this should be done already at the planning and implementation of course activities. This suggestion follows the Impact Cycle presented in PR 3.

Recommendation 4: Use of evaluation methods appropriate to the situation

In the guide “From Output to Impact in Entrepreneurship and Sustainability Education”, different evaluation approaches and methods are presented (see PR 3). As the evaluations conducted in Challenge4Impact show, the option to choose from a range of methods is important in order to select and, if necessary, adapt the appropriate evaluation methods for the respective challenge format.

Recommendation 5: Support through appropriate software tools

The evaluations that have been carried out show that these are often costly. To reduce the effort, powerful software tools are needed that effectively support the entire process of impact management, from planning to recording medium and long-term impacts. Although software tools for impact management already exist, they have so far focused on programs and activities in development cooperation and other fields, but not on the higher education sector and teaching. There is a need for development here.

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