

COULD YOU TEACH ME HOW TO THINK?

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Abstract

One of the core values of education, at any level, should be critical thinking. We educate students so that, with their knowledge, they can act critically in their future professional careers and in life in general. However, do we actually teach students to learn how to think? In science and engineering programs, through subjects such as Mathematics or Physics, students are trained to approach problems and to apply logical reasoning to find possible solutions. But we don't teach them to reflect on their own learning, as is done in other, more education-oriented disciplines. Experience has shown that, in general, university students do not used to stop and critically think about their own learning process. In this paper, we present how we have guided university students from various science and engineering degrees in the process of reflecting on their learning experiences and the skills acquired during Service-Learning (SL) projects. The study involves twenty undergraduate students who participated in a one-week SL activity in Morelia, Mexico. The program was integrated in an international and interdisciplinary initiative under the Erasmus+ Project G.I.R.L.S. (Generation for Innovation, Resilience, Leadership and Sustainability), which brought together students from the sciences, engineering and health sciences from the partner countries involved in the project. The activities covered a wide range of topics, from hygiene education to collaborative community-based interventions. The SL methodology includes well-defined phases: observation, preparation, action, reflection, recording, evaluation, and acknowledgments. It has been observed that, although most of these phases do not present difficulties for students, the bottleneck is during the reflection part. To facilitate the reflective process, a comprehensive guide outlining the phases of the project was first developed, together with guidelines designed to support the internalization and implementation of SL projects and their methodology. In addition, to delve deeper into the experience, reflection sessions were conducted in four stages: individual reflection, reflection in small groups, collective reflection in a large group, and a final reflection about future action, guided by selected questions. At the beginning of the process, students appeared to engage with their experiences at a superficial level; nevertheless, as the reflection activities advanced, they progressively demonstrated greater depth in their analysis and understanding. The results highlight the importance of promoting higher education environments that enable students to develop the competencies and strategies required for more meaningful engagement in their own learning processes.

Keywords: *Service-learning, critical thinking, reflection, higher education, science/engineering education.*

1. Introduction

One of the core values of education, at any level, should be critical thinking. We educate students so that, with their knowledge, they can act critically in their future professional careers and in life in general. However, do we actually teach students to learn how to think? In science and engineering programs, through subjects such as Mathematics or Physics, students are trained to approach problems and to apply logical reasoning to find possible solutions. But we don't teach them to reflect on their own learning, as is done in other, more education-oriented disciplines. Experience has shown that, in general, university students do not used to stop and critically think about their own learning process.

Science and engineering programs typically fail to teach students metacognitive skills and critical self-reflection about their learning process. Multiple studies substantiate this claim. May and Etkina (2002) found that students rarely reflect on how they learn specific content, with most lacking sophisticated epistemological awareness. Hernán Paz Penagos (2011) specifically noted that while students master problem-solving procedures, they do not develop self-knowledge about their learning abilities.

Wynne (2010) further revealed that students often do not value reflective activities, preferring traditional analytical assignments. The evidence suggests a systemic gap in engineering and science education, where technical problem-solving skills are prioritized over understanding one's own learning mechanisms. Developing metacognitive skills could potentially enhance students' conceptual understanding and long-term learning capabilities. Turns (2014) emphasizes the importance of integrating reflection into engineering education, focusing on teaching reflective practices and metacognitive awareness, which addresses the gap in teaching students to reflect on their own learning in science and engineering programs.

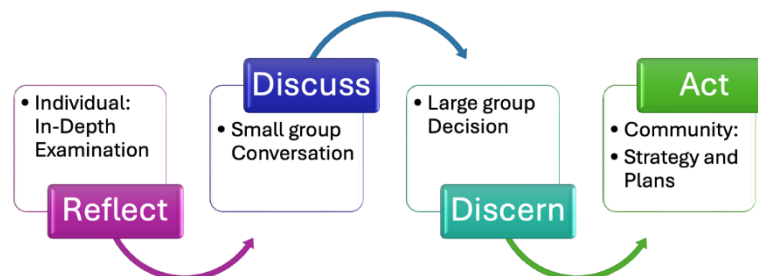
In this paper, we present how we have guided university students from various science and engineering degrees in the process of reflecting on their learning experiences and the skills acquired during Service-Learning (SL) projects. The study involves twenty undergraduate students who participated in a one-week SL activity in Morelia, Mexico. The program was integrated in an international and interdisciplinary initiative under the Erasmus+ Project G.I.R.L.S. (Generation for Innovation, Resilience, Leadership and Sustainability), which brought together students from the sciences, engineering and health sciences from the partner countries involved in the project (GIRLS, 2026).

2. Methodology

The Erasmus+ Project G.I.R.L.S. is a collaborative European initiative aimed at promoting inclusion, diversity, gender equality, digital transformation, and the Sustainable Development Goals. By integrating active methodologies such as research-based learning, game-based learning, competency-based learning, and service-learning, the project encourages both students and educators to engage in experiential learning, creativity, and leadership development (Hernández Encinas et al., 2025). This paper focuses on the Service-Learning methodology and how it can be used to foster reflection on learning among students. Specifically, we will analyze the experience carried out in the Michoacán, region of Mexico, with 20 students from four different countries (Portugal, Romania, Spain, and Mexico): thirteen engineering students, four health sciences students, and three students of Translation, Interpreting, and Language Teaching. The activities included hygiene education, public health campaigns, and collaborative problem-solving through statistical analysis with community members. The pedagogical design followed the principles of active learning and intercultural exchange. These students had already participated in Service-Learning projects at their universities (Rasteiro et al., 2025). The students involved belong to the University of Salamanca, USAL, (Salamanca, Spain), Francisco de Vitoria University, UFV, (Madrid, Spain), the Polytechnic University of Coimbra, IPC, (Coimbra, Portugal), the Technical University of Civil Engineering in Bucharest, UCB, (Bucharest, Romania) and Vasco de Quiroga University, UVAQ (Morelia, Mexico).

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Figure 1. Stages for reflection, individually and in groups, on the learning achieved through the SL projects carried out in Michoacán (Mexico).



The Vasco de Quiroga University campus in Morelia was responsible for coordinating all activities carried out during the exchange program in Mexico. Visits were made to the towns of Ciudad Hidalgo and Patzcuaro to develop various service-learning projects that the students had been preparing beforehand, thanks to information provided by professors at the UVAQ. Details of all the activities can be found on the GIRLS project website (<https://girlsproject.eu/mexico/>). As previously mentioned, three student groups were formed to carry out SL Projects:

- Team 1 (IPC and UTCB): “Statistics: How to prepare a survey and collect data”.
- Team 2 (USAL and UVAQ): “Experiments to understand the importance of hygiene, based on scientific evidence”.
- Team 3 (UFV and UVAQ): “Basic pre- and postpartum physiotherapy”.

Following the implementation of the projects in Ciudad Hidalgo, we conducted an initial phase of guided reflection with the students. To delve deeper into the experience, the reflection sessions were carried out in four stages. (Figure 1):

- Reflect. The first step is individual reflection, which invites everyone to ask essential questions about the learning experiences at all stages of the Service-Learning project (Figure 2a)).
- Discuss. The second step involves sharing these reflections in small groups, without judgment (Figure 2b) and 2c)).
- Discern. The third step is sharing the key elements that emerged in each group with the entire school community (Figure 2d)).
- Act. Finally, the fourth step is to collectively identify the relevant elements for the future that will improve the Service-Learning experience. The important thing is not so much what the decision is, but that it is the fruit of communal discernment.

Once the second intervention in Patzcuaro took place, the reflection session with the students was repeated, following the scheme proposed in the first one.

3. Discussion

At the beginning of the process, the students' reflections focused more on sensations or feelings than on the learning itself. As an example, we have compiled some of their impressions, which we present according to the type of grouping in which they were carried out (individual, small group and large group).

Figure 2. Different results and moments of reflection: a) individual, c) in small groups, e) in large groups; as well as an image of a moment when the students shared the reflection in small groups.



- In individual reflection (Figure 2a)):
 - “I feel a bit nervous but excited to know people and help”.
 - “I had no expectations but every one was so nice that it was easy to have pride”.
 - “I felt lately better than I've expected. It seems like I found a new family”.
 - “Great fun and the chance to interact and get closer to the community, serve the people”.
- Small group reflections:
 - “Comfort. Reality Check. Bonds / Friendships. Culture. Cooperation. Impact. Experiences. Multiculture. Diversity. Firm - Tequila, Mixed. Support. Union. Freedom / Freedom of speech”.
 - “Sharing the same feelings about the safe space created, empathy and kindness, our hearts were moved by emotion”.

- Community reflections:
 - *"Friendship".*
 - *"The power and the kindness of the humanity is beautiful!"*.

As teachers helped them focus on the topic, their reflections became deeper. And without a doubt, they all reflect the great transformative power that service-learning projects have on students.

- In individual reflection:
 - *"Acknowledgement of our skills and abilities and knowing that we have much to offer".*
 - *"Conscious about our role as a bridge between the university, people and community".*
 - *"The service-learning activity was really good, very organized, involving both theory and practice. The environment was very friendly and welcoming. The preparation was good, based on past videos and presentations that resumed exactly the important things. The experiments were the best impacts because they were an approximation of theory".*
 - *"The potential impact is way bigger than expected. The amount of love and hunger expressed by the locals made me feel motivated and excited. I am insatiable now to help more with my knowledge".*
- Small group reflections:
 - *"We have learned something we didn't notice about our degree, that is we always open our heart to the people and receive them with open arms. And it is overwhelming seeing that these persons open their heart to us in respond of our actions".*
 - *"As a group the project has exceeded our expectations. First of all, we are surprised by how our differences made us stronger and how every idea has been heard, and everyone had an important part on the project. We all agreed that we feel joy from being able to make a difference in the real world and we would love to help even more in the future".*
- Community reflections:
 - *"Grateful to have the opportunity to learn & share with so fantastic people."*
 - *"To change, to learn, to help, is to live".*
 - *"Serving, connecting, helping... together we make a brighter future possible".*

Based on the analysis of the reflection murals created by the participants, the following main conclusions can be drawn, summarizing the impact and lessons learned from the Service-Learning experience:

- The Human Factor and Emotional Connection. The most powerful conclusion is the deep emotional connection established with the local community. Participants describe feelings of "love," "joy," and "gratitude". The warmth of the Mexican community is highlighted, with participants mentioning that they "opened their hearts" unexpectedly. The recurring phrase "giving is receiving" summarizes the feeling that the students received more life lessons than they themselves contributed technically.
- The Awakening of Social Vocation. The project has served as a "reality check" that has transformed the students' professional vision. Many mention a "change of mindset" after applying their technical knowledge (from their academic degree) to real health and sanitation problems. There is a sense of "insatiable desire" to continue helping, the impact seen in the community has served as a source of intrinsic motivation.
- Synergy and Teamwork (Multiculturalism). The group mural highlights how the diversity of backgrounds and disciplines became a strength. It is mentioned that individual differences made the group stronger. The team managed to create a "safe space" of mutual support, where communication flowed despite initial language and cultural barriers.
- Community Empowerment. A key conclusion, especially reflected in the notes in Spanish, is the focus on community autonomy. The project is not perceived as an external, paternalistic intervention, but rather as a process where the community must be "the initiator of its own change". The ultimate goal expressed is that the work carried out will have continuity and achieve a tangible goal for the well-being of the residents.
- Personal Growth and Self-Knowledge. On an individual level, the experience was a challenge that exceeded all expectations. The participants transitioned from initial uncertainty and nervousness to a sense of pride and peace. The creation of lasting friendships ("a new family") and the discovery of personal skills they were unaware of before the fieldwork were highlighted.

As can be seen, at the end of the reflection, the students have really been able to internalize the learning that the Service-Learning methodology has provided them, while at the same time the great transformative power of this methodology is very well described.

4. Conclusions

The results of this study highlight that the implementation of Service-Learning projects in science and engineering degrees is a powerful tool not only for acquiring technical competencies but, fundamentally, for "teaching university students how to think". Based on the analysis of the experiences of the group in Morelia, the following main conclusions can be drawn.

Firstly, it is evident that structured reflection is the indispensable mechanism for transforming a field experience into meaningful learning. Without a guided reflection framework across multiple stages (individual, small group, and collective), students tend to remain at a superficial level of analysis centered on immediate emotions. The transition from "sensation" to "critical thinking" requires pedagogical mediation that challenges students to confront their technical knowledge with social reality.

Secondly, SL methodology acts as a catalyst for metacognition. Through these projects, students from technical backgrounds—accustomed to logical-mathematical reasoning—successfully identify their own knowledge gaps while simultaneously discovering transversal and vocational skills that the conventional classroom fails to awaken. This "reality check" fosters a much more human and committed vision of the profession.

Finally, the process of "communal discernment" reinforces the idea that service is not a unidirectional action, but a process of mutual empowerment. By teaching students to reflect on future action, they are prepared to become professionals capable of listening and responding to the needs of the community, promoting a mindset that moves beyond individual success to focus on the social impact of their expertise.

In conclusion, this work demonstrates that it is both possible and necessary to integrate critical thinking education into science careers. SL, supported by deep reflection, constitutes one of the best strategies for training not only competent engineers or scientists but also citizens capable of reflecting on their own learning process and their role in society.

Acknowledgments

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