Practice Paper

Recommended citation: Bakthavatchaalam, V., & Kononen, S. (2025). “The World as It Should Be”: Voices of Finnish School Students on the Role of Engineering in Shaping the Future. In Kangaslampi, R., Langie, G., Järvinen, H.-M., & Nagy, B. (Eds.), SEFI 53rd Annual Conference. European Society for Engineering Education (SEFI), Tampere, Finland. DOI: 10.5281/zenodo.17632076.

“THE WORLD AS IT SHOULD BE”: VOICES OF FINNISH SCHOOL STUDENTS ON THE ROLE OF ENGINEERING IN SHAPING THE FUTURE

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Conference Key Areas: *Dialogue between engineering and society – effects on education, The attractiveness of engineering.*
Keywords: *Engineering Education, Youth Perspectives, Social Justice, Climate Change and Sustainability, Social Justice*

ABSTRACT

This qualitative study explores how high school students in Tampere, Finland, perceive their future and the role of engineering in societal transformation. Involving 72 students aged 16–18 from both the International Baccalaureate (IB) programme and the national curriculum, the study explores how young people conceptualise their potential to effect social change through engineering. It focuses, particularly, on their understanding of engineering to promote sustainability, enable technological innovation, and advance social justice. Data were collected through group discussions and individual reflections. The results reveal a wide range of perspectives on the societal impact of engineering. While many students view engineering as essential for addressing global challenges such as climate change and healthcare, they also express varying levels of anxiety and pessimism about the future. The study provides insights into educational strategies that can enhance students’ understanding of engineering as a tool for social transformation. It offers valuable implications for educators and policymakers seeking to empower the next generation to engage meaningfully with complex global issues.

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1 INTRODUCTION

The capacity of young people to envision their futures is increasingly recognised as a critical component of education, particularly in preparing them to work with and influence complex global challenges. As the urgency of climate change, social inequality, and technological disruption intensifies, there is growing interest in how students conceptualise their roles within future-oriented disciplines, such as engineering. Traditionally regarded as a technical field, engineering is now understood to intersect with questions of ethics, sustainability, and social justice. This reframing raises important educational questions: how do students perceive engineering's role in society, and do they see themselves as potential contributors to social change through this discipline? Recent studies have begun to examine these questions, yet empirical research remains limited, particularly in contexts that foreground students' voices and lived experiences. Gender disparities, identity development, and the integration of values into STEM (Science, Technology, Engineering, and Mathematics) education continue to shape how students engage with engineering futures. This study seeks to understand how diverse learners make meaning of engineering's societal role, with the following objectives:

- Explore the conceptions of school students regarding their future and the role of engineering.
- Identify the ways how students believe they can contribute to social change through engineering.
- Analyse the students' perspectives on engineering to achieve social justice.

2 LITERATURE REVIEW

Exploring students' perceptions of their future provides an insight into how they envision their forthcoming career, responsibility, agency and social transformation. These aspirations are co-created through cultural narratives, societal expectations and the opportunities afforded by education in the country (Akbaba, 2024; Bakthavatchaalam & Shivashankar, 2024; Finnegan, 2022; Monroe et al., 2019). Within this space, engineering has emerged as strongly associated with the delivery of sustainability, climate change, poverty alleviation, public health and digital innovation agendas (UNESCO-ICEE, 2021). Yet, the literature remains fragmented on how learners connect engineering with their imagined futures and the questions of social justice.

Students increasingly perceive engineering as a field that not only builds infrastructure but also drives social progress, sustainability, and technological innovation (Jones, 2023). Integrating engineering with the values of justice and peace, as reflected in the Peace Engineering movement[1], has gained traction in curricular reform (Jordan et al., 2021). Within the context of education, studies suggest that introducing students to the social impact of engineering can enhance their motivation and engagement in STEM fields (Martinez-Marroquin et al., 2024).

Pedagogical approaches such as problem-based learning and community-oriented projects have been found to enhance student engagement. Hands-on experiences,

[1] The Peace Engineering movement (PENG) is an emerging interdisciplinary field that integrates principles of engineering, science, and technology to advance peace and sustainable development. It emphasises the identification and mitigation of the underlying drivers of conflict through the application of innovative, systemic solutions aimed at enabling a more equitable and harmonious global society.

particularly in technical education programmes, are associated with an increased career interest and a deeper understanding of engineering's real-world relevance (Bakthavatchaalam & Shivashankar, 2024; Mitchell et al., 2019).

Developing an identity is central to how young people position themselves relative to engineering. Although engineers are widely viewed as creative problem solvers (English et al., 2011; Spencer & Strong, 2011), entrenched misconceptions and gendered stereotypes continue to limit who is imagined as an engineer (Afaal & Bakthavatchaalam, 2023; Montfort et al., 2013; Starovoytova & Namango, 2016). Prior exposure to STEM, particularly through informal and hands-on experiences, is associated with stronger engineering identities.

Looking at the Nordic countries, in Finland, Aivelo & Huovelin (2020) comment that experiential learning increased participation and shifted attitudes. In Sweden, secondary textbooks on sustainability were found to obscure the complexity and under-develop key relationships between knowledge and how they can be used for sustainability (Biström & Lundström, 2021). Students often associate sustainability with environmental and economic aspects but overlook social dimensions (Björnberg et al., 2020; Flament & Kövesi, 2020). Despite positive attitudes, many students reported limited confidence in addressing sustainability through engineering. This study builds on this literature by exploring how Finnish high school students, after engaging with expert narratives and structured reflection, conceptualise engineering's societal role and their own agency in shaping the future.

3 METHODOLOGY

A qualitative design was chosen to ensure rich, in-depth conceptions, offering greater insight than structured questionnaires. The research was conducted at a high school in Tampere, Finland, with 72 students aged 16–18 from both the International Baccalaureate and national curriculum. Most participants were native Finnish, with some from multicultural backgrounds, and the majority intended to pursue higher education. No demographic data were collected to protect anonymity.

Data collection involved students first viewing video interviews with experts in academia, social entrepreneurship, and engineering, i.e., people engaged in driving social change through engineering. This was followed by group discussions and individual reflections. Group responses were collaboratively written, while individual answers were submitted electronically. Reflections centred on three areas: students' perceived capacity to contribute to social change through their skills; their understanding of engineering as a pathway to social justice; and their broader vision for the future. Responses were submitted in English or Finnish, with all Finnish responses translated into English by a native speaker (one of the authors) to ensure consistency. Thematic analysis was conducted to identify recurring patterns and themes, which were then refined into sub-themes (Mayring, 2014; Saldana, 2011).

4 RESULTS AND DISCUSSION

The results show a plethora of factors influencing their thoughts. This section discusses these in considerable detail.

4.1 Student perspectives on engineering's role in society

Students demonstrated a strong awareness of the broad role of engineering in addressing societal needs and shaping global futures. Their reflections highlighted how engineering contributes not only to economic development but also to social well-being and technological progress. One student commented that

"Engineering is the backbone of modern society, without it, we wouldn't have the structures and systems we rely on."

Beyond the economic dimension, students frequently described engineering as highly relevant for addressing essential human needs, including clean water, energy, housing, and healthcare. These comments reflect a growing understanding of the relationship between engineering and social justice. Students also saw engineering as integral to tackling global challenges. Climate change was a recurring concern, with many emphasising the responsibility of engineers to develop sustainable solutions. This aligns with broader findings in the literature that identify engineering education as a crucial space for supporting climate agency (Bakthavatchaalam & Shivashankar, 2024; C. Jones & C. Lucas, 2023; Monroe et al., 2019). As one student explained,

"Engineering is more than just building things; it's about shaping the future and making life better for everyone."

Infrastructure and technological innovation were additional areas where students perceived engineering to be transformative. They cited examples, such as the development of smart cities and resilient infrastructure, as key indicators of engineering's ongoing societal contribution. While acknowledging the profession's existing impact, students also voiced aspirations for further innovation to address future uncertainties and crises. Healthcare emerged as a key domain where students saw engineering's societal value, particularly in the context of medical devices and assistive technologies. This perspective is consistent with contemporary shifts in engineering education that highlight interdisciplinary applications in health, environment, and social infrastructure (Bakthavatchaalam & Shivashankar, 2025). Their emphasis on sustainability, equity, and innovation reflects a growing alignment with global educational goals on sustainable development and ethical engineering practice.

The next theme that emerged was their vision for the future and their personal contribution towards it. The results showed a mix of optimism and pessimism for the future by the students in being able to influence changes. Some of their pessimistic comments were akin to the works of (Wint, 2022).

4.2 The role of engineering in shaping societal and environmental futures

A key theme emerging from the data was the belief in engineering's potential to address societal and environmental challenges. Despite varying degrees of optimism about the future, there was broad consensus that engineering is a powerful catalyst for change, particularly regarding climate action, social equity, and technological advancement. One student captured this outlook by stating that

"I envision a future where sustainable practices were the norm and climate change was mitigated. I believe engineering can provide practical solutions to those problems."

Many students viewed engineering as contributing to advancing social justice, highlighting fields such as infrastructure, poverty alleviation, healthcare, and accessible technology as areas for lasting societal impact. This reflects a growing awareness among youth of engineering's role in addressing such challenges. Responses also highlighted the potential of engineering to create technologies that are more accessible and equitable. One student noted that

"I want to make technology that helps disabled people live easier lives."

This inclusive and equity-oriented perspective was echoed in reflections about sustainability, wherein students frequently cited environmental justice and improved living standards as priorities.
This sense of agency illustrates how engagement with engineering solutions empowers students to contribute meaningfully to global challenges. Many described engineers as "problem solvers" and "people who make the future better", reflecting a broad understanding beyond traditional technical roles. However, some responses confined engineering to construction or mechanical tasks, indicating a need to challenge stereotypes and highlight the field's diversity. Students' confidence in pursuing engineering careers and driving change varied: while many expressed enthusiasm for problem-solving and innovation, others raised concerns about the field's perceived difficulty.

4.3 Student proposals for engineering and social justice initiatives

Students' views on the engineering's role in promoting social justice coalesced around several themes. Many emphasised the need for inclusive design to reduce inequalities, citing examples such as gender-neutral toilets to promote gender equity and wheelchair-accessible facilities to support people of all abilities. One student highlighted the increasing female representation in engineering as key to addressing gender disparities and fostering innovation that reflects diverse needs. Others emphasised that considering the needs of minorities in society is a way engineers can help increase social justice in practice.

Students also saw themselves as agents of social change, using engineering to address community challenges and promote sustainability. While some proposed practical innovations, such as a more secure bike rack, others focused on awareness-raising, equality-building, and inspiring change through their skills.

"I could design a bike parking rack that makes it more difficult to steal a bike or makes it easier to lock your bike very securely."

Notably, over 60 of the 72 students advocated for extracurricular activities that foster interaction with peers from diverse cultural backgrounds, enhancing cultural competence. They also called for the education system to teach emotional hygiene, including conflict resolution and anti-racism. These insights highlight students' desire for schools to create opportunities that integrate technical learning with social transformation goals. It becomes essential that schools give them the opportunities to bridge technology with their social change aspirations.

4.4 Student emotional engagement and agency

The findings extend existing research on the emotional and cognitive dimensions of student engagement with climate change. Participants expressed a spectrum of emotions—most notably hope and anxiety—often linked to their views on engineering's role in addressing environmental challenges. This duality reflects prior work by Akbaba (2024), Finnegan (2022), and Ndetei et al. (2024), who note that while hope fosters well-being and pro-environmental attitudes, climate anxiety can undermine psychological resilience. Students articulated an aspirational future grounded in sustainability and social justice, with many expressing optimism about engineering's capacity to support this vision. As one student stated,

"I envision a world of equality and peace. To help create this world, I can share my ideas and thoughts on the matter and get involved in projects."

Another student similarly expressed hope, linking it explicitly to environmental action:

"I also hope that people finally realise that climate change is a huge problem that we have to tackle if we want to continue living on this planet."

The results show the emergence of the role of agency, self-efficacy, and perceived competence among students, which are identified in the literature as strong predictors of pro-environmental behaviour and sustained engagement (Diktaş Bulut, 2024; Monroe et al., 2019). Students frequently associated engineering skills with the capacity for positive change. This direct application of engineering knowledge to tangible global problems aligns with Jones and Lucas's (2023) assertion that opportunities for meaningful action and being heard reinforce young people's sense of agency.

The emotional intensity of students' engagement highlights an underlying vulnerability. Despite demonstrating solution-oriented thinking, many expressed urgency and emotional burden reflecting Rikner Martinsson and Ojala's (2024) findings that, while problem-focused coping fosters resilience, climate anxiety persists without structured emotional support. These results point toward the value of integrating cognitive learning with emotional processing in education.

Students' ability to articulate personal visions and contributions emerged as central to managing these emotions. As Jones and Lucas (2023) observe, peer dialogue and reflective discussion can aid emotional regulation and strengthen commitment. Students' narratives revealed both individual reflection and a shared aspiration for collective transformation. However, as Zjalic et al. (2024) caution, while educational interventions improve knowledge and intentions, they often fall short of building emotional resilience. The findings suggest that curricula should incorporate emotional expression and critical reflection alongside technical content.

Although many students expressed hope, a notable proportion voiced pessimism, particularly concerning climate change, conflict, and perceived governmental failure. These students questioned the efficacy of engineering in addressing such vast global challenges. As one participant starkly stated,

"The world will burn. This corrupt place ruled by those with money will end soon. At least for people like me. I will not participate in burning the world."

While these views may appear pessimistic, they also reflect the students' concern and a perceived lack of agency to effect change (Rikner Martinsson & Ojala, 2024; Wint, 2022). Their reflections suggest both a sense of helplessness and a willingness to contribute, albeit in more passive ways. Such pessimism about addressing global challenges is understandable but concerning. Schools play a pivotal role in countering this by empowering through curriculum (Adams, 2019; Diya & Shek, 2022). A transformative curriculum should not only deliver knowledge but also cultivate students' global citizenship, cultural awareness, empathy, dignity, and advocacy (Aydin et al., 2019).

4.5 Curricular changes and barriers

Current curricular models often fail to equip students with the confidence to act on their aspirations. In climate change education, for example, students express a desire to make a difference but report feeling unprepared to do so (Pickering et al., 2020), reflecting a persistent gap between ambition and capability. Bridging this divide necessitates participatory, student-centred pedagogies that promote engagement and self-efficacy (Fisette & Walton, 2014; Sevim, 2020; Sieg & Dreesmann, 2021; Zarate et al., 2024). As Sarrasin et al. (2022) argue, empowerment depends on students having opportunities for meaningful agency within their learning environments.

To close this gap, a shift from didactic teaching to experiential, action-oriented strategies is essential. Without such transformation, the disconnect between awareness and action endures, limiting the transformative potential of education. Yet, practical constraints, such as limited instructional time and rigid curricular demands, pose challenges. Problem-based learning (PBL) offers a viable model, enabling engagement with real-world issues while aligning with curriculum goals. However, implementation demands systemic support, including teacher training, policy alignment, and curricular restructuring (Bakthavatchaalam, 2024). Furthermore, the long-term impacts of such pedagogies remain under-examined; systematic research is needed to assess whether they foster enduring behavioural intentions and social engagement.

4.6 An emerging gender perspective

A notable and unexpected pattern that emerged from the results was the gendered nature of students' perceptions of engineering. Female students more often expressed uncertainty about their place in the field, with engineering described as "a job for men" or "too technical," reflecting enduring stereotypes. Nonetheless, a small number expressed a desire to challenge these norms. As one female student remarked,

"I want to prove that girls can be engineers too."

These reflections are consistent with the works of Bakthavatchaalam and Sa (2024), Subheesh et al. (2023), Afaal and Bakthavatchaalam(2023), and Bakthavatchaalam et al. (2020), who comment on how deep-rooted cultural beliefs and gender norms result in the shaping of female's attitudes toward engineering. The findings suggest that gendered perceptions remain embedded even within the Finnish education system, which is widely regarded as one of the most equitable globally and shows the ongoing need to address gender disparities in STEM. This raises important questions about the extent to which these attitudes reflect wider societal beliefs despite Finland's

strong performance on international gender equality indices. The findings highlight the need for more inclusive engineering education practices that actively dismantle stereotypes and promote the participation of underrepresented groups, particularly young women.

5 POLICY RECOMMENDATIONS

Education policymakers should integrate ethical and social dimensions into STEM curricula early on, enriching them as a tool for societal transformation. Teaching should move beyond content delivery to enable student agency through real-world problem-solving. To counter gender stereotypes, interventions such as inclusive pedagogy, diverse role models, and gender-sensitive language are pivotal. The growing social awareness among students reflects the strengths of the Finnish education system; however, schools must also equip students with emotional resilience and the capacity to develop technical and social solutions. Strengthened teacher training is needed to support discussions on sustainability, equity, and justice within engineering education.

6 LIMITATIONS AND FUTURE WORK

This study is limited by its focus on a single secondary school in Tampere, Finland, which may affect the transferability of findings to other cultural or educational contexts. Future research should incorporate quantitative methods to test these findings and evaluate the impact of expert interviews and reflection activities on students' confidence in driving social change. Notably, the persistence of gendered perceptions in a context of high societal gender equity warrants deeper exploration.

7 CONCLUSIONS

Despite Finland's reputation for educational equity, the findings reveal a more complex picture. Students acknowledged engineering's societal relevance, particularly in addressing global challenges, but expressed mixed emotions, ranging from hope and agency to pessimism and powerlessness. Gender stereotypes persisted, with many female students questioning their place in engineering despite evident interest and ability. These insights show the need for more inclusive pedagogies that challenge bias and ensure belonging. The study confirms the value of integrating social and ethical dimensions early in engineering education to cultivate critical, empowered, and socially responsible future engineers.

8 ACKNOWLEDGEMENTS

We would like to thank Dr. Maria Jose Sa, from the Centre for Research in Higher Education Policies, Porto, for her help in proofreading and suggesting edits.

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