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The impact of participation in technical student-run organisations on loneliness among engineering students

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ABSTRACT

Students across several countries have reported high levels of loneliness. The consequences of loneliness are severe, often linked to mental health issues such as depression, self-harm, excessive media consumption, and poor sleep quality. Engineering students involved in technical student-run organisations (TSROs) have reported that participation in these organisations positively affects their well-being. This paper adopts a mixed methods approach, combining interviews and a questionnaire to examine the effect of participation in a TSRO on perceived loneliness. The results from this study indicate that engineering students who had three key factors present in their lives experienced reduced feelings of loneliness compared to other engineering students. The influential elements were participating in a student-run organisation or a TSRO, being in a romantic relationship, and *not* living alone. The study contributes to understanding the factors influencing loneliness among engineering students and has important implications for university practice.

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Loneliness; engineering students; extracurricular activities; technical student-run organisations; impact

1. Introduction

Loneliness among students has increased in recent years (Victor and Yang 2012; Ousman and Nazir 2023). Sixty percent of Norwegian first-year students have felt lonely at times (Lervåg, Engvik, and Bergesen Dalen 2022), and there are similar numbers for students experiencing loneliness in Australia (Sawir et al. 2008), the UK (YouGov 2016), and the Netherlands (Pijpers 2017). Loneliness is a subjective feeling of social isolation or being alone despite being surrounded by other people (American Psychological Association 2020). Aspects of loneliness include a lack of intimate attachment, sadness, shame, guilt, frustration, and hopelessness (de Jong-Gierveld 1989). Loneliness is often linked to mental health issues (Cacioppo, Hawkley, and Thisted 2010) such as depression (Perlman and Peplau 1981). These mental health issues can negatively impact academic performance and increase the likelihood of students dropping out (Ousman and Nazir 2023). According to Lervåg, Engvik, and Bergesen Dalen (2022), there are no differences between engineering students and students in other professions, indicating that engineering students are just as prone to experiencing loneliness as students in general.

Approaches to reducing loneliness among engineering students include interventions to support good mental health (Tait et al. 2024). There has been a growing trend in training, relaxation methods, and mindfulness techniques (Crone et al. 2023; Martini et al. 2024; Miller and Jensen 2020). A report

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from Tekna (2022) – the largest professional association for engineers in Norway – suggests that engineering students who are part of a student-run organisation (SRO) are less lonely than those who are not. Such student-run organisations are often volunteer-based and include a broad diversity of activities and objectives. Participation in an SRO can be considered a form of extracurricular activity (ECA), but SROs may also be categorised as co-curricular activities depending on university practices. SROs often have different missions, activities, and participants. ECA can be defined as 'all activities beyond the classroom' (Stuart et al. 2011, 206), and ECA provide multiple benefits to both students and the university. ECA can foster happiness and well-being, help students cope, and develop resilience (Denovan and Macaskill 2017; Ito et al. 2017). Happiness is commonly researched using the measure *evaluative*, meaning rating one's life satisfaction (Nikolaev 2018). *Hedonic* and *eudaimonic* are also other measures that are used, the first relates to the balance between positive and negative emotions in people's everyday lives, and the second captures meaning, purpose, or accomplishment (Nikolaev 2018).

According to Buckley and Lee (2021), students believe that ECA facilitates the creation of strong social relationships, reduces stress, improves physical health, and provides new opportunities and challenges to explore. These emotional states help reduce loneliness. However, there is a lack of research on the impact of participation in ECA on loneliness among students, and a recent systematic literature review by Bork and Mondisa (2022) calls for more research on engineering students' well-being.

Nitschke (2022), a student representative in Tekna (a professional association with 10,000 scientists, engineers, and students), argues that loneliness among engineering students could be counteracted if students participate in technical student-run organisations (TSROs). TSROs are a subgroup of SROs and members are often engineering students who work on the design and manufacturing of technical solutions such as race cars, drones, satellites, etc., often for local or global competitions. Therefore, the purpose of this paper is to investigate if participation in TSROs has an impact on loneliness among engineering students in higher education. The research questions for this study are: 'Does participation in a technical student-run organization reduce experienced loneliness among engineering students?' and 'What are other factors that would impact the reduction in loneliness among engineering students?'

The present paper focuses on engineering students and TSROs as a particular type of ECA. The engineering students are enrolled in either three-year or in a five-year integrated master's program. This research is conducted using a mixed methods approach, starting with qualitative interviews followed by a questionnaire. The interview subjects were engineering students at the Norwegian university of Science and Technology (NTNU) who participate in TSROs, and the data is analyzed using the six-step thematic analysis (TA). The questionnaire is based on the findings from the qualitative study and is distributed to engineering students at NTNU. Some of these students participate in TSROs and SROs, while others do not.

2. Conceptual background

2.1. Understanding and mitigating loneliness among students

A growing number of adults experience severe loneliness (Victor and Yang 2012). Severe loneliness occurs when a person feels lonely almost all the time or most of the time. Loneliness is a subjective feeling of social isolation or being alone despite being surrounded by other people (American Psychological Association 2020). While loneliness is a known issue for elderly people, young people also present a significant risk of elevated loneliness levels (Luhmann and Hawkley 2016; Victor and Yang 2012). Particularly, young adults might experience loneliness more acutely and painfully than people of other ages (Rokach 2014). Leaving home to attend university is often characterised by an increased risk of loneliness (Vasileiou et al. 2019). Loneliness among university students appears to affect students across all degrees, impacting both domestic and international students.

There are three concepts of loneliness (de Jong-Gierveld 1989): the lack of intimate attachment resulting in feelings of abandonment, the feeling that loneliness is hopeless to cope with, and various emotional aspects such as grief, sadness, shame, guilt, frustration, and despair. Loneliness is often linked to mental health issues (Cacioppo, Hawkley, and Thisted 2010) and is associated with depression (Perlman and Peplau 1981). High blood pressure, poor sleep quality, and risks related to premature death are also effects of loneliness (Holt-Lunstad, Smith, and Bradley Layton 2010).

Ousman and Nazir (2023) state that difficulties in making new friends, moving away from home and immediate social support, and the pressure to perform well in academic tasks are the main causes of the large number of lonely university students. In one study, 19.4% of the students experienced social isolation (Ray et al. 2019), and these students had higher scores on the loneliness items on the UCLA Loneliness Scale (Russell, Peplau, and Cutrona 1980) used in the study. Students who experienced strong social support systems had family support, classmates, non-classmate friends, religious groups, or non-religious groups (Ray et al. 2019).

Loneliness can hinder academic performance, lead to lower grades, and increase the likelihood of dropping out. Identifying the type of loneliness and its causes is important to develop effective measures (Ousman and Nazir 2023, 93). McIntyre et al. (2018) identified stressors and protective factors among students attending a large university in northern England. The sample had high rates of clinically severe anxiety, depression, comorbidity, and suicidal thoughts. 'Feelings of loneliness consistently emerged as the strongest predictor of poor mental health' (McIntyre et al. 2018, 237). University friends were found to be the most important social group to protect against depression, anxiety, and paranoia. This research refers to social cure models of mental health from Cruwys et al. (2015). ' … bonds formed with fellow students at university are particularly important for maintaining mental health' (McIntyre et al. 2018, 237). The results also indicate that academic stressors expose students to high risks of mental health issues.

Loneliness is a significant indicator of the inability to meet the need for forming friendships or special relationships (Serin, Aydınoğlu, and Aysan 2010). If a person lacks the maturity to establish good social relationships or cannot find a group in which they feel secure, they are more prone to the emotional state of loneliness (Santrock 1993).

The Covid-19 pandemic and the isolation that followed made the study of loneliness among young adults more important (Besse, Whitaker, and Brannon 2022). During the Covid-19 pandemic, new precautionary measures changed how we operate our society. Among them were 'lockdowns,' and students were restricted to their homes with online education, resulting in an increased feeling of loneliness among students (Bakul and Heanoy 2022). Bakul and Heanoy (2022) conclude that the increase in students feeling severe loneliness and moderate levels of loneliness is due to the isolation and social distancing during the COVID-19 pandemic. Students also experienced anxiety due to the pandemic, which could result in prolonged loneliness and poor sleep patterns, affecting their overall well-being.

Social and emotional loneliness proved to be significant predictors of academic engagement (Hendrick, Opdenakker, and Van der Vaart 2023). Having a romantic relationship or a close relationship with family members during the Covid-19 pandemic helped against loneliness (Hendrick, Opdenakker, and Van der Vaart 2023). For many universities, it is common to host events for students and have peer mentoring activities (Fallavollita and Lyons 2023). Chadha et al. (2021) conclude that peer mentoring systems are not robust enough to effectively improve students' well-being. Besse, Whitaker, and Brannon (2022) indicate that students prefer mindfulness as a technique instead of coping behaviour and control conditions. Engineering students coped with loneliness during the Covid-19 pandemic using yoga and meditation (Beddoes and Danowitz 2021). Beddoes and Danowitz (2021) state that engineering students were lonelier compared to those in other study programs and suggest that these coping strategies could be initiated by the university.

Pijpers' study (2017) identified key factors associated with the experience of loneliness, such as homesickness, self-image, psychological problems, alcohol abuse, extraversion, and help-seeking

behaviour. Pijpers (2017) also identified factors that could decrease the likelihood of loneliness, such as being a member of a student association and joining a sports club. A lack of social activities that bring students together contributes to loneliness, and universities need to organise fun activities that provide opportunities for students to socialise and not only focus on academic tasks (Ousman and Nazir 2023).

According to Lervåg, Engvik, and Bergesen Dalen (2022), there are no significant differences in the percentages of male and female students experiencing loneliness. The report identified several factors that appeared to contribute to higher levels of loneliness, such as living alone (students aged 18–29 years). Additionally, younger students within this age group were the ones who experienced the most loneliness.

2.2. Extracurricular activities

ECA provide multiple benefits to both students and universities. Universities experience better student retention, and students gain better employability skills (Wallhead, Garn, and Vidoni 2014), motivation (Tran 2017), and engagement (Munir and Zaheer 2021) from participating in ECA. ECA are separate from the academic courses required to earn a degree. Alumni from UK-based universities have linked their self-confidence, well-being, and happiness to their university's social activities (Stuart et al. 2011). ECA allow students to build their human, cultural, and social capital (Kaufman and Gabler 2004). Students are motivated by different factors to join ECA, with prominent ones being a sense of responsibility and continuity, the spirit of challenge, and advancement (Aoyagi et al. 2020).

ECA can also provide an opportunity for students to learn a discipline in a different way. Fauchald, Aaboen, and Haneberg (2023) studied how students learn and develop from the process of applying for pre-seed grants. These grants contribute to the development of the student's new venture, in turn supporting their entrepreneurial learning. ECA can foster happiness and well-being, and help students cope and develop resilience (Denovan and Macaskill 2017; Ito et al. 2017). Students participating in ECA benefit universities as well, as these students develop an enhanced feeling of belonging to their institution, resulting in fewer students leaving their studies (Munir and Zaheer 2021).

The most common effect from the perspective of developing competencies and skills in ECA was the students' self-confidence (Buckley and Lee 2021). Participating in ECA can include managing a club or social activities, running events, and leading teams with other students. Students mentioned competencies and skills associated with teamwork, problem-solving, and communication. A clear majority of students in the study by Buckley and Lee (2021) believe that ECA facilitate the creation of strong social relationships, and they also suggest that ECA reduce stress, improve physical health, increase affinity with the institution, and provide new opportunities and challenges to explore.

Winstone et al. (2022) found that not all students benefit from participating in ECA; some students are more likely to engage in ECA than others, which could be problematic if participation leads to positive outcomes, such as a greater sense of belonging and higher well-being. ECA strengthen the sense of belonging.

Buckley and Lee (2021) state that when students participate in ECA, it enables a strong social network that offers physical and mental health benefits. In addition, participants experience opportunities and challenges that can make a significant contribution to their lives. An article written by a student representative implies that loneliness may be counteracted if engineering students participate in TSROs (Nitschke 2022). 'Campus environments also represent opportunities for students to develop meaningful social connections that are beneficial to their mental health' (McIntyre et al. 2018, 237). Universities should improve the efficacy of existing social connection programs to achieve better mental health among students. The important focus is on smaller group connections. Education for engineering students fosters skills related to cooperation, communication, and teamwork (Lappalainen 2011).

Students participating in ECA report high levels of stress, and they take many approaches to balancing their lives between academic, work, social, and family commitments (King, McQuarrie, and Brigham 2021). Friendships and relationships with fellow students are positively associated with

students' ability to deal with the stress of attending university (King, McQuarrie, and Brigham 2021). Holdsworth, Turner, and Scott-Young (2018) describe how clubs and university societies were founded to provide a sense of belonging and reduce the loneliness experienced by students.

Tait et al. (2024, 63) have identified a research gap in engineering student mental health and well-being interventions, stating, 'there is an urgent need for focused research in this area, including co-production work to identify and create interventions to support good mental health and well-being.' Bork and Mondisa (2022) also state that research on engineering students' well-being is limited and call on researchers to study and communicate best practices for all stakeholders.

Ousman and Nazir (2023) conclude in their study that if students involve themselves in ECA like clubs and organisations, this could be a vital step in addressing loneliness on university campuses. Ousman and Nazir call for more research to understand the dynamics of loneliness among this population and to develop tailored interventions that can effectively combat it.

3. Method and findings

A mixed methods approach was applied. Mixed methods integrate both quantitative and qualitative methods, with the idea that the combination provides a better understanding of research problems and complex phenomena than either methodology alone (Hurmerinta-Peltomäki and Nummela 2006). Mixed approaches in research design are essential to understand different issues within engineering education (Borrego, Douglas, and Amelink 2009).

In this study, the interviews were conducted first, followed by a questionnaire administered to a larger sample of 250 students. This approach aimed to first understand the phenomenon through in-depth interviews with eight students over several months, and then use that understanding to develop and test the hypothesis (see Figure 1). Each student was interviewed two to four times. In this method section the qualitative part of the study is described first and its findings, before detailing the methods and findings of the quantitative part.

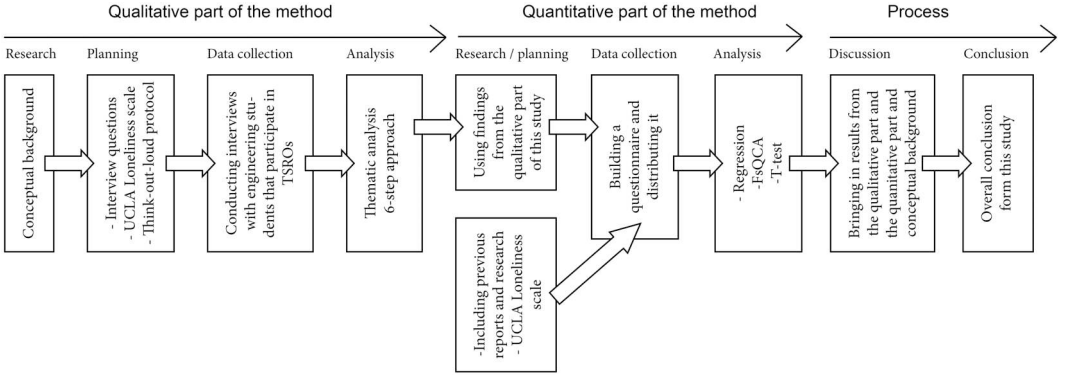

Figure 1. Overview of the process using this mixed approach.

3.1. Ethics approval

All participants agreed to the guidelines of this study and were (and still are) able to exit the study at any point and have all collected data deleted. Due to the ethical aspects of the paper, the research project was approved by the Norwegian Agency for Shared Services in Education and Research (SIKT). All research in Norway must receive approval from this council before being conducted. During the interview, the author felt prepared to emotionally deal with the sensitive topics of this study. This issue was addressed by Fenge et al. (2019). Even though the topic of loneliness is sensitive, the interviews were not of a particularly emotional character.

3.2. Method qualitative part

3.2.1. Research context

The participants in this study are all engineering students from the NTNU. The NTNU is Norway's largest university for engineering education with 43,882 students in total. Many of these are studying for a bachelor or five-year program often referred to as integrated master's in technology (e.g.: Engineering degrees are Civil Engineering, Marine Technology, Mechatronics and Product Design to mention some).

There are approximately 130 student-run organisations at the NTNU and eight of these are considered technical student-run organisations. The students have a very clear understanding of that these are, and the reason for using the term student-run is that almost all ECAs in the university (NTNU) are student initiatives and student-led, not faculty-led activities.

3.2.2. Participant selection

The participants were selected based on the following criteria: (1) they were engineering students and (2) they participated in TSRO's. The students who participated in the interviews had volunteer roles in the TSRO as leaders, sub-leaders or members and spent from five to thirty-five hours per week working in the organisation. The participant selection were in their first, second or third year of studies. They were enrolled in either a three-year bachelor's program or a five-year integrated master's program in a technical or science-based study program often leading to a career path as an engineer. The majority of the informants were male, and all the students were between the ages of 21–24 years of age. All the informants were from Norway. The target of this study is the general engineering student population.

3.2.3. Data collection

The interviews were conducted from May 2023 to February 2024, after the Covid-19 pandemic in Trondheim, Norway. Loneliness can be difficult to measure, especially by just asking participants about it in an interview. Therefore, the author included several elements in the interviews. The interviews were divided into three stages: (1) semi-structured with informal questions based on an interview guide and natural follow-up questions, (2) a think-out-loud protocol based on principles by Ericsson and Simon (1998), and (3) the UCLA Loneliness Scale (ULS) by Russell, Peplau, and Cutrona (1980). Each interview included all three parts. The think-aloud protocol and the ULS were used to gain a clearer understanding or to identify feelings that were not evident during the questions.

The think-aloud protocol and the ULS were conducted at the end of each interview, with the student receiving papers with the statements. For the think-aloud protocol, the participant was presented with a statement that they needed to decide about while sharing their reflections verbally. An example of this could be, 'I feel like a part of a friend group,' and the participant needed to rate this from 'Never,' 'Rarely,' 'Sometimes,' or 'Often.' This put the participant in a situation where they needed to simplify their experiences, and often, since they spoke out loud, they could provide an example or a reflection from their experiences that illustrated their rating.

Afterwards, a different method was applied when the participant filled in the ULS. During this part, the participant did not speak and just filled in the scale on a piece of paper in silence. They could ask questions if needed. The reason for conducting this in silence is that being lonely is a taboo topic, and it can be uncomfortable for a participant to share their true feelings on the subject in an interview setting. Filling in a scale in silence could make participants feel more comfortable about stating that they are lonely since they do not need to verbalise how they actually feel.

3.2.4. Data analysis

The interviews were conducted with one interviewer and one informant. The speech was recorded and transcribed, then subsequently coded using thematic analysis (TA) techniques. TA is an inductive

approach suitable for investigating the experiences and opinions of participants. The author followed the six-step method outlined by Braun and Clarke (2006). There is no standardised method behind TA but can be understood as an approach that have some things in common with the practices of coding and theme development (Braun and Clarke 2023). In 2023 Braun and Clarke wrote some recommendations for producing a methodically coherent TA. The next descriptions are necessary to describe how the author conducted the TA of the qualitative data. Figure 2 is the initial themes behind the analysis. Figure 3 is an overview of the thematic structure in form of a thematic map. The TA approach for this analysis is on the Big Q spectrum (Braun and Clarke 2019; Braun and Clarke 2023). During the coding of the transcribed text and while listening to the recordings, there were instances where the informants expressed more positive mentions, had a positive tone of voice or expressed something as meaningful. These were grouped under the theme 'happy.' This theme can be defined as positive emotions, purpose and accomplishment in the wider sense of happiness (Nikolaev 2018). Conversely, there were situations that evoked the opposite sentiment, resulting in students feeling 'left out.' The emotions behind the theme 'left out' can be described as a feeling of social rejection (Cheng et al. 2020). This is represented in Figure 3, which illustrates the final identified themes of the analysis. The two final themes were 'happy' and 'left out.' The data have been sorted into themes based on a topic summary approach.

Within each of these main themes, there are several items and sub-items connected to positive and negative feelings. Identifying positive themes that had a beneficial impact on the informants' mental well-being is important, as these could contribute to a reduction in loneliness levels. The themes are broad since the informants mentioned many aspects of their lives that were not directly related to participating in the TSRO. However, conducting this analysis made it easier to see both the benefits and challenges of participating in a TSRO. Some sub-items had both a positive tone of voice and a negative aspect, such as the sub-item 'conflict.'

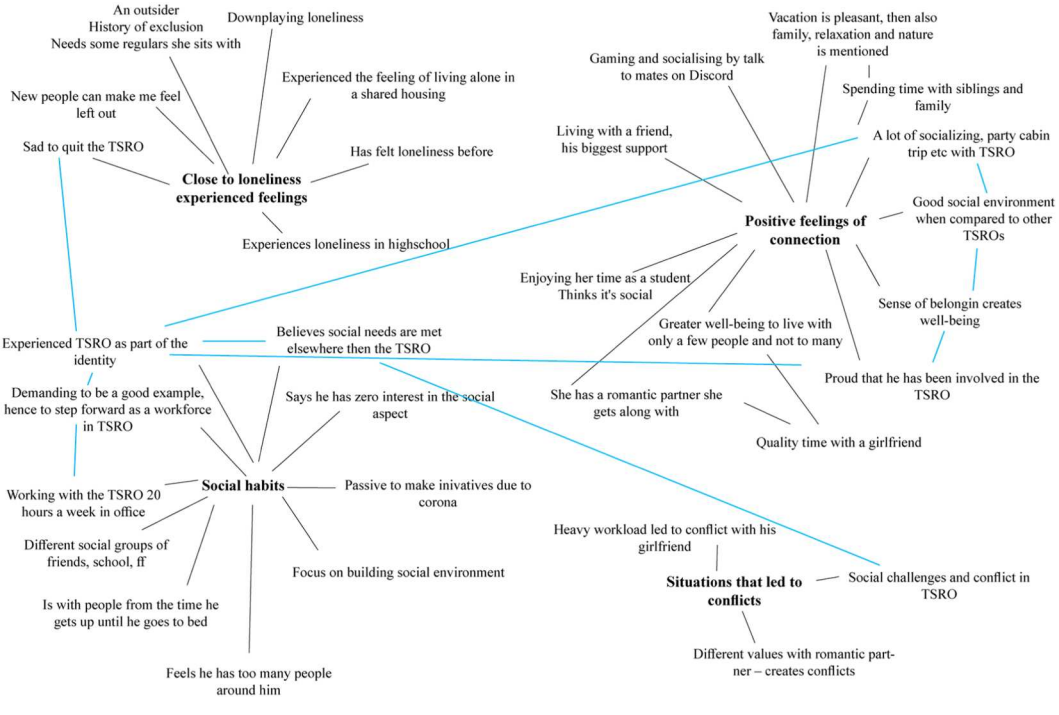

Figure 2. Initial themes of the TA method of the interview data.

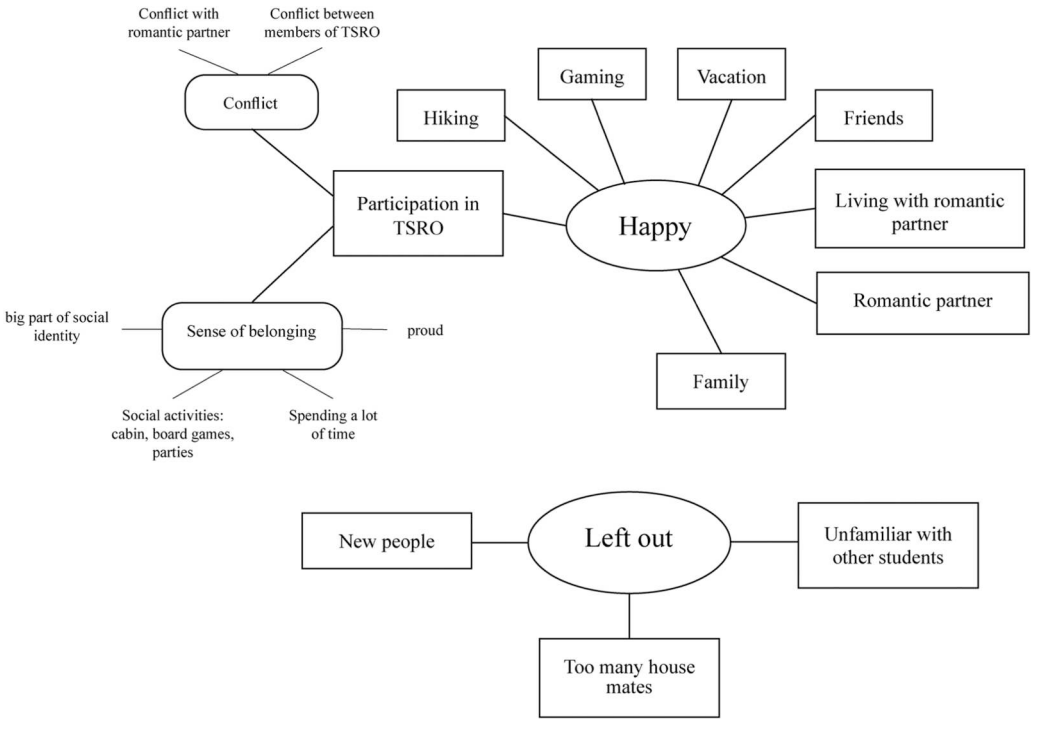

Figure 3. TA of the interview data.

The author's research values are based on the belief that practice-oriented learning is an important part of becoming a skilled engineer. The author believes that students build skills when they can learn in a community with other students through roles in student organisations, where they build both hardware and software to solve complex tasks. However, there is also the dilemma that many of these students could fall behind in their study progression and skip classes to engage in other activities where they feel more responsibility.

From the data collection the concept of member reflections as a Big Q alternative to member checking, the think-out-loud protocol and the UCLA Loneliness Scale is a way to ensure the verification of their feelings somewhat different than how this have been described in (Braun and Clarke 2023).

3.2.5. Researcher positioning

The author's research philosophy is pragmatism. Pragmatics 'recognise that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture and that there may be multiple realities' (Saunders, Lewis, and Thornhill 2012). The author's research values are based on the belief that practice-oriented learning is an important part of becoming a skilled engineer. The author believes that students build skills when they can learn in a community with other students through roles in student organisations, where they build both hardware and software to solve complex tasks. However, there is also the dilemma that many of these students could fall behind in their study progression and skip classes to engage in other activities where they feel more responsibility.

3.2.6. Strengths and limitations of method

When it comes to the measurement of experiences loneliness, especially after removing item 4 on the ULS in the analysis we do not have an item directly related with the word lonely. After the analysis of the interviews and the questionnaire the author suggest a re-phrase of item 4 and 9 in the ULS.

Based on the wording of the statements in the ULS, the author decided to also use a think-out-loud protocol to be able to re-fraise questions or other aspects that the ULS do not cover.

Based on Winstone et al. (2022) some students are more prone to engage in ECA. Therefore, the students that participate in these TSROs could also be less likely to experience loneliness just by their individual inherent attitudes. The students in this study describe how they randomly became part of the TSRO, and this could be something that challenges Winstone et al. (2022) finding.

3.3. Findings from the qualitative part

The participants in the interviews had low scores on the loneliness measures from the ULS. The scores were on average 24.4. A score of 20-30.6 indicates low levels of loneliness. From the interviews, the students expressed little or no feeling of loneliness at present. This strengthens the hypothesis that students who participate in TSROs are less lonely than other students. Three of the eight students referred to previous times they had felt lonely. They told of experiences in high school and their first years of studying during the Covid-19 pandemic lockdowns. Several of the participants said they were rarely alone and reflected that being alone and feeling lonely are two different things.

From the TA, the following themes are relevant in this data (see Figure 2: TA of the interview data): activities leading to happiness and activities leading to feeling left out. Most of the items in the theme of *happy* and *left out* could potentially resonate with other young people since they seemed generic and not only present for engineering students. There are some items that were common in the dataset for the participants in the interviews in terms of the participation in the TSRO, although there was a variance in their feelings and engagement in the TSRO. This could be impacted by their role as a leader, sub-leader, or member and therefore in relation to how much responsibility and engagement they had in the TSRO.

3.3.1. Happiness among students

For this theme, everything that was connected to a positive feeling of happiness is included. This theme is constructed of situations and elements that together supported an overall feeling to how life is going. There are eight items in this theme: *Hiking, gaming, vacation, family, friends, living with friends or romantic partner, romantic partner,* and *participation in TSRO* (not listed in prioritised order). Participation in TSRO also have sub-items; *sense of belonging* and *conflict*. Not all TSRO participation engage positive feelings.

Hiking and spending time in nature is something that makes the students happy. Not everyone mentioned this, but half of them referred to seeking out in nature when they had a lot 'on their plate'. Vacation was a common positive item to all. All of the student's felt vacation was a time to relax, be with friends and family. Three of the students that had felt a high degree of workload, looked forward to vacation and used it to not get 'overworked'. Gaming was also a social activity for four of the students. When they were gaming, they would talk to each other over Discord, most often with friends that they had known for a long time. Gaming was a good way to stay in touch and talk about positive and negative things they were experiencing in everyday life.

The students seemed to appreciate spending time with family and friends, and some of them had different friend groups in the university. One friend group for studying or class, another for hanging out or going to parties with. There was a difference in how the students talked about friends; some used the term 'friend' sparingly and often considered other people to be 'acquaintances,' maintaining some distance in their wording when referring to relationships. Someone had to be very close in order to be labelled a friend. Other students would use the term friend casually.

Romantic partner (used the terms girlfriend/boyfriend) was an item that was very interesting because it was connected to many different items. The romantic partner would appear in situations of conflict, but also seem to be something that would be a big part of their happiness. Conflict could emerge when the student spent too much time on activities related to the TSRO, and their girlfriend/boyfriend felt left out due to not being prioritised for spending time together. There is also one

example where a student (single at the time) experienced anxiety because his best friend was likely to get a girlfriend. This situation shifted rapidly when the student who had anxiety got a girlfriend (his first girlfriend) and became happier than before, with a minor reduction in loneliness levels (from the ULS). The students shared exciting plans about travelling with their romantic partners and genuinely enjoyed spending time with them.

Participation in a TSRO held both positive and negative experiences. From the positive side, there seemed to be a sense of belonging. The sense of belonging expressed itself in identity, social activities, spending a lot of time working in the TSRO and being proud of the work that was being executed by the other members of the TSRO. Key expression for identity in these interviews were 'us' and 'them, and how the students differentiated themselves from other TSROs'. They also compared themselves (the organisation) with others. They often have on t-shirts or other features displaying their identity from the TSRO. The amount of identity and ownership in the work produced by the TSRO varied. One of the participants is going on an exchange abroad and will not be part of the TSRO. The author asked how that will be for him, and he answered:

> It will be heavy. I get a little bit of a stomach ache when I am thinking I will quit in half a year. I feel a frighteningly big part of my identity is that I am the sub-leader in [name of TSRO]. And that suddenly that part will be just gone. I am going to feel like I am losing a part of myself. I think there are others who feel like this. We are the [name of TSRO]-crew. … . I will become an ordinary guy, just like everyone else.

The author asked one of the other students to describe the TSRO he was part of, and he answered:

> There are a lot of skilled people who have the potential to become really good. I think [name of the TSRO] helps people reach their potential, because now they can test it. It is a really good technical organization with great social environment. I think there is a much better social environment in [name of TSRO] than in [name of another TSRO]. In the [name of another TSRO] it is much stricter. If you do something wrong, you get to hear it. It is much more serious and rigid in the [name of another TSRO]

The TSRO is an arena for the students to experience pride over their accomplishments together. One of the leaders of a TSRO explained it took a lot of work, and he often felt like he needed to lead with being a good example and work extra hard. He thought this to be very tiring also. He described to me a key observation he had:

> When I look into the office and see how each of the groups are seated together working, but also having fun, they have become a friend group. Then I am proud of having collected a team of like-minded that truly conducts a good job too. Sometimes, I become very happy thinking that I am the one steering this 'boat'. It is a strong sense of responsibility.

There are a lot of social activities that the members in the TSRO do together, such as cabin trips, board game nights, afternoon debates with random topics, pizza fest and parties to mention some most occurring. Besides this, a lot of the members sit at the of workshop of the TSRO doing homework or other non-related TSRO work. They spend a lot of time working with the TSRO also, and this differs from 5 to 35 hours per week depending on the role in the TSRO and how the project is progressing.

> We went on a cabin trip on Friday, not all of us (he was referring to the TSRO). We were 30. We partied and played boardgames in the evenings. It was very, very fun.

Being part of the TSRO could also place them in a position of potential conflicts. Especially the leaders had to handle and make decisions that were necessary, but that some of the members felt were unfair, not correct or had other objections against.

3.3.2. Left out

For this theme, everything that the students mentioned made them feel left out is included. There were not any present stories that the author could connect directly with a loneliness theme. There are three items in this theme: situations with new people, too many housemates, and not knowing

other students in the lecture. In general, the participants in the interviews were a seeming happy bunch.

Several of the participants could not say that they never felt out in a social setting. Most of them felt rarely to often that they struggled a bit to connect with new people. One of the participants said:

> It is rarely I feel left out in social settings. I think I'm a bit bad when it comes to new people. It's always been like that, but I become better in time.

Two of the students lived with 10–15 other students in the same house/apartment. This was not so pleasant, since they felt they didn't know the others so well. One of the students said:

> I moved to a new city and was going to live in a flat with ten other people. Everything else was also new.

This student expressed that she was not so happy living with that many people, and she struggled to form any connections and good relationships with her flat mates. Next semester, when the author interviewed her again, she was happy that her living situation had changed:

> I currently live with two people, they both study construction. I didn't know them from before, but they are very nice, and we kind of do similar studies. I am happy, and It's very close to campus.

She later tells stories about how they made her a birthday cake and celebrated her birthday. It was a positive change for her moving from ten to two flatmates.

Not knowing other students in the lecture could be extremely important if students attend classes at campus. The students expressed how they had friends in class that they liked to relax and talk to during the breaks. One student shared how she did not go to class on a rainy day because she didn't know any students attending the lecture.

3.3.3. Interviews results summary

The students participating in the TSROs had a low score of 24.4 on the ULS. Neither during the questions or the think-out-loud protocol they expressed feelings of loneliness. Overall, the participants did not seem lonely. It is not clear to say that the low loneliness levels are due to participation in a TSROs or other impact factors in their lives. The other factors that led to the students' happiness were hiking, gaming, vacation, family, friends, romantic partner, living with friends or romantic partner, and participation in TSRO. Items that were connected to the students feeling left out were new people, too many housemates and unfamiliar with other students. The participation the TSRO led to a sense of belonging, but also to conflict. Students participating in the TSRO became proud of their common team efforts; participation became a big part of their identity. They joined many social activities and overall spent a lot of time in the TSRO and with TSRO members.

3.4. Method of quantitative part

The analysis of the qualitative data was followed by a questionnaire to engineering students at the NTNU with 104 respondents. This was to understand if a larger sample could indicate that students participating in TSROs had lower experiences of loneliness and thus participating in TSROs could reduce the impact on engineering students' feelings of loneliness.

For the quantitative part, the ULS was used similarly to the interviews, and the think-out-loud protocol was not continued. It was important to keep the questionnaire short enough in order to get as many responses as possible. Additionally, the author added other factors that showed to be of great importance after analyzing the qualitative data. These were; if they lived with someone or alone, were in a romantic relationship, and if they participated in a TSRO. Other things that were of importance were if they participated in an SRO (maybe there were different impacts of TSROs and SROs), and if they were engineering students or not. The author chose not to add factors such as family,

friends, gaming, and vacation since they were interesting findings in the qualitative part, but the author couldn't see the relation to the aim of this study.

3.4.1. Sample

The questionnaire was distributed in January and February in Norway directly to students in TSROs and in some of the larger classes for engineering students at [removed due to anonymous manuscript]. The questionnaire was distributed to 250 engineering students. The students who responded were a mix of first, second, and third-year students enrolled in a three or five-year engineering study program. 59% of the respondents did not participate in a TSRO. The students who participated in the study were from a diverse mix of engineering study programs, representing various disciplines and academic years.

3.4.2. Measures

The questionnaire was primarily composed of the full UCLA Loneliness Scale (ULS) (see Russell, Peplau, and Cutrona 1980), mainly in a Norwegian translation with the original English text included below the translation. Additionally, the questionnaire included items that were important from the qualitative part of this study and findings from the Lervåg, Engvik, and Bergesen Dalen (2022) report. See Table 1: Categories in the Questionnaire for an overview of what the students could select.

From the qualitative part of this study, many students had a romantic partner or were living with one, and these students generally seemed very happy. According to the Lervåg, Engvik, and Bergesen Dalen (2022) report, full-time students living alone were most vulnerable to experiencing loneliness. Therefore, the authors added categories that could be interesting in relation to these topics: having a boyfriend/girlfriend, living alone, sharing housing, or living with a girlfriend/boyfriend.

Due to the context, only domestic students responded, which is why no section for international students is included. One of the goals when distributing the questionnaire was to ensure that potential respondents found the survey short and not very time-consuming. This strategy aimed to maximise the number of respondents. The students have a clear understanding of what it means to be in either a student-run organisation or in a technical student-run organisation.

This study is relying on the ULS (Russell, Peplau, and Cutrona 1980) for measuring loneliness. The scale gave the opportunity to compare loneliness levels between groups. The ULS gives each participant a score between 20-80, and the loneliness score is calculated as the sum of the scores for each item. See Table 2 for rates. The following rates are adjusted as item 4 and 9 in the scale were not aligning with other answers (both from interviews and questionnaire). Respondents in the survey ranged from 20–72 in levels of loneliness with a median of 34. The standard deviation is high (10.887).

After initial analysis there are three factors that are interesting when combined with the loneliness levels. These factors are: Participating in an SRO or TSRO, living alone and having a romantic relationship (see Table 3).

Table 1. Categories in the questionnaire.

Which of the following statements fit you?
Study a three or five-years engineering degree at NTNU
I study in Trondheim
I am part of a technical student organisation
I am part of a student organisation
I don't study engineering
I live alone
I live in a shared housing
I have a girlfriend/boyfriend
I live with my girlfriend/boyfriend

Table 2. Rates for measuring loneliness.

Loneliness rates from Russell, Peplau, and Cutrona (1980) UCLA Loneliness Scale (adjusted).	
Low levels of loneliness	20–30.6
Low to medium levels of loneliness	30.6–45
Medium to high levels of loneliness	45–58.5
High levels of loneliness	58.5–72

Table 3. Descriptive statistics.

Variable	Mean	SD	Median	Min	Max
Loneliness score	35.951	10.887	34	20	72
Participating in student-run organisation or a technical student-run organisation (1 = yes)	0.576	0.496	–	0	1
Living alone (1 = yes)	0.201	0.403	–	0	1
Having a romantic relationship (1 = yes)	0.471	0.501	–	0	1

3.4.3. Data analysis

The quantitative data was analyzed using three approaches; regression analysis, fuzzy-set qualitative comparative analysis (fsQCA) and t-test statistics. The questionnaire received 104 complete responses. FsQCA is a set-theoretical approach that, unlike more traditional statistical methods such as multivariate regression, allows for investigating how combinations of several factors may explain an outcome (Schneider and Wagemann 2006). Thus, the data analysis is strengthened by using three approaches to assess the propositions from the qualitative part of this study.

Quantitative analyses were conducted using STATA/MP version 17.0 and fsQCA using the package 'fuzzy' by Longest and Vaisey in STATA/MP (Longest and Vaisey 2008). A significance threshold of $p < 0.05$ was set for all analyses.

The regression analyzes how factors such as if students participate in SRO or TSRO, live alone and have a romantic relationship impacts their loneliness level. These factors are independent, so the fsQCA is way to look how they together impact the loneliness levels. Variables to be included in fsQCA should have a value between 0 and 1, were 0 represents 'full non-membership' of a certain condition, such as the absence of a romantic relationship, and 1 represents 'full membership' of a certain condition, such as the presence of a romantic relationship. Preparation of the dataset through data calibration is therefore necessary, and we used the direct approach proposed by Ragin (2006) guided by the theoretical values defined for the ULS. Thus, the crossover point was set to 45, which is the value between 'low to medium' and 'medium to high' levels of loneliness. Followingly, full non-membership was set to 30.6 and full membership to 58.5. The other variables were dichotomous and thus did not require calibration.

3.4.4. Strengths and limitations of method

In terms of limitations the respondents are all living in Norway. The narrow selection could have an impact on the results, especially looking at the findings of previous similar studies form other countries that have different results. The number of respondents of the questionnaire is quite low (104 of 250), and a higher number of respondents would strengthen the study. It could also be a strength to have respondents from other geographic areas to look for a general answer to the research question. At the same time, it is also a strength to be able to clearly point out important impact factors for a specific group.

Other weaknesses to the quantitative part of this study are the exclusion of age, year of study, study program and gender. What we know is a more generic overview that these students are between 19–24 years of age and in their first, second or third year of studying a engineering degree of either three or five years. They are enrolled in a variety of study programs.

3.5. Findings from the quantitative study

Results from linear regression analysis are presented in Table 4. Living alone is the only variable significantly increasing the loneliness levels (β = 0.2324, $p = 0.019$). Neither a romantic relationship nor participation in a TSRO or SRO significantly influences loneliness. Several analyses were conducted on the participation in TSRO and the ULS scores, and the results showed that TSROs did not have a significant impact, with a relatively large standard deviation. R^2 is 0.102, which indicate these factors have a relatively low explanatory value, which is expected since many factors beyond the scope of this study may also influence loneliness.

Table 4. Regression analysis. Standardised regression coefficients.

Independent variables	Dependent variable: Loneliness score
Participating in TSRO & SRO (1 = yes)	−0.1459 (2.127)
Living alone (1 = yes)	0.2324* (2.625)
Having a romantic relationship (1 = yes)	−0.1290 (2.122)
Adjusted R^2	0.1019
Sample size (N)	104

Through the fsQCA, there was a combination of factors – a set – that explained the absence of loneliness, and no combination explaining the presence of loneliness. The fsQCA results are shown in Table 5. To obtain this reduction of loneliness levels the combination of the three factors: Not living alone, having a romantic relationship, and participating in SRO or TSRO. Solution consistency is high, well above the suggested threshold value of 0.8 (Ragin 2006).

Table 5. Results from fsQCA (R.cov = raw coverage, U.cov = unique coverage, S.con = solution consistency).

Set	Living alone	Having a romantic relationship	Participating in SRO	Loneliness	R.cov	U.cov	S.con
1	0	1	1	0	0.363	0.363	0.871

The t-test was conducted to investigate if there is a significant difference in loneliness between the respondents fitting into Set 1 and the other respondents (that is, not fitting into Set 1). According to Levens test, a t-test is appropriate. The t-test results are provided in Table 6. Participants in Set 1 have a lower (diff = 6.80) and statistically significant ($p = 0.0026$) average loneliness score than the other respondents.

Table 6. T-test (Std. Dev = standard deviation, Diff = difference).

Group	Respondents	Mean	Std. Dev.
Set 1	33	31.303	8.282
Not set 1	71	38.112	11.319
		Diff = 6.80	

The element that influenced loneliness the most in this study is whether students live alone. Students who lived alone had significantly higher loneliness levels. Living together with someone (whether friends or a girlfriend/boyfriend) reduces loneliness levels. Living alone is the item that's correlating with loneliness the most (see Table 4). Participating in a TSRO or an SRO does not have a significant impact on loneliness. With this method, there is no evidence that being in a TSRO or SRO is enough to impact the loneliness levels of engineering students. On the other hand, there was a key finding in the analysis. The best measure to reduce high loneliness levels is to combine not living alone, being in a romantic relationship, and participating in an SRO or TSRO. This combination resulted in a reduction of 7 points in the ULS score of the participants.

3.6. Summary from results both the qualitative and quantitative results

The results from this study show that engineering students who participate in TSROs experience a sense of belonging that brings several benefits to their well-being and happiness. However, participating in a TSRO alone does not explain reduced feelings of loneliness.

From the qualitative part of this study, we found that participating in a TSRO, as well as other factors such as friends and family, romantic relationships, vacations, gaming, and hiking, affects students' overall well-being.

From the qualitative part of this study, being part of a TSRO alone is not enough to significantly reduce loneliness. However, students who did not live alone, were in a romantic relationship, and participated in a TSRO or SRO had the lowest experiences of loneliness.

This paper contributes to the understanding of how ECA, particularly participation in technical student-run organisations, impacts loneliness in engineering students. It also highlights that other factors are important in reducing loneliness among engineering students.

4. Discussion

The research questions for this study are 'Does participation in a technical student-run organisation reduce experienced loneliness amongst engineering students? And 'What are other factors that would impact the reduction in loneliness amongst engineering students?'

Similarly to Victor and Yang (2012) and Ousman and Nazir (2023) there have been accounted an increase in lonely students in Norway (Lervåg, Engvik, and Bergesen Dalen 2022) and several other countries (Sawir et al. 2008; YouGov 2016; Pijpers 2017). The students from this study did not have high loneliness levels, and especially the ULS scores from the interview data gave the impression of low levels of loneliness. These engineering students were all participating in TSROs but had also other items that had an impact on their happiness. From the interview data it was possible to believe TSRO could be a cause that reduced loneliness levels. The students didn't not express any struggles of intimate attachment, sadness, frustration and hopelessness during the interview those emotions or feelings could be connected to loneliness (de Jong-Gierveld 1989). These students were a mix between first to third year students and it was not any negative emotions connected to leaving home to attend university. Leaving home could increase the risk of loneliness (Vasileiou et al. 2019). There was no data from the interviews that indicate that the participants were considering dropping out or expressed struggling with sleep, alcohol, they were not overweight, and did not have any other signs or symptoms that are often related to loneliness (Perlman and Peplau 1981; Cacioppo, Hawkley, and Thisted 2010; McIntyre et al. 2018).

From the data from the interview, it is clear that the students experienced low levels of loneliness. Because of the method and not having any data for comparison with a group that was not part of a TSRO or SRO, the hypothesis *that students participating in TSROs experience less loneliness* was tested in a questionnaire with 104 respondents. After running analysis on the results from the questionnaire there was not a significant correlation between being part of a TSRO and reduced loneliness levels in engineering students.

On the other hand, there is results from the data showing a combination of three variables are important to reduce loneliness. If students are seeking to reduce loneliness, it is suggested from these results that living with others is a helpful starting point, along with active participation in student societies and nurturing close relationships. Students living with other people have a lower feeling of loneliness.

To answer the first research question in this study, *if students participating in TSROs are less lonely*, the answer is yes but only if it is accompanied by two factors (a romantic partner and living with others. It does not matter if the student is participating in a TSRO or a SRO). Nitschke (2022) proposed that engineering students that participate in TSRO would be less lonely, based on his own experience being an engineering student. Although my findings are not so strong as Nitschke implies

them to be, TSROs have an impact when combined with other things. It also seems the TSRO is an arena were students can form bonds with fellow students. McIntyre et al. (2018) states that bonds created with fellow students are particularly important for maintaining good mental health. The leaders and sub-leaders must both handle conflict but also celebrations and milestones with their co-members. In addition, the students of the TSRO spend a lot of time together.

From Pijpers (2017) research she found that students that were a member of a student association or sports club had a decreased likelihood of loneliness. From her research variables such as age, gender, and if they lived alone or with others were not significantly associated with loneliness. This is in contrast to the findings were living alone had the biggest impact on higher loneliness levels in the quantitative part of the study. There could be several answers to this, different research design and different cultures. Her studies were done 5 years earlier, and before the Covid-19 pandemic, this might also have an impact. During and after the Covid-19 pandemic there was an increase in loneliness in students from the social isolation that was due to the restrictions and 'lock downs' (Bakul and Heanoy 2022). The participants in the interview shared how they experienced this time both as pupils in high school and first-year students at the university. This was a lonely time for some of them, and several shared how they coped during this time in their life. All the students preferred that society opened up, and they could 'do things' again.

For the measurement of loneliness in this study, the author has used the ULS (Russell, Peplau, and Cutrona 1980). The ULS has a lot of measurements connected to social isolation. The author had to remove items og 4 and 9 which are key to measure loneliness since one of them are directly stating 'I am not lonely'. The author had to remove these items since the students misinterpreted it since it was a double negative. Although the ULS has many measures connected to social isolation, this does not necessarily have to be negative in this study. Ray et al. (2019) found that students experiencing social isolation also have a higher score of loneliness. Since loneliness is a subjective feeling (American Psychological Association 2020) it is hard to measure.

Even though we cannot say that participation in a TSRO alone is a factor that could reduce loneliness levels in engineering students, it had an impact when combined with other factors. It is still interesting to understand what it is about the TSRO and what other potential factors could reduce the loneliness amongst engineering students.

In a study by Winstone et al. (2022), ECA led to a sense of belonging, and this is one of the main findings of my analysis. One of the two items connected to participating in a TSRO was 'sense of belonging', the other being 'conflict'. The conflicts could be of a negative sort, but it could also have positive outcomes. The students handling conflicts together are part of a bonding experience, and they need to go through a stressful time and resort to a solution together, which they execute. From the analysis there were also other activities that led to a sense of belonging, such as spending time together, doing activities (e.g. party, cabin trip, boardgames) and the participation led to a identity connected to the TSRO. An SRO is in many ways similar to a TSRO. What often separate a TSRO from a general SRO is the technical dept of the TSROs project and how long time the TSROs work on their projects (from 1–3 years). There could be many potential similar outcomes from being part of a SRO.

Tait et al. (2024) state that engineering students are less likely to seek help if they are lonely or struggling. This research could have practical impact for student housing and university supporting students to join TSROs and SRO. If we want to reduce loneliness in this student group, students should not live alone. Maybe living with too many is a negative thing too. From the interviews it seems it could be hard to make connections with fellow students when 'too many' students were living together. The university could also take a stand and support the students in the creation of SROs and for resources needed.

The results also concluded being in a romantic relationship has an impact on the reduced loneliness levels. Activities that enable more opportunities for social connection will enable closer relationships to develop. From a university perspective, it's important to have students with mental well-being to retain them through their studies. Students with low well-being and that are

experiencing higher levels of loneliness have bigger chance of dropping out (Ali and Kohun 2007; Kelly et al. 2007; Ousman and Nazir 2023).

This paper contributes to the literature of extra-curricular activities and well-being in engineering students. More exactly technical student-run organisations and student-run organisations and their impact on engineering students' loneliness levels. This paper presents factors leading to happiness in engineering students, and analyses what factors have an impact on the reduction of loneliness levels in engineering students.

4.1. Further research

This study looks at a few impact factors on engineering students' loneliness, and the study could be used as a background to go even further into this work on ECA but also including gender, international students, socio-economic backgrounds and other mental health issues. Other topics of interest in engineering's students' participation in TSROs and SROs are learning processes and outcomes.

5. Conclusion

The findings from this study indicate that engineering students who participate in a technical student-run organisation (TSRO) experience several positive effects, such as a sense of belonging and the creation of important bonds with other students. Students in TSROs spend a lot of time together in workshops and engage in social activities like cabin trips and board game nights. The TSRO becomes a significant part of their identity, and they take pride in their team's work and their fellow students' achievements.

Students who participated in TSROs reported low levels of loneliness according to the UCLA Loneliness Scale. However, other factors also influenced their happiness, such as having a romantic partner, living with friends, enjoying vacations, and seeing family.

The engineering students who experienced the lowest levels of loneliness were those who: (1) participated in a TSRO or a student-run organisation (SRO), (2) were in a romantic relationship, and (3) did not live alone. Although these combined factors had the strongest impact on reducing loneliness, the most important factor was living with other people, whether in shared housing, with friends, or with a romantic partner. There was no difference in the impact between participating in a TSRO or an SRO.

From this, we can conclude that for this group of engineering students, the best combination to reduce loneliness was participating in a student-run organisation or a TSRO, being in a romantic relationship, and *not* living alone. The findings from this study may not be representative of other countries with different cultures and lifestyles. Previous research has shown similar studies with contradictory findings, which might be due to differences in lifestyle and culture where the studies were conducted. This study was conducted in Norway.

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No potential conflict of interest was reported by the author(s).

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