Managing and funding the innovative path: a close look at the SimLE scientific club at Gdańsk University of Technology, Poland

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ABSTRACT: This article presents a case study of the simply learn experience (SimLE) scientific club at Gdańsk University of Technology (Gdańsk Tech), Gdańsk, Poland, showcasing an effective model for blending theoretical knowledge with practical engineering applications. This student-led organisation aims to develop soft skills and hands-on experience through project work, participation in international contests and conferences. This study examines the funding mechanisms, educational impacts and management strategies of competitive achievements within SimLE. The results show that the level of financial support moderately affects the output of academic publications. However, this support is crucial for enhancing international visibility and facilitating participation in academic conferences. Also, it directly correlates with students' engagement. Importantly, the research reveals that variations in scientific output are more closely associated with the composition of teams and management approaches rather than the extent of financial backing.

Keywords: Scientific circle, student's engagement, financing student's science activities

INTRODUCTION

In the pursuit of academic excellence and innovation, the simply learn experience (SimLE) scientific club at Gdańsk University of Technology (GdańskTech), Gdańsk, Poland, has emerged as a bridge between academic knowledge and practical application. Established in 2013, SimLE was created in response to the industry's demand for graduates who are not just theoretically knowledgeable but also skilled in applying what they have learned. The scientific club is a place where creative ideas and engineering come together, blending theory with hands-on experience.

The initiative of the science club was not just to instruct, but to actively engage students in meaningful projects [1][2]. Its aim was to educate and empower simultaneously. It is rooted in the philosophy that practical engineering tasks, from conception through execution and implementation, offer the most effective way to prepare students for their future careers, be it in the professional sphere or academia [3].

As scientific club members actively seek and analyse information, collaborate to explore various perspectives, and apply critical thinking to navigate complex challenges, they dive into research and inquiry, embodying the problem-based learning (PBL) ethos of self-directed learning [4-6]. This hands-on approach not only deepens their understanding of the subject matter but also sharpens skills like teamwork, communication and problem-solving.

In this article, the authors scrutinise the SimLE model with a particular focus on its financial management against the backdrop of SimLE's project outcomes. It explores how financial management correlates to the scientific club's success in publishing papers, enabling student international travel and participation in global conferences. It is hypothesised that the financial resources allocated to SimLE translate into an increase in its quality indicators. Drawing from a literature review [7][8], it is anticipated that heightened investments in the scientific club's projects will enhance its outcomes. To investigate this, the club's financial inflow and its impact on academic productivity is investigated.

METHODS

Assessing the quality of SimLE's actions one should take into consideration members' engagement and self-development [9][10], collaboration [11], resource management, academic excellence [12] and governance. Each of these aspects can serve as a benchmark for evaluating the performance and achievements of the scientific club. Of the utmost

importance is students' engagement [13-15]. Active involvement and the commitment level of members directly translate to the outcomes of projects and, indirectly, to the willingness of new students to join the scientific club. Therefore, the authors propose that an increase in the number of active members in SimLE could serve as an indicator of student engagement. Additionally, a direct indicator of students' engagement is the volume of messages in the messenger used for communication among SimLE members. To a certain extent, this will also reflect the collaboration, which can be categorised as intrinsic (among students within a project) and extrinsic (among students from different projects, between students and their supervisors, and between students and industry). If the communication platform is exclusive to members, the volume of messages may only provide insights into the collaboration among students within a project and those from different projects. Hence, it should be considered a measure of intrinsic collaboration only.

Placing an emphasis on self-development within a student organisation can be observed through some key activities. This may include travelling abroad as part of the scientific club's activities. Such involvement offers students unique exposure to different cultures, educational systems and professional practices. It broadens their perspectives and enhances their adaptability and cultural competence.

Lastly, for many students, travelling abroad can be a transformative experience, pushing them out of their comfort zones and enabling personal growth. For this reason, the authors propose that the number of students travelling abroad within the framework of the scientific club's activities is considered one of the indicators of the organisation's quality. Furthermore, the inclusion of the number of students travelling abroad for the first time as part of the scientific club's activities should provide an even more precise estimation of this quality.

Both, the number of international conferences scientific club students have attended, and the number of competitions in which students have participated reflect as well the opportunities for self-development. International conferences and competitions offer a platform for students to directly engage with the global academic community, presenting their research, exchanging ideas and learning about the latest advancements. They also provide invaluable networking opportunities, enabling students to connect with peers, academics and professionals. Participation in such events extends beyond the realm of academic achievement - it challenges students to interact with the global scientific community, share their work, exchange ideas and understand diverse perspectives. These experiences enhance their communication skills, promote critical thinking and foster collaboration. Consequently, tracking attendance at international conferences and participation in competitions underscores the organisation's commitment to nurturing competent, well-developed students.

The act of publishing is emblematic of academic maturity as it involves students in a rigorous cycle of research, writing and peer review. Tracking the number of scientific papers published by members of a scientific club as authors or co-authors, particularly those that are related to projects undertaken within the scientific club, is crucial for emphasising an organisation's dedication to academic excellence. Publications in conference materials and scientific journals not only serve as a tangible output of the research conducted but also contribute significantly to the scholarly community by advancing knowledge in specific fields. This measure acts as a clear indicator of the club's active participation in the academic discourse, demonstrating its commitment to deliver original research and innovative ideas.

Based on the above, a set of success indicators for an organisation like the scientific club has been defined as the number of:

- students actively involved in scientific club activities;
- messages in the communication systems used for communication among scientific club members;
- students travelling abroad within the framework of scientific club activities;
- international conferences scientific club members attend;
- competitions in which scientific club members participate;
- scientific papers published by scientific club members as authors or co-authors, which relate to work done within the scope of scientific club projects;
- students travelling abroad for the first time as part of scientific club activities.

RESULTS

The analysis of collected data includes SimLE annual financial reports, merit reports presented annually to the university authorities, records from conferences and competitions, as well as data from SimLE communication systems (Table 1). The analysis covers the period from 2016 to 2023. Specific parameters analysed include the budget for all the SimLE students' trips, ministry grants received and their purpose, the number of SimLE communication systems messages, the number of SimLE members, the number of foreign trips (workshop, visit to a foreign university, etc) in which SimLE students participated, the number of international competitions attended by SimLE students, the number of international conferences in which SimLE students participated, the number of SimLE members travelling for conferences, competitions, seminars, workshops, etc, the number of SimLE students travelling abroad for the first time as part of SimLE activities, and the number of scientific papers published by SimLE members as authors or co-authors, which relate to work done within the scope of SimLE projects. Based on those parameters, a detailed analysis will be conducted to assess the quality of activities and verify the hypothesis that increased investments in the scientific club enhance its outcomes.

Table 1: Data reflecting SimLE scientific activities in the period from 2016 to 2023.

Year	2016	2017	2018	2019	2020	2021	2022	2023	*p*-value
Budget for all the trips in a given year (USD)	0.00	503.78	4,735.52	8,816.12	0.00	45,113.35	52,644.84	127,128.97	0.007
Ministry grants received (USD)	0.00	0.00	0.00	0.00	54,659.95	51,385.39	44,332.49	127,380.86	0.023
Number of messages in the messenger	0	0	0	0	767	2318	5787	18016	0.001
Number of members	51	50	52	47	47	62	104	162	0.001
Number of foreign trips (workshop, student exchange, visit to a foreign university, etc)	0	1	3	6	0	3	4	5	0.491
Number of international competitions	0	0	0	0	0	1	1	2	0.004
Number of international conferences	0	1	1	4	0	1	3	1	0.045
Number of members going abroad for conferences, competitions, seminars, workshops, etc	0	5	9	17	0	26	31	52	0.298
Average cost of a trip for one person to a competition/conference, etc (USD)	0.00	100.76	526.17	518.60	0.00	1,735.13	1,698.22	2,444.79	0.097
Number of members going abroad and representing representing SimLE for the first time	0	2	2	7	0	17	16	39	0.026
Percentage of people going for the first time to a conference/competition (%)	0.0	40.0	22.2	41.2	0.0	65.4	51.6	75.0	-
Number of papers published	0	0	2	4	3	5	7	3	0.72

Historical values of the budget for all the trips in a given year, as well as ministry grants received have been adjusted to account for year-on-year inflation, resulting in figures for the periods before 2023 being higher than their actual past values due to the positive inflation rates. According to data from the European Central Bank, inflation in the Eurozone increased by 1.9% in 2018, 2.3% in 2019, 0.7% in 2020, 2.2% in 2021, 5.1% in 2022 and 5.7% in 2023, as indicated by the European Central Bank's Harmonized Index of Consumer Prices (HICP) [16]. Therefore, the budget for all trips in a given year and ministry grants received have been adjusted to account for the inflation rates mentioned above. Moreover, these values were converted from PLN to USD, considering the exchange rate at 3.97 PLN/USD [17].

First, the datasets are tested for the distribution. For small sample datasets, non-normality is less likely to be detected, therefore the Shapiro-Wilk test is preferred as it is generally more sensitive than skewness or kurtosis tests. The null hypothesis for the test of normality: the data are normally distributed. If the *p*-value is under 0.05, the null hypothesis is rejected and there is significant evidence of non-normal data. For each row in Table 1, the *p*-value is calculated and presented in the last column. For example, the Shapiro-Wilk test in regard to the budget for all the trips in a given year gives *p*-value = 0.007 as shown in Table 1. Since the *p*-value is less than 0.05, the data do not appear to be normally distributed.

The Spearman correlation coefficient, which is based on ranks, is calculated for all the relationships, where at least one dataset is non-normally distributed. This tool is particularly suitable for assessing correlation in this case because some data do not have a normal distribution and some datasets include zero-values. Moreover, this method is less sensitive to outliers, which are present in the dataset due to its coverage of the activities during the Covid-19 pandemic period. Travel restrictions, as well as the lack of possibility to meet in person on the university premises in 2020, significantly influenced some of the analysed numbers necessitating use of other tools than e.g. the Pearson coefficient.

DISCUSSION

First, the relationship between the budget for all the trips completed by SimLE members within a given year and the number of members during that same year is analysed in respect to the budget for all the trips completed by SimLE members within a given year and the number of members in the following year. In the first dataset, a Spearman's correlation coefficient rho = 0.76 with a *p*-value of 0.027 indicates a strong positive correlation between the budget for of all students' trips and the number of students in the same year. This suggests that as the total expenditure on student trips increases, the number of students also tends to increase, indicating a probable relationship, where higher investment in student trips is associated with higher student participation or enrolment in that particular year.

The statistical significance of this relationship is confirmed by the *p*-value, which is less than 0.05, suggesting that the observed correlation is unlikely to have occurred by chance. Conversely, the second dataset, characterised by a Spearman's correlation coefficient rho = 0.38 and a *p*-value of 0.39, presents a weaker and non-significant correlation between the budget for all students' trips within a given year and the number of students in the following year. The correlation coefficient indicates a mild positive relationship. However, the high *p*-value suggests that this correlation is not statistically significant, implying that any observed association could be due to random variation rather than a true relationship. This lack of significant correlation might indicate that the total expenditure on student trips in a given year does not have a clear influence on the student numbers in the following year or that any potential influence is obscured by other factors not accounted for in this analysis.

The analysis of the dataset encompassing the budget allocated for all trips as a dependent variable and the funding received from the Ministry (independent variable) results in rho = 0.44 and a *p*-value of 0.275 (Figure 1, left). This indicates a moderate positive correlation between the trip budget and ministry funding, where an increase in ministry funding is associated with an increase in the budget for trips. The relatively high *p*-value does not meet the

conventional threshold for statistical significance, suggesting that the observed correlation might not reliably represent a genuine relationship in the population from which the data were drawn, casting doubt on the direct correlation of the ministry funding and the trip budget based on this dataset alone. A visual representation of both datasets on a time scale (Figure 1, right) gives a hint of what might have caused a relatively low correlation coefficient.

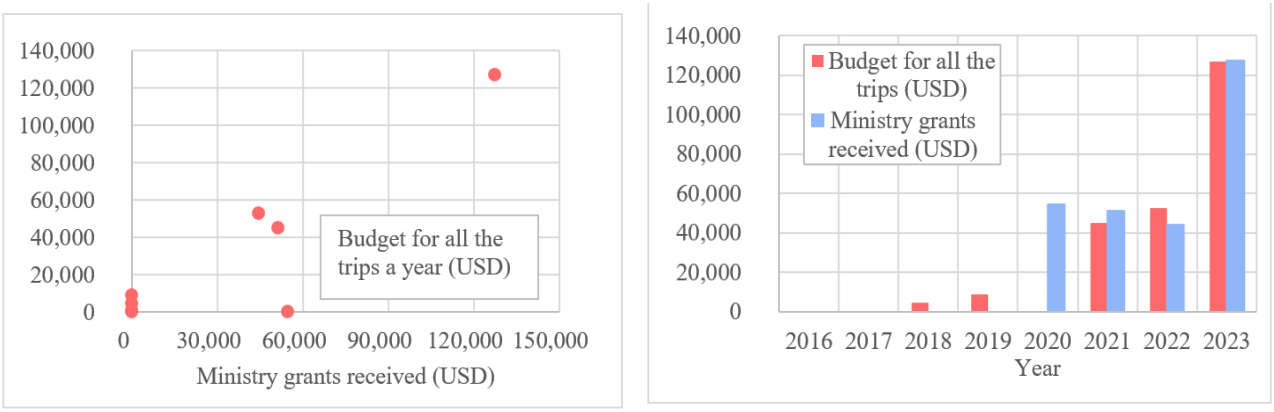

Figure 1: Relation between the ministry grants received and the budget for all the trips a year (left), and the budget of all the trips against the ministry grants received over the years 2016 to 2023 (right).

All the budget allocated for trips was entirely suspended in 2020 due to Covid-19. In the meantime, the Ministry provided financial support that year. If the financial support for that year was zeroed or the budget allocated for all trips in 2020 only was adjusted to the adequate level of the ministry funding (e.g. 50,000), then Spearman's correlation coefficient would rise to approx. 0.87, with a *p*-value of approx. 0.01, indicating a very robust dependency. In that case, such a strong and significant correlation would imply that the ministry funding plays a critical role in determining the budgeting and planning for trips, suggesting that any changes in funding policies by the Ministry could directly influence the feasibility and scale of trip planning within the observed period. In fact, the ministry grants were almost entirely allocated for students' travel activities, with only 15% of these funds (on average) allowed to be used for other purposes. This explains the strong relationship between the funds obtained from the Ministry and those allocated for trips. An exception is the year 2020, during which no trips were undertaken due to the Covid-19 pandemic.

The number of members travelling abroad for conferences, competitions, seminars, workshops and similar activities has shown an upward trend year over year, reaching a peak of 52 individuals in 2023 (Figure 2, left). Cumulatively, over the span of eight years, these activities have facilitated international travel experiences for a total of 140 individuals. When correlating the budget for all the trips with the number of members going abroad for conferences, competitions, seminars, workshops and similar activities (Figure 2, right), rho = 0.836 with a *p*-value of 0.009. This strong positive correlation indicates that as the budget for trips increases, so does the number of members participating in international events, what generally seems intuitive. The statistical significance of this correlation is followed by a very low *p*-value, pointing that the probability of this correlation occurring by chance is very low. These results imply a likely causative relationship, where increased financial investment in trips is associated with greater participation in international scholarly activities, reflecting an integral relationship between budget allocations and academic engagement abroad.

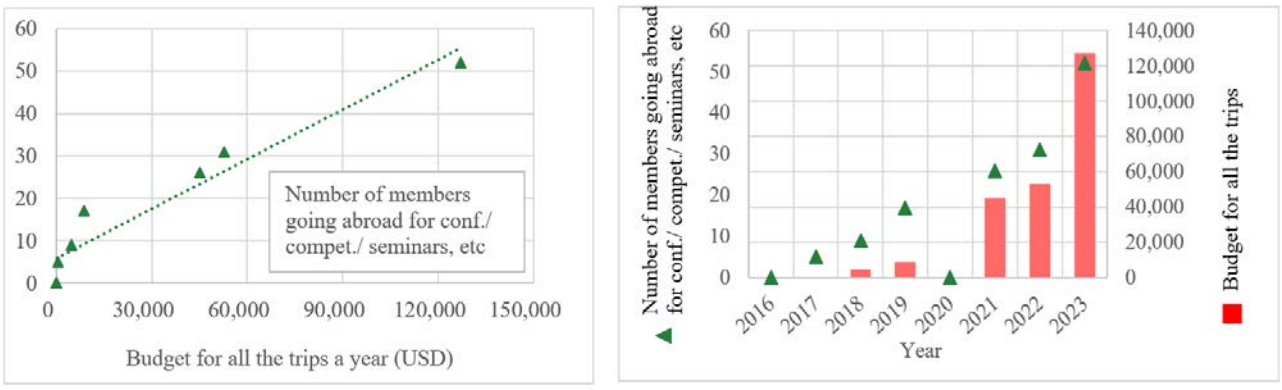

Figure 2: Relation between the annual budget for all the trips and the number of members going abroad for conferences, competitions, seminars, workshops and similar activities, with a trend line included representing the linear approximation of their relationship (left) and the distribution of both datasets over the span of years (right).

Another analysed dataset includes the budget for all the trips in a given year in relationship to the number of papers published that same year (Figure 3, left, rectangles), as well as to the number of papers published in the following year (Figure 3, left, diamonds). The first relationship is characterised by rho = 0.66 with a *p*-value = 0.007, indicating a strong positive correlation between the trip budget and the number of publications within the same year. Notably, the slope of the linear approximation for this first set is twice as steep as that for the second dataset, which has rho = 0.31

and a *p*-value = 0.49, denoting a weaker and statistically insignificant correlation of the trip budget with the number of publications in the subsequent year. These findings suggest that while the budget for trips appears to have a significant positive impact on SimLE's output within the same year, its influence on the publications of the following year is less evident and not statistically substantiated.

The strong relationship between the annual trip budget and the number of publications within the same year could be explained either by the fact that most of the materials published by SimLE students are conference proceedings, and therefore academic output is dependent upon funds allocated for conference attendance or because most of the papers published are resultant from activities connected with taking part in competitions, which in turn are very costly in respect to any other trip activity (Table 2). To verify which of those working hypotheses is correct, an analysis of the number of members going abroad in respect to the number of papers published is carried out (Figure 3, right).

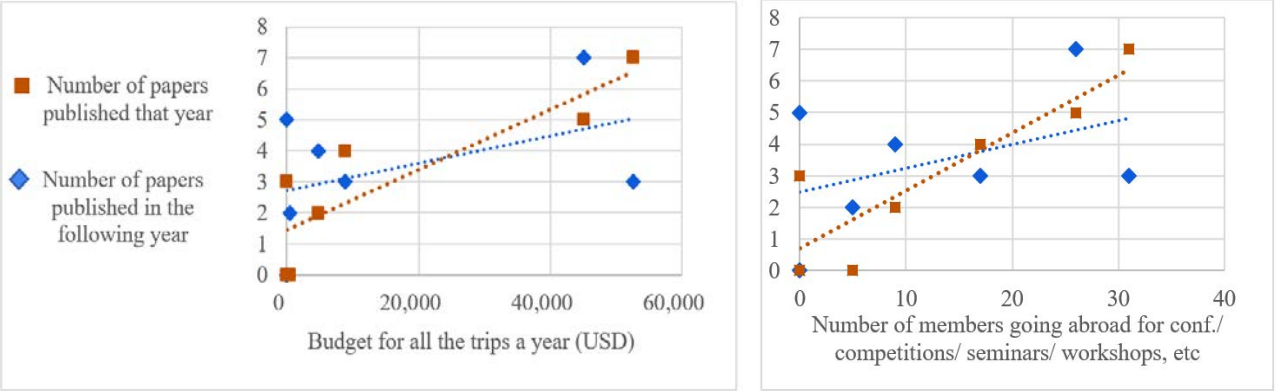

Figure 3: Relation between the budget for all the trips and the number of papers published that year (left, squares), as well as for the number of papers published in the following year (left, diamonds), with trend lines as linear approximation included, and relation between the number of members going abroad for conferences, competitions, seminars, etc, and the number of papers published that year (right, squares), as well as for the number of papers published in the following year (right, diamonds), with trend lines included representing their linear approximation.

Table 2. Travel budget allocated for various events from 2018 to 2023.

Year	2018		2019		2022		2021		2022		2023	
	Budget (USD)	No. of events	Budget (USD)	No. of events	Budget (USD)	No. of events	Budget (USD)	No. of events	Budget (USD)	No. of events	Budget (USD)	No. of events
Conferences	3,526.45	1	4,282.12	4	0	0	19,420.65	1	19,395.47	3	19,773.30	1
Competitions	0.00	0	0.00	0	0	0	19,647.36	1	28,211.59	1	92,872.04	2
Workshops, etc	1,209.07	2	4,534.01	2	0	0	6,045.34	3	5,037.78	4	14,483.63	5
Budget per event												
Conferences	3,526.45		1,070.53		0		19,420.65		6,465.16		19,773.30	
Competitions	0.00		0.00		0		19,647.36		28,211.59		46,436.02	
Workshops, etc	604.53		2,267.00		0		2,015.11		1,259.45		2,896.73	

The Pearson correlation coefficient is calculated for the number of members going abroad for conferences, competitions, seminars, etc, in respect to the number of papers published that same year (Figure 3, right, rectangles), as well as for the number of papers published in the following year (Figure 3, right, diamonds). In both cases, the correlation is much weaker than dependency upon the budget. The first dataset, shows a correlation of r = 0.56 and a *p*-value = 0.150, indicating a moderate and statistically non-significant correlation of papers published that same year to the number of members going abroad. The correlation is even weaker in the second dataset - the number of members going abroad in respect to the number of papers published in the following year (Pearson's correlation coefficient of 0.42 and a *p*-value of 0.343). Those findings suggests that participation in high-cost activities abroad is strongly related to an increase in publication output, and therefore higher publication rates result from activities connected with taking part in competitions.

The analysis of datasets exploring the relationship between the number of international competitions, international conferences and foreign trips in a year with the number of messages in a messenger platform that same year reveals distinct correlation strengths and statistical significances. The first dataset, correlating international competitions with messenger activity, exhibits rho = 0.92 and a *p*-value of 0.001, indicating a very strong and statistically significant positive correlation. This suggests that increased participation in international competitions is closely associated with a higher volume of messenger communications.

Conversely, the relationship between international conferences and messenger activity is characterised by rho = 0.10 and a *p*-value of 0.8, denoting a very weak and statistically insignificant correlation, implying that participation in international conferences has little to no association with the number of messenger messages. Similarly, the third data set, concerning foreign trips, shows rho = 0.33 and a *p*-value of 0.419, indicating a weak and not statistically significant correlation. These findings highlight the specific nature of international competitions as a significant driver of increased communication on messenger platforms. The increase in the number of messages, which is assumed to indicate student

engagement in the activities of the scientific club, is in fact attributed to participation in competitions that require close co-ordination of the team preparing for the event.

The trend in the number of students embarking on their first international journey as part of the SimLE activities showcases a significant increase. From humble beginnings in 2018, with only two students taking their inaugural trips, the number has risen impressively to 39 in 2023. This growth reflects the scientific club's success in inspiring new students to step out of their comfort zones and engage with the global academic community. Moreover, the proportion of these first-time travellers among all travelling students has shown an upward trajectory to an impressive 75% in 2023.

CONCLUSIONS

A detailed analysis of financial and quality data aligns with the hypothesis that financial resources allocated to SimLE translate into an increase in the scientific club's quality indicators, albeit with nuanced outcomes across different areas of activity. The strong positive correlation between the budget for all trips and the number of members participating in the same year supports the hypothesis, indicating that increased financial investment in SimLE is directly associated with higher student participation and engagement. This correlation suggests that financial resources are a critical factor in enabling student activities, particularly international competitions, which, as the analysis show, significantly enhance academic productivity. However, the weaker correlations observed in subsequent years' participation and publications, introduce a complexity to the direct impact of financial resources on long-term academic productivity.

Factors that may have influenced the analysed indicators, yet were not quantitatively incorporated into the analysis:

- The level of commitment by individuals prioritising was scientific engagement. Publications authored by a two-person team: 2018 (2), 2019 (4), 2020 (2), 2021 (5) and 2022 (1) constitute nearly all of the SimLE's publications in this time frame. Both authors were PhD candidates at Gdańsk Tech, further evidencing their dedication to research. This suggests that publication activity within SimLE is closely linked to the personal ambitions of its members. Therefore, to ensure the club's publication activity, close collaboration between students and other academic staff is essential [18][19].
- Communication difficulties and human factors within one of the projects in 2021 and 2022, leading to a significantly lower members' activity and less discussions on Discord.
- The adoption of alternative collaboration platforms in addition to Discord for projects, such as SimBa, Slugg.

The conducted analysis offers a multi-faceted view of SimLE's impact on academic and personal development. The significant increase in students travelling abroad for SimLE activities underscores the importance of experiential learning and international exposure in enhancing educational outcomes. It also highlights the transformative potential of these experiences, evidenced by the number of students travelling abroad for the first time, suggesting that SimLE effectively broadens their horizons and contributes to their holistic development. In this scope, the financial management of SimLE not only facilitates logistical support for various activities but also strategically invests in the intellectual and professional growth of its members. And, while the direct correlation between financial resources and long-term quality indicators may present complexities, the overall impact of these investments is undeniably positive, contributing to both the immediate and sustained success of SimLE's members in their academic and professional endeavours.

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BIOGRAPHIES

Dr Wiktor Sieklicki, earned his MSc and PhD degrees in mechanical engineering from Gdańsk University of Technology (Gdańsk Tech), Gdańsk, Poland, in 2006 and 2010, respectively, both with honours. Between 2010 and 2013, he worked for Telerobot S.R.L. and the Istituto Italiano di Tecnologia (IIT) in Genova, Italy, as an experienced researcher within the ITN Marie Curie Programme. His main research interests include human-robot interface, bio-signals acquisition and robotics for rehabilitation. Wiktor Sieklicki serves as the supervisor of the SimLE student scientific club at Gdańsk Tech, and is a coach of the Odyssey of the Mind Programme.

Maciej Zawadzki, having earned his Bachelor's degree in energy technologies in 2024 from Gdańsk University of Technology (Gdańsk Tech), Gdańsk, Poland, is currently pursuing his Master's degree in mechanical engineering at the same institution. He actively serves as the Vice-President of the SimLE student scientific club. As a participant in the SimLE SeaSentinel programme, he has represented Gdańsk Tech twice at the RoboBoat competition in the United States of America.