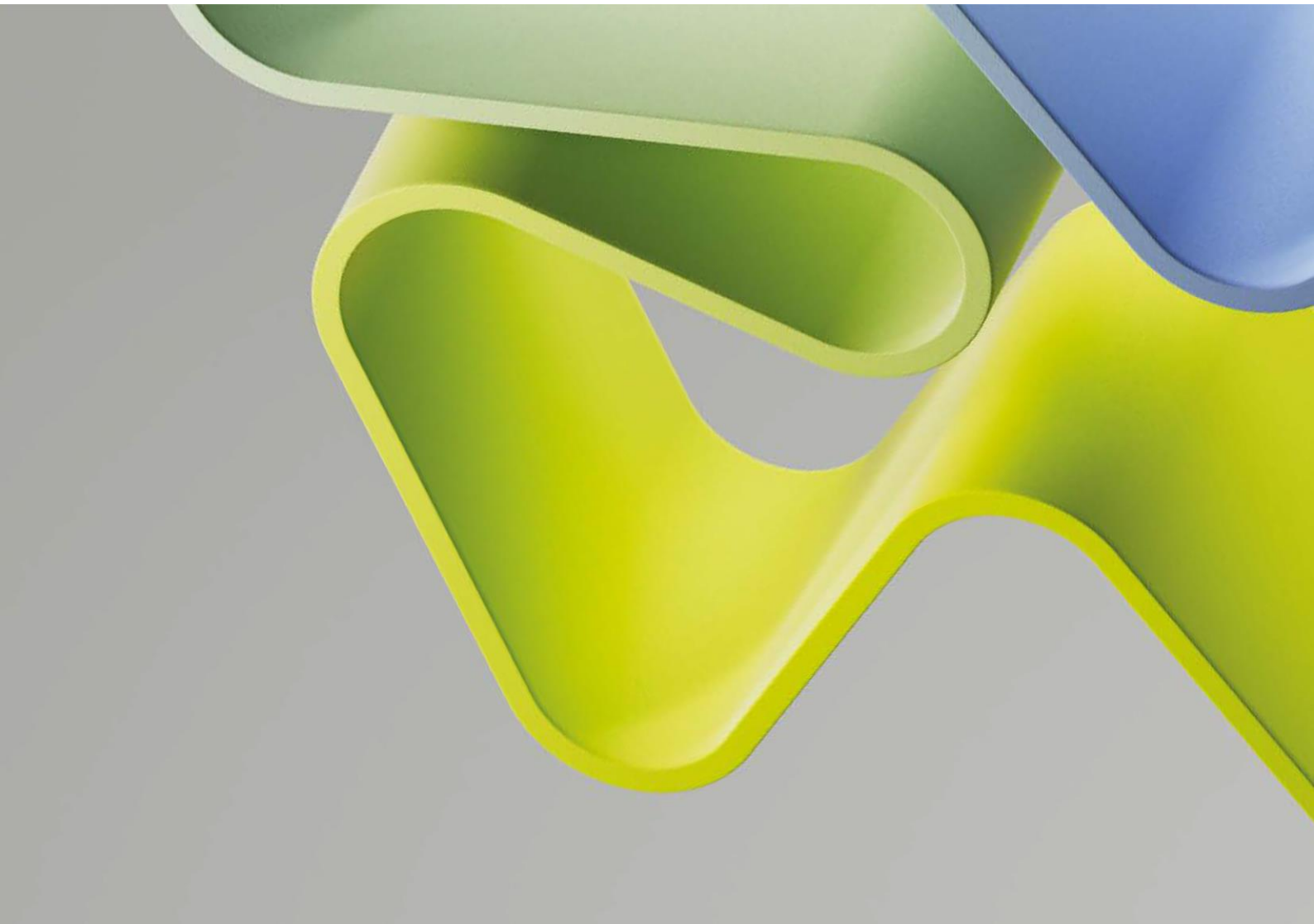
The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

Evaluation Report for Research Group

Research Group: Software Engineering and Learning Technology (SE-LT)
Administrative Unit: Department of Computer Science (IDI)
Institution: Norwegian University of Science and Technology (NTNU)

Panel 7



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Preface

The Research Council of Norway (RCN) is given the task by the Ministry of Education and Research to perform subject-specific evaluations. The primary aim of this evaluation of mathematics, ICT and technology 2023-2024 (EVALMIT) is to reveal and confirm the quality and relevance of research performed at Norwegian Higher Education institutions and the Research Institute sector in an international perspective. Such knowledge is useful for the institutions that participate in the evaluation, for the Research Council who advice the authorities on how research should be developed further, and for the authorities, who set targets and frameworks for research and higher education. Research groups submitted by their administrative unit will be assessed by 15 expert panels organised by research subjects or themes. The expert panels will assess research groups across institutions and sectors based on research group's self- assessments and examples of scholarly output. These research reports will be part of the evaluation of their belonging administrative units.

Executive summary

The Software Engineering and Learning Technology (SE-LT) research group at the Norwegian University of Science and Technology (NTNU) comprises an adept team of full and associate professors, postdoctoral researchers, and PhD candidates, augmented by adjunct faculties from various sectors. The group is distinguished by its sharp focus on empirical research within software engineering and learning technologies. It is dedicated to pushing the boundaries of how complex IT systems and interactive learning technologies can be designed and improved to meet societal and organisational needs. Central to the group's mission is its commitment to producing sustainable and influential research outputs, securing substantial external funding, and enhancing its visibility on an international scale. The SE-LT group has set itself ambitious goals to become one of Europe's premier research entities in these specialised fields.

In the broader context of similar research groups nationally and internationally, the SE-LT research group is notable for its clear strategic focus and robust project acquisition capabilities, which have propelled it into a leading position within global research communities. Despite its strong position in Europe, there remains room for growth on the European and global stage. The group's ongoing initiatives to secure more competitive funding, such as from the European Research Council (ERC), and its drive to increase top-tier publication outputs are essential for enhancing its global research stature. These efforts, combined with substantial contributions to both theoretical advancements and practical applications in software engineering and learning technologies, position the SE-LT group as a vital player in advancing these critical areas of research and their application in society.

The group has set clear benchmarks to publish and play a central role in premier SE and LT conferences and journals, develop strong project portfolios, and impact society and the IT industry through research-based education and technological innovations. These benchmarks are ambitious but achievable, given the group's historical performance, strategic focus, and the support structure provided by NTNU.

Overall assessment

The SE-LT research group exhibits robust performance characterised by a well-defined focus and strategic alignment, impressive project acquisition capabilities, and an extensive network in academia and industry. These strengths collectively foster a strong publication track record and ensure a sustainable output, underscoring the group's prominent role within the international research community.

One of the key strengths of the SE-LT research group is its clear focus and coherent strategy that spans both software engineering and learning technologies. This strategic clarity allows the group to effectively target and secure relevant projects, ensuring their research activities are both impactful and aligned with global technological trends. The group's ability to consistently secure substantial competitive funding, particularly from national and European sources, supports ambitious research endeavours and positions the group favourably for future success. Additionally, the extensive networks the group maintains in research and practice not only enhance the quality and relevance of their research but also ensure that findings are translated into practical applications, thereby increasing the group's visibility and influence within the field.

Internationally, the SE-LT group is strong and particularly recognised for its contributions to educational technologies and software systems (e.g., the game-based learning platform Kahoot!). Their consistent output of high-quality research, as evidenced by regular publications in top-tier journals and conferences, positions the group competitively on a global scale. The group's research outputs are not only recognised within academic circles but also widely utilised in educational practices and industry, highlighting its broad impact.

There are areas where improvements could further enhance the group's performance. The moderate gender imbalance within the group is a concern that could affect its diversity of perspectives and innovation. Addressing this imbalance by implementing targeted recruitment and retention strategies for female researchers could enrich the group's research environment and outputs. Additionally, while the group has been successful in securing substantial funding, there is potential to tackle more competitive funding schemes, which is already recognised by the group.

Grading:

Dimensions		**Score**
Organisational dimension	How adequate the organisational environment is in supporting the production of excellent research	5
Quality dimension	Research and publication quality	5
	Research group's contribution	5
Societal impact dimension	Research group’s societal contribution	5
	User involvement	5

Recommendations

Increase Gender Diversity: Actively recruit and promote female researchers at the professor level within the group to address gender imbalances and enrich the research environment. As the group has led several initiatives to empower gender balance in IT and has promising postdoctoral researchers in its ranks, this should be feasible.

Pursue More Competitive Funding: Aim to secure funding from more prestigious sources such as the ERC and Norwegian Centres of Excellence (SFF) to support ambitious projects and enhance international competitiveness.

Expand Top-Tier Publication Output and Presence in Prestigious Venues: Intensifying efforts to publish in top-tier journals and conferences consistently will further solidify the group’s reputation in SE and LT research and further close the gap to more productive research groups in Europe and worldwide. The group should also actively pursue more leadership roles in prominent venues such as the International Conference on Software Engineering (ICSE) and International Conference on Learning Analytics & Knowledge (LAK).

Improve Documentation and Transparency of Knowledge Transfer Initiatives: While the group's knowledge transfer activities and societal contributions largely speak for themselves, it is advisable to document and communicate these efforts more explicitly for future reporting, including details about spin-offs and policy development efforts, to increase visibility and impact.

1. Strategy, resources and organisation

1.1 Research group’s organisation and strategy

The SE-LT research group at NTNU is organised into two main clusters: Software Engineering (SE) and Learning Technology (LT), each with a strong empirical research focus. The focus on empirical research is particularly apt given the practical nature of SE and LT fields, which demand evidence-based approaches to innovation and theory development. The group is supported by dedicated labs and entities such as the Norwegian GEMINI Center for Software Engineering, the Software for a Better Society lab, and the Learner–Computer Interaction lab. This structure facilitates robust research and development activities and supports master's and PhD supervision. The diverse team composition includes professors, associate professors, postdoctoral researchers, PhD candidates, and adjunct professors, ensuring a rich collaborative environment. The group's composition and organisation are well-suited to its research goals, providing a balanced focus between SE and LT. However, there is a need for more female (full and associate) professors to address gender imbalances (33% and 25% are female professors, respectively) and enrich the diversity of perspectives within the group. A mid-to long-term opportunity might be to “upgrade” female postdoctoral researchers (100% of postdoctoral researchers are female) to the professor level.

The SE-LT group aims to maintain and expand its position as a world-class research hub in SE and LT. The strategy is anchored in four main objectives: (1) scaling up the project portfolio through national and international projects, (2) increasing publications in top-tier venues, (3) maintaining innovation leadership through award-winning systems, and (4) enhancing its role in global academic and professional networks. This strategic alignment is designed to leverage the group's empirical research strengths across SE and LT.

The group has set clear benchmarks to publish and play a central role in premier SE and LT conferences and journals, develop strong project portfolios, and impact society and the IT industry through research-based education and technological innovations. These benchmarks are ambitious but achievable, given the group's historical performance, strategic focus, and the support structure provided by NTNU.

SE-LT is integral to NTNU's strategy, contributing significantly to cross-disciplinary research and education. The group's work on complex IT systems and learning technologies directly impacts teaching methods and quality at NTNU, aligning with the university's goals of advancing digitalisation and educational excellence. The group's contributions through technology development and policy influence also underscore its central role in advancing the university's strategic goals.

The group is highly engaged in education at both the master's and doctoral levels (both undergraduate and graduate), providing specialised courses and encouraging international mobility. This educational engagement is crucial for cultivating the next generation of researchers and professionals in SE and LT. Education at the undergraduate level is research-based, while at the graduate level, the focus shifts towards project-based education in collaboration with the industry.

The group’s extensive collaborations across interdisciplinary, national, international, and non-academic domains significantly enhance the quality and impact of its research. It has outstanding partnerships with the software and learning IT industry (e.g., Equinor, Kantega), the public sector (e.g., the Norwegian Welfare Administration), and international research

institutes (e.g., Carnegie Mellon University, TU Eindhoven, Swiss Federal Institute of Technology Lausanne, Peking University).

Recommendations to the research group:

Increase Gender Diversity: Actively recruit and promote female researchers at the professor level within the group to address gender imbalances and enrich the research environment. As the group has led several initiatives to empower gender balance in IT and has promising postdoctoral researchers in its ranks, this should be feasible.

Consider Establishing a Formal Leadership Structure: Given that the group currently lacks a formal role at the section or department levels and derives its strategy from external missions, it would be beneficial to establish formal leadership and a dedicated strategy at the department level to create a common infrastructure for research and improve coordination and effectiveness across ongoing and planned project portfolios. This approach would also facilitate the development of internal incentive schemes to acknowledge the group's research contributions, reward them with research resources, and potentially reduce their teaching obligations.

1.2 Research group's resources

The SE-LT research group has demonstrated robust capabilities in resource acquisition and utilisation. Over the last five years, the group secured over 100 million NOK in competitive research funding, reflecting a strong portfolio of national and international projects. Funding sources included the Norwegian Research Council (NFR), various EU frameworks such as Horizon Europe, and industry collaborations. The group's resources are well-aligned with its strategic objectives, supporting a wide range of research activities in software engineering and learning technology. This success indicates the group's high scientific quality and relevance, aligning well with funding priorities in technology and education. The substantial growth in funding over time underscores the group's increasing prominence and ability to compete at high levels of research funding. However, there is potential to aim for even more prestigious grants, such as the ERC and the SFF schemes, which could further elevate the group's research profile. The necessary conditions are already established, as the group is among the select few in Norway with proven expertise in managing large EU projects and reaching the final stage of ERC evaluations.

NTNU provides significant support to the SE-LT group, including specialised infrastructure such as HCI/UX, Maker, and Neurophysiological labs. This support extends to data access and administrative assistance for both national and international project management, which is crucial for the group's operational efficiency. The institution's commitment to supporting faculty toward achieving top-tier research grants and publications further enhances the group's research capabilities.

The group efficiently utilises external funding to foster significant research outcomes. This includes funding PhD and postdoc positions, leading cutting-edge projects in software engineering and learning technology, and maintaining high-quality research output. The group's strategy to leverage funding for fundamental research and innovation has led to notable advancements in both research domains.

The SE-LT group is actively involved in several key Norwegian and European research infrastructures, which significantly contribute to the development and quality of research. These include the Norwegian GEMINI Center and the Learner-Computer Interaction lab, which support large-scale empirical studies and advanced user experience research. These

infrastructures not only facilitate high-level research but also foster collaboration with top-tier national and international institutions, enhancing the group's research quality and impact.

Recommendations to the research group:

Pursue More Competitive Funding: Aim to secure funding from more prestigious sources such as the ERC and SFF to support ambitious projects and enhance international competitiveness.

2. Research quality

2.1 Research group’s scientific quality

The SE-LT research group is structured around two main research strands—Software Engineering (SE) and Learning Technology (LT). The group has a distinct emphasis on empirical research in both areas, contributing extensively to the development and understanding of complex IT systems, as well as the design and implementation of innovative learning technologies. The group has maintained a robust publication record with consistent outputs in top-tier journals and conferences internationally.

The SE-LT group significantly contributes to advancing the state of the art in its disciplines both nationally and internationally. With numerous publications in top-tier journals, high citation counts, and presentations at major conferences, the group influences the broader scientific community in software engineering and learning technologies. The focus on quality over quantity in their publication strategy ensures that their research outputs are impactful and respected within the academic community. The SE-LT group has established a solid reputation in Europe and worldwide, marked by its productivity and innovative contributions to both software engineering and learning technology. Their research activities significantly impact the academic community and have practical applications that influence industry practices and educational methodologies (e.g., Kahoot!).

The group exhibits strong international cooperation, engaging in numerous projects with global partners and maintaining high visibility in the international research community. This includes interdisciplinary collaboration that enhances the group's research scope and depth, integrating perspectives from related fields such as human-computer interaction, psychology, and education. Such collaborations not only broaden the group’s research horizons but also elevate its scientific contributions to a wider audience.

The SE-LT group's listed projects, funded by national bodies like the Norwegian Research Council and international frameworks such as Horizon Europe, demonstrate the group's ability to operate at the forefront of scientific research. These projects address cutting-edge issues within SE and LT (e.g., learning science, learning ecosystems, agile software development 2.0, blockchain-based supply chain management systems, extending design thinking, big data, and social entrepreneurship), yielding findings that push the boundaries of existing knowledge and technology. The group’s attempts to secure funding from prestigious calls like the ERC, despite not always being successful, indicate their ambition and alignment with high scientific standards.

The group’s publications maintain a high level of scientific quality, with a significant number published in top-tier journals (i.e., between 2012 and 2022: 33 scientific articles in top Swedish journals and more than 30 publications among the most reputable LT journals). Several publications listed in the report have achieved high numbers of Google Scholar citations (>400) over a short amount of time. This consistent quality underscores the group’s expertise and the rigour of their research methodology. While the group has been successful in targeting high-impact journals and conferences, there is an expressed need (explicitly articulated by the group) to increase their presence in such top-tier venues further over the coming decade. Additionally, their monographs and books, which are tailored more towards practitioners, highlight the group's commitment to societal impact, applying their research findings in practical, user-oriented contexts.

Recommendations to the research group on research quality:

Expand Top-Tier Publication Output and Presence in Prestigious Venues: Intensifying efforts to publish in top-tier journals and conferences consistently will further solidify the group's reputation in SE and LT research and further close the gap to more productive research groups in Europe and worldwide. The group should also actively pursue more leadership roles in prominent venues such as ICSE and LAK.

Broaden Research Horizons and Diversify Focus Areas from a Strong Core: The group should consider strategically expanding its research scope to include emerging and critical areas that are closely related to the core SE-LT fields, such as software engineering for AI, sustainable software engineering, and AI and context-aware learning technologies. This expansion would not only sustain the group's leadership in its existing domains but also position it at the forefront of evolving research trends.

2.2 Research group's societal contribution

The SE-LT research group has made significant contributions to societal, economic, and cultural development both in Norway and internationally. The group's development of widely used software tools and platforms, such as Kahoot! (50 Mio+ downloads in Google Playstore) or BitPet (5000+ downloads in Google Playstore), exemplifies its impact on educational practices and engagement worldwide. Products from spin-offs like Kahoot!, which are utilised by millions globally, not only revolutionise educational methods but also promote interactive learning and accessibility. Another great example of societal contribution is the development of the EduApp4Syria app, which helps Syrian children learn how to read in Arabic and improve their psychosocial well-being. These contributions demonstrate the group's ability to translate research into practical, impactful applications that benefit a broad user base.

The group's involvement in knowledge transfer, especially in policy and resource development for software engineering and learning technologies, plays a critical role in shaping industry standards and educational practices. For example, the group initiated the GEMINI National Center in SE and developed several widely used SE resources. It has also funded the national network for game developers (JoinGame), which has contributed to the coordination and strengthening of the Norwegian game industry. Their efforts to contribute to diversity, equity, and inclusion (EDI) initiatives in computer science further enhance their societal impact (e.g., via outreach programs in high schools). Overall, the SE-LT group has effectively involved non-academic partners in its research processes, which has enriched the relevance and applicability of its research outputs. Collaborations with educational institutions, industry, and public sector entities ensure that the research findings are grounded in real-world needs and can have immediate societal impacts. This extensive collaboration not only fosters innovation but also ensures that the research conducted is directly aligned with societal needs and challenges.

Recommendations to the research group:

Improve Documentation and Transparency of Knowledge Transfer Initiatives: While the group's knowledge transfer activities and societal contributions largely speak for themselves, it is advisable to document and communicate these efforts more explicitly for future reporting, including details about spin-offs and policy development efforts, to increase visibility and impact.

Appendices (separate document)

- Mandate for expert panels
- Expert panel description and list of experts
- Template research group self- assessment
- Scales for research group's assessment

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