**InnTELT** Innovating Teacher Education with new Learning Technologies
*for professional identity, 21st Century skill development and educational relevance*

## 1. Excellence

InnTELT addresses today's **challenges** of shifting demands on teachers' roles and requirements for professional development, as theory-based teaching and practical training are currently disconnected. These shifts are **needed** to respond to: 1) the rapid digitalization of learning arenas; and 2) for education to remain relevant in its response to societal needs and the growing pursuit of sustainable development. Our **solution** is to generate innovative approaches using AI and VR technologies, as well as blended learning techniques, to prepare future teachers and teacher educators to respond effectively to a changing society.

The Faculty of Education (LUP) in collaboration with Faculty of Audiovisual Media and Creative Technologies (AMEK) at Inland University of Applied Sciences (INN) has initiated several important efforts to establish new learning arenas to *enhance the provision and quality of its education programmes*. These include a) digital learning technologies (including artificial intelligence (AI) and virtual reality (VR)) to bridge between classroom and praxis-based learning; b) an integrated praxis period to enhance experiential learning and practical application; and c) a learning hub (part of PARK business and start-up house) as a future classroom lab for innovative learning technologies and co-production between different stakeholders. The InnTELT project will 1) investigate how use of technologies (including AI and VR) can enhance learning outcomes across these new learning arenas, using teacher education as a pilot, and 2) strengthen their strategic integration into education programmes to enhance innovations in pedagogical practice, professional development and the quality and relevance of education. Innovative applications for **future learning arenas** will be practically applied, tested, and refined to achieve *flipped classroom, virtual classroom, virtual dialog simulator,* and *active-blended learning*. Key to this research is understanding how teacher education responds to changing roles of teachers and development of professional identities, and how the use of new learning technologies strengthens this, and the impact it can have across other educational programmes.

### 1.1 State of the art, knowledge needs and project objectives

Recent studies[1–3] have identified a disconnect in teacher education between theory-based teaching and practical training which negatively impacts on the professional development of student teachers. In turn, this results in newly qualified teachers feeling unprepared for the challenges of school teaching environments, as well as for the recent advancements in teaching technologies and pedagogical approaches. SINTEF's surveys in 2010 and 2013 on perceptions of quality in teacher education highlight students' experience of theory-based teaching and practical training being treated as two separate and unrelated cycles[4,5]. A new model of quality training and practice for student teachers is needed, and teacher education institutions and partner schools should strengthen collaboration to provide inquiry-rich and coherent teaching school experiences.[3] The *National Guidelines for Teacher Education* discuss the need to prepare teachers for changing societal demands for skills/competencies (e.g., sustainable development). Teacher education should "equip teachers to develop relevant knowledge for the contexts they will encounter" and to "adapt to new social conditions, new curricula, and new research in relevant subject areas"[6].

While the current competency focus in education for sustainable development (ESD)[7–10] has gained much attention both in literature and in practice, it is also notable that much of the literature on sustainability competencies avoids discussing how pedagogical methods and teaching approaches support their development. Sustainability competencies play a key role in ESD and provide a targeted focus towards delivering quality education. However, they alone do not provide guidance in relation to the pedagogical design of quality education, nor how learners gain the capacity for proficient application of these competencies. Research-oriented programmes need to integrate more practice-oriented strategies if they want to increase competency development, especially in relation to building learners' practical skills and methods[11]. Therefore, the **knowledge needs** for teacher education are: **1)** greater synergy between theory-based teaching and practical training; **2)** development of professional skills and competencies that can be adapted and applied to different situations; and **3)** diverse pedagogical experience and expertise, including significant competence in digital learning technologies.

To tackle limitations of current research and practice, InnTELT's **primary objective** is *to develop and test how the use innovative learning technologies (including AI & VR) in teacher education can strengthen educational quality, relevance and the professional development of future teachers to respond effectively to the changing nature and challenges of education and society in the 21st Century*.

InnTELT will generate new knowledge and innovations by creating points of *critical praxis* where *theory-driven design* and *design-based research* find synergies to establish meaningful and practical knowledge to successfully respond to the changing demands on teaching professionals and the ability of education to develop sustainability competencies and 21st Century skills, which includes digital literacy skills related to information literacy, media literacy and information and communication technologies (ICT) literacy. The project will intervene within its points of critical praxis by developing and testing innovative learning technologies, using AI and VR, and by conducting research on the impact this has on professional development, teacher identity, skill/competency development, as well as educational quality and relevance.

Through these efforts, InnTELT aims to achieve its **secondary objectives**:

**S0.1.** Develop new AI and VR learning technologies and apply these into education programmes to strengthen active, blended learning approaches and create synergy between teaching and praxis cycles.

**S0.2.** Investigate how new learning technologies impact on the competency and professional development of future teachers, especially related to 21st Century skills, ICT literacy and sustainable development.

**S0.3.** Provide research-based advancement in the assessment of learning outcomes specifically linked to competency development and professional development.

**S0.4.** To investigate the potential transfer of AR and VR learning technologies tested in InnTELT to other fields of professional development, and across INN educational programmes.

### 1.2 Research questions, theoretical approach, and methodology

**RQ.1.** How can teacher education utilize AI and VR technologies to better prepare student teachers to adapt to changing roles and learning environments to respond to needs for educational quality and relevance?

**RQ.2.** How do active, blended learning technologies and methodologies affect and inform the professional and competency development of student teachers, and what is potential for transferability of these impacts to other fields of professional development?

**RQ.3.** How can learning outcomes related to the development of 21st Century skills, digital literacy skills and sustainability competencies be effectively assessed?

**RQ.4.** How do the different learning technologies and approaches applied in the InnTELT project impact on the development of 21st Century skills, digital literacy skills and sustainability competencies? How does this enhance the quality of educational programmes across INN?

**RQ.5.** How can game elements and user experience (UX) enhance learning outcomes?

**Theoretical approach.** InnTELT will apply a grounded theory framework to study processes in natural settings and invoke pragmatic criteria of usefulness to evaluate the completed studies[12]. Grounded theory provides an effective approach for researching applied, practice-based scenarios in education, and shifts the focus of knowledge generation from deductive, hypothesis testing towards an inductive process of developing theory through practice. This is achieved by i) naming of an emergent social pattern grounded in research data, and ii) getting the 'voice' of the participants to define concepts and reflect on possible hypothesis[13].

InnTELT will conduct applied educational research to produce practical-oriented knowledge to strengthen teacher education in its efforts to improve professional development, achieve adaptive skill and competency development, and enhance educational relevance. We will do so by implementing two main approaches: Tier 1) theory-driven design (TDD), and Tier 2) design-based research (DBR) to generate points of critical praxis for the productive interaction between practice and theory. The former is the core to generate scientific knowledge through theory building (discovery, domain limitation, relationship building) and theory testing (prediction, validation, refinement) which are carried in cycles. TDD faces challenges that affect its impact and relevance[14], thus we combine it with DBR to mitigate limitations and generate relevant project outcomes. For DBR, typically used in learning sciences, we will use the contextual frame generated through TDD and develop solutions/interventions within a participatory design. InnTELT will be carried across three work packages (WP) where WP 1 will focus on TDD (Tier 1), WP 2 on DBR (Tier 2), and WP 3 on impact generation and quality management (Tier 3).

| WP 1 | Active, Blended Learning with Digital Learning Technologies |
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| **Purpose.** Strengthen praxis-based learning opportunities and advance an active, blended learning environment by developing, piloting and testing the use of digital learning technologies, including AI and VR, in teacher education programmes. *Theory-driven design* will be supported by supported by a multi-disciplinary team with diverse expertise in digital technologies, learning technologies, professional development, teacher education, and pedagogical approaches for active, blended learning. WP1 will address **SO1** and **SO2,** and **RQ.1.** and **RQ.2**. | |
| **Description of tasks (T) and methods: T1.1 Virtual dialogue simulator.** Enhance its application within teacher training to simulate unfamiliar and challenging situations in a safe learning environment and reduce the praxis-shock experienced by recently qualified teachers. **T1.2 Virtual classroom.** Utilise the Core Platform technology to develop and pilot a virtual classroom as a new learning arena and collaboration platform for student teachers that provides high relevance to the professional environment. **T1.3 Integration of active, blended learning approaches**. Integrate active and blended learning pedagogies (supported by digital learning technologies) for active engagement and collaboration in a dynamic and flexible manner. | |

| WP 2 | Research on digital learning technologies impact on teacher professional development |
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| **Purpose.** WP2 will conduct *design-based research* that is significantly grounded in points of critical praxis, thus providing opportunities for increased methodological triangulation and cross-referencing of findings. WP2 aims to produce findings with practical-relevance on how the application of new learning technologies can be best applied to strengthen teacher education, as well as determining relevance for other areas of higher education and professional training. WP2 will address **SO2, SO3** and **SO4**, and **RQ.3, RQ.4**. and **RQ.5.** | |
| **Description of tasks (T) and methods: T2.1 Research on teacher professional development.** Investigate how different digital learning technologies impact on competency and professional development. Method is *narrative inquiry* to study and understand experiences,[35] and elucidate how teachers' identities are influenced and enhanced by different blended and digital learning approaches. **T2.2 Research on relevance of new learning technologies in teacher education.** Investigate how to prepare teachers with relevant digital literacy and technological skills to adapt to changing roles and contexts. Methods are surveys, observations, and semi-structured group interviews with students, praxis facilitators and teachers, to elucidate how different digital learning approaches can strengthen educational quality and relevance. **T2.3 Impact mapping of digital learning technologies on learning outcomes.** Assess and map the impact of learning technologies on learning outcomes related to 21st Century skills, digital literacy skills and sustainability competencies. | |

| WP 3 | Quality management and impact generation |
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| **Purpose.** WP3 will provide timely and effective coordination of the project and facilitate productive collaboration of project partners through well-maintained management routines, communication standards, quality assurance, accountability mechanisms, and regular monitoring, review and reporting. WP3 will also ensure effective dissemination of InnTELT results, findings and recommendations. This will be achieved through a diverse communication strategy that will target a variety of stakeholders: in-service teachers, student teachers, teacher educators, academics, policy makers, and school students. Impact generation will both be targeted within Norway and internationally. | |
| **Description of tasks (T) and methods T3.1** Regular coordination meetings & project management software deployment**, T3.2** Quality Assurance (and monitoring & evaluation plan), **T3.3** Project reporting and accounting, **T3.4** Project website and social media profile (connected to PIER21 platform), **T3.5** Dissemination of project outcomes and results, **T3.6** Annual seminars | |

**Risk assessment.** 1) Technology challenges: expected or planned technologies might not be available or have limitations. *Mitigation:* Strong collaboration through PIER21 Network with partners Fynd Reality, Klosser Innovasjon, and VRINN provide expertise for digital learning technology. 2) Project anchoring may require additional support from Faculty. *Mitigation*: the participants are connected to several research groups and in strategic positions, with a focus area for the faculty (LUP and AMEK) leadership. 3) Game design: the games will be built with the aim of putting students through challenging scenarios which do not necessarily have a right or wrong solution. There is a risk of participants losing interest or withdrawing from the study if the design is too challenging, not challenging enough or not perceived as relevant to their education or professional development. *Mitigation***:** This risk will be mitigated through collaboration with AMEK who will be looking at how the scenarios are 'gamified', the target audience, the projects primary and secondary objectives in close collaboration with researchers from LUP. **Interdisciplinary approach.** InnTELT will reach interdisciplinarity at two key points: 1) co-production with people from different faculties and scientific backgrounds (i.e. technology developers, in-service teachers, school managers, researchers[36]); and 2) through the assessment of 21st century skills and sustainability[37]. **Stakeholder use, ethics.** We will collect

experiences from teacher students, educators, and in-service teachers. A detailed ethics evaluation is attached with this application. **Gender perspectives**: The project group includes 6 women and 5 men (not including the yet recruited PhD candidate and FYND realty, as the participating members has not been specifically allocated at this stage. Furthermore, the project will consider gender as a variable when evaluating responses from participants, looking at gender differences in approaching VR/AR technology, engagement in the various scenarios, and when completing focus group interviews exploring topics such as emotions, reflections, challenges and opportunities. **Information governance:** All information from stakeholders will be fully anonymised as per GDPR and NSD guidelines. We will follow the guidelines of the Norwegian National Research Ethics Committees (NESH and Ethnic groups resources). A preliminary data management plan is attached with this application.

### 1.3 Novelty and ambition

InnTELT will develop and test *TDD innovations* in practice, piloting in teacher education and investigating transferability to other fields of professional development. The novel points of our research are: i) development of AI, VR and other digital learning technologies piloted in in teacher education, ii) advancing an integrated and blended learning environment, and iii) strengthening teacher professional development. Novelty is produced through a combination of TDD and DBR to create points of critical praxis. InnTELT aims to elaborate on several interventions targeting increased opportunities for active, blended learning in teacher education, as well as in primary and secondary education. A recurring challenge for education is to ensure that it adequately prepares learners for the future they will inherit, the society of tomorrow, and challenges they will experience. The grand challenges of halting climate change and achieving sustainable development are defining features of the 21st century, and they are challenges that learners must be prepared to meet and address. InnTELT will be the first to assess the processes and learning outcomes related to these skills which will enable renewal to advance the overall quality of education and to maintain both its relevance and adaptability. An ambition of InnTELT is to tackle a key challenge of quality education: ensuring the relevance of education and the applicability of knowledge and competencies for addressing sustainability challenges. This focusses on developing lifelong learning competencies needed to reach sustainability across diverse contexts[15]. InnTELT will work with existing 21st Century skills frameworks[16–18] and include updated perspectives towards digital literacy[19,20] while also considering linkages to noted sustainability competencies. This is important within research as current programmes do not integrate practice-oriented strategies that focus on sustainable development.

## 2.0 Impact. **2.1 Potential impact of the proposed research**

**Scientific impact.** InnTELT has a dual perspective towards TDD and DBR that aims to produce practically relevant impacts through research on teacher education and pedagogical practice. By conducting phronetic research at points of critical praxis, InnTELT will produce qualitatively rich knowledge on the application of AI, VR and digital learning technologies in teacher education and how different learning technologies impact on professional development and adaptive capacity of newly qualified teachers. This research will utilise a new assessment framework to investigate how different learning approaches influence skill/competency development, and in doing so will bridge the theoretical gap between sustainability competencies and the pedagogical approaches to support their development. **Societal impact.** InnTELT will address the challenge of how teacher education can best respond to the shifting demands on teachers' roles and requirements for professional development and maintain educational relevance. It emphasises the needs for increased synergy between theory-based teaching and practical training, development of professional skills and competencies, and flexible and adaptive digital literacy and pedagogies. Practical outcomes in InnTELT will provide an enhanced model towards an integrated learning environment and innovations in digital learning technologies. These innovations will target target improvements in teacher education and provide insights for the wider higher education system on enhancing use of digital learning technologies and increasing synergies between classroom learning and practical training. **Impact on UN-SDGs.** InnTELT will focus on teacher education to strengthen the capacity for high-quality teaching and better orient educational activities towards the development of sustainability competencies and 21st century skills. **SDG 4** (to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all) is at the core of the PIER21 project and will be broadly addressed, while specific targets of SDG 4 will receive particular attention in this project, i.e., 4.1, 4.4, 4.7, 4.b, and 4.c.

**2.2. Measures for communication and exploitation**

InnTELT envisions a diverse communication strategy that will **target a variety of stakeholders**: in-service teachers, student teachers, teacher educators, and academics within Norway and internationally. Open-access publication of all research findings in peer-reviewed journals ensures both the quality of and public access to all generated results. Dealing with the general public, communication channels will be based on the **project website**, **social media**, and **blog/vlog** (connected to the wider PIER21 project platform) where information and news will be updated on a bi-monthly basis. For teaching professionals, InnTELT will publish 1 article in national **teacher magazines** such as *Utdanningsnytt*. For academics, InnTELT will publish at least 3 **peer-review articles** in journals such as *Nordic Studies in Education* and *International Journal of Educational Development*, *as well as journals focusing on new research within AR and VR technology such as Virtual reality*. Present research at least at 2 international conferences (e.g. *Nordisk forskningskonferanse om bærekraft i utdanning* and *Nordic VR Forum*). **Annual seminars** will be held at INN for research and experience with new AI and VR technology application in higher education.

**2.3. Potential for impact on INNs ability to implement AI, VR/AR in its research activity**

InnTELT draws on LUP's efforts to bridge the disconnect between theory-based teaching and practical training through the development of an integrated praxis design and the use of AI and VR technologies to simulate real-world professional experiences. It draws on existing collaboration with the INN business school (HHS) and Østlandsforskning to establish a learning hub to strengthen collaborative learning processes with diverse stakeholders within the local community. We will also be strengthening the research collaboration between AMEK and LUP, in terms of investigating the pedagogical interplay between the design and user experience of different interventions in AR and VR applications. This lays the foundation for several new research proposals to the Norwegian Research Council and potentially European Commission, some of which are already in development. The research findings will provide insight into how digital learning technologies can be used in higher education to strengthen quality and relevance of education, and will specifically target approaches to improve professional development, prepare students for real-world challenges, develop a greater adaptive capacity in their skill and competency learning. Working with Fynd Reality, InnTELT will further develop the Core Platform and pilot its application as a virtual classroom. This technology could provide a valuable platform for extension to other faculties and programmes at INN and provide an effective digital learning environment.

## 3. Implementation. **3.1. Project manager and project group**

InnTELT is designed as an independent but complimentary project to the PIER21 proposal submitted to NFR's call for *collaborative and knowledge building projects.* PIER21 is a collaborative, multi-stakeholder project with 31 actors across 13 institutions including schools, private sector, local government and higher education institutes with a focus on developing and researching the application of new learning arenas in teacher education. Drawing on this partnership, InnTELT provides opportunities to strengthen research and development on new learning technologies within the overall context to strengthen professional development, 21st Century skills and sustainability competencies.

Karen Parish is the Principal Investigator (PI) and manager for InnTELT and is connected to PIER21 as a work package lead for research focussed on assessing the impacts of different active and blended learning approaches on student teachers' learning outcomes. Karen has a background in teaching lower and upper secondary students and has firsthand experience with the potentials and limitations of utilizing new learning technologies and their impact on professional practice and competence development. She works on projects that utilise technology in both school and university settings, including VR and humanoid robots. The project team comprises of 10 persons from 2 institutions and includes collaboration with the private sector (Fynd Reality). In addition, the PM for the PIER21 project, Robert Didham (director of the Centre for Collaborative Learning for Sustainable Development, UNESCO Chair on Education for Sustainable Lifestyles), will also hold an advisory role in InnTELT to ensure strong collaboration and synergies between these two projects.

**3.2 Project organisation and management**

InnTELT is divided into 3 WPs that will be carried over 3 years from approx.. March 2023 to March 2026. This may be changed depending on the recruitment period for the PhD.

**Project management (WP3):** InnTELT establishes a robust mechanism for timely and effective project coordination to ensure effective management routines, communication standards, quality assurance, accountability mechanisms and regular monitoring, review, and reporting.

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