Application for doctoral position

1. **Curriculum:** Educational Science 80338

2. **Project title in English:** Effective interventions for systematic use of mobile learning in integrated science and math learning process

3. **Project title in Estonian:** Tõhusad sekkumised nutiseadmete süstemaatiliseks kasutamiseks loodusteaduste ja matemaatika lõimitud õppeprootsessis

4. **CERCS speciality:** S281 Computer-assisted education

5. **Doctoral candidate:**

<table>
<thead>
<tr>
<th>First name</th>
<th>Surname</th>
<th>Current activity</th>
<th>E-mail:</th>
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6. **Supervisor:**

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<tr>
<th>First name</th>
<th>Surname</th>
<th>Affiliation</th>
<th>Position:</th>
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<tbody>
<tr>
<td>Margus</td>
<td>Pedaste</td>
<td>Institute of Education</td>
<td>Professor of Educational Technology</td>
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7. **Research group where the doctoral thesis is being done:**

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<thead>
<tr>
<th>First name</th>
<th>Surname</th>
<th>Affiliation</th>
<th>Position:</th>
<th>PhD student</th>
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<tbody>
<tr>
<td>Margus</td>
<td>Pedaste</td>
<td>Institute of Education, Centre for Educational Technology</td>
<td>Professor of Educational Technology</td>
<td>no</td>
</tr>
<tr>
<td>Äli</td>
<td>Leijen</td>
<td>Institute of Education, Centre of Teacher Education and Higher Education</td>
<td>Professor of Teacher Education</td>
<td>no</td>
</tr>
<tr>
<td>Miia</td>
<td>Rannikmäe</td>
<td>Institute of Ecology and Earth Sciences, Centre of Natural Science Education</td>
<td>Professor of Science Education</td>
<td>no</td>
</tr>
<tr>
<td>Leo</td>
<td>Siiman</td>
<td>Institute of Education, Centre for Educational Technology</td>
<td>Senior Research Fellow</td>
<td>no</td>
</tr>
<tr>
<td>Liina</td>
<td>Adov</td>
<td>Institute of Education, Centre of Teacher Education and Higher Education</td>
<td>Junior Research Fellow in Education</td>
<td>yes</td>
</tr>
<tr>
<td>Mario</td>
<td>Mäeots</td>
<td>Institute of Education, Centre for Educational Technology</td>
<td>Research Fellow of Educational Technology</td>
<td>no</td>
</tr>
<tr>
<td>Külli</td>
<td>Kori</td>
<td>Institute of Education, Centre for Educational Technology</td>
<td>Junior Research Fellow</td>
<td>yes</td>
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8. Description of necessary available resources (equipment, finances):

The current doctoral research project will be conducted in the context of a larger research project “Smart technologies and digital literacy in promoting a change of learning” funded by Estonian Science Fund since 2015 to 2020 as an institutional research grant of the University of Tartu. This project is coordinated by the supervisor of the PhD student and the project covers all necessary resources for conducting the study (equipment, travel costs) and for participating in international conferences to present the outcomes. The project team (listed as the research group where the doctoral thesis is being done) also provides important intellectual support to the PhD student (feedback to the plans and outcomes, consultation in statistical analysis and writing articles). Doctoral student will have a physical work-place with necessary resources and equipment (personal table, computer, software, etc.) in the Centre for Educational Technology, Institute of Education (Salme 1a room 312).

9. Doctoral thesis’ innovativeness and importance for development of this scientific direction:

This PhD study will be conducted in the context of the research project “Smart technologies and digital literacy in promoting a change of learning”. The larger project has three goals:

1. Investigate what factors explain the access and usage patterns of mobile learning technologies (in this context smart phones and tablets), in general; and the potential use for learning purposes by STEM teachers and students in particular,

2. Develop three interventions, based on the investigations to improve students’ motivation and learning in the context of STEM education, and

3. Conduct a large-N field experiment to evaluate how these interventions perform in an applied classroom context.

The current PhD study focuses on the second and third goal.

Mobile learning technologies (tablet computers and smart phones) are increasingly used in everyday life, but overwhelmingly for entertainment (listening to music, playing games) or communication (voice, messaging, email, social networking). Noting this trend, we argue that schools should play a strong role to prepare future citizens to more ably apply mobile learning technologies to achieve a wide range of personal and educational beneficial goals. This is especially so in enhancing competencies (values, attitudes, knowledge and skills) needed in the 21st century. Of the six fundamental competencies listed, digital literacy is expected to be the key
category in understanding and using mobile learning technologies effectively in education, pointing the way to further use of unknown technologies in the future.

With the rapidly expanding uptake of tablets and smartphones, one might expect that the new generation of students, the so-called ‘digital natives’ (Prenski, 2011), would be very active in using mobile learning technology. This, indeed, seems to be the case. However, as Beemt, Akkerman and Simons (2010, 2011a, 2011b) clearly show, this does not mean that they are digitally literate. The same has been appeared in the cross-sectional survey conducted in the first phase of the large-scale project where the current PhD study is planned. The findings about Estonian schools (6th and 9th grade students’ science and mathematics learning) show that there is only 4.9% of ‘digital natives’ who use mobile learning technologies actively in variety of learning processes – information search and retrieval, communication and collaboration, digital content creation – while almost half of the students (49.9%) use them in learning only once in a month or even less (Pedaste, Must, Leijen, Mäeots, Siiman, Kori & Adov, 2017).

Therefore, usage of mobile learning technologies in classrooms seems to be limited and little is known about the effectiveness and acceptance of mobile learning technologies in education. Studies so far have been generally small and their number limited. Melhuish & Falloon (2010) discuss the affordances and limitations of the iPad in education. They suggest that iPads may become exciting platforms for consuming and creating content in a collaborative, interactive way. Nevertheless, the authors warned that research on these affordances and careful integration in effective and innovative practices is needed, so that learners are empowered and enriched by the learning experiences with mobile learning technologies.

The potential benefits of mobile learning technology in education can be used to help mitigate a serious problem in STEM (science, technology, engineering and mathematics) education – in Europe not enough students take up science and technology related careers (European Commission, 2004). Two importance causes for this may be the abstractness and non-relevance of science as it is typically taught in schools today (Osborne et al., 2003; European Commission, 2007; Tytler, 2007). Students do not see school science as useful for their lives and future developments, with too much repetition and too little challenge (Osborne & Collins, 2001; Sjøberg, 2001; Abel & Lederman, 2007). International studies (e.g. TIMMS; PISA) show that students in developed countries, including Estonia, age 14-15, have low motivation towards learning science, especially in chemistry and physics (Teppo & Rannikmäe, 2008; OECD, 2007).

Therefore, we can say that innovative interventions are needed to motivate STEM students, and improving students’ digital literacy to apply mobile learning technologies offers a promising solution. In this context there is also a need to adopt the main approaches that have proved to be effective in STEM education: problem solving and inquiry learning. Several studies show how in the context of STEM education, problem solving and inquiry processes need to be supported by metacognitive and cognitive support elements (Pedaste & Sarapuu 2014; Runnel et al., 2013; Holbrook & Rannikmäe, 2010). These support elements should facilitate students in developing digital literacy, thus producing and creating new products, often in solving design problems (Jonassen, 2000). Therefore, the design principles of reflection (Benammar, 2004; Mezirov, 1991; Schön, 1983; Leijen et al., 2012) should also be taken into account in developing interventions for using mobile learning technologies to motivate both students and teachers in STEM education.

In conclusion, the main aim of the current PhD project is to develop evidence-based interventions to integrate science and mathematics learning using mobile learning technologies in lower secondary school and to test them in large-scale experiment to provide a conceptual framework for using mobile learning technologies in STEM learning.
10. **Doctoral thesis project:**

1. Systematic literature review to specify the characteristics that are important in developing interventions for STEM learning with mobile learning technologies and to figure out the first version of the conceptual framework for using mobile learning technologies in STEM learning. Writing the first article based on the literature review. Autumn 2017.
2. Choosing, evaluating and adjusting appropriate methods (including instruments to measure learning outcomes) and learning software to be used in the interventions. Autumn 2017.
4. Data analysis based on the co-creation process and piloting. Writing the second article based on the pilot studies. Spring 2018.
5. Teacher training and consultation to engage teachers who will be involved in large-scale studies to test interventions. Spring and autumn 2018.
6. The large-scale interventions in schools, data collection and analysis, enhancement of interventions. Writing the third article based on the large scale intervention. Autumn 2018, spring 2019.
7. Analysis of the results and development the conceptual framework for using mobile learning technologies in STEM learning. Writing the fourth article to justify the framework. Autumn 2019 and spring 2020.
8. International research visits to improve the framework and to get feedback from international scholars (semester in abroad). Autumn 2020.

11. **Summary in Estonian**

   **Title:** Tõhusad sekkumised nutiseadmete süstemaatilise kasutamiseks loodusteaduste ja matemaatika lõimitud õppeprotsessis

   **Supervisor(s):** Margus Pedaste (PhD)

   **Annotation:**

   Doktoritöö põhieesmärk on välja arendada tõenduspõhised sekkumised loodusteaduste ja matemaatika lõimitud õppeprotsessiks, milles kasutatakse mobiilsete õpotehnoloogiaid (nutitelefone ja tahvelarvuteid) põhikooli vanemas astmes. Selleks viakse esmalt läbi süstemaatiline kirjanduse analüüs, et mõista olulisemaid põhimõtteid mobiilsete õpotehnoloogiate disainimiseks. Seejärel arendatakse välja raamistik ja sekkumised mobiilsete õpotehnoloogiate rakendamiseks loodusteadusi ja matemaatikat lõimivas õppeprotsessis. Raamistiku ja sekkumiste arendamine ja testimine toimub ühistööna, misse on kaasatud õpetajad ja õpilased. Lõpuks testitakse sekkumisi ulatuslikus uuringus Eesti koolides. See uuring annab olulise sisendi, et täiustada tõös väljaarendatud raamistikku ja koguda tõendeid selle relevantsuse kohta koolis.

12. **Summary in English:**

   **Title:** Effective interventions for systematic use of mobile learning in integrated science and math learning process

   **Supervisor(s):** Margus Pedaste (PhD)

   **Annotation:**
The main aim of the current PhD project is to develop evidence-based interventions to integrate science and mathematics learning using mobile learning technologies (smart phones and tablets) in lower secondary school. Therefore, there will be conducted a systematic literature review to understand the most important principles in designing learning process using mobile learning technologies. Next, there will be developed a framework and interventions to use mobile learning technologies in integrated science and math learning process. The framework and interventions will be designed and piloted in co-creation with teachers and students. Finally, the interventions will be tested in a large-scale study in Estonian schools. This study provides important input to develop further the framework and to collect evidences about its relevance in schools.