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Sustainable development processes of education technologies - A multiple case study

Bolmsten Johan [d*], Kasepold Kadi [c], Kaizer Adam[a], Ziemska Monika[a], Heering Dan [c], Alop Anatoli [c], Chesnokova Marina [b], Olena Sienko [b]

[a] Gdynia Maritime University, Gdynia, 81-225, Poland
[b] National University "Odessa Maritime Academy", Odessa, 65029, Ukraine
[c] Estonian Maritime Academy, Tallinn, 11712, Estonia
[d] World Maritime University, Malmo, 211 18, Sweden

[*]Corresponding author. E-mail: jb@wmu.se

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Abstract

The purpose of this study is to identify sustainable development processes of education technologies. The theme of the IAMU AGA21 targets innovation and sustainability, including innovative MET environment and GMP applications. It is, however, a known issue that the outcomes of research and education technology development projects do not sustain beyond the lifetime of the projects. This research study is a multiple case study of education technology development at three different Maritime Education Training institutions. The cases are analyzed using a framework of sustainable participatory processes of education technology development. The individual cases show the need for and dynamics of integrated e-learning infrastructure; empowering teachers with new e-learning activities and resources; and enabling students to contribute to educational capacity-building as part of their studies. The study highlights key considerations to sustain the results of research and development projects. The results are valuable to maritime education and training institutes to enhance their study programs with online, blended, and distance delivery modes.

1. Introduction

The starting point of this paper is building educational and technical capacity at Maritime Education and Training Institutes (METI), beyond isolated research and development projects. The International Association of Maritime Universities (IAMU) has a capacity-building role, and each year IAMU supports research and development projects. The theme of the IAMU AGA21 targets innovation and sustainability, including innovative MET environments and Global Maritime Professional (GMP) applications. The recently published GMP initiative and book of knowledge

develops and systemizes IAMU's commitment to joint capacity-building and provides a framework to support and coordinate such future efforts (IAMU 2019)[1]. The commitment to capacity-building research and development projects makes it crucial that the results are of practical and sustained value to the maritime universities. The research question guiding this study is how do research and development projects inform sustainable development processes of education and technologies at METIs?

The study uses a multiple case study to examine sustainability issues at three maritime universities that participated in a joint development project about educating the GMP using new e-learning technologies. The paper is structured as follows: Section 2 situates the study in concurrent research on education technologies and sustainable development processes; section 3 describes the multiple case research approach and the analytical framework that is used to analyze the empirical data; section 4 presents the empirical findings; Section 5 concludes the paper.

2. Background

2.1 Education technologies

The usefulness of education technologies has early on been of interest to METIs. Muirhead (2004) and Ircha and Balsom (2005) recognized the qualities of different types of technologies, such as the difference between "push-based" one-directional and "pull-based" learner-centered approaches. Muirhead (2004) also recognizes key development considerations such as the need for staged growth and planning to achieve educational usefulness. Bolmsten and Manuel (2020) and Ahvenjärvia et al. (2019) indicate how the GMP learning outcomes and taxonomies prompt the development of new educational approaches and the usefulness of e-learning technologies. In the context of the maritime competency-based approach to education, the interrogation of online constructivist learning approaches is especially relevant. According to the constructivist learning approach, the learning process is complex and multifaceted, where learners, based on personal reflection, seek new information and test ideas together with others (Vygotsky 1978; Rogers 1969). Bolmsten et al. (2021) develop an online constructivist approach using the rapidly developing affordances of online technologies. Based on earlier research on online collaborative learning by Bates (2018), it is shown how a synchronous live mode of delivery and an asynchronous anytime and anywhere mode of delivery can be blended.

[1] Other concurrent capacity-building projects include e.g. Skillsea: https://www.skillsea.eu/

2.2 Sustainable participatory processes of education technology development

To build capacity, GMP projects relating to the development of education technologies need to provide practical and sustained value to the project participants. Capacity-building through education technologies is at the center of UNESCO (2015) and related policy documents. The importance of a participatory process is highlighted for the design, implementation, and framing of education. UNESCO's policies and guidance relate to research concerning the sustainability of education, focusing on optimum educational development, leadership, and innovation practices (Davies and West-Burnham 2003; Alharthi et al. 2019). Mednikarov et al. (2016) provide a practical account of the need to increase the sustainability of research and development of applications and infrastructures to benefit MET systems. Several research studies put forward frameworks for the development of sustainable education technologies, including the interrogation of institutional embedment (Casanova and Price 2018) and learning and power dynamics at individual, collective, and networked levels (Alharthi et al. 2019). This research study uses a framework based on the sustainable participatory processes of education technology development (see *Figure 1*), where the joint knowledge development of domain experts and technical experts is in focus (Bolmsten and Manuel, 2020). The framework relates to research on Participatory Design (Poderi and Dittrich 2018; Bødker et al. 2004) and "infrastructuring" depicting procedural, ongoing, and multi-relational development activities, which unfold over extended periods of time (Star and Bowker 2002; Simonsen et al. 2020).

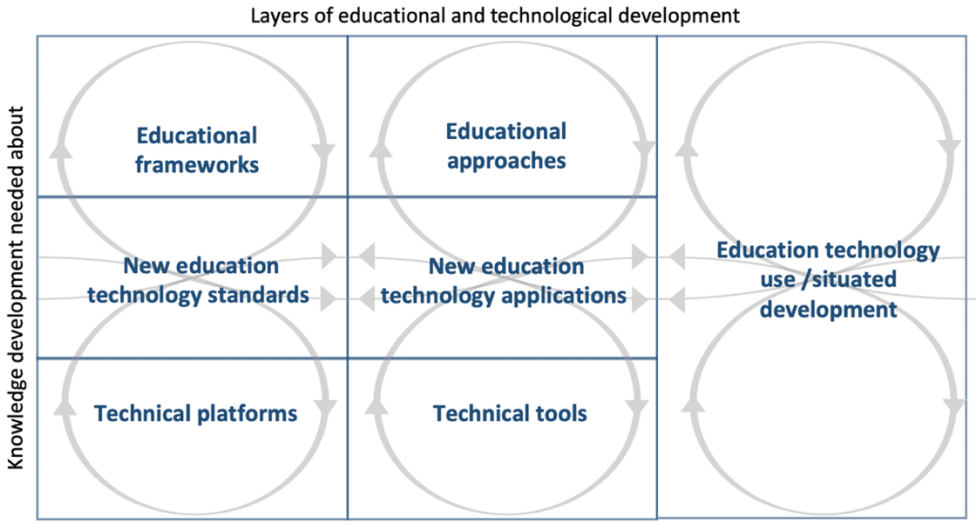

Figure 1. Framework on the sustainable participatory processes of education technology development.

The horizontal layers in the analytical framework denote the need for participatory knowledge development processes relating educational knowledge (top horizontal layer) and technical knowledge (bottom horizontal layer), which, when combined, result in knowledge development about new education technologies (middle horizontal layer). This knowledge development process, in turn, relates to standards (left vertical layer), applications (middle vertical layer), and in-situ development (right vertical layer). The evolutionary process in the framework links educational and technical know-how in the layers of standards, applications, and in-situ development. The evolving cycles highlight how a general understanding of technical provisions or educational matters is not enough. The focus is on the new knowledge development needed in the interfaces between education and technical knowledge.

3. Research Approach and setting

This research study is a multiple case study of education technology development at three different METIs. A common way to aggregate qualitative research is through multiple case studies (Yin 2013). The evidence from multiple cases is often considered more robust than a single case study to build theory and develop policy implications (Yin 2018).

The three METIs participated in a two-year research and development project to build young maritime professionals' capacity in Maritime Innovation Management (MIM) using blended-learning education technologies. The MIM project's work packages started with the analysis of educational needs. Three onsite partner workshops were carried out - one in each METI – to gain the perspectives of the faculty, students, and administrators. Participatory workshop techniques/activities were used to understand the issues at hand and aid the development of solutions. These included a SWOT analysis that was developed throughout the project and workshops, rich pictures to gather additional relevant descriptions of existing work practices and design visions and proposals, and onsite tours. The last part of the project was an action research study that tested the results from the analysis of the educational needs by designing and delivering a new blended e-learning course with student groups from each partner university.

This study follows up on the project results to understand how they informed capacity-building at the participating universities. Although all the three METIs participated in the same project activities and the development of the same education technology solution, during the project, there was already a realization that these were of different practical value to the METIs. Therefore, this

multiple case study was initialized based on the assumption that each case provided different but complementary insights (Yin 2018 p55) into the issue of sustainable development. The study revisits the empirical data to understand how the unfolding of topics and issues during the workshop and action research informed the development processes at the respective institutions. The study also follows up with the project participants and key stakeholders to gain their perspectives on the project's value after its completion. The analysis is structured with the framework on sustainable development processes of education technologies developed by Bolmsten and Manuel (2020) to make cross-case comparisons and draw conclusions (Yin 2018 p58). Each METI is treated as a case study where the analytical focus is how the project activities and results informed different points of innovation or breakdowns at the METIs (Pipek and Wulf 2009). The cases were first coded separately to be sensitive to the specifics of each case, using the qualitative analysis software NVIVO. The analysis was then iteratively developed, where the authors compared the cases to arrive at the findings presented in the following section.

4 Result

4.1 Case 1: The need for new knowledge of linking educational frameworks to technical platforms

The first case gave evidence to an METI that had started to apply the GMP educational framework in practice. From the students' perspective, for their future maritime careers, they placed a high value on acquiring knowledge beyond the essential STCW competencies to cope with the maritime industry's rapid technical development and globalized nature. The students needed to expand their knowledge in areas such as new autonomous technologies and soft skills such as teamwork, leadership, and cultural awareness. To meet these educational needs, the university’s overall strategy included using new blended-learning approaches, and complementing existing classroom teaching with new e-learning delivery options to expand their educational offering.

In this case, using the framework for sustainable development processes (Bolmsten and Manuel, 2020), the follow-up analysis came to focus on the need for developing new education technology standards. The analysis showed that the METI faced constraints in meeting its educational needs and putting the MIM project results into practice due to the lack of an e-learning platform. During the MIM project’s onsite workshop and action research, the project participants build their understanding of new constructivist educational approaches using new e-learning tools, where students could collaborate with each other on practical cases and access new industry and academic

expertise. To make use of these results after the project ended, the METI needed to additionally build their capacity of the underlying e-learning platforms and the linkages to local educational frameworks, including quality assurance standards of online delivery and assessment. The MIM project revealed a specific need for local capacity-building by showing how a general-purpose e-learning platform could be used, including technical standards to share and co-create content with industry and academic experts. The MIM project, thereby, informed the development of education technology applications and highlighted the need to develop underlying linkages to the local implementation of educational frameworks and e-learning platforms to sustain the results. The continuous development process thereof and developing these linkages over time is key for the METI to sustain the MIM project results, and the results of future education technology capacity-building projects

4.2 Case 2 - Empowering instructors

In the second case, the key issue was empowering instructors to develop educational approaches to the GMP educational framework. The results from the second case centered around the needs of a group of instructors teaching management specialization topics, including innovation management in the maritime industry. The instructors were already teaching these courses at an advanced level, and developed lectures combining theoretical issues with practical tasks, cases, and assignments. One of the instructors commented that the challenge was in each new semester to "try to update the material, add something new and interesting, so that students can get useful and up-to-date information about innovations and areas in which innovations can be applied […] I learned a lot of useful information [during] the project and [I am] ready to cooperate". Both the instructors and students recognized how the issue concerning topics such as innovation management - given the globalized nature and rapid technological development in the maritime industry - was that the METI operated in too much isolation in its national jurisdiction.

In this case, the follow-up analysis using the sustainable development framework (Bolmsten and Manuel, 2020) shows that the design and testing of the constructivist e-learning mode of delivery during the MIM project provided practical insights for the instructors to develop educational approaches for specific learning outcomes in their courses concerning

- Accessing new topical expertise using e-lessons: E-lessons dynamically combine learning activities and resources, such as recorded videos, reading resources, and assessments. In this case, the e-lessons showed how new academic and industry expertise could be provided to the

METI students; and the possibility to blend the e-lessons with established classroom teaching activities to gain a deeper understanding through reflection between the students and teacher.

- Enabling new collaboration through online video and forums: Another insight was using online video tools beyond a one-way lecture delivery mode. Of relevance to the management and innovation studies at the METI, the MIM project showed how students could collaborate and undertake case studies with students from other METIs through the advanced use of synchronous video collaboration tools and asynchronous forums to apply their knowledge, innovate, and analyze the outcome.

In this way, the second case shows how new education technology applications were in focus and how instructors evolved their established educational approaches through the utilization of new technical tools. In this case, by linking to their existing education frameworks and technical platforms, the instructors could sustain the MIM project results by continuing to build their educational capacity using new technical tools.

4.3 Case 3: Making use of students' input in educational activities

In the third case, making use of students' input in educational activities was in focus. The METI was already using the GMP educational framework to develop curricula with advanced use of its e-learning system to deliver courses across the institution. Different e-learning usage levels were established, ranging from basic course information, study materials, and literature to advanced additional plugins to support the learning process either in parallel to classroom lectures or through complete distance studies. The development of the e-learning courses and platform was also part of the quality assurance system. Students, for example, provided feedback after the end of each course about the visual appearance, structure, accessibility of materials, and additional plugins. The concurrent challenge concerned developing student projects and involving them in the development of education at the METI. This challenge relates to inputting user experiences and situated development into the sustainable development of educational and technical application and institutional standards (Bolmsten and Manuel, 2020). For the METI, already for basic seafarer education, the development of analytical skills is an important part, considering the rapidly developing maritime sector and labor market. The students' projects take the form of course-based challenges wherein the students undertake inquiries and developments that, in turn, input and develop the educational activities at the METI. At a Bachelor or Master level of education, this relates to the students' thesis work and the undertaking of more advanced independent inquiries.

Overall areas of student projects concerned maritime service design, entrepreneurship, managing innovation, and business model development. In the third case, the participatory workshop techniques deployed during the MIM project provided new knowledge about the possibility of developing the students' projects related to the METI's work with the surrounding maritime cluster. The MIM project showed the possibility of how to include new cutting-edge knowledge and create synergies through new collaborations with the maritime industry and other METIs. The possibility to make use of the students' input indicates how the METI can continuously input new knowledge to inform the sustainable development of its educational and technology applications and platforms.

5 Conclusion

The results from this multiple case study improve the understanding of how research and development projects build educational and technical capacity at METIs, based on the analysis of sustainable development processes (Bolmsten and Manuel, 2020). Figure 2 summarizes the results from the three METIs.

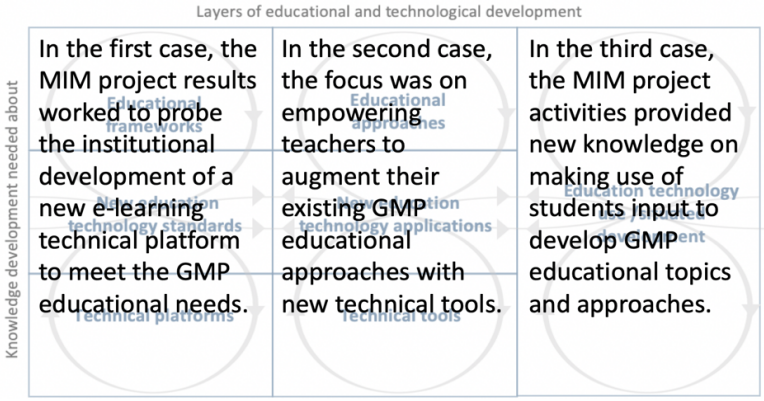

Figure 2. Summary of results in the framework on the sustainable participatory processes of education technology development (Bolmsten and Manuel, 2020).

The combined results show how a research and development project does not build *de novo* capacity but needs to relate to the *installed base* (Star and Bowker 2002) at the METIs. For this purpose, the analysis shows how it is key to understand how capacity-building occurs through situated education and technical knowledge development in layers of standards, applications, and situated development. The contribution of this multiple case study, thereby, systemizes and sensitizes how research and development projects on education technologies trigger capacity-building at METIs.

The results can strengthen the process of how the annually funded IAMU research and development projects define proposals with common objectives and work packages and how the results contribute to sustained capacity-building at the partner universities. To further develop theory and policy implications for IAMU and its member universities, it is recommended that additional case studies are added to the results of this study through new and multiple case studies (Yin 2013 2018), action research (Robson and McCartan 2016), and synthesizing the results of already published cases (Hoon 2013). The results of this multiple case study will be developed using a longitudinal empirical case study design. Based on the concurrent conceptual development of "infrastructuring" (Simonsen et al. 2020), the objective is to develop the framework of sustainable participatory processes of education technology development to determine the outcome of capacity-building projects and support the design of new ones.

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