Curriculum development in (information)technology-oriented field

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Summary

This article looks at the complexity of the problem of formulating, achieving, and assessing learning outcomes for curriculum modules in the above-mentioned field. At innovation and technology-related fairs, the emphasis has been placed more and more on the importance of competencies connected with cooperation between humans and machines, with the keyword being *co-opetition* (a portmanteau of competition and cooperation) between people and robots, among others. In its most general sense, coopetition involves cooperation directed towards innovation and exceeding the boundaries of traditional fields of activity (Corbo et al., 2023).

This article is a fresh attempt to introduce an integrated approach to curriculum development in a technology-intensive field and validate the insights gained from participation in international projects with other institutions of higher education. The empirical material is derived from the results of two projects, Digilog and IntelTrans, to which the Institute of Logistics at the TTK University of Applied Sciences (*Tallinna Tehnikakõrgkool*) contributed as the Estonian partner.

Since the middle of the last century, change in the technical fields of higher education has been driven primarily by rapid technological development and the advance of a knowledge-based society, in which institutions of higher education have become more and more intertwined with research institutions and both in turn with other social institutions.

Regarding the learning outcomes expected by the world of work, they are, unfortunately, rather local in nature and often time-specific. The only knowledge and skills which are needed today are generally expected, and there is little forecasting of what future competencies might be needed, for example, after a university student has completed one or two levels of study. From the student's perspective, it is essential to consider his or her previously acquired competencies, including critical thinking skills, study skills, and a knowledge of ethics. So, in the case of curricula in technical fields, it should be emphasised that all of the above-mentioned perspectives on learning outcomes are relevant, and it

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is necessary to try to find a harmonious balance among them and, if necessary, analyse the reasons for any conflicts.

The following are some important trends which may have an impact on the future of curricula in technical fields:

- Modern technology: Curricula should continue to reflect ongoing technological developments. For example, this may include the Internet of Things (IoT), blockchain technology, cyber security, cloud computing, virtual and augmented reality, and robots and other autonomous systems.
- Digital transformation and artificial intelligence: In technical fields, digital transformation is an important trend. Curricula should include the development of digital skills, such as programming, data analysis, artificial intelligence, and machine learning.
- A multidisciplinary approach. Technological development often occurs in a multidisciplinary context. Future curricula in the technical fields may have more team projects that bring together different fields, such as engineering, design, business, and the social sciences.

Bearing in mind the above-mentioned focus areas and development trends in transport, we would like to draw attention to the following proposals regarding future curricula in transport management.

- Transport and traffic management, including smart and other new technologies. Reasonable transport management reduces traffic congestion and is an input to traffic flow. Use more simulation and modelling facilities in the learning and teaching processes while analysing the total impact of different solutions and scenarios on the environment.
- Our key experts have singled out areas connected with the evolution of electric cars, digitalisation, security, sustainability, and environmental friendliness in transportation.
- Mobility and traffic safety, using ICT technologies to ensure traffic safety and security. Assisted driving, autonomous driving, and advanced driver assistance systems.

Taking the process model view and recognising curriculum development as a continuous process, the present authors have set themselves the following two research questions:

- What should be the balanced input in the modernisation of the technology curriculum modules?
- Can we use the Carpe Diem instructional design methodology to improve modules?

Taking the above-mentioned into account, we agreed with representatives from partner universities in Latvia and Finland that it was necessary to develop together an integrated understanding of smart and innovative traffic management. Our goal would be to create a joint study module, "Intelligent Transport and Traffic Management", which would bring together the best competencies in the field of three universities from three different countries. The development model for the module is shown in Figure 1.

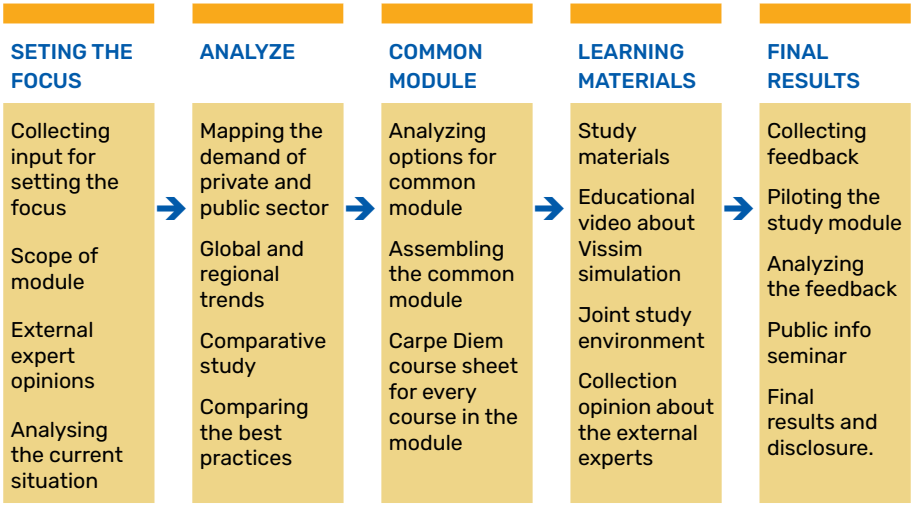

Figure 1. Module development model, prepared by the authors.

To develop the module, we used the Carpe Diem methodology, first introduced in the year 2000, which is an iterative team-based learning design process for developing a teaching/learning action plan. It was given the name "Carpe diem" (Latin for "seize the day") to emphasise its focus on student action (courses are designed around elements which are like calls to action).

The main challenge now for academic personnel teaching technical subjects is, alongside the possession of subject-related and pedagogical knowledge and skills, the application of modern and relevant principles of learning design. The creative planning of teaching and learning in technical subjects using modern digital resources across different forms of study demands a broad array of competencies and should include the participation not only of instructors but also trained learning designers. The use of the Carpe Diem methodology to plan modern e-learning courses and modules for students thus requires the formation of teams composed of both academic and non-academic staff. The course design storyboard is presented in Figure 2.

Storyboard of course "ITS solutions for traffic and safety management"

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
ITS introduction	ITS technologies	ITS applications and user services	ITS architecture	European ITS framework	ITS standards	ITS deployment Case Studies	Europe Action Plan for ITS
General information about ITS	Description of main ITS technologies	Taxonomy of ITS applications its overview	Logical and physical ITS architectures	ITS masterplan at national, regional, and local levels	Overview of ITS standards	Strategic planning	EU action plan for ITS

Learning outcomes

1. Knowledge of basic terminology of ITS. 2. Ability to describe the structure of intelligent systems. 3. Ability to analyze ITS applications 4. Know and be able to use the main EU documents in the field of ITS. 5. Ability to identify the main advantages when using ITS 6. Know examples of practical use of ITS applications 7. Have the skills to develop the main provisions of the ITS implementation master plan.

Seminars and workshops with the lecturer

Face – to face meetings with the lectures

Open-book tests in Moodle	Self test in Moodle	Virtual consultation		Self-test in Moodle

Assessment

Group project "Master plan for ITS application implementation in the home city"	Report and presentations	Test with short answers/ questions	Report
			Presentations

Figure 2. Storyboard of course "ITS solutions for traffic and safety management", completed by the authors.

In the next stage, teaching materials were created for the selected module subjects and then piloted. The feedback collected was used to help instructors improve subject content and teaching strategies.

After the results of the piloting had been analysed, the authors of the different module subjects added more materials and links for independent study.

It is necessary to get different inputs, though, on their own, they are not enough. The suggestions received must be analysed and filtered, considering the developments in the higher education area, best practices in other countries, and the application of modern teaching methodologies, including e-learning methods.

Regarding the first research question, the present authors found that developing curricula in technical fields requires broad-based input from different stakeholders and experts and investigation of the best practices of other universities. Unfortunately, such suggestions are not always directly or readily applicable and need to be adapted to a methodological higher education didactics framework. One must also avoid seeing viewpoints as absolute and fixed, particularly when considering the views of business enterprises and students. Different viewpoints on learning outcomes also increase the complexity involved in their formulation. Sometimes, the process may even be dominated by the academic community's understanding of the "nice to teach" principle. Unfortunately, a broad-based and comprehensive approach to the improvement of curricula in technical fields is inescapable. When describing learning outcomes, there is also no avoiding them, considering the many ways of defining them.

Moving on from the stage of more general and specific suggestions to the stage of updating a course module, we applied the Carpe Diem methodology, beginning with creating a blueprint or visual plan and ending with piloting the course and subsequent development of principals guiding its continuous improvement. The present authors stress, however, that the effective implementation of the Carpe Diem methodology relies on good cooperation between academic and support personnel, broad-based e-learning support, and extensive feedback and feedforward when a course is piloted. Given the rapid changes in the teaching of technical subjects, a one-off approach is not enough. According to the authors, action must be taken every 3–5 years.

Keywords: curriculum, digital learning, technology innovation, *Carpe Diem*