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Research Article

Innovations for Euro-Inf Quality Label-Awarded Computer Science Programme

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Abstract. In this article, we examine a case study of the Bachelor's degree programme "Computer Science" at the University of Latvia. We explore several factors that enabled it to (a) obtain the European Informatics Quality Label three times, (b) be ranked first in the national employer survey as the most recommended educational Programme for nine years, and (c) adopt a student-centred approach. Using a case study methodology, we highlight several innovations that together make the Programme highly regarded both academically and in the labour market. At the end of the paper, we divide the key outcomes of the study into two sets of innovations. National-level solutions, such as learning outcome comparison and the development of industry terminology with student participation, are important primarily in the local context. Whereas (a) the framework for gaining both industry and academic experience through the Practice Course and Qualification thesis, and (b) curriculum expansion with Special Seminars and the creation of opportunities for students to acquire additional knowledge through Excellence Studies and Remedial Courses, can be transferred internationally.

Keywords: computer science curriculum, EQANIE accreditation, learning outcomes, student-centred approach, knowledge requirements, ICT industry requirements, internship.

1. Introduction

The Faculty of Science and Technology (FST) at the University of Latvia (UL) offers the Computer Science bachelor's programme (hereinafter referred to as the CS Programme or Programme) in Latvian and, since 2018, also in English. Since 2021, a Dual Award Programme in Computer Science has been available in collaboration with the University of Lincoln, UK, adding another component to the Programme. This article discusses the development of the Programme from 2012 to 2025, covering the period during which it was accredited by the European Quality Assurance Network for Informatics Education (EQANIE).

The Computer Science Programme at the University of Latvia is the only one in Latvia accredited at both the national and European levels. In the 2025/2026 academic year, the Programme is attended by 896 students from Latvia and 33 other countries. Considering the Programme's offering in a broader national context, it should be noted that, since its inception, computer science studies have also been available at other universities in Latvia. In the 2025/2026 academic year, ten accredited higher education institutions offer studies in the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science (AIKA, 2026). This creates strong competition for applicants among these universities. Therefore, in developing the UL CS Programme, the quality of the curriculum is an even more important factor, enabling it to attract the best students.

When discussing various aspects of the Programme beyond its title and the names of its fields of study, we use the term "Computing". When discussing internships, we also use the term "Practice", reflecting the course title and its common usage in Programme documents. As the name of the structural unit implementing the Programme has changed several times, we use the current name, "Department of Computing", and indicate the previous name that existed at a specific time, if necessary.

In this article, we use the terms "course" and "study course" to refer to a self-contained unit within a Programme curriculum, defined by specific learning outcomes and assessment criteria. In doing so, we follow the terminology used in all study Programme descriptions for international students at the University of Latvia, as well as in specific units of the Programme mentioned later in the article, such as "Practice Course".

Since this article discusses the development of the Programme and its design improvements, the department's faculty is presented as a unified collective evolving throughout the Programme. Thus, the innovations described in this article are regarded as a collectively created framework, within which faculty members have the opportunity to develop courses while also observing the principles of individual academic freedom.

Student feedback on the implementation of the Programme is monitored at both departmental and university levels. Students are required to reflect on the overall study process twice: in the first year of study and before graduation. UL policy also requires students to evaluate courses anonymously through mid-semester surveys and after completing each course (UL Documents, 2024). In the Department of Computing (Faculty of Computing until July 2024), throughout the accreditation period of the Programme, students evaluated courses by completing questionnaires for each course before receiving grades. The assessment of a course could only be entered in the examination protocol after submission of a completed questionnaire. This process provides grade-independent feedback and ensures the involvement of all students. University policy allows course instructors and Programme directors to view student survey ratings. Every six years, these data are used to evaluate the instructor's teaching performance, and consistently low course ratings result in the faculty member responsible for the course attending lectures. This is followed by discussions and recommendations on improving work with students. Student feedback must also be included in the Programme accreditation documents.

Before using several broad concepts accepted in pedagogy, we wish to contextualise them from a Programme development perspective. By "student-centred approach", this article emphasises that curriculum innovations facilitate students in building their own knowledge through practical work and determining their own learning path within the existing curriculum in an academic environment. By "constructivist approach", we mean that all students construct their own body of knowledge through the practice course, together with a Qualification Project and a Special Seminar course, which are discussed later in the article. When referring to "problem-based learning", we acknowledge all components of the Practice course experience.

The concept of Programme accreditation originates from best practices in the computing industry, which follow internationally recognised guidelines. Throughout the 20th and 21st centuries, several evaluation and quality assurance frameworks have been developed to provide up-to-date information on best practice trends in computer science. The most well-known are ABET (Accreditation Board for Engineering and Technology), which has operated under the acronym ABET since 2005 to reflect its broader range of disciplines (ABET, n.d.), and EQANIE. Both agencies accredit applied programmes, thereby ensuring they meet the profession's quality standards. EQANIE currently accredits 452 study programmes from 119 higher education institutions in 25 countries (EQANIE, n.d.).

The CS Programme at UL is accredited by EQANIE and has received the Euro-Inf Quality Label (European Informatics Quality Label) three times since 2012, with the most recent accreditation valid until autumn 2029. This provides the foundation for students to receive a high-quality, contemporary education covering various branches of computing and offering a solid, systematic knowledge base in the field.

On the other hand, the ICT industry requires new employees who, in addition to theoretical knowledge, have already acquired work experience. Throughout the duration of the Programme, work experience, alongside education, has been a dominant employer requirement (Borzovs and Borzovs, Jr., 2000). This remains true, as shown in the latest EU employer survey, where employer requirements were used as a parameter for statistical measurement (Cedefop and Eurostat, 2025). Referring to Cedefop's research and using its methodology, the situation in the Latvian labour market in 2025 is characterised by the fact that, in most job advertisements, work experience is indicated next to qualifications or education level (Romele, 2025).

Among the EQANIE-accredited programmes, several others also combine academic and practical components of study. A few examples include: University of Bath; Queen's University Belfast; University of Liverpool; Royal Holloway, University of London; University of Warwick (UK); Universitat Politècnica de València (Spain); and Fachhochschule Aachen – University of Applied Sciences in Germany (The Euro-Inf Quality Label Accredited Programmes, 2025).

However, experience reports on linking university education with industry practice in a European-level accredited programmes that includes both components remain largely unexplored. The same applies to additional opportunities for interdisciplinary or in-depth student training within the programme to create a more student-centred learning environment and to address the challenges that programme developers in engineering education face in different countries when adapting curricula to rapid technological developments and maintaining curriculum relevance (Gerwel et al., 2025).

The aim of this article is to share our experience and discuss the methodology of teaching computing by periodically conducting international quality control and integrating innovative components into the Programme to create a student-centred curriculum. This leads to the research question: how can an internationally accredited computer science study programme be created and developed to academically support the interests of both employers and students?

The objectives of the article are to analyse: (1) how to combine local (in this case, Latvian) higher education requirements with EQANIE requirements; (2) how to ensure that employers' expectations for experienced employees are met by creating a multi-level education system; and (3) how to expand the programme to provide both interdisciplinary and in-depth studies in computing that support a student-centred approach in accordance with each individual's educational and professional career goals.

We use a qualitative research approach, employing an extensive case study methodology and drawing on various information sources, including policy documents from the University of Latvia and its structural units, CS Programme accreditation documents, study course descriptions, curriculum mappings, and employer survey results. The scope of the research is a longitudinal study of a specific Bachelor's programme. It offers ideas for the development and implementation of similar programmes, without claiming to make broad generalisations about aspects related to the national context.

In the following sections, we discuss the origins of the Programme and the decision to accredit it at the European level, and share our experience with its practical implementation. We focus on several innovations. First, we show the process design by which the individual learning outcomes of each course and the overall Programme are aligned with both local and EQANIE requirements. Second, we analyse how the Practice Course and Qualification Project are incorporated into the Programme. Then, we show how a student-centred approach is implemented through the creation of a Special Seminar course that allows students to choose additional training in both theoretically and practically oriented directions. Furthermore, we discuss two innovations essential for an inclusive approach: Excellence Studies during the Programme for students who are willing and able to learn more, and additional training at the beginning of studies for students whose knowledge is insufficient, both offered without additional payment. In the results and conclusions section, we highlight the Programme's innovative achievements and discuss further research directions.

2. Development of the Computer Science Programme at the University of Latvia

To better understand the current version of the Programme and its innovations, we provide a brief overview of its development. The evolution of the Programme is continuous and does not involve abrupt changes. However, we distinguish two stages: (1) the period before 2012, when the Programme was developed following ACM and IEEE guidelines, and (2) the period since 2012, when further development has been in accordance with Euro-Inf Framework Standards and Accreditation Criteria. Therefore, we first discuss the beginnings of the Programme and then focus on the EQANIE accreditation stage.

2.1 History of Programme Development

The Computer Science Programme was launched in the late 1980s and early 1990s, during Latvia's transition from the higher education system established in the Soviet Union to independent programmes based on the Western educational system. "It [the Programme] was based on the computer science curricula of some North American universities. Recognising the leading position of the United States and its universities in the information and communication technology (ICT) sector and education, this was considered a rational decision" (Borzovs, 2004).

As the Programme evolved, it became clear that its quality would be improved by comparison with international standards. Since the early 2000s, the Programme has mainly followed the recommendations of the Association for Computing Machinery (ACM) and the IEEE Computer Society (IEEE-CS), which provided undergraduate study guidelines for computing curricula in computer science, computer engineering, software engineering, information technology, and information systems (ACM/IEEE-CS, 2001).

2.2 Decision to Accredit the Programme at European Level

In 2009, EQANIE was established in Europe to promote the implementation of quality assessment practices in European informatics education. It developed a system for awarding the Euro-Inf Quality Label to informatics degree programmes. The decision to accredit our Programme at the European level was supported by EQANIE's statement that the Euro-Inf Framework Standards "describe the programme (learning) outcomes of an accredited higher education programme but allow for considerable variation in the emphasis of individual programmes" (EQANIE, 2009). In 2011, the UL Computing Department submitted documentation and, together with two other European universities, was among the first to be granted full-term accreditation.

The current CS Programme offers five directions within the curriculum: Theoretical Computer Science; Software Engineering; Information Systems; Information Technology; and Computer Engineering (UL Bachelor's study programme "Computer Science", 2026).

To accredit the Programme at both national and European levels, it was necessary to create a system that would allow each of the Programme's courses, as well as the Programme as a whole, to be compared to EQANIE learning outcomes. The next section describes the design of this process.

3. Meeting Academic Programme Accreditation Requirements Using a Student-Centred and Practice-Based Approach

In Latvia, higher education study programmes must be accredited. This is the responsibility of the Quality Agency for Higher Education. To submit a programme for international accreditation to EQANIE, it must first meet national requirements (EQANIE, 2016, p. 4). The national accreditation standards, as well as the procedure for course descriptions and learning outcomes, were well known to the teaching staff. However, as already mentioned, European-level accreditation requires comparing the learning outcomes of each course with those defined by EQANIE. The design of this comparison process became an innovation that guarantees, and continues to guarantee, the compliance of each course with both Latvian and international requirements.

3.1 Meeting EQANIE Study Quality Criteria

To ensure that the learning outcomes achieved in each course meet all requirements, an innovative two-tier learning outcome course development system was created. First, the course developer formulates the learning outcomes for the course according to the system developed in Latvia, indicating the knowledge, skills, and competences that students will acquire by meeting the requirements according to the specifics of their course. According to the Higher Education Act, the course developer is responsible for defining the outcomes to be achieved. (Legal Acts of the Republic of Latvia, 2026) Next, the course developer, using the code and numbering system[1], must add the EQANIE learning outcomes. The system also allows partial matching of a particular EQANIE learning outcome. In this case, the EQANIE code is written in lowercase. However, the course author defined outcomes, and EQANIE outcomes must be interconnected. This ensures quality control of each course's compliance with the overall direction of the Programme. Table 1 shows how learning outcomes are formulated in "Software Engineering", one of the Programme's core courses.

[1]According to the Outcomes for First Cycle Degree (FCD) Programmes in the document "EQANIE Outcomes for Informatics Degrees", the numbering corresponds to each of their point. "E" is an abbreviation for EQANIE, and "B" denotes a bachelor's degree. The EQANIE Outcomes for Informatics Degrees are available at: https://eqanie.eu/wp-content/uploads/2019/09/Euro-Inf-Framework-Standards-and-Accreditation-Criteria-V-2016-10-24.pdf (pp. 20–23). Accessed March 10, 2026.

Table 1. Latvian and EQANIE learning outcomes for the course “Software Engineering”. The code letters are capitalised if a particular EQANIE learning outcome is fully covered, and lowercase if only partially covered. This table includes the learning outcomes that meet EQANIE requirements. The full list is available in the course description[2].

Course Author Defined Outcomes: Knowledge	EQANIE Outcomes
Explains the main concepts used in key software engineering processes.	EB32
Describes the life-cycle models of software development, the principles of project development teams.	EB32
Describes the types of software requirements, the standards to be used for documenting them and the modelling capabilities.	eb31
Describes the architectural styles used in the software design, modelling options.	eb31
Explains the key principles for software quality assurance.	eb31
Course Author Defined Outcomes: Skills	**EQANIE Outcomes**
Analyses the team’s work in the development of the system, assess the risks and the possibilities for reducing them, forecast the amount of future effort and plan it jointly with the group.	EB33, eb34, eb61, eb62, EB65, EB21, EB22, EB23, eb24, EB14, eb15
Takes part in s reasoned debates in the group on the requirements of the system to be developed and the options for design solutions.	EB33, eb34, eb61, eb62, EB65, EB21, EB22, EB23, eb24, EB14, eb15
Course Author Defined Outcomes: Competence	**EQANIE Outcomes**
Assesses the compliance of developed software specifications and design documentation with industry standards.	eb31
Assesses the impact of developed software specifications and design documentation on the quality of the software product.	eb31
Gives reasoned proposals to improve software specifications and design quality.	eb31

The Programme director then reviews the compliance of all Programme courses and the Programme’s overall compliance with all EQANIE learning outcomes. By meeting EQANIE accreditation requirements, we can be confident in the quality of the courses and the overall compliance of the Programme with current demands.

However, neither Latvian nor EQANIE requirements specifically address how to promote students’ practical preparation for the labour market. What employers expect in addition to good theoretical preparation, and how to meet these needs, is described in the next section.

[2] “Software Engineering” course description is available at: https://www.lu.lv/en/studies/study-process/courses/courses/?tx_lustudycatalogue_pi1[course]=DatZB038&tx_lustudycatalogue_pi1[action]=detail&tx_lustudycatalogue_pi1[controller]=Course. Accessed March 10, 2026.

3.2 Industry Practice and Qualification Project

To ensure that students gain work experience and are prepared for the demands of the labour market at any stage of the Programme, a mandatory work placement (internship) called a "Practice Course" has been integrated into the process of obtaining a BSc degree since 2005. The Practice Course enables all students to gain professional experience. In addition, the young people can determine whether they have chosen the right study programme and career (Borzovs, 2008). Securing an internship place is achieved through collaboration between employers and the UL.

The internship is implemented in the fourth and fifth study semesters for 17 weeks, during which students work full-time. This is formalised through an internship agreement, which requires the employer to comply with specified rules but imposes no financial obligations. First, students must apply and receive acceptance from the employer, then keep a practice diary during the internship, and, at the end, prepare an oral report on the progress of the practice. The overall assessment of the Practice Course is based on (a) the student's internship diary, (b) the employer's assessment, and (c) the student's oral report. The Practice results correspond to 20 EQANIE-defined learning outcome criteria (DatZR006: Practice FST UL, 2026).

Upon completing their Practice Course, students must prepare and defend a Qualification Project. The objectives of the Qualification Project are to create a software product or perform computer network administration work and to provide a technical description of the work completed. The Qualification Project is evaluated by a commission that includes, in addition to the professors of the Department of Computing, at least 50 percent employer representatives. The chairman of the commission is an employer representative. Each year, after the thesis defence, employers provide an overall assessment of the students' work results and offer suggestions for future improvement regarding the Qualification Project design. Qualification Project meets 24 EQANIE criteria (DatZK006: Qualification Project FST UL, 2026).

Throughout all EQANIE accreditation periods from 2012 to 2025, the number of employers providing internship positions each year ranged from 52 to 117 companies and institutions. In 2025, there were 107 such companies and 147 internship contracts.

Several other innovative Programme additions that allow every student to gain additional practically oriented or theoretical experience are discussed in the next section.

4. Programme Course Extensions for Creating a Student-Centred and Inclusive Learning Environment

A student-centred approach is now recognised as an important aspect of achieving learning outcomes, and its inclusion in course design is recommended by both Latvian and EQANIE accreditation requirements (AIKA, 2024, p. 14; EQANIE, 2016, p. 12). In the UL CS Programme, alongside the overall student-centred approach, students have access to several innovative components that directly support their individual interests. More broadly, this enables students to build their own set of knowledge, skills, and competencies in their chosen field or fields. Thus, the Programme further supports a constructivist approach to teaching.

4.1 Special Seminars

The Special Seminar course was introduced into the curriculum in the second half of the 1980s, and its necessity has always been recognised, including in the current version of the Programme. The topics and number of Special Seminars offered vary, but typically at least 10 to 15 options are available each semester. Seminars usually reflect the research interests of professors or industry specialists and often involve students in research or offer employment related to the seminar specialisation.

Table 2 lists the names of the Special Seminars offered by the faculty. The Table is organised in reverse chronological order, starting with seminars that are still ongoing. Here, three groups of seminars, where the results exceed those achievable in the standard study process, have been highlighted.

1. The first group covers various fields within theoretical computer science. Each semester, one or more seminars from this group have been offered since the inception of the Special Seminar course. In the table, the group is highlighted as *Advanced Topics in Computer Science*. Individual professors with internationally recognised research, as well as members of the Quantum Computer Science Centre, have taught and continue teaching the seminars in line with their research focus. A distinctive feature of this seminar group, which continues today, is that some former seminar students, mostly after earning their doctoral degrees, gradually become faculty members and go on to develop their own seminars.

Two other seminars focus on language models and technologies from the perspective of theoretical computer science and more practical aspects.

2. A seminar group, led by UL professors and members of the Artificial Intelligence Laboratory (founded in 1992) at the Institute of Mathematics and Computer Science, UL, together with their industry partners, supports teaching students to use machine learning and other language technology tools for creating translations. This seminar group is highlighted in the Table as *Language Technologies and Artificial Intelligence*. By participating in this seminar, students gain in-depth insight into current topics related to large language models and successfully engage in research and industry projects of national and international significance.
3. The other seminar, *Information and Communication Technology Industry Terminology* (abbreviated as ICT seminar hereafter), is organised in cooperation with the Terminology Commission of the Latvian Academy of Sciences (LAS) and the Information Technology, Telecommunications and Electronics (ITTE) Terminology Subcommittee. It promotes the correct use of Latvian terminology in both

academia and industry. This seminar format ensures student involvement, allowing for the adaptation of current terms – often used by a demographic other than professors – into Latvian. Students also provide their suggestions for the latest ICT terms that should be secondary created in Latvian.

Table 2. List of Special Seminars. Seminars marked with an asterisk (*) have been taught multiple times with similar content, but under slightly different titles.

Special Seminar title
Quantum Computing; Quantum Computers; Quantum Algorithms & Programming*; Quantum Computing & Programming*; Programming Quantum Computers; Quantum Programming Environments; NISQ Quantum Computers; ADEQUATE: A Cutting-Edge Quantum Computing Course*; Thematic [Quantum] Game Development with AI Tools; Programming Practice in Quantum Computing; Automata Theory and Quantum Computing; Underground University [Interesting Topics Related to Computer Science]; *Advanced Topics in Computer Science*; Boolean Function Polynomials; Algorithms and Automata; Algorithm Complexity and Polynomials; Game Theory
Large Language Models: Development, Research and Application; Language Technologies; Fundamentals of Natural Language Processing; *Language Technologies and Artificial Intelligence*; Deep Machine Learning; Computational Linguistics and the Semantic Web
ICT seminar with Participation in the Translation of English ICT Terms at the Meetings of the ITTE Subcommittee of the Terminology Commission of the LAS*
Current Developments in the Information Society; Deep Neural Network Models and Applications; Robotics Club and Cyber-Physical Systems*; From Product Design to User Experience Design; From Modern to Contemporary Art / From Design to Web Design; Food Computing; Creative Applications of AI Tools; Computer System Security Challenges; Clean Code Paradigm*; Artificial Intelligence and Society: Opportunities, Risks, Challenges; Additional Courses in System Administration; Cyber Security Research; Blockchains; Cyber-Physical Systems: Research and Development
Experimental Methods; Modern Cloud Computing Technologies*; Deep Learning and Robotics*; Open Science – What Is It and why Do We Need It? ; Emotional Artificial Intelligence / Affective Computing for Effective Crisis Communication; Joint Mini Accelerator Class/Product Development Course, in Collaboration with SSE Riga and the Art Academy of Latvia*; Open Data and Data Quality*; “Internet Of Things” with a Focus on “Localisation Systems and the Internet of Things in Medicine”; Getting Things Done with Python*; Didactics of Computer Science; From ‘Black Box’ to ‘Glass Box’: Explainable Artificial Intelligence; Survival Kit of the New, Digital Era [Provided by Company Accenture employees and invited guest speakers]; Competitive Programming [Sport Programming]; Current Networking Technologies; Reports and Data Visualization; Guest Lectures at the Department of Computer Science; [Cyber] Security and Vulnerabilities; Modern Approaches and Technologies for IT Product Development; Practical Computing; Practical Deep Machine Learning; Product Commercialisation; Visual Tools for Data Analysis; Building Graphical Modelling Tools; Software Testing; IT Industry Business; IT Security; Garage 36 (Mobile App Development); Web Application Development Automation; Biologically Inspired Computing (Collective Intelligence)*; Image Analysis and Synthesis; Opinion Mining; Experimental Mathematics; Product Commercialization; Building Graphical Modelling Tools; Open Source Technologies; Unsupervised Machine Learning; Modelling and Tool Building*; Software Quality

Seminars are offered as a separate course, allowing students to participate in and receive assessment for up to four seminars. This enables students to attend several of them, whether theoretical or practical. Each student must choose and pass at least one Special Seminar course within the framework of the bachelor's programme. However, during their studies, about 40–50% of students choose to attend two seminars, and about 25% attend three seminars. Some students attend four seminars.

4.2 Practical Implementation Considerations for the Programme

To ensure that each student can individually shape their learning progress while completing the curriculum, two innovations have been integrated into practical course instruction. The first, called "Excellence Studies," provides methodological and, in some cases, direct financial support for those who wish to study a subject or subjects in greater depth. The second, the "Remedial Course" in high school mathematics, ensures that all students have the necessary mathematical knowledge for computing. The participation in the Remedial Course does not exclude participation in Excellence Studies.

4.2.1 What Should Be Done for Those Who Wish to Learn More Than Is Offered in the Study Programme?

In 2010, the University of Latvia decided to develop the so-called Programmes of Excellence (UL Strategic Plan 2010–2020, 2010). The Department of Computing (then the Faculty of Computing, abbreviated as FC) responded by creating Excellence Studies, a special, individually chosen study opportunity within the framework of the existing study Programme. Excellence Studies requires students, while fulfilling the requirements of the standard study programme, to additionally acquire and demonstrate knowledge that exceeds the course requirements. The status of an excellent student allows:

(a) acquisition of an additional 20% of the credit points free of charge;

(b) study according to an individual plan, meeting the requirements set by the University of Latvia regarding the volume and duration of studies;

(c) substitution of courses provided in the programme with other courses that better match the student's interests, including courses taught at other universities;

(d) selection of a mentor from among lecturers or computer science experts and receipt of their consultations on scientific or engineering problems to be addressed by the student;

(e) the opportunity for a paid business trip to a conference that has accepted the student's paper.

Each faculty member can set criteria for excellence in their courses. At the end of the studies, the threshold for excellence points (calculated as credit points and excellence credit points) is 30 ECTS. This system expands study opportunities at the individual level, allowing students to receive confirmation that they have passed specific courses with distinction. Students graduating from a Programme receive a Certificate of Excellence, a written testimony to their outstanding academic performance, if the following requirements are met: at least 20% of the Programme volume, excluding internship and "C" part courses, has been completed at the excellence level; the final thesis has been defended with a grade of at least "9" (excellent); the overall weighted average grade is at least "8" (very good) on a ten-point grading system; and significant work has been carried out demonstrating professional readiness (for example, publication of a scientific article, development of a non-trivial software product or information system, or significant achievement in professional contests or competitions), for which the Director of the study Programme has provided a decision. The certificate may be awarded regardless of whether the student has held the status of an excellence student (UL FC, 2011).

4.2.2 What should be done for those who lack sufficient high school knowledge?

To successfully acquire knowledge in computing, students must have mathematics knowledge at the secondary school level. The quality of this knowledge can be confirmed by the result of the centralised exam (in Latvia) or by the assessment in the secondary education certificate for foreign students. To participate in the admissions competition, the mathematics score must be at least 4 to 8 points on a 10-point scale, depending on the country in which secondary education was obtained (UL Bachelor's study programme "Computer Science", 2026).

It should be noted that students in Latvia come from various types of schools, where they have had different opportunities to choose advanced course packages that provide in-depth study of the subject (Legal Acts of the Republic of Latvia, 2025). If a student has chosen a different advanced course package in high school, their knowledge in mathematics may not be sufficient for computer science studies. In contrast, foreign students come from different countries with varying cultural backgrounds, traditions, and secondary education requirements. Therefore, students may have diverse experiences in learning mathematics. When implementing a Programme, it is not assumed that a lack of prior knowledge necessarily indicates an inability to follow the study programme, but this knowledge must be acquired to avoid problems in later stages of study.

The Remedial Course in Mathematics began in 2007. At that time, students with high entrance results in the subject (at least seven on a ten-point scale) were exempt from the initial diagnostic exam in mathematics, which tested high-school knowledge in algebra, functions, trigonometry, and geometry. However, now all students must take this exam. If they pass, they may participate in the examinations for the Programme courses "Algebra" and "Discrete Mathematics for Computing" without additional training. Those who fail the test must take the Remedial Course in high-school mathematics alongside their university courses. Once students have demonstrated mastery of the missing knowledge by successfully passing the repeated diagnostic mathematics exam, they are admitted to the exams for the relevant university courses.

In this section, we have examined three ways to implement a student-centred approach with Programme course extensions. One of these – a Special Seminar course – was prioritised as it impacts every student. However, two further considerations – how to create a learning environment for students who wish and are able to achieve more, and how to avoid losing students who struggle to keep up when they enrol – are also essential to providing an inclusive learning experience.

Overall, in chapters three to five, we discussed various methods that have contributed to curriculum development. The results section summarises innovations that create an academically valued, employer-recognised and student-centred computer science programme.

5. Result Analysis

In the results section, we will first discuss the outcomes of individual innovations. Then we provide a summary to show the overall contribution of these innovations to the development of the Programme.

1. A two-tier learning outcome system ensures that each faculty member can easily align all specific parts of their courses with EQANIE requirements. As UL policy requires course descriptions to be updated every two years, this also offers an opportunity to improve and supplement courses in areas that have become relevant as computer science theory and technologies evolve. Accreditation procedures stipulate that the Programme benefits from regular updates to each course alignment to two-tier learning outcomes, and receives feedback on all aspects of the Programme implementation.
2. The Practice Course and defence of the Qualification Project provide students with both industry experience and academic reflection on that experience. This offers an opportunity to further develop students' practical and theoretical knowledge in the academic environment, while also helping to meet employers' expectations regarding the qualifications necessary for future employment. Overall, this experience equips students with additional problem-based learning skills through the selection of the most suitable available internship for each student and practical work experience. Even if students face the challenge of finding an internship relevant to their particular field of interest, they still gain practical experience in responding to the demands of the labour market. Successful transitions from study to employment are reflected in graduate employment statistics. According to data submitted for accreditation in 2024, the employment rate is 91.8%. However, this does not include graduates living abroad, for whom statistical data is not collected by the Ministry of Education.

As a result, over the last nine years, since 2017, the Programme has been named the most recommended study programme by employers in Latvia (UL News, 2025).

3. Special Seminars, reflecting current trends in computing and related fields, enable students to develop or deepen their knowledge according to their interests. Thus, the seminars help each student individually construct their own knowledge.

Seminars have also contributed to a broader context.

(a) In the 2025/2026 academic year, 15 former participants of the *Advanced Topics in Computer Science* seminars are teaching and conducting research in the Department of Computer Science at the University of Latvia. Additionally, others are faculty members at foreign universities, including those in Japan, the Netherlands, Denmark, Sweden, and other countries.

(b) The seminars on *Language Technology and Artificial Intelligence* foster collaboration among the university's computing department, research institutes, and language technology companies. These seminars provide students with opportunities to engage in theoretical and applied research projects and also foster the commercialisation of their work results.

(c) The seminar *Terminology of the Information and Communication Technologies Industry* enables students to participate in the creation of national terminology, while also promoting a future-oriented approach to the correct use of the Latvian language in computing. This directly contributes to teaching the study Programme in the official language using appropriate Latvian terminology. Overall, together with the Terminology Commission of the LAS and the ITTE Terminology Subcommittee, seminar participants have secondary created more than 4,000 terms in Latvian since 2012.

4. Throughout all EQANIE accreditation periods from 2012 to 2025, the number of students who received the Excellence Certificate ranged from one to seven academically outstanding individuals each year. In 2025, there were two such graduates.

Due to the Remedial Course, by the end of the first year, 70–75% of students registered in Programme courses "Algebra" and "Discrete Mathematics for Computing" had successfully completed them.

Table 3. Summary of innovations for CS Programme.

Innovation name	Benefits	Results
Two-tier learning outcomes	Ensures that each study course and the overall curriculum comply with EQANIE requirements	Curriculum quality assurance
Practice Course and Qualification Project	Integrates professional and academic training experience	Curriculum quality assurance; implementation of a student-centred approach; problem-based learning approach, constructivist approach

Innovation name	Benefits	Results
Special Seminar course	Expands the study Programme thematically, enabling the development of up-to-date and cross-disciplinary studies with a deeper theoretical or practice-based curriculum	Implementation of a student-centred and constructivist approach
Excellence Studies	Provides advanced learning, enabling students to undertake individual in-depth studies	Implementation of a student-centred and constructivist approach
Remedial Course	Ensures the student's knowledge meets the requirements of the core courses in the curriculum	Implementation of a student-centred approach

6. Discussion and Conclusions

This study allows us to draw several conclusions about innovations in the development of the UL CS Programme. First, in the national context, two innovations are most important:

1. Comparing national accreditation and EQANIE learning outcomes for each course has enabled the creation of a Programme that, while evolving, remains aligned with international industry guidelines, ensuring a high-quality student training methodology.
2. Ensuring the correct use of the national language by involving students as language policy creators through the ICT seminar.

However, several innovations are more broadly applicable, providing a framework for adapting similar approaches in CS programmes internationally.

1. Incorporating a Practice Course into the Programme diversifies and enriches students' knowledge, offers better opportunities for entering the labour market, and provides employers with a more qualified workforce. Thus, the quality of education in the Programme is guaranteed by the European-level accredited academic curriculum, which includes both the Practice Course and the development of a Qualification Project.
2. The inclusion of a Special Seminar course allows each student to choose additional courses not included in the core programme that directly correspond to their research or practical interests. The seminars, in addition to educating students, have indirectly contributed and continue to contribute to the preparation of university teaching staff in computer science; foster cooperation among the university, research institutions, and industry; and support the development and implementation of ICT terminology in the national language.
3. Including the Excellence Studies and Remedial Course allows for consideration of the variety of students' interests and study goals, and the diversity of their prior

knowledge. Thus, the Programme provides opportunities for each student to acquire the necessary knowledge for their future professional career.

The innovations described in this article each originated as design solutions to improve the quality of studies, but together they form a whole that transforms the Programme into something greater than the sum of its parts.

We have also identified further opportunities for research development. As the Programme continues to evolve, one future scenario could include its comparison with ABET guidelines, once again evaluating the US and European approaches.

This study, based on 14 years of development experience of the UL Computer Science Programme, can promote the alignment of curricula with international professional standards, ensuring that students receive a computer science education that is strong in theory and supported by practical experience.

In a broader context, the paper's contribution to European computer science education and accreditation practice lies in providing a detailed framework for incorporating industry experience and theoretical knowledge, as well as developing programme additions to enrich the computer science curriculum.

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