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Evaluation of the instruction of programming in general upper secondary education

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The Finnish Education Evaluation Centre (FINEEC) evaluated the state of the instruction of programming in general upper secondary education in autumn 2021. The evaluation was implemented as a service subject to a fee, and it was commissioned by Maunula Secondary School and Helsinki School of Mathematics. (Viipurin Reaalikoulu Oy). This evaluation is related to the special educational mission to develop the instruction of mathematics that has been granted to Maunula Secondary School and Helsinki School of Mathematics.

Programming has been part of the National core curriculum for basic education since 2014 and pupils already begin to practise the basics of programming and programmatic thinking in grades 1 and 2. However, by 2019, programming had not been included at all in the National core curriculum for general upper secondary education, and even in the curriculum implemented in autumn 2021, it is mentioned only as part of module MAA11 Algorithms and number theory in the advanced syllabus for mathematics. Therefore, as programming and different software have a central role in today's society and the programming sector already employs a large number of people, it is important to also recognize the role of programming as part of general upper secondary education.

The evaluation surveyed the instruction of programming offered in the last academic year 2020–2021, in other words, before the implementation of the new curriculum, and examined how the new curriculum will affect the instruction in programming offered in the future. In addition, it was examined how many students had included programming in their studies and what factors promoted and limited the instruction offered in programming. The data was collected with questionnaires aimed at principals and teachers teaching programming. The questionnaire was sent to 60 general upper secondary schools. Responses were received from 40 of them, of which 31 were Finnish-speaking and 9 Swedish-speaking general upper secondary schools.

Study units including programming were already available before the new curriculum in approximately two out of three general upper secondary schools. However, all of the offered study units were not realised and in reality, the instruction of programming was implemented in

approximately one half of the general upper secondary schools. Of all periods of teaching offered in programming in general upper secondary schools, one quarter were not realised. There were no differences in the number of study units offered between Finnish and Swedish-speaking general upper secondary schools or the areas of regional state administrative agencies. Programming was offered on average more in general upper secondary schools with a large number of students than in small or medium-sized ones.

Only few students included programming in their studies, and those who participated in study units in programming were mainly boys. It would be important to encourage girls to study programming and their number in the participants of study units should be increased to attract more women to the technology sector in the future.

Based on the responses, the study units in programming are mainly offered as part of studies in the field of mathematics and natural sciences, especially in the advanced syllabus for mathematics and in information technology. However, programming is a skill that can be used widely in different subjects and, with the new curriculum, it can also be made part of other subjects and phenomena by combining modules from different subjects. In the majority of study units containing programming, the content was related to studying the very basics of programming or a certain programming language. Many of the study units also often contained robotics.

Teachers' enthusiasm and capabilities to teach programming were considered one of the most important factors promoting the instruction of programming and, correspondingly, a lack of these capabilities as well as a constant rush and challenges with schedules were considered factors that limited it. A majority of the teachers found they needed in-service training to be able to teach programming and that, in spite of the programming studies included in their own earlier education, teaching programming required them to learn an entirely new skill. Resources and opportunities for in-service training aimed at teachers should therefore be provided to increase the instruction offered in programming in general upper secondary schools. On the other hand, cooperation with higher education was also considered to play an important role in implementing the instruction of programming in the future. Some of the educational institutions already took advantage of this cooperation in the academic year 2020–2021. Independent completion of different free programming courses offered by higher education institutions online was rare and only individual students used the opportunity to include them in their general upper secondary studies. However, participation in these courses independently or with the entire teaching group could provide an opportunity to increase programming competence regardless of what the resources or teachers' capabilities are in one's educational institution. To increase programming competence, information about different open courses should therefore be disseminated to educational institutions and students.

Keywords: programming, evaluation, general upper secondary education