

# ENGINEERING EDUCATION PARADIGM SHIFT IN METROPOLIA UAS

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## ABSTRACT

Simultaneous changes in decline of public funding and new metrics how universities are compared caused a financial crisis especially to the field of engineering education. For this reason, Metropolia University of Applied Sciences implemented two year long MeTeLi-project to re-think the engineering education for the following financially challenging years and still maintain the high quality of the education. The MeTeLi-project took place between 2011-2013 and caused a major paradigm shift in Metropolia's engineering education. A great emphasis was put into the first year studies, integrated learning, co-teaching, and project based learning principles. During the re-design process, the CDIO Standards provided excellent answers to numerous practical questions. This paper summarizes the results of the MeTeLi-project and analyses how this transformation affected on the metrics.

## KEYWORDS

Government funding, Integrated learning, Rethinking engineering education  
Standards: 3, 4, 5, 7, 8, 9, 10,

## INTRODUCTION

Due to economic recession the public funding for universities of applied sciences has declined about 19% since year 2009 in Finland. At the same time the ministry of education came up with new metrics on how to measure and compare the performance of the institutes. The model that the ministry of education uses to fund the universities of applied sciences was modified to be solely based on these metrics. In addition, the Finnish Ministry of Education decided also to change the structure of higher education by ending the regulation of degree programmes and introducing a new term of "educational provision". These changes caused big challenges especially to the field of engineering education. Therefore Metropolia University of Applied Sciences implemented two year long MeTeLi-project to re-think the engineering education for the following financially challenging years and still maintain the high quality of the education.

The MeTeLi-project took place between 2011-2013 and caused a major paradigm shift in Metropolia's engineering education. A great emphasis was put into the first year studies,

integrated learning, co-teaching, and project based learning principles. During the re-design process, the CDIO Standards provided excellent answers to numerous practical questions. The plans were put into practice on fall 2014 when the total number of degree programmes was significantly reduced by merging the old degree programmes (Valmu, 2014). It was decided by the pedagogical management board of the university that the new curricula are based on a modular structure and the pedagogy is based on collaborative teaching and learning (Barkley, 2006). This paper summarizes the *results* of the MeTeLi-project and analyses how this transformation affected on the metrics.

## CHANGING ENVIRONMENT

Finnish Ministry of Education introduced educational provisions in order to simplify the structure of higher education degrees. Before the change all university degrees were organized as degree programmes, which were agreed with the Ministry of Education every 4 years.

The legislation evolved to give the universities more autonomy. Each university currently have their educational provisions, which permit to grant higher education degrees up to a predefined number of students. Old degree programmes are now part of a provision, and universities can start new, end old, or change existing degree programmes as long as the number of graduates studying in each educational provision does not differ from the contract with Ministry of Education.

In Finland most of the funding of the Universities of Applied Sciences comes directly from the Finnish Ministry of Education. Due to economic recession, the level of this funding has been on a decline since 2012 and will settle to about -22% by 2020 as shown in figure 1.

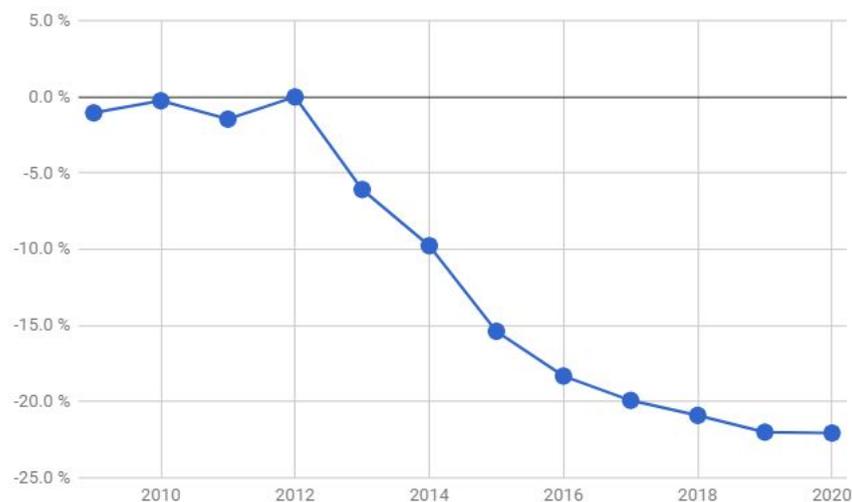


Figure 1: Funding decline of Finnish Universities of Applied Sciences, adjusted to inflation

Previously the funding was based on the number of degree students (70%) as well as the number of graduates (30%). Currently the funding is still based heavily on the number of

graduates (40%) but no longer on the total number of students (see figure 2). Instead the funding is based on the number of students making more than 55 ECTS credits per study year of the 60 ECTS total (Minedu, 2017). Fundamentally this meant transformation from input-driven system to output-driven system. Notice that the funding metrics is used only on distributing the government funding between the universities of applied sciences, and the institutes are budgeting the final sum internally using their own rules.

The universities want to improve the student progression in order to make sure that the students make all the courses in time to fulfil the funding criteria. The results in that respect have been relatively poor in the past, since the studies in the engineering degree programmes have been rather flexible and therefore it has been possible for the students to leave some courses to be completed in the future semesters instead of completing all the courses in due time. The curricula of the engineering degree programmes in Metropolia have been previously based in small courses of 3 ECTS credits only and if the students have two of such courses a year pending, the funding criteria is not met.

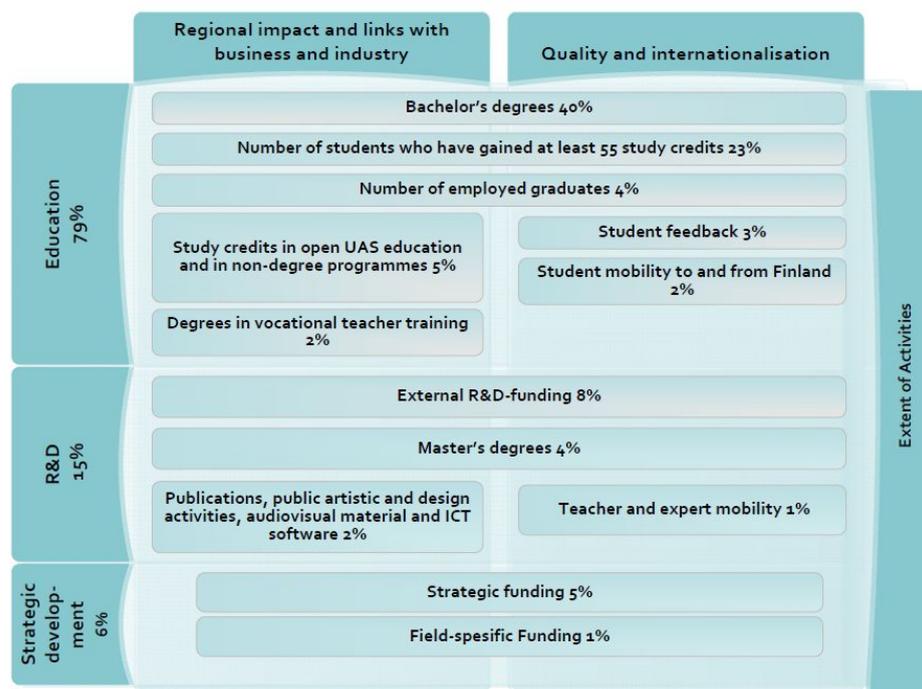


Figure 2: Finnish University of Applied Sciences funding (MinEdu, 2017)

### MeTeLi Project

The changing environment prompted an urgent need to find solutions for the evolving challenges. The calculations showed that the new funding metrics would hit hardest the field of technology mainly due to high drop-out rate and slow study progress of students. At the end of year 2011, the Metropolia Management Board decided to invest to an internal development programme MeTeLi (Metropolia Tekniikka ja Liikenne = Metropolia Technology and Transport), which was divided into four main work packages:

1. Vision, strategy, and action plan to improve the results on the most important funding metrics. The target was to create a clear, tangible, and operational image as a basis of Metropolia Field of Technology strategy, set targets for funding metrics 2016, and create action plan how to achieve the target.
2. Educational provisions and operational model for year 2014. The target was to find a model on how the engineering education will be organized. The new model had to be implemented starting fall 2013 and be ready for new student entrance on fall 2014.
3. Teaching, learning, and know-how. The target was to update the engineering education to define a common foundation, common structure for the engineering syllabi, and common elements of education. In addition, another important target was to start a long-term development to clarify the pedagogical choices, develop flexible assessment methods, create dynamic study paths, and find new ways to organize courses to support new learning methods and improve the study progress.
4. Regional cooperation with industry/stakeholders, and constant development. The target was to create operational models to cooperate more closely with regional stakeholders, develop continuous education, and improve the R&D efficacy as an engine of creating new knowledge.

## IMPLEMENTATION

The MeTeLi project was completed at end of year 2013 and the engineering education went through a major overhaul during the following year. All Metropolia's 29 engineering degree programmes were merged in that process into 7 educational provisions. For example, the degree programme of Electrical Engineering and the degree programme of Automation Technology were merged and the first students started their studies in the new degree programme of Electrical Engineering and Automation Technology (tuition in Finnish) in August 2014. Also degree programme in Health Technology was merged with degree programme in Information Technology. The new curricula of degree programmes were linked to the curricula of other engineering degree programmes in order to offer efficiently multiple specialization options in the students' study path (Valmu et al., 2014).

Further improvement was still necessary and since the curricula had to be renovated in 2014, it was decided that all the courses will be organized in larger entities of 5-15 ECTS credits based on collaborative teaching and learning and continuous assessment. Most of the engineering students currently study their first year by taking four 15 ECTS courses implemented as project based integrated learning experience. Each course is built around a Conceive-Design-Implement topical task, which works as learning environment for mathematics, physics, and professional topics as well as communication and group working skills.

Table 1: Changes in Metropolia UAS 2012-2016

	<b>Before</b>	<b>After</b>
Funding based on	the number of students and graduates	production based metrics
Degree granted by	Degree Programme	Educational Provision
Development cycle	Academic year	Calendar year
Organization	Degree programmes with common management resources	One year on matrix, and then changed to educational provision based line organization
Pedagogy	short courses with single topic	integrated learning in larger modules
Courses taught by	one teacher	team of teachers

## RESULTS AND DISCUSSION

The actions planned during MeTeLi-project showed some good progress on the funding metrics point of view. For example, in the old programmes of Electrical Engineering, Automation Technology and Electronics the number of first year students fulfilling the funding criteria of 55 ECTS study points was even smaller than 50% in 2012. When the new funding principles were announced in 2012, many actions were taken within the old curriculum as well. The teaching staff was encouraged to use continuous assessment instead of the end exams, alternative resit options were given to the students etc. By these means the number of first year students fulfilling the criteria in these three programmes was raised above 70% in 2013 (Valmu et al., 2015). Similar very promising results were also found on other engineering programmes who rearranged the curricula to larger course entities and truly focused on course integration, continuous assessment, and cooperative teaching and learning. Unfortunately those engineering degree programmes and departments who followed the new paradigm only at minimum level are have not improved basically at all and are now facing very difficult financial challenges.

Figure 3 A shows how the percentage of engineering degree students achieving full 60 ECTS/year for Metropolia and other UAS for years 2012 and 2016. This comparison indicates that Metropolia engineering education has improved students' performance more than the other universities of applied sciences. However, when we are looking at the 55 ECTS/yr comparison (figure 3 B), we can see that the other universities of applied sciences started improving earlier than Metropolia. There seem to be about 1-1.5 year time shift between Metropolia and others, which requires more detailed analysis than reported in this paper. On the other hand, while the others have reach their saturation point at year 2015, we cannot yet see where Metropolia's results will settle.

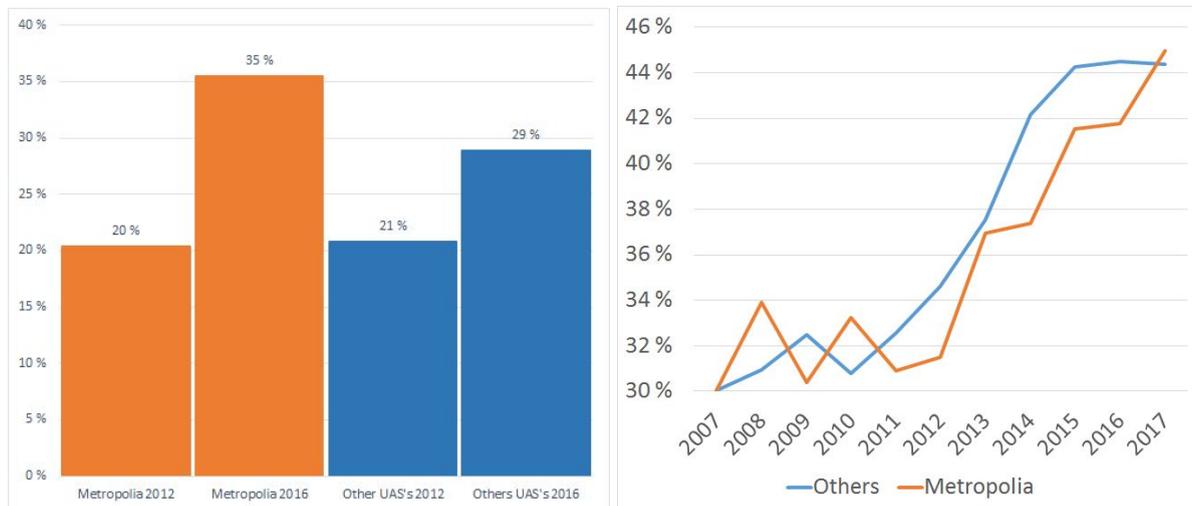


Figure 3. A: The percentage of registered students in the field of technology gathering at least 60 ECTS/yr, B: Percentage of registered enrolled engineering students gathering 55 ECTS/yr or more

The overall situation is more complicated when we start looking at a larger picture. Table 1 represents government funding of engineering field compared to other fields normalized with number of students for years 2012 and 2016. These years were selected since 2012 was the highest ever funding year, and 2016 is the latest year with official statistics (this paper was written before the complete official national 2017 statistics were made public).

This table is formed based on information mainly gathered from Vipunen-portal, which is the main source of education statistics in Finland (Ministry of Education and Culture, 2018). The 2012 funding figures are formed using the Finnish National Agency for Education (2018) statistics of the 2012 UAS funding as a source. The €/student numbers are counted based on the respective funding models used in 2012 and 2016. All of the data is counted based on the ISCED-fields of Information and Communication Technologies and Engineering, Manufacturing and Construction. Some adjustments are made in order to make the statistics comparable to the fields of education that were used in Finland in 2012.

It may be clearly seen that all the Universities of Applied Sciences in Finland are facing hard times in all fields of study. Despite good success in raising the percentage of students who gather at least 55 ECTS each study year, Metropolia UAS is not doing any better than the other universities in terms of total funding. Its financial decline in Engineering is a bit larger than the decline of the other universities. The comparatively large decline of engineering is mainly due to poor results in the external R&D funding- and publications -indicators. Metropolia's Technology is responsible of only 5-6 % of the Finland's technology field results in these indicators compared to 17 % in the case of 55 ECTS. While the MeTeLi-project focused on improving the engineering education, at the same time less attention was paid to improve R&D operations.

Table 1: Government funding (adjusted to inflation) per student calculated from metrics.

University of Applied Sciences	Students 2012		Students 2016		€/Student 2012		€/Student 2016		Ratio (€/S) 2016/2012	
	Tech	Others	Tech	Others	Tech	Others	Tech	Others	Tech	Others
Centria	1 193	2 395	1 017	2 039	7 837 €	5 451 €	7 038 €	5 947 €	-10 %	9 %
Diakonia	0	3 114	0	2 909	0 €	7 944 €	0 €	6 843 €		-14 %
Haaga-Helia	1 744	8 902	1 874	9 101	5 464 €	6 056 €	4 366 €	5 717 €	-20 %	-6 %
Humanistinen	0	1 483	0	1 544	0 €	9 187 €	0 €	8 728 €		-5 %
Häme	3 127	4 676	2 797	4 544	6 054 €	6 358 €	5 621 €	5 013 €	-7 %	-21 %
Jyväskylä	2 496	5 426	2 878	5 190	6 205 €	6 356 €	4 599 €	6 152 €	-26 %	-3 %
Kaakkois-Suomi	2 615	5 948	2 995	6 215	6 855 €	7 462 €	6 401 €	6 211 €	-7 %	-17 %
Kajaani	715	1 425	869	1 433	6 183 €	6 767 €	5 244 €	5 563 €	-15 %	-18 %
Karelia	1 144	2 769	988	2 759	6 681 €	7 485 €	6 027 €	5 890 €	-10 %	-21 %
Lahti	1 500	3 744	1 489	3 541	5 840 €	7 199 €	4 476 €	6 656 €	-23 %	-8 %
Lappi	2 005	4 127	1 833	3 994	6 936 €	6 908 €	5 403 €	5 744 €	-22 %	-17 %
Laurea	716	6 957	733	6 958	5 820 €	7 151 €	4 911 €	6 273 €	-16 %	-12 %
Metropolia	8 066	7 974	8 238	8 359	5 915 €	7 746 €	4 279 €	5 691 €	-28 %	-27 %
Oulu	3 218	5 331	3 404	5 142	6 940 €	6 550 €	4 342 €	5 671 €	-37 %	-13 %
Saimaa	908	2 223	673	2 622	8 045 €	5 981 €	5 654 €	5 720 €	-30 %	-4 %
Satakunta	2 255	3 599	2 145	3 708	6 271 €	6 965 €	4 446 €	5 670 €	-29 %	-19 %
Savonia	2 249	4 197	2 288	4 312	7 268 €	7 240 €	5 253 €	5 431 €	-28 %	-25 %
Seinäjoki	1 458	3 512	1 493	3 332	5 235 €	7 149 €	5 450 €	5 420 €	4 %	-24 %
Tampere	4 122	6 291	4 041	6 192	6 197 €	7 107 €	4 535 €	5 697 €	-27 %	-20 %
Turku	3 638	6 012	3 477	6 044	6 579 €	7 709 €	4 748 €	6 174 €	-28 %	-20 %
Vaasa	1 562	1 984	1 547	1 680	5 866 €	5 852 €	3 567 €	5 095 €	-39 %	-13 %
Arcada	460	1 900	398	2 069	7 859 €	7 010 €	6 038 €	5 760 €	-23 %	-18 %
Novia	1 544	2 213	1 596	2 461	6 799 €	7 700 €	5 459 €	5 538 €	-20 %	-28 %
<b>Total</b>	<b>46 735</b>	<b>96 202</b>	<b>46 773</b>	<b>96 148</b>	<b>6 384 €</b>	<b>6 996 €</b>	<b>4 899 €</b>	<b>5 888 €</b>	<b>-23 %</b>	<b>-16 %</b>

## CONCLUSIONS

Metropolia engineering education went through a series of big changes, and used it as an opportunity to modernize education. As a result, the engineering syllabi are now less fragmented, which shows up in some degree programmes as improved student progress when measured by number of students reaching 55 ETCS/year. However, based on the results on funding metrics we cannot see clear evidence for success, since the other universities of applied sciences have also improved their outcomes. Comparison between different fields inside Metropolia reveal that the engineering education has been able to maintain the same rational decline as the other fields in average.

The final level of improvement in both student progression and number of graduates in the engineering degree programmes in Metropolia UAS is still to be seen, since the curriculum change (the paradigm shift) was done in early 2014 and the first students started their studies based on the new pedagogy in late August 2014. These student groups are to graduate after the spring term of 2018 and already it seems quite clear that many degree programmes will reach their all-time records in the number of graduates this year. Most other universities did only minor reforms to improve their results and their improvement seems to be already saturated in 2015 as seen in Fig. 3B when Metropolia UAS is still improving very strongly when the number of students in the new modernized programmes based on the new pedagogy increased constantly until September 2017 (and the results of the last group are first included in the metrics of 2018).

We also can see that the bigger universities of applied sciences have not been able to benefit from their size, but quite opposite: six largest universities of applied science are performing worse than average when compared on the decline of engineering funding results. This study was conducted mainly to see if the big changes planned in MeTeLi project had a positive change in the most important funding metrics, namely 55 ECTS/year and number of graduates. The study also revealed that more research should be done in order to deeply understand how to optimize the funding. In future we are going to do similar analysis also to other funding parameters and find some cure for the funding challenges.

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