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Version: Accepted manuscript / Final draft

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To cite this article please use the original version:

Mustonen, L., Heikkilä, S. (2020). Mixed Groups as a Way to Teach Meta-Skills to Engineering Students. In Proceedings of The 2nd International conference on Advanced Research in Education, Teaching and Learning. Berlin: Diamond Scientific Publishing.

Available online:

<https://www.doi.org/10.33422/2nd.aretl.2020.03.82>

Mixed Groups as a Way to Teach Meta-Skills to Engineering Students

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Abstract.

The purpose of this article is to describe an example of teaching so-called meta-skills in Häme University of Applied Sciences Electrical and Automation engineering study programme. The method has been conducted twice, in 2018 and 2019. Both times the first-year students were given a development project in which they studied the basics of programming. More important than programming was to learn meta-skills: teamwork skills, language and communication skills, IT skills, problem-solving skills, and skills to apply knowledge to practice and acting in a multicultural environment. The feedback was gathered after the implementations by the questionnaire. The results show that students think this kind of pedagogical method improves their previously described meta-skills. For teachers this means working more as a supervisor than a source of knowledge. In addition to meta-skills, the method increases interaction between students of different cultural and educational backgrounds. The method works as means of internationalization for Finnish-speaking students. For foreign students, the method is one way of increasing interaction with Finnish-speaking students and can act as a part of the integration process to Finnish society.

Keywords: meta-skills, teamwork skills, pedagogical method

1. Introduction

Finland is rapidly becoming more international. To compete in the competitive global market, companies need employees who are used to working in an international environment. Traditionally focus has been on the English language, but only learning the language is not enough. There is a need for skills to be able to participate in project works with international participation and a general understanding of the interaction between cultures. At the same time, there is a growing lack of educated workers, especially in engineering and in social and health care services. Foreign students are taught in international degree programmes of universities, but the challenge is to get them to integrate with Finnish society and to find employment in Finnish companies. When combining this with fast-paced technological advancement that changes working conditions and daily lives, we get a combination that challenges teaching staff of universities. The question is: how to teach students the skills of the working life of the future?

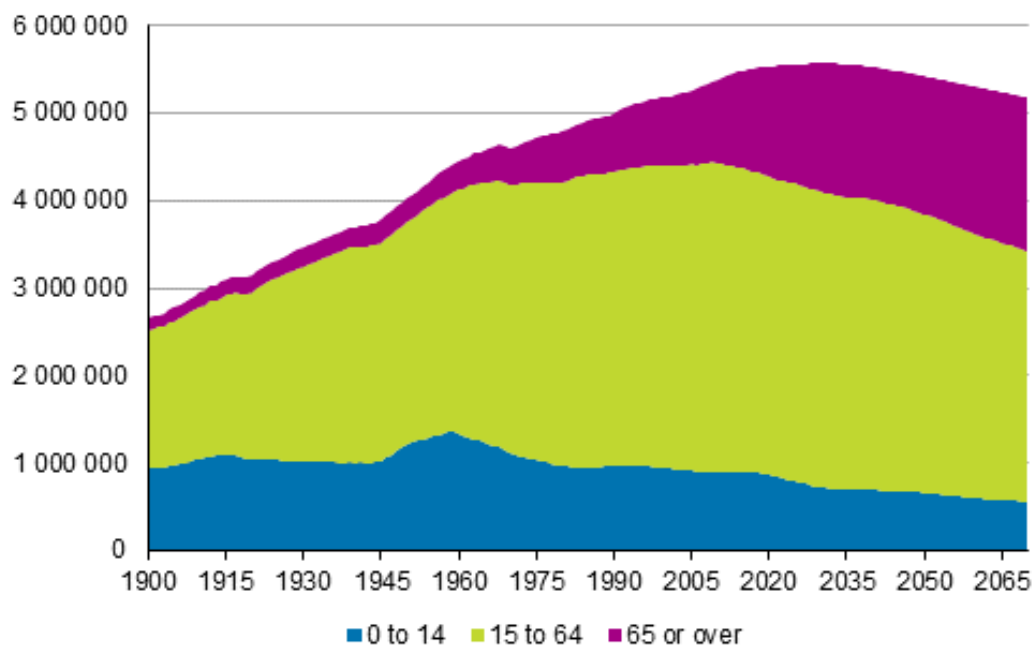
This article describes a pedagogical method used in Häme university of applied sciences (HAMK) electrical and automation engineering programme to answer the described challenges and what kind of feedback was given by students. This is the second implementation of the method. The first implementation has been introduced in the article: "Changes in Working Life Create Challenges to Engineering Education" (Mustonen & Heikkilä, 2019).

2. Theoretical background

2.1 The need for labor

The changes in the age structure will create significant challenges for Finland. The population is aging and there are not enough children born to compensate (Fig. 1). Several industries are experiencing a shortage of employees because of this.

Figure 1: Population by age 1900–2018 and projection 2019–2070



Source: (Population and Justice Statistics. Statistics Finland)

This development affects society in multiple ways. When the number of retirements increases companies may have difficulties to find suitable employees. Economic cycles also affect the need for labor. Currently many technology companies in Finland lack the workforce they need. One solution is to increase the immigration of educated foreigners.

The situation is the same in many European countries. For example, in Germany 1.4 million employees will retire by mid-decade and it affects the engineering sector the most. One proposed solution is to hire educated workers from abroad and increase the number of students in universities. (Finlandabroad.fi, n.d.)

The number of foreign students in OECD-country universities has clearly increased in the last four decades and they represent 5.6% of all students (Poort etc, 2019).

With the increase of international degree programmes the number of foreign students in Finland has also increased. The challenge is to get the graduated students to stay in Finland. Companies still have difficulties to recognise the proficiency of international students and possibilities, especially in export industries. Finnish language is known as a difficult language and that may

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also form a problem though English is often used in larger companies. Many projects and actions have been taken to encourage integration.

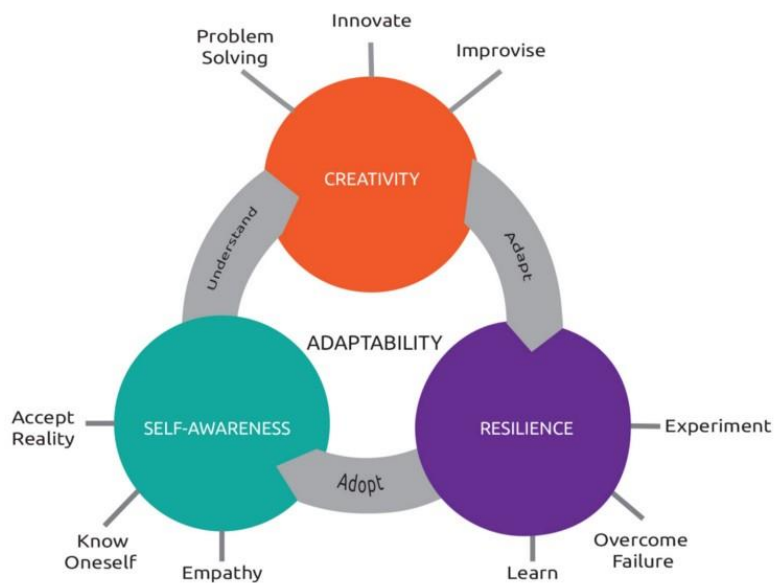
In HAMK there are about 600 foreign degree students with 7500 students in total. To encourage learning Finnish a new scholarship system has been implemented this year. It rewards from learning the language. This system is hoped to further the integration to the Finnish working environment. One of the goals of the pedagogical method described in this article is to advance this integration.

2.2 The 21st century skills

“Skills are temporary, meta-skills are permanent.” (Razetti, n.d.) The citation describes the change in the way of thinking that has been in the limelight.

Razetti brings up a concept of adaptation that requires three meta-skills (Fig. 2): Self-awareness, which means to know yourself but not only that, also to understand others. Creativity, which is crucial to be able to solve problems in more and more complex world. Resilience, which means skills to find solutions and the ability to experimenting even if there is a possibility to fail.

Figure 2: Adaptive Mindset: The Meta-Skill of 21st Century



Source: (Razetti, n.d.)

Skills needed in the working environment are similarly described by British innovation foundation Nesta and the University of Oxford: five most important skills are judgement and decision making, fluency of ideas, active learning, learning strategies and originality. (Condliffe, 2017)

Technological development leaps, especially in artificial intelligence (AI), robotics, nanotechnology, 3D printing, and biotechnology change our living circumstances. (Schwap & Shamans, 2016). The increase of robots reduces the need of labour and makes some professions

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that need mechanical work obsolete. AI also affects professions related to information management. (Condliffe, 2017).

This development combined with the increasing globalization of companies and the number of highly educated foreign students create the environment to which the universities educate the students. The engineers need the basic skills but, in the future, we need to focus towards the meta-skills.

3 Implementation

3.1 Background of the Implementation

In the article of HAMK's university's Rector and Vice Rectors "Beyond Alliance for Knowledge from HAMK's Point of View" they describe HAMKs pedagogy as follows: "Students at the Häme University of Applied Sciences (HAMK) are owners of their own learning, and teachers act as instructors and enablers of learning. We also encourage our students to cultivate creativity and critical thinking in a complex operating environment. Thus, the students' role is increasing, and they need more self-direction skills. Teachers' work is also changing rapidly, and they need support to succeed." (Puusaari et al, 2019) A clear instruction can be found in the citation for the staff: students need to get the possibility to participate in projects where they have the possibility to develop themselves. Students need to be an active part of the process instead of just taking and adopting information passively.

Education at HAMK is carried out in modules consisting of 15 credits. Teachers work in teams so that the module team plans the implementation of the module. The teaching staff is encouraged to use different pedagogical methods. Learning objectives have been determined but the teaching team has the freedom to choose the best methods to achieve those goals. Team teaching reinforces the teachers' ability to plan and test different kinds of pedagogical methods, provided there is trust between the team members. (Kunnari, 2018)

The tested teaching method had a favorable basis of team teaching and teaching culture with a positive attitude for experimentation. The method is based on a thought that the meta-skills described in chapter 2.2 are not taught separately as their own subjects. So there is no, for example, separate course for internationality or teamwork, instead, the teaching method are made to result in desired results. At the basis its controlled risk-taking: students are consciously pushed outside of their comfort zone at the start of their studies by mixing up Finnish and foreign students.

It is the same kind of implementation that Poort, Jansen & Hoffman (2019) use the naming Intercultural group work (IGW) learning strategy. Its purpose is to create benefits for students from their university's cultural diversity.

Partly with the same type of objectives and methods Maks Summers and Simone Volet describe their activities in their 2008 article "Students' attitudes towards culturally mixed groups on international campuses: impact of participation in diverse and non-diverse groups". According to them, international campuses offer a good chance for cultural exchange, but typically students stay in their groups of similar cultural backgrounds (Summers & Volet, 2008). This trend has been noticed in our universities as well.

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Summers & Volet made a study spanning multiple years on students' change of attitude regarding culturally mixed group assignments. Their study provides support for organizing culturally mixed groups. Anyhow, the results of the students' opinions and attitudes seem to be a bit complex and further research is needed. (Summers & Volet, 2008)

3.2 Description of the Implementation

The programme for both English and Finnish language electrical and automation engineering studies begins once a year. Students may have a high school degree, a vocational degree or both. Traditionally, education for educational programs in different languages has been organized separately.

The teaching method was implemented the second time in the autumn semester of 2019. The first implementation was conducted year earlier. Objective of both groups was to increase the meta-skills/skills needed in the 21st-century working environment.

The project itself was the same as the previous one. The project integrated an automation task to English, Finnish language for foreign-language students and Finnish communication for the Finnish language programme. The studies were centred around a joint technology project lasting about four months. Students were assigned to groups of 3 to 4 students consisting of different nationalities and educational backgrounds. They were given a challenging project and while completing it they had the possibility for peer learning as well as encounter differences. They were encouraged to find the team's strengths and create a spirit of communion where they help others and learn together.

A survey was conducted for students with the intention to find out about students' experiences about the pedagogical experiment.

4 Results

The questions were based on the need to develop engineers' meta-skills. The survey was answered anonymously. Of the 103 students, 87 responded to the survey, so the response rate is 85%. There were 6 questions in the survey. Results are seen in figures 3 - 8.

Both surveys forms, the years 2018 and 2019, have been combined in the graphs. Answers of students in 2019 were somewhat better at some points in comparison to 2018. However, both results as a whole are so similar that a detailed comparison is not relevant.

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Figure 3: The teaching method improved my teamwork skills

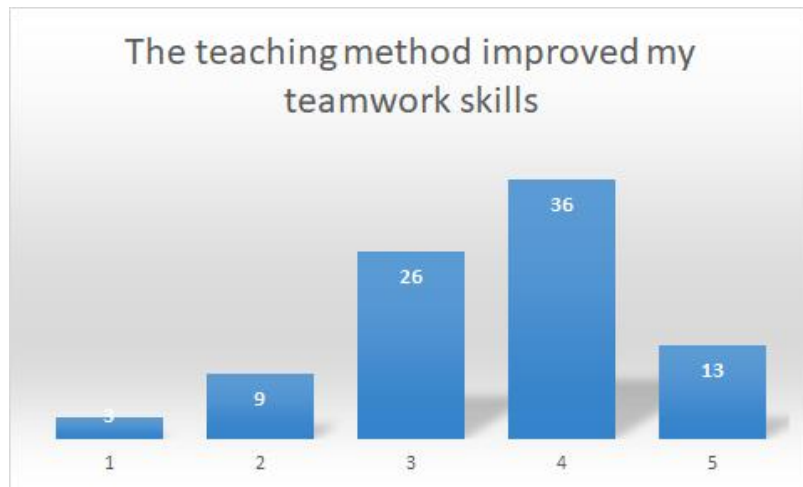
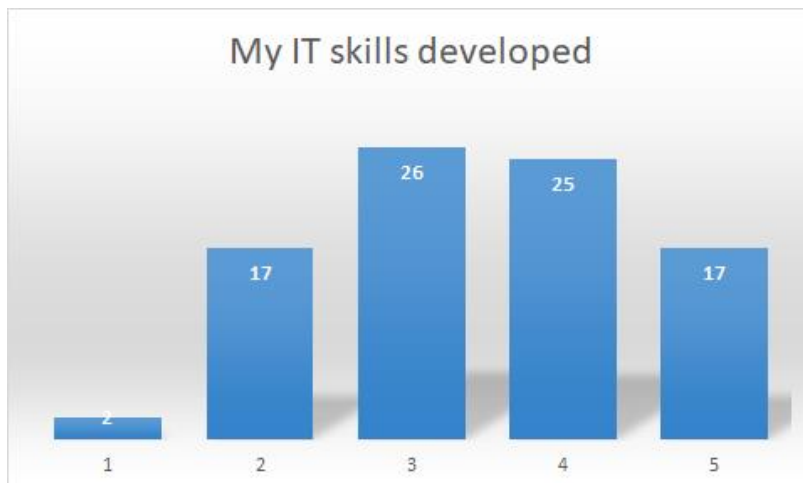


Figure 4: My language and communication skills developed



Figure 5: My IT skills developed



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Figure 6: I learned to apply knowledge to practice

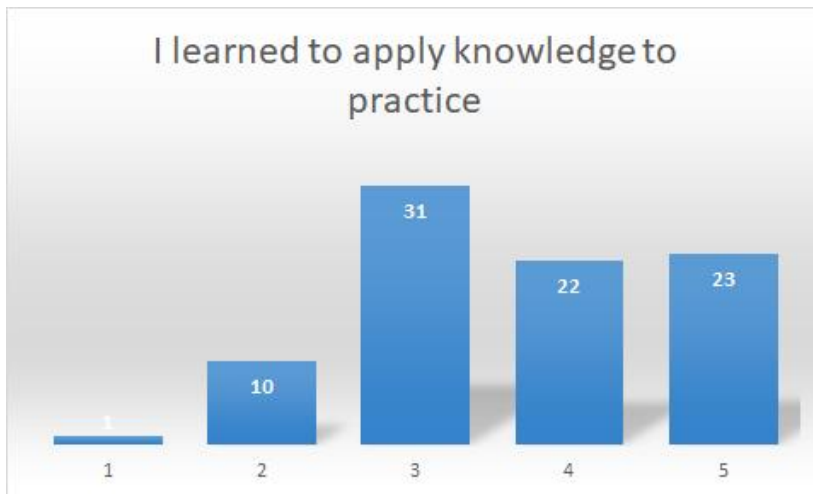


Figure 7: I learned problem-solving skills

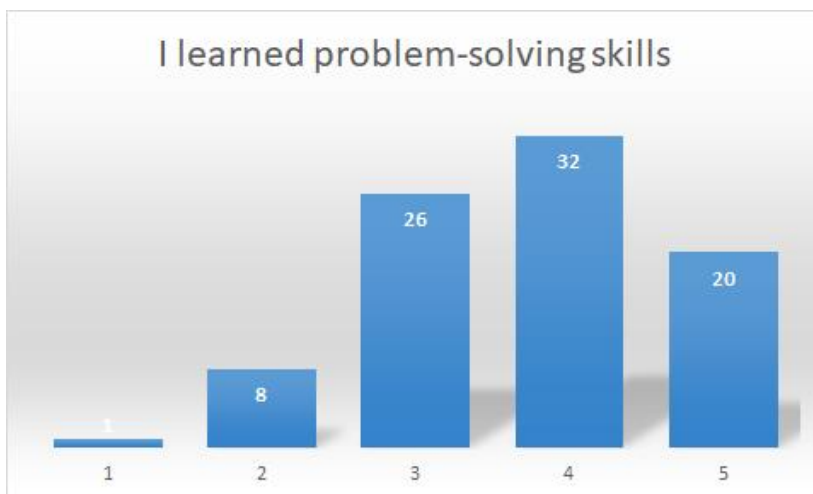
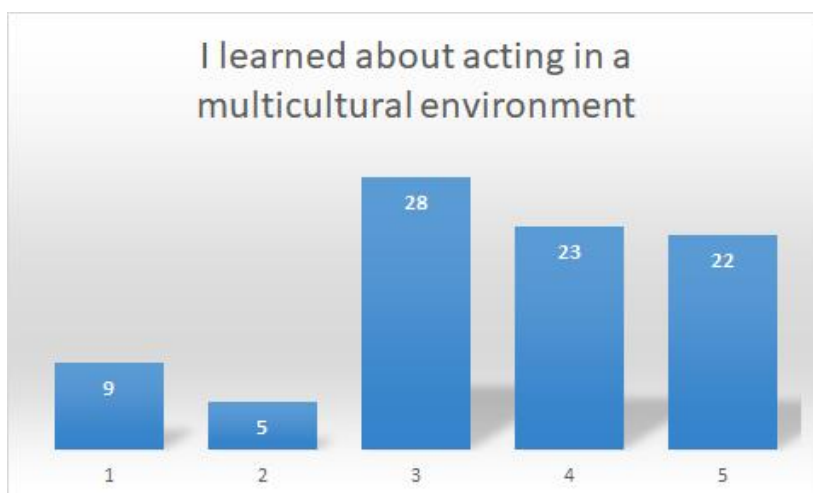


Figure 8: I learned about acting in a multicultural environment



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There was no remarkable difference between the results of the Finnish-speaking and the English-speaking groups. That is why all the responses are shown in the same pictures. Anyhow, the responses of English-language education students were a bit more divided into extremes, while the Finnish-speaking group had more reviews of 3 and 4.

Based on the results, it seems to be recommendable to organize such implementations in the future as well. The positive feedback can be seen in all questions and especially in questions 1, 5 and 6 (figures 3, 7 and 8).

In the survey, there was a possibility to give written feedback. 28 pieces of written feedback were submitted. In free comments, the module received both positive and negative feedback; for some students, the module was either "super great!" or "not wise". The majority was positive feedback. For example, some of the feedback comments were:

“In this course I learned how to control my team and to give for each one the task that is appropriate for him, also I learned how to solve different tasks and I developed my communication skills.”

“During this project, it encourages teamwork, problem-solving and leadership skill developed to me and my team members”

“Solving problems was the most useful part.”

There was also a bit of criticism that the division of labor was not equal in some teams.

The free verbal feedback amplifies the positive results of the survey. Generally, the teaching method was perceived to have worked well and the students felt that they have learned skills that were the objective: working in teams, communication, and IT skills, applying knowledge in practice, problem-solving skills and acting in a multicultural environment.

5 Conclusions

On the basis of student feedback, students generally liked the project and felt like they learned desired/necessary skills but in the comments there is also some deviation and criticism towards the team work. During the project, also the supervisors noticed that every groups' work was not harmonious.

The students were forced to enter their discomfort zone and problems with schedules, responsibilities, working methods and problems around language emerged.

However, this was expected and a part of the learning process. The supervisor needs to guide the students and also take a step back while guiding a project like this. At the start of the first problems the teacher should not resolve the issue, but to guide the students towards the solution. Sometimes it is better to ignore critique at first with no reaction like changing the procedures or instructions. The teaching team needs to have objectives that everyone agrees on and is committed to.

The central part of the teaching method used was the principles of adaptation described in chapter 2.2. We think that the self-awareness of students increased while they learned more about themselves and how their group members act in unpredictable situations. Problem-

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solving situations increased resilience and problem solving skills. Resilience is also a basis for the teaching staff because that is the basis that these kinds of pedagogical tests can be build on. With the lack of ready solutions ,we also consider the teaching method cultivating the third dimension of adaptation, creativity.

Creativity is a concept that is not typically associated with engineering studies. However, it is not possible to partition strictly a certain job description in a modern work community, where only the creative people innovate and engineers try to make a practical solution of it. The solution to the complex present and future problems will not be found without re-thinking, teamwork, readiness to try and make mistakes meaning technical creativity and experimental culture. The pedagogical method described can at best give the readiness to face the challenges to studenys and also the teaching staff.

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