Project NEDIA

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O2 REPORT

NEW TRAINING METHODS AND THEIR IMPLEMENTATION IN MODERN VOCATIONAL EDUCATION

Raisio, Turku, Tallinn, Liepaja 2015

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1 Introduction

There are five partners from three countries in the NEDIA project and it's obvious that they use already now modern teaching methodologies and tools. Organizations' existing learning methodologies may still be usable for them in the future and the methodologies may be novel for some other NEDIA project partners. Therefore it was important to start O2 part of the NEDIA project by analyzing As-Is situation and the future To-Be targets. NEDIA project partners considered NEDIA project O1 report results in their To-Be proposals. Possible To-Be teaching methodologies and tools was also identified by doing literary reviews, internet searches, and interviews and discussions with people whose organizations aren't participants in the NEDIA project. Some of the discussions have been taken place before the NEDIA project.

The aim has been to identify and find practical teaching methodologies instead of complicated academic theories.

As-Is and To-Be analyzing answers were combined as generalized summaries in this report. In an evaluation table (table 3) is listed requirements from analyzing summaries, or from single analyzing answers and the most interesting teaching methodologies which have been identified. All of the analyzing summary issues weren't use in the evaluation table if those weren't relevant in learning methodology evaluation. Learning methodologies which fulfill enough specified requirements are suitable as To-Be learning methodologies in the NEDIA project's organizations. NEDIA project's O3 phase's lecture materials will be developed for selected learning methodology or methodologies.

2 Analysis of existing needs

In an analyzing phase all partners identified "As-Is methodologies", "As-Is Tools", "Support and motivation", "Challenges", "To-Be methodologies", and "To-Be Tools" in their organizations. "To-Be methodologies" are preliminary proposals based on existing situation and challenges in organizations.

In some places in this report methodologies and tools aren't necessary listed under a proper header but on the other hand it's not always so straightforward should they consider as a methodology or a tool. This doesn't reduce value of the report because it's the most important that all relevant ideas have been succeeded to catch.

Table 1 Table demonstrates "Analysis of existing needs"

As-Is methodology	**Support and motivation (As-Is)**	**To-Be methodology**
- Class room teaching - Etc.	- Student counsellor - Curator - Etc.	- Students responsibility and involvement should be increased in daily school work - Etc.
Tools (As-Is)	**Challenges (As-IS)**	**Tools (To-Be)**
- Vocational books - Etc.	**Students:** - Motivation - Etc. **Teachers:** - Maintaining of work life knowledge and skills **Economical limitations:** - Unit price (financial compensation per student) - Etc.	- Distance learning / e-learning - Etc.

It's is used abbreviations IMECC, TTHK, LVT, KTK, and RASEKO to refer from which organization idea or opinion is coming from.

These abbreviations stand for:

- IMECC, IMECC OÜ Innovative Manufacturing Engineering Systems Competence Centre
- TTHK, Tallinna Tööstushariduskeskus (Tallinn Industrial Educational Centre)
- LVT, PIKC Liepajas Valsts Tehnikums (Liepaja State technical school)
- KTK, Koneteknologiakeskus Turku Oy (Machine Technology Centre Turku)
- RASEKO, Raision seudun koulutuskuntayhtymä (Raisio Regional Education and Training Consortium)

It's not always easy to divide methodology, tools, and challenges because there are tight connection between those subjects. Some To-Be things are already in use but implementation is still in progress. Compilation of partners' analysis results are listed under the following headers.

2.1 As-Is methodology

- Lessons in classrooms, theory lectures [Raseko, LVT, TTHK]
- Practical teaching in Workshop, learning by doing [Raseko, LVT, TTHK, KTK]
- Teaching in IT-class (CAD, Excel, Word, etc.) [Raseko, TTHK]
- **Blended learning.** TTHK's document includes an illustrative figure of this methodology. See Figure 1 [TTHK]
- On-the-Job learning (domestic and international) [Raseko]
- Students' written work plans and work reposts, individual research work [Raseko, LVT]
- Work reports as a blogs, case study tasks [Raseko, LVT]
- Information, instructions etc. searching by utilizing internet (team work and individually) [Raseko]
- Learning diaries, short blocks [Raseko]
- Company visits (improves learning motivation) [Raseko]
- Exhibitions [Raseko]
- Work demonstrations
- "Festo methodology" (utilization of Festo learning platforms and teaching materials) [KTK, Raseko]
- Remedial teaching [Raseko]
- Self-control [TTHK]
- Cases [TTHK]

Summary: Teaching takes place in different environments and seems partly to be quite traditional. However practical teaching, combination of theory and practice, and relationship with different stakeholders are appreciated.

2.2 Tools (As-Is)

- Books for vocational substance teaching, paper and e-books [Raseko, TTHK, LVT]
- Books for other subjects teaching (physics, mathematics, languages, etc.) [Raseko, LVT]
- Paper copies and teaching materials, and e.g. PowerPoint teaching materials made by teachers [Raseko]
- Learning/teaching materials in learning platforms and other e-learning environment
    - Moodle, IT'S Learning, Internet, and video materials. TTHK has lots of e-training courses in Moodle and web pages, eg. PLC programming, pneumatic automation, sensors in industrial automation, CAD, mechatronic equipment etc. There are links to web-pages and Moodle in a document that TTHK has delivered. [Raseko, TTHK, LVT]

- Equipment sets and exercise materials in workshops (prepared by teachers; robot programming, PLC programming, and other exercise materials) [Raseko, TTHK, KTK]
- Ready equipment sets / training stands / work benches from several vendors like Festo. Vendors have also delivered exercises which are used with their exercise work benches (e.g. Festo's hydraulic work bench, pneumatics work bench, measurement work bench, etc.). KTK has listed long list of Festo's equipment sets, PLCs, 3D printers etc. in their document. [Raseko, TTHK, KTK]
- Real works for internal and external customers. [Raseko, KTK]

Summary: Tools are from traditional books to e-learning environment and equipment sets. Variation is large. Probably aspiration is to combine theory and practice.

2.3 Support and motivation (As-Is)

- Student counsellor is used for students guiding and supporting [Raseko]
- Curator is used for students guiding and supporting mainly in their daily life problems. [Raseko]
- There is so call "Eetu" in mechanical engineering department whose job is to support weak students in their studies. Students may have learning problems, lot of absence in school, they have not passed exams, they have not finalized their exercises in workshop, etc. [Raseko]
- Laboratory engineers support students [KTK]
- World class teachers, teachers who coach World Skills competitors [KTK]
- Modern learning environment [KTK]
- No student support for teaching [LVT]
- Weak feedback about teaching methods and quality [LVT]
- TTHK presented "factors that determine learning performance" in their document. This is too complicated to present and describe in a few words. [TTHK]

Summary: In some organizations are used support staff who support and assist students and teachers.

2.4 Challenges and problems (As-Is)

Students:

- Low knowledge level when students graduate from comprehensive school. Especially in mathematics and languages. [Raseko, TTHK, KTK, LVT]
- Many kind of learning problems (mathematical, linguistic, perception, etc.) [Raseko, TTHK, KTK, LVT]
    - Many students have been in special groups in comprehensive school [Raseko]
- Huge variation in knowledge (students who need lots of support and extremely talent students) [Raseko]
- Motivation challenges [Raseko, TTHK, KTK, LVT]
- Attractiveness of vocational education in mechanical engineering [Raseko]

- Poor knowledge of mechanical engineering industry in general
- Mechanical engineering industry has weak reputation (parents, comprehensive schools student counselors, other students etc. strengthen this wrong image)
- Students don't know much about postgraduate opportunities after vocational studies

=> Mechanical engineering department receives mainly students who wouldn't approve as students in other fields which are more attractive. => weak motivation => other problems…

- Students' life management skills [Raseko]
- Poor effectiveness of learning [LVT]
- Teaching materials are not attractive enough. [TTHK]
- Not enough visual teaching materials. [TTHK]

Summary: In general students' motivation is low and they have many kind of learning problems. Other challenge is that variation is high and there are also very talent students in the same student group. It should be possible to give bigger challenges for talent students. Mechanical engineering is not attractive for many young people.

Teachers:

- Maintaining of work life knowledge and skills, or no practical experience in profession at all [Raseko, LVT]
- Vocational skills and knowledge maintaining, and further education [Raseko, KTK]
- Teaching of proper things (co-operation and relationship to industry is important) [Raseko, KTK]
- Vocational skills and knowledge maintaining [Raseko]
- No experience of teaching (freshman) [LVT]
- No experience and knowledge to teach students who needs special support [Raseko, TTHK]
- Co-operation with other teachers and with student counsellor and curator [Raseko]
- More teaching/learning development projects [KTK]
- Not so much international experience [TTHK]

Summary: Teachers should be up to date what is going on in industry and with the latest technology.

Economical limitations:

- Unit price (financial compensation per student) [Raseko, TTHK]
  - Teaching materials procurement
  - Equipment, machineries and premises
  - Amount of teaching and guiding hours per week, and number of students in a one group
  - Visits to companies, exhibitions and relationships with stakeholders
- Salary and work load inadequate [LVT]

Summary: Lack of money may hinder development.

Others:

- On-the-job learning places [KTK]
- Financing [KTK]
- Prestige of profession [LVT]
- State education policy reform that more destroy than improve studies and teaching [LVT]
- Unhealthy competition with secondary schools students [LVT]
- The following aspects should be considered before a blended learning course is launched: [TTHK]
    - What are the advantages of face-to-face learning?
    - What are the known dangers that accompany virtual learning?
    - Which parts of training should be preferably planned as face-to-face learning and which components can be web-based?
    - What to consider for choosing different (technological) tools and so-called mediated teaching methods?

2.5 To-Be methodology

- Students **responsibility and involvement** should be increased in daily school work. Teaching and learning process has to be more interactive. "Less teaching more guidance". [Raseko, LVT, TTHK]
    - TTHK presented learning based on self-regulation, using **7E learning process model** (involvement, creating interest, investigation, explaining, specification, extending, and assessment) in their analyze document. See Figure 2.
- Teachers' and students' deeper and closed co-operation with industry and company visits [Raseko, LVT]
- More co-operation with university students [KTK]
- Flexibility [Raseko]
    - More flexibility in study arrangements [e.g. extended on-the-job learning period, 2+1 and 1+2 studies (last or two last years' apprenticeship study)
    - Knowledge and skills identification and recognition (this decreases time used to studies)
    - Personalized study paths (fast or slow graduation, more selection in study subjects, utilization of previous studies, part of the studies in other schools, etc.)
- Theory studies in workshops at the same time with practical studies, more practical teaching, and more efficient use of existing machines [Raseko, LVT]
- Innopedagogy [KTK]
- Versatile existing methods [KTK]
- "Multi education" (several or at least two teacher per student group) [Raseko]
- Students' peer support [Raseko]
- Small teaching class in some subjects or in all subjects for students who need more support [Raseko]
- Alumnis' motivation visits and lectures in school (a graduate student or employee in an industry) [Raseko]
- Teacher training (internal training, external training, work periods in industry, etc.). Teachers have to follow trends of subjects and industry. [LVT, Raseko]
- Mobility [TTHK]

Summary: Students' involvement and responsibility has to be increased in learning process. Students' motivation has to be increased. Students' different needs has to be consider, some students need special pedagogy and other students want to make fast progress and they need lots of challenges.

2.6 Tools (To-Be)

- Distance learning / e-learning [Raseko, KTK, TTHK mentioned this as an As-Is tool]
- Utilization of IT-technology, videotaping, and more visual examples [Raseko, TTHK, LVT]
    - Students videotape each other's practicing and working and then they watch the video and analyze and reflect education event
    - TTHK presented how to use multimedia applications in teaching in their analyze. See Figure 3.
    - RFQ label on machines (user and maintenance manual, work instructions, and safety instructions)
- Teachers must do more attractive presentations and teaching in general [KTK, LVT]
    - 3D printing kits
    - Robotic kits
    - RC cars
    - YouTube
    - Easily untestable learning material
- Different tools – case by case tools and equipment [KTK, this is perhaps close to **Blended learning** which TTHK presented as As-Is methodology)
- Visuals and virtual teaching materials [TTHK]

Summary: Tools should be modern and motivational which enable reflection. Tools should be visual which combine theory and practice. Tools should allow slow or fast progress in studies. Effective materials are expensive.

3 Literary review

Novel training methods were identified by interviewing NEDIA project participant organisations as describted above. These interviews are not mentioned in reference list. Novel training methods were also searched and identified by conducting literary reviews, internet searches, interviews and by participating meetings. Some meetings and discussions have taken palce already before the start of the NEDIA project.

The aim has been to identify and find practical training methods instead of complicated academic theories.

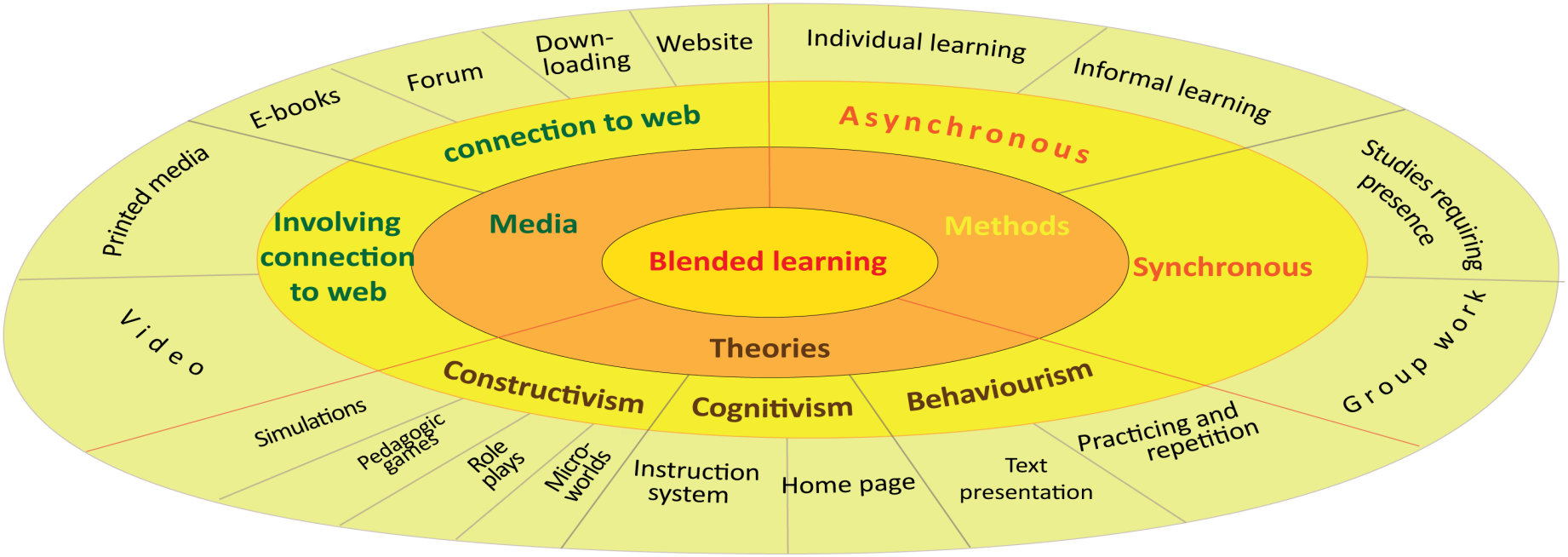

Figure 1 Holistic approach to blended learning (C. Wiepke, 2006)


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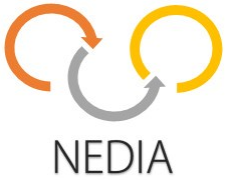
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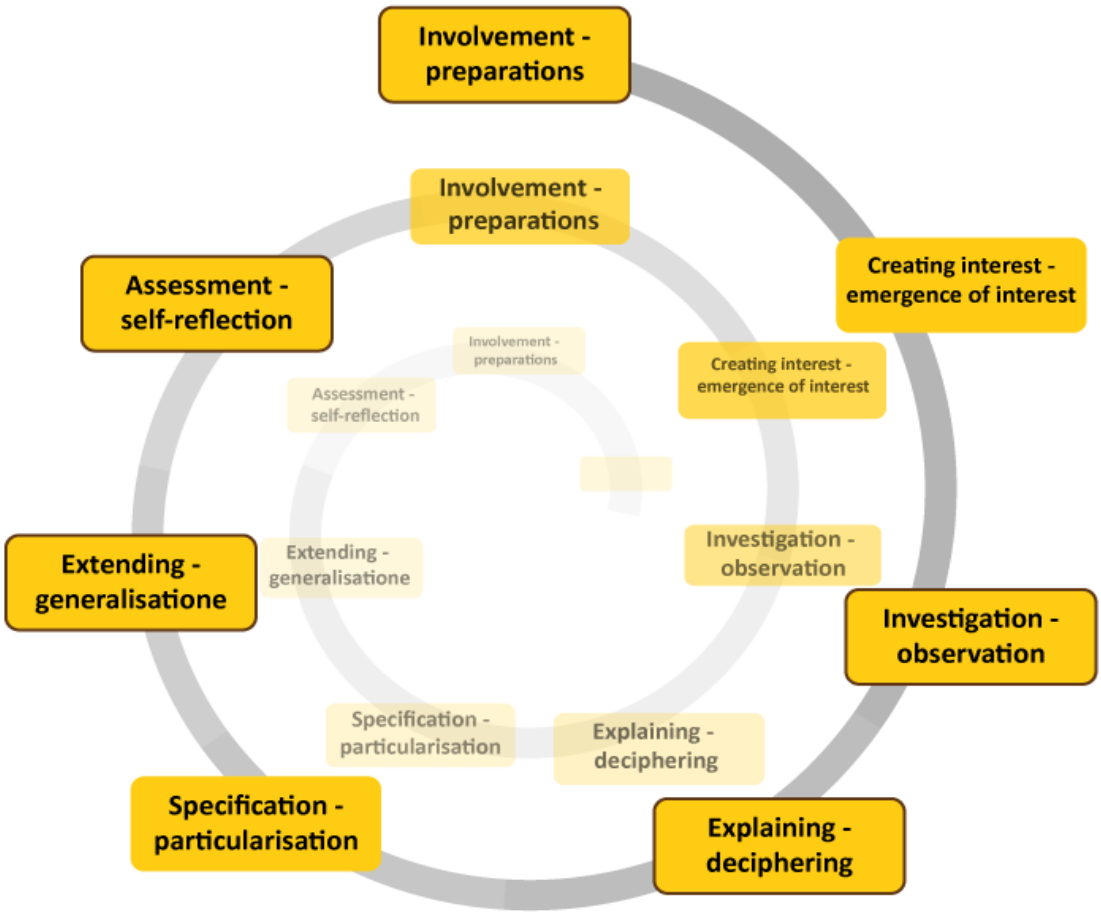


Figure 2 Learning, based on self-regulation, using 7E model. Developed from NASA's 5E model.

Source: Eduard Brindfeldt Visually structured methods and tools for industry automation, Tallinn 2013.

The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications By Rodger W. Bybee, Joseph A. Taylor, April Gardner, Pamela Van Scotter, Janet Carlson Powell, Anne Westbrook, and Nancy Landes

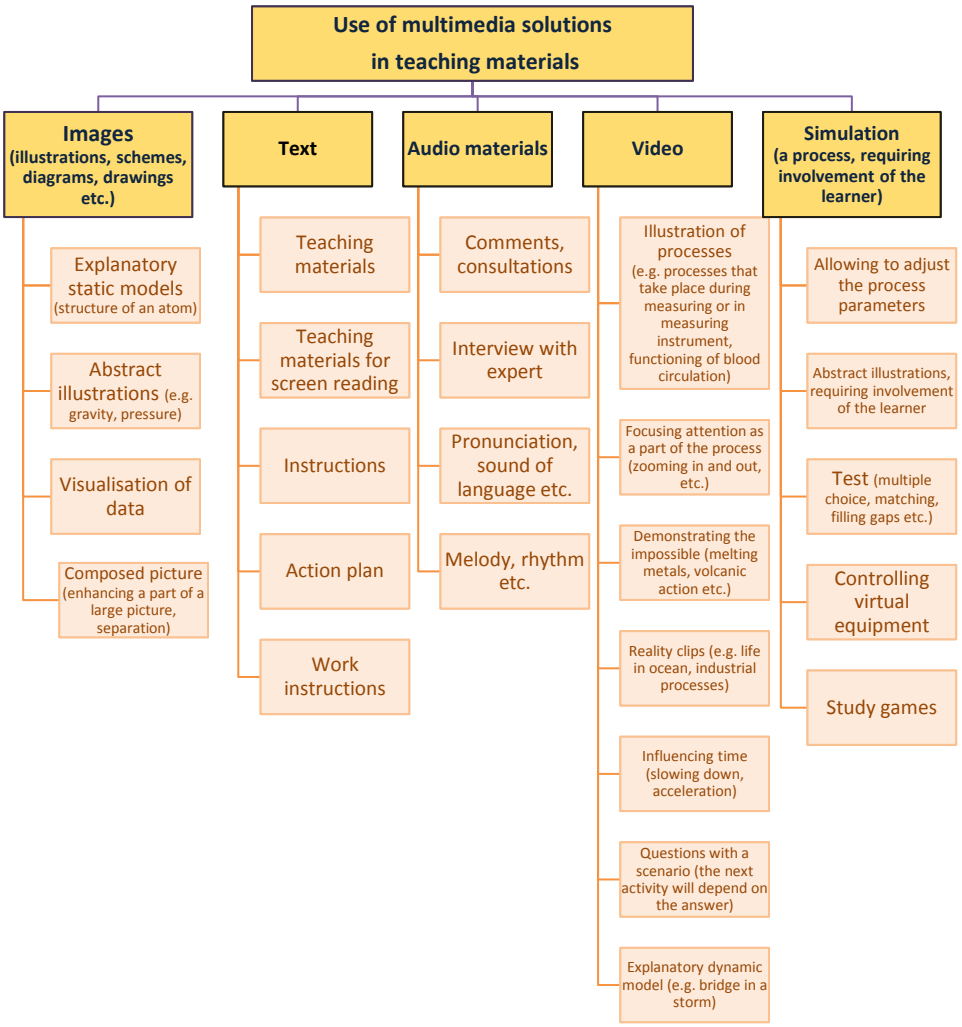


Figure 3 Multimedia applications in teaching. Figure is done by Tallinn Industrial Educational Centre. (Koumi, 2006)

Table 2 New learning methodologies based on literately review, internet search, and interviews

Methodology	Short description and limitations	Reference	Notes
Phenomenon-based learning (*ilmiöpohjainen oppiminen*)	In a phenomenon –based learning and teaching basis is holistic real world's phenomenon. Phenomenon is viewed and observed as a whole in a real context. There are not any subject related borders in a phenomenon examination. Basic difference between phenomenon-based learning and traditional learning is that subjects and things are not split as relatively small and disconnected pieces.	PowerPoint presentation of Aki Luostarinen, Otava Opisto, 2012 https://sites.google.com/site/ilmioopas/home	According to recent Finnish articles phenomenon-based learning is suitable for talent students
Project learning (active learning, learning by doing) [*Projektioppiminen (toiminnallinen oppiminen, tekemällä oppija)]*	- Learning takes place together with other students who have the same target to solve some problem according to a plan (targets, schedule, job assignments and resources). - Projects can be from small to very large projects. In small projects may be few students and in larger projects can be a group of students,	Lupa kokeilla, erilaiset tavat toteuttaa opetusta ammatillisella toisella asteella ("***Permission to try, different ways to carry out teaching in vocational secondary schools***"), ISBN 978-952-5892-35-2	- Teacher's role is enabler, supporter, person who clarifies the target, and builds bridge between different opinions - Students equal involvement and work load has to assure through the project phases - One small project example is building of RC-car. It was used 4 hours per a week during six week.

	and even the whole school who executes projects together with other schools, companies, or third sector organizations. - Purpose is to interact with others in a planning phase, execution, and evaluation phase. Students learn work life skills like problem solving, responsibility taking as a person and as a team member, and co-operation and interaction skills. - Project learning improves students' team spirit and social cohesion.		- Other example is NY 24h leiri (Young entrepreneur 24 hours camp) where students learn by "learning by doing" business and basic work life skills
Simultaneous teaching, "teaching together" (*Samanaikaisopetus eli yhdessä opettaminen*)	- Two or more teachers teach one or several subjects at the same time in the same place for one or several student groups - This doesn't cause extra cost. Subjects which earlier were different time are now at the same time in school timetable. Students' school days are shorter. - Targets are to improve learning, increase number of graduates, and ensure that entities of subjects are according to working life requirements. - To share teachers educational responsibility, to avoid teachers burnout, and improve teachers	Lupa kokeilla, erilaiset tavat toteuttaa opetusta ammatillisella toisella asteella ("***Permission to try, different ways to carry out teaching in vocational secondary schools***"), ISBN 978-952-5892-35-2	- It's easier to teach and connect theory to practice in a real work - It's possible to teach languages in a work shop at the same time with practical teaching

	evaluation skills		
Diverse learning environments (*Erilaiset oppimisympäristöt*)	It's possible to learn everywhere – in classroom, work shop, working place, inside, outside, abroad, etc.	Lupa kokeilla, erilaiset tavat toteuttaa opetusta ammatillisella toisella asteella ("***Permission to try, different ways to carry out teaching in vocational secondary schools***"), ISBN 978-952-5892-35-2	- E.g. OTE project in Meyer shipyard. Students are in an **extended on-the-job-learning period** for 2 months in shipyard - Long work shop periods for students who can't concentrate on classroom teaching - 2 + 1 model, 2 years in school and one year in apprenticeship training - 1 + 2 model, 1 year in school and two years in apprenticeship training
IT technology and networks in teaching (*Tietotekniikka ja verkot opetuksessa*)	- Handheld use in teaching (smartphones, pads, etc.) - Social media like Facebook, Twitter, blogs and Wikies in teaching - Virtual learning environments like Moodle, IT's learning, cloud services, etc. - YouTube	Lupa kokeilla, erilaiset tavat toteuttaa opetusta ammatillisella toisella asteella ("***Permission to try, different ways to carry out teaching in vocational secondary schools***"), ISBN 978-952-5892-35-2	Students have all the time smartphones with them. Students could record videos when they are doing exercises in work shop. Students would analyses and reflect afterwards how they succeeded and what could be done differently. Electrical teaching material should be modified short and suitable for smartphone use, e.g. easy to read with smartphone. There could be QR codes (Quick Response) in workshop and students could reach e.g. work and safety

			instructions by reading QR code Study material should behave like smartphone games (study games). This would increase students interest and motivation Teachers' IT skills should be developed
Places for remedial teaching (*Rästipajat, läksyparkki, oppitupa, jne*.)	A place where student can get support for his studies and opportunity to learn and practice more. Also possibility to accomplish studies if student haven't attended enough to theory or practical teaching	Lupa kokeilla, erilaiset tavat toteuttaa opetusta ammatillisella toisella asteella ("***Permission to try, different ways to carry out teaching in vocational secondary schools***"), ISBN 978-952-5892-35-2	- This has to "sell" for students as an opportunity not as mandatory
Business run by students	In some Finnish schools students accomplish at least part of their studies as an entrepreneur. Teachers have assisted students to establish co-operatives or limited companies. Students run those companies business in different roles. After graduation the business is transferred for new students immediately or during some transition time.	- School visit in Turku University of Applied Science, Lemminkäisenkatu 30, 20520 Turku, April 2010. hosted by Timo Linnonsuo. - School visit in Salo Region Vocational College (Salon seudun ammattiopisto), Hyvoninkatu 1, 24240 Salo, 28.5.2014, hosted by Jaana Nyström.	
Methodologies which are usually consider as innovation and ideation methods	- Road map - PBL (problem-based learning) - Brainstorm - Mind map	Methodologies have been presented in HAAGA-HELIA, School of Vocational teacher education lectures in Turku on spring 2010	- Involvement of all students is high

	- Debate - Learning Café - Tuplatiimi (partly like Nominal Group Technique) - Storyboarding	Short presentation of these methodologies is behind this table	

Phenomenon-based learning is topic in several press releases and bulletin boards in Finland and there are big expectations for this methodology.

Christiane Ala-Nissilä from Turun Suomalaisen Yhteiskoulun Merilinja (http://www.tsyk.fi/merilinja/) and Lauri Kosomaa from Turku University of Applied Science (http://www.tuas.fi/en/) presented shortly their three days physics sailing in "Sea education forum" meeting. Turun Suomalainen Yhteiskoulun Merilinja is upper secondary school whose studies are emphasized to navigation. Physics sailing participants were students from above mentioned schools and Aalto University. Upper secondary school students were selected based on success in their studies. University students coached and teach physics for upper secondary school students during the sailing. During the sailing students analyzed navigation, weather, etc. phenomenon by utilizing navigation physics. As you can imagine it's not possible to plan and be prepare to all phenomenon they met during the sailing. Physics sailing was a success which will be repeated next year. Sailors try to get press release to Navigare magazine. (Merikoulutusfoorumi "Sea education forum" meeting on the 2nd of November, 2015)

Problem-based learning (**PBL**) actively engages the student in building their own understanding of complex issues, which places it in the tradition of constructivism. The use of PBL techniques means that how a problem is approached will likely result in a variety of viable solutions; its premise is that some complex problems will in fact have more than one solution. (http://hlwiki.slais.ubc.ca/index.php/Problem-based_learning) In problem-based learning (PBL) courses, students work with classmates to solve complex and authentic problems that help develop content knowledge as well as problem-solving, reasoning, communication, and self-assessment skills. These problems also help to maintain student interest in course material because students realize that they are learning the skills needed to be successful in the field. PBL is characterized by a student-centered approach, teachers as "facilitators rather than disseminators," and open-ended problems (in PBL, these are called "ill-structured") that "serve as the initial stimulus and framework for learning Instructors also hope to develop students' intrinsic interest in the subject matter, emphasize learning as opposed to recall, promote group work, and help students become self-directed learners. Learning is "student-centered" because the students are given the freedom to study those topics that interest them the most and to determine how they want to study them. (White, 2001)

Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. (https://en.wikipedia.org/wiki/Brainstorming)

Mind map is a diagram used to visually present words, ideas, tasks, and other issues around the key word or idea which is located in the midle of a map. Mind map is used for generation and development of ideas, and visualisation and organising complicated relationships. Mins map is used in ***teaching***, organizing, problem solving, and decision making. Mind map represents ideas and things multidimensionally, grafically, and nonlinearly which encourages participants to generate new ideas. (http://www.oph.fi/saadokset_ja_ohjeet/laadunhallinnan_tuki/wbl-toi/menetelmia_ja_tyovalineita/mind_map)

Debate is co-operative method which can develop rhetoric and communication skills, problem solving, locigal thinking, and conclusion making skills. (http://www.edu.helsinki.fi/malu/kirjasto/yto/vaittely/index.htm)

Learning café is a methodology where bigger group is divided to smaller gropups for examble to five persons groups. Each small group has a chairman who maintains discussion and assists to make notes. Gropus solve each problem about 20 minutes and after that other group members except chairman move to a new group.

Chairman stays to his/her place and makes summary from previous group's work to a new group. The new group continues to develop previous group's ideas. A common summary is prepared by all chairmans when all groups have rotated through all group chairmans. This common summary is reviewed with all participants.

Learning café methodology is quite similar with World café methodology. (Järvensivu, Nykänen, and Rajala 2010)

Finnish company Innotiimi Oy has registered methodology which they call as **Tuplatiimi**. Tuplatiimi is little bit similar with international methodology Nominal Group Technique. Group or groups of people identify big number of ideas and solutions and then they select the best ones to redevelopment and as a final solution. (https://fi.wikipedia.org/wiki/Tuplatiimi)

Storyboarding is a methodology where team members can view a problem from different viewpoints. Each team menber writes their ideas and thoughts to a paper, one piece of paper per one idea. Piece of papers are sticked to a big white wall paper. Finally team select the best ideas to further development. (Klubnik & Greenwood 1996)

4 Evaluation of teaching methods and conclusion

Seleted teaching methods are evaluated in a below selection table (table 3). Evaluation is conducted so that teaching method should fullfill as many specified reguirements as possible. Teaching methods which fulfill enough specified requirements are suitable as To-Be teaching methodologies in the NEDIA project's organizations. NEDIA project's O3 phase's lecture materials will be developed for selected learning methodology or methodologies

Table 3 Evaluation table how well teaching methodology fulfill specified requirements.
(**+**) means that methodology fulfill requirement
(**-**) means that methodology doesn't fulfill requirement
(o) means that requirement is not valid for the methodology or it may vary case-by-case
(?) means that this is unclear

	Combines theory and practice, and visual	Improves students' motivation	Increases students' involvement and responsibility	Consider different kind of learning problems (visualization problems, dyslexia, mathematical problems, concentration problems, etc.)	The studying is independent of location	Student group which is homogenous, some students need more support and time and some students need more challenges	Allows slow or fast progress in studies	Teachers should be up to date with the latest technology and what is going in the industry --> co-operation with industry	Co-operation with other secondary schools, university of applied science, and universities	Notes and limitations (See below notes)
Methodology										
Blended learning	+	+	+	+	+/o	+/o	o	o	o	
Phenomenon-based learning	+	+	+	o	+	?	?	o	o	1)
Project learning	+	+/o	+	o/?	+/o	+/o	+/o	+/o	+/o	
Simultaneous teaching	+/o	+	+/o	+	o	+	+/o	o	+/o	
Extended on-the-job-learning period	o	+	+	+	+/o	+	+/o	+	o	2)
Long work shop periods	+/o	+	+	+	+/o	+/o	+/o	o	o	2)
Combination of school studies and apprenticeship training e.g. 2 + 1 model,	+/o	+	+	?	+/o	+	+	+	o	2)&3)

blog writing	+	+/o	+/o	+/o	+/o	o	o	o	+/o	
Virtual learning environments like Moodle, IT's learning, cloud services	+/o	+/o	+/o	+/o	+/o	+	+	o	+/o	
Students' video recording and group reflection afterwards	+	+	+	+/o	+/o	+/o	o	o	o	4)
Ready-made video recordings in teaching	+/o	+	o	+/o	+/o	+/o	+/o	o	o	5)
Places for remedial teaching	o	+/o	+/o	+	o	+	+	o	o	
Business run by students	+	+	+	+/o	+/o	+/o	+/o	+	o	2)

Notes:

1) Some articles state that this methodology is good for talent students. Therefore it's unclear does it fit for less talent students.
2) Assumption is that it's student selection to involve to this teaching methodology
3) There are conflicting opinions that is this methodology suitable just for "good students" or also for less good and less motivated students.
4) Videos can also be used in teaching afterward even those would include errors and mistakes
5) Teachers' and students' self-made videos are used when those are not available for example from YouTube

Evaluation table's assessments are subjective and individuals' assessments may differ from the evaluation table's assessments. Evaluations may also vary by case-by-case.

Conclusion

It's not surprise that all evaluated teaching methods got high scores in evaluation because methodologies' preselection was used. Preselection was conducted so that partners discussed which teaching methodologies might be suitable in their organizations and based on this discussion methodologies were selected to more detail and accurate evaluation (See table 3). High scores means many pluses (+), not too many nulls (0), and as little as possible minuses (-).

Duration of the NEDIA project set some obstacles to the teaching method selection. Some evaluated methodologies would need big effort and preparation before those could be implemented. One example is business run by students. Establishment of a company and its business starting wouldn't be ready before closing of NEDIA project. But if some partner has already earlier started some long lasting projects, NEDIA lecture materials might be possible to produce and utilize in those teaching environments.

Even most of evaluated methodologies are suitable for O3 phase it's obvious that partners' has to have authorization to select the most suitable methodology or methodologies just for them. This selection freedom is good and fruitful for the project because the project will produce many different kind of lecture materials which can be tested and use later on in other organizations.

The most important criteria for the methodology was improvement of student's motivation, increasing of student's involvement and responsibility, combination of theory and practice, and visualization. Partners have to consider above mentioned criteria very highly in their methodology selection. It's also recommended that partners will test something that is really new for them even there would be big risk to failures.

References

Books and magazines:

Järvensivu Timo, Nykänen Katri, and Rajala Rika. 2010. Verkostojohtamisen opas: Verkostotyöskentely sosiaali- ja terveysalalla (”*Network management guide book: Networking in field of social and healthcare”)*

Kilpinen Jaana and Pusa Juha. 2013. Lupa kokeilla, erilaiset tavat toteuttaa opetusta ammatillisella toisella asteella (”*Permission to try, different ways to carry out teaching in vocational secondary schools*”), ISBN 978-952-5892-35-2

Klubnik, J.P. & Greenwood, P.F. 1996. Ongelmanratkaisu tiimissä. Käytännön malli. („*Problem solving in a team. Practical examble*“) Helsinki: Rastor.

Koumi. 2006. Designing Video and Multimedia for Open and Flexible Learning

Wiepke. C. 2006. Computergestützte Lernkonzepte und deren Evaluation in der Weiterbildung., Hamburg: Blended Learning zur Förderung von Gender Mainstreaming.

White Hall. 2001. Problem-Based Learning. Stanford university newsletter on teaching. Winter 2001 Vol. 11, No. 1

Web pages:

Phenomenon guide: https://sites.google.com/site/ilmioopas/home

Problem-based learning (PBL): http://hlwiki.slais.ubc.ca/index.php/Problem-based_learning

Brainstorming: https://en.wikipedia.org/wiki/Brainstorming

Mind Map: http://www.oph.fi/saadokset_ja_ohjeet/laadunhallinnan_tuki/wbl-toi/menetelmia_ja_tyovalineita/mind_map

Depate: http://www.edu.helsinki.fi/malu/kirjasto/yto/vaittely/index.htm

Tuplatiimi: https://fi.wikipedia.org/wiki/Tuplatiimi

Phenomenon-based learning. PowerPoint presentation of Aki Luostarinen, Otava Opisto, 2012

Interviews, seminars, visits in organisations, etc:

School visit in Turku University of Applied Science, Lemminkäisenkatu 30, 20520 Turku, April 2010. hosted by Timo Linnonsuo.

HAAGA-HELIA, School of Vocational teacher education lectures in Turku, Lemminkäisenkatu 30, 20520 Turku, spring 2010

School visit in Salo Region Vocational College (Salon seudun ammattiopisto), Hyvoninkatu 1, 24240 Salo, 28.5.2014, hosted by Jaana Nyström.

Merikoulutusfoorumi "*Sea education forum*" meeting in Aboa Mare (Auriga Center) Juhana Herttuan Puistokatu 21 Turku, on the 2nd of November, 2015

Appendix A RASEKO's best practice teaching methodology – Blog writing

Topic: Work report writing as a blog

Target group: Mechanical engineering students on the secondary vocational school.

Purpose: Student has to write short work report as a block. In a writing phase students makes reflection. This also develops student's ability to write short summary what he has done. This is required in work life where workers write similar kind of texties in production management and service systems.

Methodology: Short work reports as a blog. Students use Google's Blogger program and blogs are private and therefore it's not possible to see those if you haven't received invitation to see students' blogs.

Students have also used Google Drive where they have written their schoolworks and they have shared them to the whole class. Students have also common textes which tehy have written and modified together. Students are satisfied because thay have access to Drive also via smart phones and bads. At least Finnish language teacher has used this methodology.

Appendix B RASEKO's best practice teaching methodology – 2 + 1 model

Topic: 2+1 methodology (2 years studies at school and 1 year in apprenticeship training). During the 3rd year student study e-g. one day per week at school.

Target group: Mechanical engineering students on the secondary vocational school.

Purpose: Increase co-operation with industry, to offer opportunity for student to study in a real work environment. This also increases students motivation.

Methodology: Diverse learning environments

Results: Methodology motivates student and she/he can also earn money during studies.

Your feedback or comments. We have had one 2+1 student in mechanical engineering department. We are very satisfied for this pilot case. We believe that 2+1 methodology is suitable for motivated and talent students. In the literature are examples and recommendations that this methodology is also suitable for students who are unmotivated and who have difficulties to finalise their studies in school.

Miro valmistui 2+1-mallilla automaatioasentajaksi

Miro Reijo on ensimmäinen Rasekosta 2+1-mallilla valmistunut opiskelija. Miro opiskeli Raision ammattiopiston kone- ja metalliteknologiapuolella kaksi vuotta ja siirtyi kolmanneksi vuodeksi oppisopimusopiskelijaksi suihkutilakalusteita valmistavaan Hietakari Yhtymään.

Oppisopimus toteutettiin käytännössä niin, että Miro työskenteli yhtymän Naantalissa sijaitsevassa tuotantolaitoksessa neljä päivää viikossa ja opiskeli viidennen päivän teoriaa ja ammattiaineita tutussa koulussa koulutuspäällikkö Harri Simolan ohjaamana.

2+1-malli sopi Mirolle täydellisesti. Hän kokee oppivansa tekemällä paremmin kuin koulun penkkiä kuluttamalla. 2+1-mallissa myös taloudellinen toimeentulo on turvatumpaa, saahan opiskelija palkkaa koko ajan.

- 2+1-malli sopii oma-aloitteisille ja vastuuntuntoisille opiskelijoille, sanoo Oppisopimustoimiston Markku Rantala. - Kaikki ammattia täydentävät tutkinnon osat tullee olla suoritettuina ennen oppisopimukseen lähtemistä ja opiskelijalla tulee olla valmiudet työelämään.

Ensi keväänä 2+1 -mallilla on valmistumassa mm. kolme rakennuspuolen opiskelijaa ja yksi sosiaali- ja terveysalan opiskelija. Kokeilua on tarkoitus laajentaa joissain määrin muillekin koulutusaloille.

Article from RASEKO's internal magazine Rumpu, number 1/2014

Article's free translation:

Miro graduateed as automation assembler by 2 + 1 model

Miro Reijo is the first student in Raseko who graduated by 2 + 1 model. Miro studied 2 years in mechanigal engineering department in Raisio Vocational College and he studied the last year as an apprenticeship student Hietakari Group. Hietakari Group is a manufacturer of bathrooms' shower walls.

Miro worked four days per week in Hietakari Group's work shop in Naantali. He studied one day per week in Raisio Vocational College theory and practical subjects and his teacher and instructor was head of mechanical engineering department Harri Simola.

2 +1 model was excellent for me because I learn more by doing than by studding in a class room. Other benefit was that I earned money during the apprenticeship period.

Markku Rantala head of Raisio Apprenticeship Centre says that 2 + 1 model is suitable for self-imposed and responsible student. Student can't have any unfinished studies and she/he has to have working life readiness.

Next spring there are three students from building and construction departmment and one from social and healtcare department who will graduate by 2 + 1 model. We have plans to expand this piloting also to other sectors of vocational education.

Appendix C RASEKO's best practice teaching methodology – Video recording

Topic: Induction motor's start, stop, and emergency stop functions by using relay

Target group: Mechanical engineering students on the secondary vocational school.

Purpose: Combine theory and practice

Methodology: Video recording and reflection

Results: Student can realise function of relay.

Your feedback or comments. Visual and good teaching methodology

Appendix D LVT's best practice teaching methodology – Mechatronic system

Topic: Mechatronic system

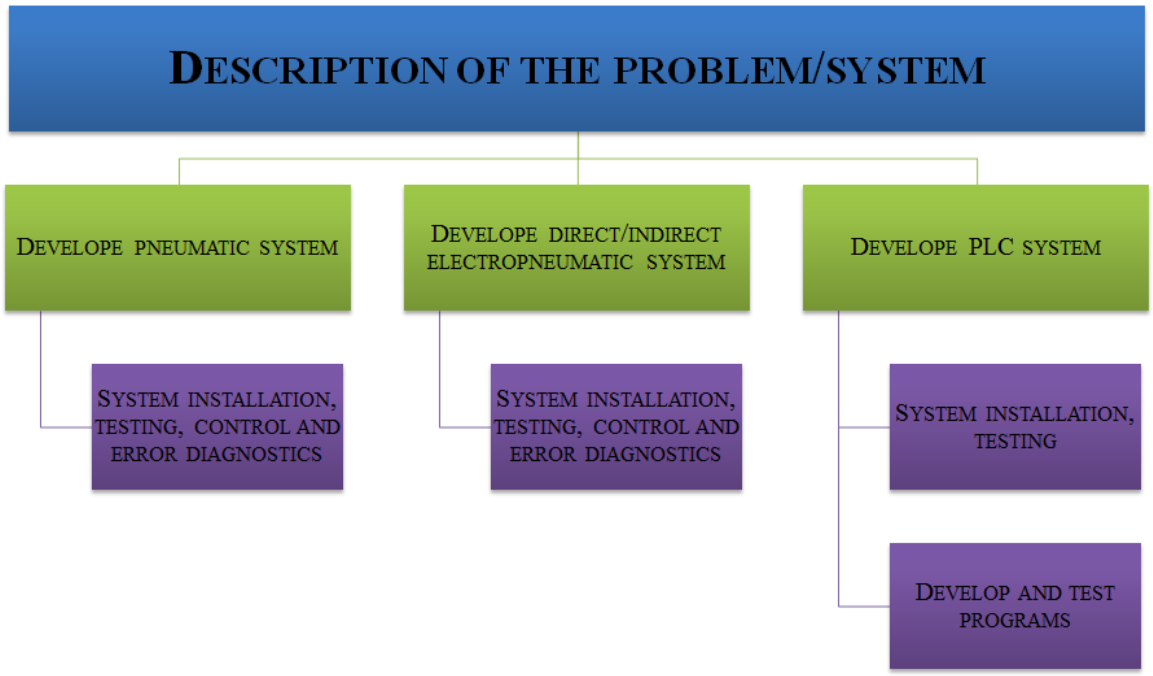
Target group: third course, learners aged from 19-21

Purpose: Acquire skills pneumatic, electro-pneumatic and PLC control system modeling, assembling and programming

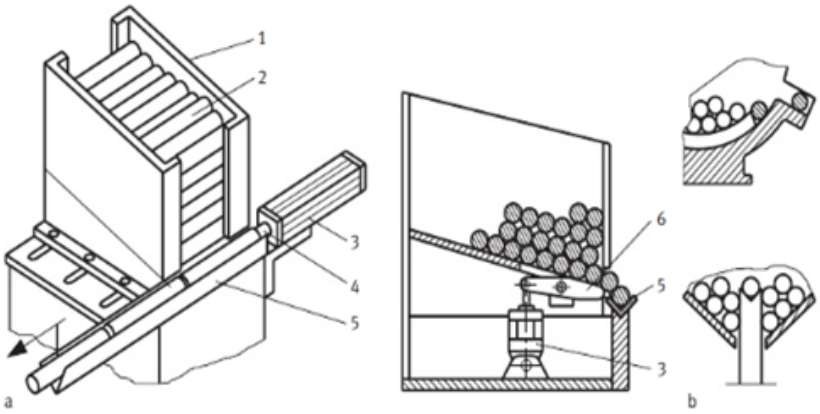
Methodology: Practical work

Innovative teaching methods:

Practical work structure



System example:



For more detailed description, see Annex.

6. Results:

• analyze task, each system's strengths and weaknesses
• knowe elements
• develope system and programme
• can understand the different elements of system
• view simple and complex systems
• over time could assemble the entire plant with all components, it would be understood as a complete cycle is a mechatronic system

7. Your feedback or comments.

Task improvements for the future:

- Develop and assemble the full system completely from the carcass to a functioning machine
- Create each control system analysis
- To develop team work

Appendix E LVT's best practice teaching methodology – Microcontroller programming

Topic: Microcontroller programming

Target group: second course, learners aged from 17-20

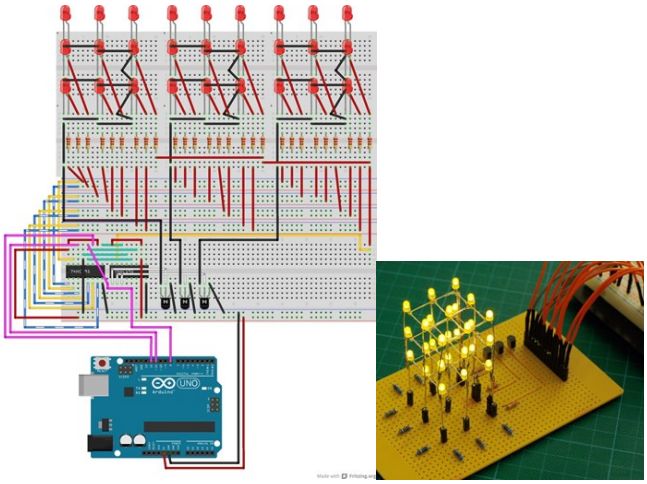
Purpose: To learn the programming and electronic circuit assembly skills

Methodology: Practical work

Innovative teaching methods:

- Implementation of the project using the resources available on the Internet
- Calculation of electronics components
- Make a electronic circuit
- Programming electronic devices using Arduino

Example of Led cube



Results:

- Interdisciplinary link (electronics, programming and English)
- Use of different types of information sources: Internet, video
- Students learn to study independently
- The teacher is a consultant in the learning process
- Student can create interesting projects

Your feedback or comments.

Task improvements for the future:

- Can create complex systems such as CNC, 3d printer, smart house

•Can make different project

Appendix F TTHK's best practice teaching methodology – Microcontroller programming

It is quite difficult to explain how automatic control works, if we use for teaching only text files and static drawings.

It is much easier for students to understand, if we use for explainig animations.

Here are animations for diferent kind of water levael control:

Demonstration Example 1.1 Water tank level without control and with disturbances
Demonstration Example 1.2 Water tank level without control and with set point
Demonstration Example 1.3 Water tank level manual control
Demonstration Example 1.4 Water tank level min/max control
Demonstration Example 1.5 Water tank level closed-loop control