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LECTURE, FLIP, INTEGRATE, AND FOCUS: A CASE STUDY ON STEPWISE TRANSFORMATION OF AN INDUSTRIAL NETWORKING COURSE FROM LECTURING TO INTEGRATED TEAM LEARNING

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Abstract

A major change within the Finnish system of Universities of Applied Sciences was introduced as a governmental reform in 2014. [Helsinki] Metropolia University of Applied Sciences (MUAS)[1] introduced changes, especially in all engineering programmes. The rationale of the steering reforms are briefly introduced.

As an institutional response, many UAS's reacted in their own way and strategy. MUAS in general, introduced larger units of teaching and learning. A fragmented curriculum including dozens courses, typically 3 ECTS can be challenging. If they run in parallel for the whole of academic semester, the student may have up to 10 courses in parallel. Losing of focus is easy. The general principles of the new curricula is discussed.

The main structural changes were introducing minimal load of a course to 5 ECTS and compressing the length of all courses to half-semester, i.e. 8 weeks. This creates the parallel load on three courses only. Some programmes went even further, especially in the first study year, by integrating these into 15 ECTS integrated theme per each half-semester, now to be called a period. This style of integration into periods was in various forms introduced by many degree programmes, such as in Information and Communications Technology, and Electronics and Automation. Learning outcomes are discussed using Industrial Networking course as example, both comparative and longitudinal between the old and reformed curricula.

The implementation shifts activity away from lecturing towards various forms of flipped classroom, using lecturing style only to introduce new tasks, leaving more teaching resources to help with the learning tasks. Subject matter integration into larger thematic areas, often in project form, forces to integrated teacher team collaboration at least in weekly basis. A tight coupling of teaching activity and removal of potentially irrelevant or overlapping substance matter enhances more focused student learning experience. A case study of stepwise refinement is discussed.

This paper focuses on this stepwise transformation process as a case study of one 3 ECTS course: Industrial Networking, originally implemented by one lecturer to a 15 ECTS course, implemented by team of four teachers. Four of the course implementations are in various individual forms, followed by the 5th implementation in an attempted integrated form. The three first implementations are analysed based on lecturer's own reflection on the structure and implementation. The last two are compared using a student feedback, both quantitative and qualitative. In both implementations the content of the subject matter and the learning objective has been relatively unchanged, however the transformation process over the various teaching methods provides an insight of a change process as a case.

Other experiences in MUAS, especially in ICT major of Health Technology, have shown a way forward to even larger, thematically integrated semesters, but now with highly integrated student learning experience, including an applied project work, mainly done to real clients outside the UAS. This case study is based and supported strongly by the thematic mind-set. Industrial Networking being the first implementation of the author in area of Automation technology, some areas of development, both in implementation details and in teacher team co-operation could be critically reflected, based on student feedback.

Keywords: Engineering Education, Integrated Curriculum, Learning Experience, Learning Methods, Teaching Methods.

[1] Institutional name change dropped the Helsinki from 2017.

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1 INTRODUCTION

A major change within the Finnish system of Universities of Applied Sciences was introduced through a governmental reform in 2014. The objective of the reform was efficiency improvement, Method was to introduce institutional autonomy i.e. increase strategic freedom, balanced by financial responsibility and fully output-oriented financing model. Within the funding model the UAS's are also in a relative competitive position within each performance indicator. The rationale of reform is discussed further in our paper [1]. The reform also forced a similar structure of programmes by introducing only a limited number of titles of student entry. This forced specialized programmes to be merged into specialization options or majors of much larger programmes [2].

1.1 Institutional Background and Previous Results

Metropolia University of Applied Sciences (MUAS) is the largest UAS with 16000 students, nearly half of them in engineering programmes. As an institutional response, many UAS's reacted in their own way and strategy. MUAS introduced the changes, especially in all engineering programmes in somewhat similar principles [1]. In general, MUAS introduced larger units of teaching and learning. A fragmented curriculum including dozens of relatively independent courses, typically 3 ECTS is challenging as a learning experience and for maintaining a coherent and non-overlapping structure both in planning and in implementation. If they run in parallel for the whole of academic semester, the student may have up to 10 courses in parallel. Losing of focus is easy.

The main structural change was introducing minimal load of a course to 5 ECTS and compressing the length of all courses to half-semester, i.e. 8 weeks. This creates the parallel load on three courses only. Some programmes went even further, especially in the first study year, by integrating these into 15 ECTS integrated theme per each half-semester, now to be called a period. This style of integration into periods was in various forms introduced by many degree programmes, such as in Information and Communications Technology, and Electronics and Automation. Quantitatively significant early results from the first year students are reported in [2] and [3], respectively.

The author is mainly in charge of Health Technology as Head of Degree Programme. This previously independent programme was integrated to be a major in ICT. This process forced us to re-think the focus, modular thematic approach, and team-based thinking. We also introduced qualitative immediate feedback collection [4] since the beginning of the new major, as well as relatively rapid quantitative follow-up of learning outcomes [5]. The core of these is implementation-level quick, even with small sample analysis, leading to immediate corrective actions.

Industrial Networks (IN) has been one of the optional courses in degree programme of Automation Technology. As a result of the reform, the programme also merged to be Electronics and Automation. Also here, large units of study were introduced. Thus, the IN learning objectives were included within one 15 ECTS unit of Information and Communication Technology in Automation (ICT-A), implemented within one period. After the qualitative [4] and quantitative [5] follow-ups, a potential to perform both comparative and longitudinal analyses emerged.

Due to his long history in ICT and networking [6], the author became involved in implementing the IN during three consecutive academic years (2015-2017), initially in the original form, and just recently first time in the integrated form. During fall 2017 still one last implementation of IN old format is on-going and the second implementation in the integrated form will commence. Organizationally, this study can be considered as benchmark of the related majors by cross-cultivating presumably good practices on a course implementation and management levels. Similarities of the case backgrounds, data collection templates and analyses enable to draw a few conclusions and generalizations, however limited by available amount of data.

1.2 Research Question

Various pedagogical approached of the same Industrial Networks -course were implemented by the author. A number of them is summarised in terms of resource usage, topics and activities included, as well as weekly timing. The learning objectives of a design exercise were kept unchanged and the grade distributions were also collected. The new questions to emerge are:

> Was there is a traceable pedagogical shift, or a development path, in the sequence of IN course implementations, which is also is reflected learning outcomes? [as it feels subjectively to be the case]. What are the characteristics of the new teaching- and learning team based model?

The nature of the research questions are mainly qualitative and partly subjective in terms of final interpretation and relevance the collected data. This is also the case that many cases the sample size is statistically insufficient to make definite conclusions. However, the basis of the analysis is exact data from course implementation and study records to strongly limit any subjectivity. The applied value of the analysis is reflection of work done and being a baseline for further iterative improvement.

1.3 Related work

Definitions of the levels of learning, or learning taxonomies have been suggested. [7] Particularly relevant in Bachelor's level engineering programmes is the balance between general knowledge and applied practical skills. In terms of taxonomies, a curriculum must be based on competence hierarchies, instead of traditional knowledge hierarchies, which is especially true in Industrial Networking. [6] Tuning project also made distinction between transferrable, general skills and subject-related, non-transferrable skills. [8] Examples of transferrable skills in IN could be group work in design and locating network problems in a large context, whereas subject-related ones could be configuration and testing of particular devices.

A competence can be broadly defined as: "the ability to apply knowledge, skills and values to relevant workplace/studyplace environments based on the standards/success criteria required by that environment". In other words, a competence is always a marriage between knowledge and skill. [6][9] Some consideration of what is more relevant learning outcome than some other lies in the educator's decision to use the limited time and resources to focus more on reaching high level on competence on e.g. network design, instead of introducing large volume of network protocol theory. Network design competence can be evaluated only by designs, whereas protocol theory mainly by exams.

Various, and some very widely accepted initiatives, such as CDIO [10],[11] have been introduced to enhance competence and skill development. CDIO puts a special emphasize in concept creation, design, implementation and operation of products, and as such includes the engineering point of view to product life-cycle. As described in [1], MUAS did not adopt CDIO throughout other disciplines, such as Social- and Healthcare, or Culture in its merger in 2008. Instead, various forms on large learning units, thematic approaches, and more interestingly, many theme-related student group projects were possible to be developed. [1][2][4] This paper discusses yet another case of learning experience.

2 MATERIALS AND METHODS

2.1 Cycle I: Baseline Resource Usage

Figure 1 shows the timeline of the IN course implementations over three academic years (AY), each divided into four 8 week periods (P1-P4). The course was provided to relative small student groups of 1) young, full daytime students, and 2) adult students as evening classes. In both curricula, the course was 3 ECTS, independent (non-integrated) and optional. No significant difference between these Cycle I (A, B and C) existed.

Implementation		AY 2014-2015				AY 2015-2016				AY 2016-2017			
Target	ECTS	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
Young	3 / 3				B							F	
Adult	3 / 3			A			C				D		
Young	3 / 15										**E**		
Adult	3 / 15												**G**

Figure 1. Industrial networks course implementations timeline.

The resource, scheduling and learning outcomes data was collected and summarized. Unfortunately, the student feedback template that we used on Health Technology programmes [4] was introduced a in fall 2015. Thus no feedback for comparison is available for Cycle I. Therefore the analysis is limited to structure and self-reflection against the leaning outcomes, mainly against Cycle II.

Education management is about allocating the scarce teaching resources in an optimal way to achieve the desired learning outcomes. Thus, within the given timing- and working hour framework, the search for optimal pedagogical approaches on a day-to-day basis can be explored. The framework of resource usage and activity data per each course implementation is shown in Table 1.

Table 1. *Course implementation example data set for implementation A.*

A	Industrial Networks	66		Activity distribution						Return		3 ECTS	Outcomes	
Wk	TD00AA42-3004, TD11S2	32	34	Le	Pc	La	Dw	Ds	Ar	R	P	80	Grade	#
1	Topologies, OSI, components	4	4	x	x-				-			6	A	8
2	OSI, LAN, IP, TCP, Wireshar	4	4	x								6	B	2
3	Switch, subnet, routing, NAT	4	4	x								6	C	0
4	VLAN & switching	4	4	x								6	D	0
5	SWITCH LAB	4	6			x						6	E	1
6	Lab recap, DESIGN INTRO	4	4	x			x-	x				15	F	0
7	DESIGN, industrial comm's	4	4	x			x-	x				15	NR	1
8	DESIGN. Firewall, netop	4	4	x		x+		x	x	11	11	20	Total #	12

The first column indicates the course case identification (A), and teaching weeks (1-8), with a possible P indicating calendar week with no contact teaching, referring to a project- or self-study week. These appear in spring semesters only. The second column header simply denote the course id, implementation sequence number, and student administrative group for author's own consistency.

The third main column topmost row shows the allocated teaching hours for this particular course implementation. Traditionally, half of the resource is used to contact teaching and the other half to preparation, course administration, and evaluation. In recent years, there has been a strong attempt to develop pedagogical approaches to reduce the overall resource usage, while maintaining the intended learning outcomes. A longitudinal view in case of this course does not show such tendency. Thus, it is possible to keep this factor constant in the analysis, also in terms of summary distribution between contact and non-contact resource usage.

Therefore, the remaining flexibility lies within the pedagogical choices of breaking the 50:50-rule of contact vs non-contact hours; re-organization of weekly activities within the period; and introducing more effective and engaging learning activities and learning experiences. These activities are identified as elements of the Activity distribution as Lecturing (Le); computer class exercises (Pc); Networking lab exercises using switches and routers (La); design workshops (Dw); design assignment self-study (Ds); and assignment returns (Ar).

The fifth main column is a rough indicator of number of returned assignments (R) and number of acceptable designs, also indicating passing (P) the course. The rightmost column only denote that the estimated amount of average student's work is equal to 3 ECTS, or 80 hours. In principle, 80 hours total gives 10 hours per week average. In some implementations this column is edited to estimate the varying workload resulting from different pedagogical approaches. A similar dataset as in Fig. 2 was collected from all IN implementations in Cycle II.

Finally the learning outcomes in terms of ECTS grades (A-F) by numbers (#) and no-returns (NR), summing up to student count (Total #). For readers not familiar in acronyms, the contents of the course is roughly divided by colours: blue identifying knowledge, green laboratory exercises, and yellow the design. There is no exam. The course is evaluated by the quality of design documentation.

2.2 Cycle II: Integrate and Feedback

Same set of resource, scheduling and learning outcomes data, now augmented with student feedback template was collected from two parallel implementations of mainly the same IN contents. The course D was a single, non-integrated 3 ECTS course, similar to Cycle I. In parallel, the same content was integrated into a 15 ECTS unit denoted as E. In this model the whole period is one single, full-time course of 8 weeks.

Systematic feedback enables continuous development. The first IN in integrated model (ICT-A) was scheduled in late fall 2016 for four teacher team. The feedback was gathered at the end period. Obviously this survey in only one method to collect feedback. Recognition of subjective feedback is also a part of each professionals work. In addition to resource usage data set of Table 1, a student feedback was collected from course implementations D and E. The data set is shown in Table 2.

Table 2. *Student feedback survey questions for Cycle II course implementations.*

Student feedback questions of individual (3 / 3 ECTS) and integrated (3 / 15 ECTS) course implementations: relevance marked with X.	3 / 3 ECTS	3 / 15 ECTS
Q1) Assignments and timing of returns	x	x
Q2) How good timing and synchronization was in this period		x
Q3) How different course parts supported each other		x
Q4) Amount of work: a) could have been more, b) suitable, c) too much	x	x
Q5) I worked: a) <30 hours, b) 30-40 hours, c) 40-50 hours, d) > 50 hours per week		x
Q6) What was good in this [course] / period?	x	x
Q7) What should be developed in this [course] / period?	x	x

As shown in column of non-integrated (3/3 ECTS) and furthermore optional course the questions of timing (Q2), interlinkages (Q3) or student load for evening courses (Q5) are not relevant. However they were included for the potential of richer qualitative data to compensate the smallish sample in D. The case E material, expectedly provides the best material and is most crucial for the next steps. This data set is also comparable with all of our experiences in [2], [4], and [5]. This provides a possibility to benchmarking between programmes, period implementations and teaching- and learning team organization methods. In this paper mainly the experienced loading (Q4) is considered.

2.3 Cycle III: Focus, Flip and Team-building

The Cycle III is on-going or in very near future. One independent implementation (F) is in progress and one integrated implementation starts soon in period 4. These can be discussed based on experience and feedback from Cycle II. Because of the timing, some conclusions are drawn later in the discussion. Most of the findings are under the headings of team work and intra-group communication.

2.4 Methods

The analysis of the input resources is based on actual material in work resourcing data on a summary level, and course implementation data from the learning platforms, such as Moodle, on a weekly activity level. Weekly distribution of activities is kept qualitative, as the number of hours is relatively low and more detail is irrelevant.

The analysis of learning outcomes is based on number returned assignments (R) and the accepted ones (P), where obviously, a small difference reflects the good quality of designs. The evaluation criteria of the designs has remained mainly unchanged. Thus the R/P remains as a reasonably acceptable indicator of learning outcomes, when the structure and approach of the course itself was repeatedly revised.

This section presents the results from the student feedback survey gathered at the end of the first module of ICT-A. Results are divided into workload, what was good and what should be developed.

3 RESULTS

3.1 Cycle I: Resource Usage in Lecturing Style

Cycle I results for A, B and C can be seen as the starting point to examine variations of weekly timing and balance between knowledge and practice. The data sets are shown in Tables 1, 3 and 4, respectively. Implementation A and B are structurally identical: 4 weeks of theory, lab and 3 weeks of design. Resource amount differs but this is partly due to reserve to two lab groups, which did not realize. A was for adult group and B for younger students. Unfortunately B produced higher level on non-returned designs. Both show probable overloading of work in the last weeks. After implementation B it seemed unclear if this variation is actually related to younger students (B), and not to adults (A and forthcoming C), or just some more random issue.

Table 3. *Course implementation data set for implementation B.*

B	Industrial Networks	106			Activity distribution						Return		3 ECTS	Outcomes	
Wk	TD00AA42-3003, TD11S1	55	51		Le	Pc	La	Dw	Ds	Ar	R	P	80	Grade	#
1	LAN, IP, WIN7 cmd	4	4		x	x				-			6	A	4
2	OSI, LAN, IP, TCP, recap	4	4		x								6	B	0
3	Switch, router, NAT, etc	4	4		x								6	C	0
4	VLAN, switcing	4	4		x								6	D	0
5	SWITCH LAB	10	5	5			x						6	E	3
6	Recap labs, DESIGN Intro	4	5		x			x	x				10	F	0
7	DESIGN, special issues	10	10		x			x	x				20	NR	5
8	DESIGN, extra labs, misc.	15	10		x-		x-	x-	x	x	8	8	20	Total #	12

Implementation C is for a larger group and two lab groups are necessary. They are also started earlier to allow a recap and return to the basic ideas of design. The amount of time reserved for design task remains the same, however. The course is for adult student group, and now the problem of non-returned designs again disappears. However, the probable overloading of student work remains in the last weeks. Number of excellent designs were produced, with only one dropout, as shown in Table 4.

Table 4. *Course implementation data set for implementation C.*

C	Industrial Networks	66			Activity distribution						Return		3 ECTS	Outcomes	
Wk	TD00AB39-3001, TD12S2	34	32		Le	Pc	La	Dw	Ds	Ar	R	P	80	Grade	#
1	WIN7, cmd, intro IP	4	4			x				-			6	A	11
2	LAN, TCP/IP	4	4		x								6	B	6
3	SWITCH LAB	5	4				x						8	C	2
4	SWITCH LAB, VLAN, WLAN	5	4		x		x						8	D	1
5	Recap labs, IP calc again	4	4		x		x						6	E	1
6	Recap, DESIGN Intro	4	4		x			x					6	F	0
7	DESIGN, industr.networks	4	4		x			x	x				20	NR	1
8	DESIGN, extra labs	4	4		x		x-	x-	x	x	21	21	20	Total #	22

The Cycle I implementation of the three courses A-C appear quite similar, and all indicate that the student workload should be balanced. Possibly the reservation of more time to the design, the larger group size of adults also required more recaps to keep the group coherently in the learning process. The model indicates that less theory is sufficient for completing the design task. It also shows that les theory is required before the practical lab work. Lecturing of the theory continues still until the end of the implementations, but his raises the question if this actually necessary knowledge, if the target is on design competence.

3.2 Cycle II: Focus on Design Competence

Cycle II case D is a very small adult group, as shown in Table 5. Experimentation with D shows a radical omission of network protocol knowledge as such, and approaching the network design as early as possible. For administrative reasons weeks 1 and 4 were non-teaching weeks, so the minimal amount of theory necessary for the design was introduced intensively within one week, followed by design introduction Leaving week 4 unloaded, this gave 6 weeks for the design.

This implementation shifts activity away from lecturing towards various forms of flipped classroom, as shown in Table 5. The flipped model in this case means that the students continue their design task and the instructor's role is to advise or consult, or provide theory, at the moment it is required. This is roughly indicated in Tables 5 and 6 as "missing" lectures (Le). To some extent it is true that irrelevant theory, detached from the actual design task, was reduced. It is true that there is always difference between the written, actually taught and actually learnt curriculum. Here it seems necessary to reflect that the written curriculum contained knowledge without its application. The remaining lecturing is indicated with blue- and the flipped class or design workshops focus is shown with red dashed area

Table 5. *Course implementation data set for implementation D.*

D	Industrial Networks	66			Activity distribution						Return		3 ECTS	Outcomes	
Wk	TD00AB39-3002, TD13S2	36	30		Le	Pc	La	Dw	Ds	Ar	R	P	80	Grade	#
1		2								-			0	A	4
2	WIN7, IP, LAN, devices	8	4	4	x	x							12	B	2
3	VLAN & DESIGN Intro	4	4		x			(x)	x				12	C	1
4									x				8	D	0
5	SWITCH LAB	4	5				x	x	(x)				8	E	1
6	DESIGN, VLAN, resit labs	4	5		(x)		x+	x	x				16	F	0
7	DESIGN, IP	8	4					x	x	x+	4		16	NR	0
8	DESIGN, finalizing	6	4					x-	x	x	8	8	8	Total #	8

Doubling the design time has a positive effect. Good quality of designs indicated that the traditional knowledge set of protocol theory might have been unnecessary for the task. Their implementation in parallel with the relatively large group E on younger students, and shown in Table 6. E is the first integrated implementation.

Subject matter integration into larger thematic areas, often in project form, forces to integrated teacher team collaboration at least in weekly basis. A tight coupling of teaching activity and removal of potentially irrelevant or overlapping substance matter enhances more focused student learning experience. All this is more easily said than implemented in large scale. The case D above was paralleled by E, also implemented with the more focused contents and workshop-orientation, as shown in Table 6. Unfortunately week 5 was necessary to spend in the overall integration attempts and workshop of IN within the ICT-A unit. Also, the group size was exceptionally large, so two weeks was spent on lab work. This left very little time for completing the design task.

Table 6. *Course implementation data set for implementation E.*

E	Industrial Networks 3/15	72			Activity distribution						Return		3 ECTS	Outcomes	
Wk	TX00BX07-3001, SA14A	40	32		Le	Pc	La	Dw	Ds	Ar	R	P	80	Grade	#
1	WIN7, IP, LAN	4	4		x	x				-			8	A	15
2	Switch, VLAN, IP addressing	4	4		x								8	B	21
3	DESIGN Intro	4	4		x								8	C	5
4	(Return intermediate design)	4	0						x	x	3		8	D	1
5	Integration review (ICT-A)	6	4				(x)	(x)					8	E	0
6	SWITCH LAB. gA, DESIGN	2	6				x		x	(x)			12	F	2
7	SWITCH LAB. gB, DESIGN	2	6				x		x	(x)			12	NR	0
8	DESIGN	14	4					x	x	x	12	11	16	Total #	44

However, keeping the design intro as early as week 3 allowed design self-study time and intermediate return already on week 4. Only part of the groups used this feedback opportunity, but it seemed helpful tool to get learning feedback in both ways.

3.3 Student Feedback

This section discusses student feedback. This is based on Table 2 questions applied to D (n=2) and E (n=22) in Cycle II. In qualitative use, these give reasonable indication of workload and possible timing issues. In D not much can be concluded, but the design results were very good and no dropouts happened. One student considered the workload correct and the other perhaps somewhat high.

Case E most (20/22) students considered the workload reasonable, one that the load was still at the end, and one commented that the assignment return of In was rushed into same timeframe as by the other instructor's tasks. This is quite relevant, and should be coordinated in integrated team teaching. Instructor observation and Table 6 suggest again high load towards the end of the module. Now, it the focus on design competence seems valid, but even more interleaving of activities could be possible.

3.4 Cycle III: Keep Focus and Flip

The ongoing implementation F is probably the last non-integrated IN course. It is for young fulltime student group of about 18, and starts with PC-labs with IP address exercises and design brief. Only necessary device theory is provided in the second week to allow for practical labs in the third week. After this learning experience, the concepts of VLAN and the actual design intro is repeated.

Table 7. *Course implementation data set for (a still ongoing) implementation F.*

F	Industrial Networks	66		Activity distribution						Return		3 ECTS	Outcomes	
Wk	TD00AB39-3003, TD13S1	40	26	Le	Pc	La	Dw	Ds	Ar	R	P	80	Grade	#
1	WIN7, cmd, DESIGN w. IP	10	4	(x)	x				-			8	A	
2	Recap IP, LAN, devices	3	4	x								8	B	
3	SWITCH LAB	3	6	x								8	C	
4	VLAN, DESIGN Intro again	3	4				x	x				12	D	
5	(Return design version 1)	3						x	x			10	E	
6	VLANs, IP subnets, DESIGN	3	4	x			x	x				10	F	
7	(Return design version 2)	3						x	x			12	NR	
8	DESIGN Finalizing	12	4				x	x	x			12	Total #	18

The expedited learning experience flips the class on week 5 with no contact hours at all, but the first draft of the design to be returned and commented. Theory and design workshop continues in week 6, followed by week for returning design version 2. The final week is yet again design workshop to finalize the documentation. Two intermediate returns accompanied with high motivation that the feedback is actually relevant will be the strongest steering vehicle the self-study. The feedback allows most probably very good steady workload distribution and student confidence that the course is progressing well.

In addition, week 1 lecturing was strongly augmented by a “workbook” -approach, where the students learned the previously lectured material using computer class and “IP design workbook”. The course is still ongoing, but instructor’s initial experience on this minor flipping still is positive. The design task, i.e. the goal of the whole course was briefed right at the beginning. This was suggested by two of the feedbacks. Most likely the same principle is applied in implementing the second integrated module G, as shown in Fig. 1.

4 CONCLUSIONS

The paper discussed the rationale of UAS system reforms and it’s institutional responses in terms of curricula adjustments. Several practical course implementations we analysed to explore development of new pedagogical characteristics when implementing an Industrial Networks -course. Some related and theoretical connections were drawn to MUAS previous work in network- and competence development. A stepwise transformation process case study of one 3 ECTS course: Industrial Networking. Originally implemented by one lecturer to a 15 ECTS course, implemented by team of four teachers.

In Cycle I the first three implementations were analysed to be largely similar in structure, but indicating variance in results, and work overload towards the end. The pedagogical model was mainly lecturing, intended to support design assignment. Similar data sets were collected and analysed, but without student feedback.

In Cycle II one implementation of non-integrated and one integrated course implementations we run in parallel with reduced about of theory, which is largely irrelevant to the design assignment; lecturing was reduced and replaced by design workshops; and student feedback was collected, especially from the integrated one, which is the future model. Techer role was changed from lecturer to design consultant. The usefulness of intermediary return of designs was tested as a tool to interact and as a tool to distribute the workload more evenly. The intermediate returns are also expected to reduce dropouts.

Cycle III is the current implementation version of the IN course. In non-integrated form is running last time in writing of this paper. Being implemented and in a stepwise way refined, it has been a tool to enable us to focus on competences and to flip the class gradually. Although some of the implementations have been small, it has then allowed more pedagogical freedom to reorganize the content several times. Perhaps the greater value is the transfer of knowledge and experience to the final teaching team of future ICT-A -course, which will be running permanently with higher volume.

The paper has its limitations. Comparable feedback should be collected systematically at least in a few future implementations, to allow for consistent development of each of its parts. Now only the IN was analysed. More student feedback qualitative data is available about IN and ICT-A as a whole. These must be left for future analysis, likely after the second integrated implementation.

Other experiences in MUAS, especially in ICT major of Health Technology, have shown a way forward to even larger, thematically integrated semesters, but now with highly integrated student learning experience, including an applied project work, mainly done to real clients outside the UAS. This case study is based and supported strongly by this kind of thematic mind-set. Industrial Networking being the first implementation of the author in area of Automation technology, some areas of development, both in implementation details and in teacher team co-operation could be still critically reflected. Teaching team-building is a long and systematic process. Also in design exercises and other tasks, relatively stable student teams, at least in period level, are necessary. Analysis of these processes is outside the scope of this paper.

However, this case study and similar ones are a form of systematic self-reflection and being on implementation level, not requiring resource changes, enable Plan-Do-Check-Act (PDCA) -style of gradual quality development on a rather practical context.

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