Relations between civil engineering students' approaches to learning, perceptions of the development of professional skills and perceived workload

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INTRODUCTION

In recent years, the development of professional skills has been one of the main themes among engineering education research. Many researchers [e.g. 1, 2, 3] argue that in higher civil engineering education should focus more on learning of professional and generic skills. These skills should be better integrated to the present contents of the study programs. On the other hand, the curriculum designers have been struggling with the growing workload of the students, because there is pressure to adapt new skills and contents to curriculums. This paper examines engineering students' approaches to learning and their perceptions of the development of the professional skills and perceived workload in their studies. Research on students' approaches to learning (the SAL-tradition) examines how and why students engage in learning. The research is usually based on the students' self-reports of their

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learning in specific learning environment or learning situation [4, 5, 6, 7]. The students' approaches to learning can be divided into deep and surface approaches to learning. Also the third approach, organised studying, has been identified in previous studies [8, 9]. There is evidence that the deep approach is positively related to learning outcomes [10, 11, 12] and negatively related to the perceived workload [13, 14].

The aim of this paper is to investigate how civil engineering students' approaches to learning are related to their perceptions of the development of professional skills and to the perceived workload. The research data consist of students' answers to the Learn questionnaire (n=215). The questionnaire has been developed for the Finnish context at the Helsinki University Centre for Research and Development of Higher Education and it has proved to be a reliable instrument to measure students' approaches to learning based on many studies in Finnish university contexts [see 15]. The Learn questionnaire consists of 22 items on students' perceptions of the teaching-learning environment, 12 items on students' approaches to learning, seven items on the development of professional skills and three items on perceived workload in studies. In this study were analysed the students' approaches to learning, professional skills and workload sections. This study is a further research to our previous research, where students were grouped into four clusters based on their approaches to learning [16]. The identified clusters are: 1) Unorganised students applying a deep approach, 2) Students applying a surface approach, 3) Organised students applying a deep approach and 4) Organised students. In this study, these clusters were compared with regard to students' perception of the development of their professional skills and perceived workload. The research questions are as follows:

1. How do civil engineering students perceive the development of professional skills in their studies?
2. How are students' approaches to learning related to their perceptions of the development of the professional skills?
3. How are students' approaches to learning related to their perceptions of the workload in their studies?

1 THEORETICAL FRAMEWORK

1.1 Students' approaches to learning

Students' approaches to learning have been one of the main topics in learning science after Marton and Säljö [17] found deep and surface level learning processes in their studies. They investigated the differences between the students in how they approached a specific learning task. Some students used a surface level learning process and others a deep level process. Students who used a surface level learning process tried to reproduce the learning material whereas students who used a deep level process tried to understand the learning task. The combination of the intention to learn and the level of the learning process is referred to as an approach to learning [4]. The surface approach to learning is related to memorizing, reproducing the content, lack of regulation and students' inability to see relations between ideas [10, 18, 19]. It means that students not necessarily achieved the understanding about the subject. Understanding the subject is related to a deep approach to learning, which consist of the intention to understand and an active and critical approach to learning [10].

Also a third approach to learning has been identified, the organised studying [10, 20]. It describes how students organise studying and how they manage time [8]. The students who are organised are usually well aware of the demands for completing the courses and complete the courses systematic in time. Also students' motivation and learning skills are related to the organised studying [8, 9, 21]. The organised studying refers to students' way of planning and organising their learning whereas the deep and the surface approaches to learning describes the students' way of handling the learning task [6, 22].

1.2 Civil engineering students' professional skills

The changes in the construction sector are setting new challenges for the higher education of the construction sector. Anymore, just plain technical skills are not adequate for civil engineers [e.g. 1, 2, 3]. In the future, engineers will need better generic and professional skills. According to literature review by Salmisto [23] in higher civil engineering education should focus more on multidisciplinary collaboration skills, learning skills and other professional skills like project management, understanding the complexity of the construction projects, and leadership skills. The construction projects have become more and more complex involving numerous stakeholders. For example, in recent years the number of designers has increased in the construction projects, which is setting high requirements for multidisciplinary collaboration skills [24].

1.3 Students' perceived workload

The research on students' workload has been recently based on measuring the perception of the students' concerning workload [14]. Earlier, time spent on studying has been used as a measurement, but it has been noticed that this is not reasonable enough to measure students' workload [24]. Many previous studies [e.g. 10, 25, 26, 27] argue that a perceived excessive workload is positively related to a surface approach to learning, whereas other studies [e.g. 28, 29] argue that an appropriate workload is positively related to a deep approach to learning and negatively related to a surface approach to learning.

2 METHOD

The research was conducted at a university of technology in Finland. The data of this research were collected with a Learn questionnaire in 2012 and 2013. The Learn questionnaire has been developed, based on the Experiences of Teaching and Learning questionnaire (ETLQ) [see 30] and Approaches to Learning and Studying Inventory (ALSI) [9], at the Helsinki University Centre for Research and Development of Higher Education [see 15]. It has proved to be a reliable instrument to assess students' approaches to learning based on many studies in Finnish university contexts since 2005 [see 15]. In this study were analysed three sections of the Learn questionnaire: 1) the students' approaches to learning (12 items), 2) professional skills (7 items) and 3) perceived workload (three items). A five-point Likert scale was used with responses ranging from 'agree' to 'disagree'.

2.1 Participants

Altogether, 215 students responded to the questionnaire: 53 (24.7%) women and 162 (75.3%) men. The ratio of female to male respondents corresponds to the ratio of female and male students at the university. Of the 215 students, 169 (78.6%) respondents were studying civil engineering and 46 (21.4%) respondents were studying in other disciplines (architecture, materials engineering, industrial

engineering and management, automation engineering, information management, mechanical engineering). Of the 215 answers, 207 were suitable for the analyses. The students completed the questionnaires during learning events in the three civil engineering mass courses. The respondents covered second- to sixth-year civil engineering students ranging in age from 19 to 50 (average age, 22.9).

2.2 Statistical analyses

The clusters used in this research have been defined in our previous study, where the procedure of the statistical analyses has been described more closely. In this section is presented briefly these analyses and the defined clusters. Firstly, the similarities between civil engineering students and students from other disciplines were analysed with a cross-tabulation and a Chi-square test. The analyses showed no statistically significant differences between the groups in terms of their approaches to learning. Therefore, the entire data was analysed as a single sample. Exploratory factor analyses were used to test how the Learn questionnaire functioned with the data. The internal consistency of the factor solution was estimated with Cronbach alfa. The results of the factor analyses suggested three-factor solution. The factors and their reliabilities are presented in Table 1.

Table 1. Cronbach's alphas of the factors measuring students' approaches to learning

Factor	α
Approaches to learning	
Deep approach	0.718
Surface approach	0.750
Organised studying	0.708

After the factor analyses, the students' approaches to learning were analysed with K-mean cluster analyses using the factor scores of each factors. The mean values for each approach were calculated: 1) a deep approach, M = 3.32, s = 0.639, 2) a surface approach, M = 2.62, 0.651, 3) an organised studying, M = 3.11, s = 0.718. A cluster analysis was used to examine respondents' placement on four clusters based on these three approaches. Three-, four- and five-cluster solutions, which all were acceptable, were tested. The four-cluster solution was selected for the analyses, because the clusters were almost of equal size ($n_{cluster1}$ = 45, $n_{cluster2}$ = 41, $n_{cluster3}$ = 57 and $n_{cluster4}$ = 64) and the cluster profiles were clear and theoretically logical. The respondents differed from each other statistically significantly in terms of a deep approach ($F(203)=81.807$, $p<.001$), a surface approach ($F(203)=41.940$, $p<.001$) and an organised studying ($F(203)=140.350$, $p<.001$).

Cluster 1, *Unorganised students applying a deep approach*, consisted of students who adopted the deep approach to learning. They scored low on items measuring the surface approach and the organised studying. In cluster 2, *Students applying a surface approach*, there were students who scored high on a surface approach to

learning. Their scores on the items measuring the deep approach and organised studying were low. Cluster 3, *Organised students applying a deep approach*, consisted of students who scored highly on a deep approach and on organised studying. In this cluster the scores on a surface approach were low. In cluster 4, *Organised students*, there were students who emphasized an organised studying approach. Their scores on a surface approach were low and the scores on the deep approach were average.

Univariate analysis of variance (ANOVA) was used to explore the differences in students' perceptions of the development of professional skills and perceived workload between the clusters. Before the ANOVA, the relationship between clusters and explanatory variables (gender, age, disciplinary and study year) were analysed with cross-tabulation analyses. The analyses showed that there was not a statistically significant difference between the clusters and explanatory variables.

3 RESULTS

The aim of the study was to investigate the development of the students' professional skills and the relation between civil engineering students' approach to learning and their perceptions of the development of the professional skills and perceived workload in higher education. The professional skills were measured with seven items: 1) theoretical knowledge, 2) cooperative and social skills, 3) analysing information, 4) examining subjects from different points of view, 5) examining subjects critically, 6) presenting justification and look for solutions to them and 7) developing new ideas. The perceived workload was measured with three statements: 1) workload of the studies is too high, 2) I have to work too hard in my studies and 3) I feel stress.

The results revealed (*Table 2*) that students have perceived that they have learned to examine subjects critically and from different points of view and to present justification for their ideas. Students scored the lowest on Developing new ideas and Applying theoretical knowledge to practice -items.

The ANOVA showed that all seven 'professional skills' -items and two out of three 'perceived workload' items (see *Table 2*) differed statistically significantly across the four clusters ($p < 0.050$). One item, 'Workload of the studies is too high', did not differ statistically significantly across the clusters ($p = 0.134$). The test of homogeneity of variances showed that the variances of the items, Applying theoretical knowledge to practice, Developing cooperative and social skills, Developing new ideas, Workload of the studies is too high, I have to work too hard in my studies and I feel stress, are homogenous ($p > 0.050$). For these items, Bonferroni's post hoc –test was used to analyse which clusters differ from each other statistically significantly. Dunnett 3T –test was applied for other items ($p < 0.050$).

Table 2. The results of the univariate analysis of variance

Items	Total (N=207)	Clusters: Unorganised students applying a deep approach (n = 45)	Students applying a surface approach (n = 41)	Organised students applying a deep approach (n = 57)	Organised students (n = 64)	F	p
Professional skills							
Applying theoretical knowledge to practice	3.13	3.33	2.76	3.51	2.89	9.085	0.000
Developing cooperative and social skills	3.31	3.22	3.10	3.65	3.22	4.322	0.006
Analysing information	3.37	3.42	3.07	3.61	3.31	5.228	0.002
Examining subjects from different points of view	3.54	3.64	3.20	3.84	3.42	6.929	0.000
Examining subjects critically	3.64	3.76	3.41	3.91	3.45	4.106	0.007
Presenting justifications	3.63	3.76	3.41	3.89	3.44	5.553	0.001
Developing new ideas	3.06	3.16	2.61	3.47	3.06	7.458	0.000
Perceived workload							
Workload of the studies is too high	2.49	2.40	2.76	2.35	2.51	1.882	0.134
I have to work too hard in my studies	2.31	2.16	2.56	2.11	2.44	2.863	0.038
I feel stress	2.62	2.38	3.15	2.36	2.70	5.142	0.002

The results revealed that the students who adopt a deep approach to learning perceive that their professional skills have developed more than the students, who adopt a surface approach (*Table 2*). The students in cluster ‘Organized students applying a deep approach’ achieved the highest scores from all aspects. Students who belonged in the cluster ‘Students applying a surface approach’ achieved the lowest scores in all aspects (*Table 2*). Also, students who adopt a deep approach have perceived less workload than other students. Students who belonged in the clusters ‘Unorganised students applying a deep approach’ and ‘Organised students applying a deep approach’ achieved the lower scores on all three items measuring the perceived workload than students who belonged in the clusters ‘Students applying a surface approach’ and ‘Organised students’.

Table 3. Statistically significant differences between clusters (Bonferroni, Dunnett T3)

		Cluster 1	Cluster 2	Cluster 3	Cluster 4
Applying theoretical knowledge to practice (Bonferroni)	Cluster 1	-			
	Cluster 2	**.011**	-		
	Cluster 3	1.000	**.000**	-	
	Cluster 4	**.046**	1.000	**.001**	-
Developing cooperative and social skills (Bonferroni)	Cluster 1	-			
	Cluster 2	1.000	-		
	Cluster 3	.073	**.010**	-	
	Cluster 4	1.000	1.000	**.034**	-
Analysing information (Dunnett T3)	Cluster 1	-			
	Cluster 2	.128	-		
	Cluster 3	.679	**.000**	-	
	Cluster 4	.974	.359	.078	-
Examining subjects from different points of view (Dunnett T3)	Cluster 1	-			
	Cluster 2	.093	-		
	Cluster 3	.601	**.002**	-	
	Cluster 4	.499	.719	**.004**	-
Examining subjects critically (Dunnett T3)	Cluster 1	-			
	Cluster 2	.381	-		
	Cluster 3	.922	**.023**	-	
	Cluster 4	.436	1.000	**.018**	-
Presenting justifications (Dunnett T3)	Cluster 1	-			
	Cluster 2	.243	-		
	Cluster 3	.888	**.018**	-	
	Cluster 4	.151	1.000	**.003**	-
Developing new ideas (Bonferroni)	Cluster 1	-			
	Cluster 2	**.032**	-		
	Cluster 3	.462	**.000**	-	
	Cluster 4	1.000	.075	.076	-
Workload of the studies is too high (Bonferroni)	Cluster 1	-			
	Cluster 2	.377	-		
	Cluster 3	1.000	.156	-	
	Cluster 4	1.000	.974	1.000	-
I have to work too hard in my studies (Bonferroni)	Cluster 1	-			
	Cluster 2	.248	-		
	Cluster 3	1.000	.095	-	
	Cluster 4	.643	1.000	.263	-
I feel stress (Bonferroni)	Cluster 1	-			
	Cluster 2	**.008**	-		
	Cluster 3	1.000	**.003**	-	
	Cluster 4	.795	.249	.535	-

Table 3 shows that there is a statistically significant difference ($p < .050$) between the clusters 'Organised students applying a deep approach' and 'Students applying a surface approach' in every 7 items ($p = .000$ - $.023$) measuring students' perceptions of development of the professional skills. Also, between clusters 'Organised students applying a deep approach' and 'Organised students', there are statistically significant difference all items except Analysing information ($p = .078$) and Developing new ideas ($p = .076$). Between clusters 'Unorganised students applying deep approach' and 'Students applying surface approach', there is statistically significant difference in Applying theoretical knowledge to practice ($p = .011$) and Developing new ideas ($p = .032$) -items. The results also show that there is not a statistically significant difference between the clusters 'Unorganised students applying deep approach' and 'Organised students applying a deep approach' in any item.

Although students who apply a deep approach to learning have perceived less workload than the other students in their studies, there is not so strong a relationship between perceived workload and students' approaches to learning. There is statistically significant difference only between clusters 'Organised students applying a deep approach' and 'Students applying a surface approach' and between 'Unorganised students applying a deep approach' and 'Students applying a surface approach' in I feel stress -item.

4 CONCLUSIONS AND DISCUSSION

The first objective of the study was to investigate how civil engineering students perceive the development of professional skills in their studies. This research indicates development in engineering education students' ability to examine subjects critically and from different points of view. This is important, as critical thinking and analytical abilities are vital generic skills of future engineers [e.g. 31].

Students have thought that their skills in developing new ideas have not developed as well as critical thinking during their studies, although innovativeness and creativity are important skills in knowledge society [32]. Many researchers [e.g. 2, 31] argue that innovation skills have become more and more important for future engineers. The results are in line with Sahlberg's [32] claim that the education systems have difficulties in adopting creativity and innovation skills in students' learning processes in current education. Also students have perceived that their skills in applying theoretical knowledge to practise have not substantially developed during the studies. Some researchers [e.g. 33, 34] have noticed the same in previous studies. Engineering students have had problems to implement in practise what they have learned in theory.

The second aim of the study was to analyse how students' approaches to learning are related to their perceptions of the development of professional skills. The results revealed that there is a positive relation between a deep approach to learning and students' perceptions of the development of professional skills. Because the results are based on students' self-reports, it cannot solidly be argued that their skills have improved. On the other hand, previous studies [10, 11, 12] have shown that students who adopt a deep approach have achieved better learning outcomes than other students. Students' own perception is notable because it indicates students' motivation for learning. If students adopt a deep approach to learning, they are

probably more motivated to learn. The motivated students are ready to spend more time on studying [35], which affect positively learning outcomes.

The third objective was to determine how students' approaches to learning are related to the perceived workload. The results revealed that there is a slight negative relation between a deep approach to learning and students' perceived workload in their studies. According to Kember [25] there is not necessarily a correlation between time spent on studying and perceived workload. Although the students, who adopt a deep approach, probably spend more time on studying, they perceive less workload and pressure than students who adopt a surface approach.

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