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RESEARCH ARTICLE

Students' experiences and engagement in a flipped classroom course on pharmacokinetics

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Abstract

Objective: The aim of this study was to examine whether the flipped classroom method enhances the quality of students' learning by exploring the change in students' processes of understanding, their relation to study success, and students' experiences of the course.

Methods: A mass pharmacokinetics course, comprising 148 second-year pharmacy students was transformed by using the flipped classroom method. Students answered a 'HowULearn' questionnaire in their first and last lecture before (n=126) and after the course (n=100) to measure their processes of understanding. Paired sample *t*-test, chi-square test and correlation analysis were used to analyse the change in students' scores, examine the relationship between the scales, and course grade. Students' experiences of the course were examined with open-ended questions, and these responses were analysed using qualitative content analysis.

Results: The response rate to the first and second questionnaire was 68%. Surface-level processing statistically decreased significantly (t= 3.72; p <0.001) and deep-level processing increased (t= -2.34; p= 0.022) during the course. The proportion of students scoring low on deep-level processing was smaller and the percentage of students representing high on surface-level processing was smaller during the course. At the end of the course, surface-level processing was negatively related to exam points (r= -0.34; p= 0.003). Deep-level processing (p= 0.82) and surface-level processing (p= -0.11) were not statistically significantly related to course grade at the beginning of the course. According to students' experiences the new course design, including pre-lecture tasks, supported their learning with 63 students out of 84 (75%) students reporting feeling this way.

Conclusions: The study showed that the flipped classroom approach resulted in decreased surface-level and increased deep-level processing. This suggests that the flipped classroom method can improve students' processes of understanding.

Keywords: *Flipped Classroom, Deep-level Learning, Pharmacokinetics, Study Performance*

Introduction

Today's demanding labour markets require good quality teaching and thus, teaching should enhance students' learning (Biggs & Tang, 2003). This effort is not restricted to new tools and practical tricks for teaching, but is more widely based on the current understanding that students should become experts, able to construct and process knowledge in order to be able to apply that knowledge effectively to actual problems in real-life situations (Boshuizen & Schmidt, 2008). Students should apply deep-level processing in their studies in order to build high quality learning (Entwistle & Ramsden, 1983; Biggs, 1996; Biggs & Tang, 2003; Varunki *et al.*, 2017). Teaching and assessment methods play an essential role in guiding the students' learning (Entwistle & Ramsden, 1983; Biggs, 1996, Biggs & Tang, 2003) and should thus concentrate on helping students to develop their quality of learning and metacognitive skills (Tynjälä, 1999).

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The characteristics of teaching and learning can have disciplinary differences. Disciplines can be categorised as 'hard pure' (for example, mathematics), 'soft pure' (for example, psychology), 'hard applied' (for example, pharmacy) and 'soft applied' sciences, based on the characteristics of the discipline (Becher, 1994). Studies have shown that in 'hard' and 'hard applied' sciences like pharmacy and medicine, students tend to adopt surface-level processing in their studies (Nieminen *et al.*, 2004; Varunki *et al.*, 2017). They do not tend to emphasise knowledge construction, and have fragmented knowledge about the subject matter, which in turn leads to low-level learning. Studies have also shown that pharmacy students' deep-level processing develops only slightly during their studies (Nieminen *et al*., 2004). In addition, it has been shown that in life sciences, deep-level processing is not necessarily related to study success (Rytkönen *et al*., 2012). Students' engagement plays an important role in fostering good-quality learning (Biggs & Tang, 2003) and there is a need to find new ways to promote students' active knowledge construction in the life sciences context.

One way to explore the different ways of processing qualitatively is to use the students' approaches to learning (SAL) framework (Lonka *et al*., 2004; Parpala *et al.*, 2010; Asikainen *et al*., 2013; Asikainen & Gijbels, 2017). Approaches to learning also reflect the cognitive engagement, also known as the strategies students use (Ainley, 1993). This framework identifies two distinct processess of understanding: deep-level and surface level process. Deep-level processing means aiming to understand and applying strategies which promote meaningful learning such as critical thinking and relating ideas in learning (Entwistle & Ramsden, 1983; Lonka *et al.*, 2004; Parpala *et al.*, 2010; Asikainen *et al.*, 2013; Asikainen & Gijbels, 2017). Deep-level processing has been found to be related to better learning outcomes than surface-level processing (such as memorising and struggling with the fragmented knowledge base) (Entwistle & Ramsden, 1983; Lonka *et al.*, 2004; Asikainen *et al.*, 2013). This framework also acknowledges a third approach, organised studying, which refers to effort and time management and is often associated with deep or surface learning (Entwistle & McCune, 2004). This does not reflect students' processes of understanding as such and it has not been included in this study. Furthermore, it seems that especially surface-level processing is harmful, and recent research has shown that it has a linkage with poor learning but also with study-related burn-out, low self-efficacy beliefs, poor study success and problems in proceeding with studies (Asikainen *et al*, in press). One important goal in pharmacy education is to pay attention to ways to enhance students' learning towards deep-level processing and to decrease surface-level learning. Thus, there is a need to develop and study new procedures to enhance students' study processes.

Students' learning processes are also related to their perceptions of the teaching-learning environment (Biggs & Tang, 2003; Parpala *et al*., 2010; Varunki *et al.*, 2017). It has been shown that students who score high on surface-level processing in learning systematically experience the teaching-learning environment more negatively than students who apply deep-level processes (Parpala *et al*., 2010; Asikainen *et al*., 2013). Teaching that encourages students' own active learning has been found to promote quality of learning (Arrue *et al*., 2017). However, research has shown that changing the students' levels of processing during studies is not easy. A recent review study has shown that students' development of deep-level processing and decrease in surface-level processing is not obvious in higher education (Asikainen & Gijbels, 2017). Thus, new ways to support students' processes of understanding should be developed.

One example of a teaching method which aims to foster students' deep-level processing is the flipped classroom (Arrue *et al.*, 2017). The flipped classroom, also called the 'inverted classroom' (McLaughlin *et al.*, 2014), is a model of blended learning in which the study material is dispensed to the students for their self-paced use prior to classes. The principle is to reverse traditional lecture teaching: the student studies the material independently before classes, which in turn are used to clarify the topic through student-engaging activities. The learning material is frequently provided as recorded online lectures and includes pre-readings of written material (Pierce & Fox, 2012; Ferreri & O'Connor, 2013). The teacher may give mini- or micro-lectures during classes in response to misconceptions or gaps in the students' knowledge, as recognised via student-teacher dialogue or real-time assessment. To further promote higher -level thinking amongst students, flipped courses have employed several types of active learning exercises such as pair activities, student presentations, quizzes, or case studies (Ferreri & O'Connor, 2013; McLaughlin *et al.*, 2014). The flipped classroom method has been used in pharmacy courses, including pharmaceutics, renal pharmacotherapy, self-care, and pharmacokinetics (Edginton & Holbrook, 2010; Pierce & Fox, 2012; Ferreri & O'Connor, 2013; Persky *et al*., 2017). In these studies, the time spent on pre-assignment readings and the students' performance that result in improvements in student performance have been examined (McLaughlin *et al*., 2014; Persky *et al*., 2017). However, in these studies, the students' learning processes and the effect that the flipped classroom method has on them have not been examined, even though higher-level thinking processes are especially important for health professionals, who must continually absorb new information. Furthermore, recently it has been pointed out that more research and evaluation of flipped models and their affects and impact is needed (Persky *et al.*, 2017).

The aim of this study was to examine whether the flipped classroom method enhances the quality of students' learning by exploring the change in students' processes of understanding in relation to study success, and students' experiences of the course. The authors' hypothesised that students' processes of understanding, namely deep-level and surface-level processing, change during the flipped classroom-method course towards better understanding. In addition, a positive relationship between deep-level processing and success in the course was expected.

Methods

Pharmacy education in Finland is a two-stage process. First, all students complete a three-year degree called the Bachelor of Science in Pharmacy, which authorises them to work in a pharmacy and dispense medications, including prescriptions. Students can apply to continue their studies for two more years and become a Master of Science in Pharmacy, which enables them to supervise or own a pharmacy. Between 2012 and 2014, the Faculty of Pharmacy undertook a major curriculum reform. In this process the curriculum was designed to be outcomes-based, and learning outcomes for the degrees were formulated (Katajavuori *et al*., 2017). Furthermore, the curriculum was designed to be a more activating and student-centred learning environment in order to foster students' learning.

To test and develop constructive and activating teaching and learning methods, a compulsory pharmacokinetics mass course of three credits for second-year pharmacy students (N=148) was selected as the pilot course. In terms of student workload, three credits is approximately equal to 82 hours of study, including lectures, practice and independent study during the course and for the exam. In this course, in many previous years, students had demonstrated a poor ability to apply pharmacokinetic knowledge. For example, in the previous year before the curriculum reform started, almost 40% of the students either failed the examination or passed by achieving the minimum requirement. Therefore, this course was reformed and designed according to the principles of the flipped classroom method (Persky *et al*., 2017). The aim of this reform was to foster students' learning in the course.

For all contact-teaching sessions, the learning objectives and core subject matter were designed according to the principle of constructive alignment, which promotes students' active learning and emphasises the alignment between course aims, methods and assessment (Biggs, 1996). The course syllabus consists of 28 hours of contact teaching: 20 hours with the whole group and eight hours of small-group exercises, which means that 54 hours was planned to be used for students' independent studying during the course in order to complete the workload of a three credits course (82 hours of studying). The flipped classroom method was applied as follows:

- Learning objectives, text book chapters, course slides and activating pre-lecture tasks were available to students via Moodle (an e-learning tool) before each contact teaching session;
- Students read the material and answered a pre-lecture task via Moodle;
- Students had the opportunity to send questions to the teacher and they peer-reviewed each other's answers to the pre-lecture task before each contact teaching session;
- The contact session was designed according to learning outcomes, students' questions, and challenging topics noticed in earlier years. Answers to the pre-lecture task were given;
- Small-group exercises were voluntary. Exercises and learning objectives were presented in a handbook.

The instructors organised an introduction to this new course design, during which the principles of the course were explained and the new way of studying during this course were discussed with the students. Students were encouraged to study continuously during the course and to take part to the small-group exercises. Between 30% and 50% of the students took part in these small-group exercises, depending on the theme of each exercise. The pre-lecture tasks and peer assessment were scaled so that they required one or two hours to conduct them. Students were awarded an extra three marks in their overall examination mark if they answered and peer-reviewed 80% of the pre-lecture tasks.

There was a final examination at the end of the course. In previous years, the exam had been based mostly on factual knowledge but for this new course, the final exam was modified to assess students' understanding of the course contents. This new exam included statements, calculations, concept definitions and these questions covered the whole course. All the questions in the exam required knowledge application and understanding of the course contents – it was not possible to pass the exam with pure fact-memorising. Thus, this exam was more demanding than the exam in previous years. The final exam was graded by using the 0-5 scale where 0= failed; 1= passing with minimum requirements of 50% of the maximum points; and Grade 5 meaning excellent performance. The maximum number of marks from the exam was 37. During the final exam, the students were asked to assess themselves for their own effort and for achievement of goals. When students did the pre-lecture tasks in time and completed 80% of the given pre-lecture tasks, they received three extra marks for the exam. In addition, if students did the self-assessment in the exam carefully, they received one extra point for this task too, so altogether students could get four extra points towards the exam – with these points student could upgrade their exam grade by one grade. The mean self-evaluation grades (0-5) were calculated for students receiving each examination grade (0 to 5). At the end of the course, students were also asked to assess the course workload and the clarity of the learning outcomes of the course.

A total of 148 students had enrolled for the course in August 2015 (23% male, 77% female). Before and after the course, the students were asked to complete a widely used and validated 'HowUlearn' questionnaire (Parpala & Lindblom-Ylänne, 2012) with four questions measuring students' surface processing and four questions measuring deep processing (Table I) on a 5-point Likert scale. The first HowUlearn questionnaire was answered by 126 students and 102 completed a second questionnaire. A total of 97 students voluntarily gave their permission to be included in the study and of these, 84 could be matched for comparison to analyse changes in deep and surface processing.

Table I: Questions measuring surface and deep processing HowULearn

Deep Processing	Ideas and perspectives I've come across while I'm studying make me contemplate them from all sides.
	I look at evidence carefully to reach my own conclusion about what I'm studying.
	I try to relate new material to my previous knowledge.
	I try to relate what I have learned in one course to what I learn in other courses
Surface Processing	I often have trouble making sense of the things I have to learn.
	Much of what I've learned seems to be no more than unrelated bits and pieces.
	I am unable to understand the topics I need to learn because they are so complicated
	Often I have to repeat things in order to learn them

The experiences of those 97 students who gave permission to study their responses were analysed according to the questionnaire at the end of the course. In the second measurement, the questionnaire also included open-ended questions about students' experiences of the course, comprising aspects which improved or reduced their learning in the new course. In addition, the students were asked to compare their experiences of this course with a traditional lecture course. The students' consent was sought before their data were used in the study and permission to use the questionnaire for research was provided by the University of Helsinki. This research was exempt from ethical review because it did not cause harm to the students.

Sum scales were conducted from the scales measuring deep-level processing and surface-level processing, based on the factor solution from earlier studies (Parpala *et al.*, 2010; Parpala *et al.*, 2011; Asikainen *et al.*, 2013). To analyse the change in students' scores on these two dimensions before and after the course, paired sample *t*-test and Cohen's D was used. In addition, the students were then divided into three score groups (low/medium/ high) where the middle group was formed using the mean +/- a half standard deviation. The frequency of students in each group before and after the course was compared using cross tabulation and chi square test. To examine the relationship between the scales and course grade, a correlation analysis was conducted. Furthermore, students' open-ended answers about their experiences of the course were analysed using inductive content analysis (Miles & Huberman, 1984). The students' responses (N=84) to the question "Which aspects of this course enabled your learning?" were divided into four categories: new course design, small-group exercises, student-dependent factors, and course material. These categories were non-exclusive, i.e. one response could comprise several aspects of the different categories. Each of the main categories was further divided into more specific answers according to how many times they were mentioned. In addition, the students' responses (N=73) to question "Which aspects of this course impeded and caused deterioration of your learning?" were likewise divided into four non-exclusive categories which were: new course design, student-dependent factors, overlapping courses, and course textbook, consisting of more specific sub-categories.

Results

Based on the paired-sample *t*-tests (Table II), surface-level processing showed a statistically significant decrease at the end of the course (t= 3.72; p< 0.001), and a statistically significant increase in deep-level processing (t= -2.34; p=0.022). The effect size of the change in deep processing was quite small (Cohen's D= 0.22) but for the change in surface-level processing it was moderate (Cohen's D= 0.47). Furthermore, comparison of the proportions of the students in the categorised groups concerning deep- and surface-level processing showed that the biggest change in the percentage of students could be seen in the low-deep group and low-surface group (Table III). At the beginning of the course, 24% of the students were categorised in the low-deep group but only 13% of the students represented the low-deep group at the end of the course. In addition, 24% of the students represented the low-surface category at the beginning of the course but 43% of the students were categorised here at the end of the course. A chi-square test showed that there was a significant difference between the deep categories at the beginning and end of the course (p< 0.001; χ= 24.0). The difference between the surface categories at the beginning and end of the course was not significant (p=0.055; χ= 9.3).

Table II: The paired-sample *t*-test measuring change in surface and deep processing

	Surface 1 M (SD)	Surface 2 M (SD)	*t*	*p*	Cohen's D
Deep processing	3.52 (0.563)	3.64 (0.531)	-2.34	0.022	0.22
Surface processing	2.85 (0.717)	2.54 (0.549)	3.72	<0.001	0.47

SD = Standard Deviation

Table III: The number of students in low, average and high groups concerning deep and surface processing

	Deep Beginning (N)	Deep End (N)	Surface Beginning (N)	Surface End (N)
Low	20	11	20	35
Average	40	44	40	35
High	22	27	22	12

A correlation analysis showed that surface-level processing at the beginning and the end of the course (r= 0.32; p= 0.004) as well as deep-level processing at the beginning and the end of the course (r= 0.64; p< 0.001) were statistically significantly related to each other. In addition, surface-level processing at the end of the course was negatively related to exam marks (r= -0.34; p= 0.003) deep-level processing at the end of the course was positively related to course grades, but the relationship was not significant (r= 21: p= 0.059). Deep-level processing (p= 0.82) and surface-level processing (p= -0.11) at the beginning of the course were not statistically significantly related to course grade. That is, students who applied more deep-level processes in their learning tended to achieve a better result in the exam than students who applied repetitive and unreflecting strategies in the course, who achieved a worse result in the exam. The correlations can be seen in Table IV.

Table IV: Correlations between surface and deep processing at the beginning and the end of the course, as well as achievement in the course

	DB	DE	SB	SE	EP
DB Deep beginning	1				
DE Deep End	0.64*	1			
SB Surface beginning	-0.37*	-0.17	1		
SE Surface end	-0.21	-0.28*	0.32*	1	
EP Exam points	0.04	0.17	-0.09	-0.34*	1

* = p< 0.001

Eighty-four students responded that there were beneficial aspects of the new course, meaning 13 respondents did not respond to this question. As seen in Table V, 63 out of the 84 students perceived different aspects of the new course design as being beneficial. Among these answers, 89% of the students stated that the pre-lecture tasks had fostered their learning. Other learning-enhancing factors were the course exercises in general (26%) and student-dependent factors such as the student's own motivation, effort or study methods (27%). The course material was seen as being beneficial by 23% of the students.

Table V: The students' experiences of the beneficial aspects of the new course (N=84)

New course design (N=63)	Pre-lecture tasks (N=56) Lectures (N=18) Studying steadily throughout the course (N=10)
Example (student #7): "*The course was planned so that the student works throughout the whole course instead of just studying on the night before the exam. To my mind this arrangement fostered my learning well, and I hardly even needed to study for the exam*."	
Small-group exercises (N=22)	Calculations (N=17) Small-group exercises (N=14)
Example (student #3): "*The computer and situation practices were good, and the calculation exercises also helped me to understand things more deeply*."	
Student-dependent factors (N=23)	The student's own motivation, effort or interest (N=10) Independent studying, own effort (N=7) Peer support (N=6)
Example (student #26): "*My learning was enhanced by my own interest and curiosity to understand things that were unclear to me*."	
Course material (N=19)	Lecture slides of good quality (N=13) Specific learning objectives for each section (N=4)
Example (student #31): "*...The lecture materials on Moodle really helped me when I had to confirm the facts I had studied in the book. They made it really easy to review the material*."	

Despite the beneficial effects perceived by the students, 73 students also recognised factors which impeded their learning during the course (meaning that 24 of the respondents did not comment on any factors that impeded them) (Table VI). Of the students who responded to this question, 53% felt that the new course design was difficult for them and experienced some aspects of the new course as being unsuitable. The authors examined these answers more closely and found that only 12% of the students saw the course design in general as unsuitable for learning. In fact, most of the criticism (42%) was aimed at the practical implementation of the method, especially incoherence of lectures and failure to clarify correct answers to pre-lecture tasks or other exercises. Almost the same number of the comments were related to students themselves: the students' own motivation, attitude, or lack of time was a hindrance according to 40%, and overlapping courses were for 23%.

Furthermore, students were asked to compare their learning and studying experiences in this new course design with the more traditional and lecture-based course. Ninety students commented on this question and reported on both the strengths and weaknesses of this course. Many of the students' comments consisted of both positive and negative experiences of the course. Almost 80% (n=71) commented in some way on the positive effects of this new course design. Of these, 59 students gave more specific comments on this question.

Table VI: The students' experiences of the factors impeding learning during the new course (N=73)

New course design (N=39)	New course design in general (N=9) Practical implementation of the course (like new teaching method, lack of normal lectures, too scarce contact teaching, problems in implementation of pre-lecture tasks of calculation exercise (N=31)
Example (student #59): "*The lectures were often incoherent and there wasn't always time to discuss the pre-lecture tasks thoroughly enough. There was also confusion due to unclear and ambiguous questions among the tasks*."	
Student-dependent factors (N=29)	The student's own inefficiency, laziness, attitude or lack of motivation (N=16) Lack of time (N=14)
Example (student #27): "*I was not as actively involved in the course teaching as I should have been in order to achieve optimal learning. It was just because of my own inefficiency*."	
Overlapping courses (N=17)	Overlapping courses (especially systematic pharmacology) (N=17)

These positive learning and studying experiences were related to positive experiences with the pre-lecture assignments, an increase in study motivation and their own effort during the course and the new teaching-concept. Students felt that the pre-lecture assignments had enhanced their learning by activating them to learn and to study during the course. These assignments had forced them to study steadily during the course and before the lectures. The assignments had also increased their study motivation and helped them to learn during the contact session because the themes were already familiar to them. For example, some students' comments were:

"*This course was better because by doing these assignments you really had to study and learn and your study motivation increases when you notice that you do not know how to do these assignments*." [Student #85]

"*This teaching method forced me to study during the course and study the whole course content step by step*". [Student #43]

"*Before this course I had not been able to study during the course but only just before the exam. In this course you were not forced to study during the course either, but I felt it was reasonable to do them because the teacher emphasised the significance of these assignments. So, I did them even though I sometimes felt there was lack of time to do them...*" [Student #89]

Almost 40% of the students (N=33) reported negative experiences and expressed views about the weaknesses of this study method. Most of these comments (N=21) concerned the disorganised and messy teaching and course design, and obscure or difficult pre-lecture assignments which were sometimes unclear. Students felt that in addition to the new method and pre-lecture assignments, there is also a need for lectures. This study method was also laborious and demanded the students' own effort, but at the same time, "forced" them to study continuously. Only seven students (8%) commented that they preferred the traditional rather than the new method. One very critical student commented on this:

"*I absolutely prefer traditional teaching. I think it is important that the teacher teaches the contents of the course comprehensively*" [Student #8]

Some students also expressed doubts about the suitability of the method to all students:

"*Lecture-based courses suit me better. This kind of studying may be better-suited to those who need more support to master the content of the course.*" [Student #29]

There were also a few neutral comments about the course. As one student commented:

"*I did not experience the learning method as being especially good or bad. Pretty much the same as the ordinary lecture course. There was too little time to prepare for the pre-lecture tasks*" [Student #81]

One comment summarises well the students' experiences of this course:

"*I think the pre-assignments, case-studies and IT stimulations were really good and supported my learning. However, the lectures were quite disorganised, and it was difficult to get anything out of them. The pre-assignments motivated me to study and learn, but this course was much more laborious than the traditional course*". [Student #27]

Discussion

The purpose of this study was to explore the change in students' processes of understanding during a flipped classroom course. The aim was to examine the relationship between processes of understanding and study success in the course as well as students' experiences of the course.

The main finding, the decrease in surface-level processing and an increase in deep-level processing, indicates that during this course, students' processes of understanding changed towards them having a better understanding. In addition, the proportion of students who scored high on surface-level processing and low on deep-level processing decreased during the course. This result is in line with earlier research which has shown that the flipped classroom method can improve the quality of student learning (Ferreri & O'Connor, 2013; Missildine *et al.*, 2013). Furthermore, the results showed

that students' performance in the course was negatively related to the surface approach to learning, as shown by the correlation analysis. During this course, only 18% of the students either failed the examination or had the lowest passing grade (1/5), compared to the previous year, when the number of these students represented 38% This was expected since deep-level processing is related to better performance (Zorek *et al*., 2010; Asikainen *et al.*, 2013). The improved learning outcomes observed with decreased surface-level processing is in accordance with previous studies which have shown a negative relationship between surface-level processing and academic achievement (Zorek *et al.*, 2010; Asikainen *et al.*, 2013). This is a positive result since in life sciences, deep-level processing and study success are not necessarily related to each other (Rytkönen *et al*., 2012). Recent research (Asikainen *et al.,* in press) has also shown that surface-level processing is linked to study-related burnout and problems in study success and study progress. It has also been shown that students applying a surface approach to learning experience a heavier workload and have negative perceptions of the teaching-learning environment than students applying a deep approach to learning (Kyndt *et al*., 2011). Thus, decreasing surface-level processing and increasing deep-level processing in this course is a promising result.

The results from this study showed that the change in surface-level processing was stronger than the change in students' deep approach. This was a good result since earlier studies found that changes in processes of understanding are not easy or obvious (Asikainen & Gijbels, 2017). In addition, when considering the percentages of students in high/average/low groups, the most notable differences in the proportions were seen to be smaller in the low-score groups for deep-level and surface-level processing. There were also other changes. Earlier studies have found that individual changes in students' processes of understanding during a course is a common phenomenon as there are many changes in students' ways of processing a single course (Lindblom-Ylänne *et al*., 2013; Postareff *et al*., 2015). Thus, it can be expected that individual changes will occur as well. Nevertheless, at a general level, a decrease in surface-level processing and a increase in deep-level processing could be seen.

Students' experiences of the course in terms of supporting their learning were also quite positive - more often they commented positively then negatively about this new course design. The students' experience was that the teaching method helped them to study and that this way of studying was useful for their learning, however they felt that implementing this new course design was disorganised and many of the students had problems in taking an active role in their own learning process. Earlier studies also found mixed results about the students' satisfaction in flipped classroom courses. A review study on this subject found that in many courses, students' experiences of the flipped classroom were quite negative despite the improved learning outcomes (O'Flaherty & Phillips, 2015). In addition, different students have different learning preferences and therefore they experience the learning environment differently (Parpala *et al*., 2010). Thus, students with low self-regulation skills for example, usually prefer teacher-led teaching and do not have the skills to regulate their own learning (Vermunt & Verloop, 1999). In this study, most of the criticism was about the disorganised teaching and difficulties with the pre-lecture assignments. As this was the first time the new design was implemented in this course, it is likely that these problems will decrease in future delivery of the course. However, it is important to take into consideration this feedback and to try to improve the organisation of teaching. It is also important for teachers to recognise that this method improved students' quality of learning despite this criticism, and that students also felt that this new design fostered their learning. However, there were students who felt that they had problems with their own motivation or attitude. Thus, it is important that teachers know this new design demands good self-regulation skills from the students and that students may have problems taking responsibility for their own learning, and thus, students may need support and guidance.

When asked to compare the new and traditional course design, the flipped course was preferred more often than traditional lectures. The experiences reported by the students highlighted the benefits of pre-lecture learning tasks; they felt this method enhanced and motivated them to study better and many reported a good attitude towards the method, including a number of students who had been sceptical at the beginning. Analogously, Canadian pharmacy students started to show increased enthusiasm for blended learning after a pharmacokinetics course applying various active-learning methods (Edginton & Holbrook, 2010). Good motivation is likely to increase the students' engagement and thereby their higher-order learning (Biggs, 2003). Teacher-centred knowledge transmission, in contrast, can promote bulimic studying that includes binge-memorisation followed by rapid forgetting of the material (Zorek *et al*., 2010). Indeed, many of the students applauded the fact that this method encouraged them to study consistently throughout the course. Criticism of the practical arrangements of the course was substantial, emphasising the importance of careful planning of structure and content. In the future, the authors are mindful of the need to improve the structure of the course further.

One limitation of the study was the relatively small number of students who participated in both measurements. Responding to these questionnaires was voluntary and unfortunately the response rate for these questionnaires was quite low. Not all of the students commented on the beneficial or impeding factors of the new course design, and thus, the results may be distorted. However, the sample was quite representative of the population and gave us important insights into students' experiences in the course and the problems and beneficial issues of new activating teaching methods. In addition, the authors had only two measurement points in the longitudinal design. Thus, the change in the levels of processing could be difficult to interpret due to problems such as regression to the mean (Bartlett *et al*., 2005).

However, the qualitative data supported the finding by showing that many students also experienced an improvement in their learning. In addition, the authors were not able to follow how students' study processes develop after this one course. In the future, it would be interesting to study in more detail how students' study processes evolve during the course of their studies.

Conclusions

In conclusion, the flipped classroom method may help to guide students, especially surface-oriented learners, towards a more active role in their own learning and could foster the quality of students' learning in pharmacy as it is considered that deep processing in learning to fosters student understanding of the subject matter more than repetitive and unreflective surface learning (Asikainen & Gijbels, 2017). This study illuminated the fact that during a flipped classroom course, students' processes of understanding changed towards better understanding. Students' experiences were also quite positive, even among students who criticised the new course design. Despite the criticism, this course was shown to enhance the students' quality of learning. Friction between students' processes of understanding may cause negative experiences although the learning outcomes get better. Although the course resulted in better understanding by the students, examining the students' experiences of the course enabled the authors to see the targets for development of the course. Improving the structure and organisation of lectures as well as improving the pre-lecture assignments should help students to study even more effectively. The authors argue that the flipped classroom in pharmacy teaching is a good way to promote student learning. The importance of fostering students to adopt a more deep-level processing in their studies should be considered by educational designers, and in this process, more activating study methods (like the flipped classroom) may serve as a beneficial tool. However, educational designers should also take note that teaching should be thoroughly designed and implemented, as discordant course design impedes students' learning.

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