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Changing a Traditional Lecturing Approach into an Interactive Approach: Effects of Interrupting the Monologue in Lectures*

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A study of the effect of interactive instruction in lectures on student results, study behaviour and student motivation is presented. The study indicates that changing a traditional teaching approach in lectures into an interactive lecturing approach is feasible. Such an interactive approach was shown to positively influence student motivation. Students' increased motivation seemed, however, restricted to the classroom, as only weak effects on students' self study were found. Student results increased when lecturers involved their students more in their lectures. It can be concluded that changing a traditional approach in lectures towards a more interactive approach can be considered beneficial to the students.

INTRODUCTION

THE SIGNIFICANT involvement of engineers in the development of new technologies and, in turn, the impact of these technologies on the world economy suggest that engineering education programs must be modernized to reflect the needs of the future. With the amount of information expanding at an ever-increasing rate, education programs must cater for the rapidly changing technological and industrial environment and continue to provide a forum for intellectual growth in the 21st century.

Against this background, it is important that university engineering education help students develop more advanced and independent ways of learning. Within this perspective on teaching and learning, active participation of students in the learning process is often put forward in educational literature as a means of developing higher order cognitive skills and of changing attitudes [1]. This assumption is based on the constructivist view of learning, which states that students are actively involved in the construction of mental representations, instead of merely being empty vessels waiting to be filled with knowledge [2]. Learning is thus defined as an active, constructive and cumulative process [3].

Research has shown that traditional lectures still predominate in university classrooms [4–5]. McDowell argues, however, that relatively inexperienced learners are not likely to become very actively involved in their learning process, if the main teaching approach is that of traditional lecturing [6]. The problem with lectures is that inexperienced learners can find themselves locked into a transmission model of learning, in which it is assumed that the purpose of lectures is to transmit facts that simply need to be recorded and learned. By contrast, if instructional effort explicitly encourages the development of learning strategies, students are found to develop more advanced learning strategies.

In a longitudinal study, Vermetten *et al.* showed, for instance, that students adapt their learning strategies, to a certain degree, to the characteristics of a learning environment [7]. More specifically, the quality of student learning was found to improve in the first two years of studying. This improvement was partly attributed to changes in the learning environment, which had become increasingly more activating. Two studies by Trigwell *et al.* [8–9] also showed that the teaching approach adopted by teachers can have a distinct influence on the learning of their students. These studies showed that qualitatively different approaches to teaching are associated with qualitatively different approaches to learning. The results indicated that, in classes where teachers describe their approach to teaching as having a focus on what they do and on how they transmit knowledge, students are more likely to report that

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they adopt a superficial approach to learning that subject. Conversely, but less strongly, in classes where students report adopting significantly deeper approaches to learning, teaching staff describe their own approach to teaching as more oriented towards students and to changing students' conceptions. These studies thus highlight the importance of discouraging teacher-focused transmission of teaching in attempts to improve the quality of student learning.

In addition, studies comparing classrooms using active learning to those using passive learning show that active learning methods generally result in greater retention of material at the end of a class, superior problem-solving skills, more positive attitudes and higher motivation for future learning [1]. In addition, active learning may benefit students by providing greater and richer enjoyment of class meetings. According to Shenker *et al.* students like classrooms that involve active learning and teachers find such classes more fun and less boring as well [10]. It is hypothesised that students' increased enjoyment of lectures may, in turn, encourage their engagement with learning materials inside and outside the lecture room [11], thus positively influencing student results in the long term [1].

Despite the increasing amount of publications describing the merits of activating instruction in lectures, there is still a large gap between educational research and what happens in practice. A survey among the university teaching staff at a technological university in the Netherlands showed that the average lecturer still tends to concentrate on covering and explaining the subject matter, and only occasionally poses questions or allows students to ask questions [12]. This was similar to the results of a study performed by Vinke [13]. Vinke observed 16 members of teaching staff and found they were teaching in a traditional way, using 80% of class time for transmission of information. The class size, often less than 40 students, did not provide these teachers with a compelling reason to lecture in a non-traditional way. Jochems [14] concluded, based on the results of the study of Vinke [5], that teachers have some kind of 'standard mode of operation' with respect to teaching. He stated that, for a lot of teachers, this 'standard mode of operation' equates to traditional lecturing.

The picture painted by Van Dijk *et al.*, Vinke and Jochems is not unique. It is a commonly shared misconception among teaching staff that teaching large classes is equivalent to traditional lecturing. The relevant literature, however, suggests various instructional strategies which may be used in lectures to foster a more interactive climate characterised by greater student participation [4, 15–16]. A study conducted by Murray and Brightman confirms the hypothesis that large engineering classes can be activated successfully if realistic goals and clear limits are set [17]. An increasing amount of practitioners are now publishing examples of interactive teaching methods and reporting on their success [18–20].

The choice of many lecturers to adopt a traditional lecturing approach can be considered as an inheritance of the past, when teaching was viewed as a structured transmission of knowledge. For many lecturers, their own experiences as students are the only frame of reference that they have and, consequently, many lecturers teach in the way that they themselves were taught [21]. They feel comfortable with this traditional teaching approach, which they regard as an efficient way of teaching, and are reluctant to teach in a more interactive way. Activating students requires time which they would normally devote to lecturing. Lecturers often voice the concern that they will not get enough material across in interactive lectures and that this will negatively affect student learning.

Many lecturers thus remain sceptical where interactive teaching is concerned. They question the generalisation of foreign (mostly American) studies to a Dutch context and the generalisation of studies conducted within the context of arts or social sciences to a technical engineering context. This article reports the results of an intervention study which was carried out at Delft University of Technology (DUT). Two experienced lecturers were trained to change their lecturing approach in order to improve student learning. Based on the research literature described above, it was expected that student motivation, study behaviour and learning results would benefit from a change towards more interactive lecturing. Below, the design and the results of the study will be described.

DESIGN

The effect of activating instruction in lectures on student results, study behaviour and motivation was studied in two introductory courses in mechanics. Course I was programmed in the students' second year of study and consisted of a series of 16 lectures. Course II was programmed in the students' first year of study and consisted of a series of five lectures, five tutorials and weekly tests. For students in both courses, the course studied was their first course on mechanics at university. Selection of the lecturers involved in the study was based on availability, willingness to participate and on the representativeness of their teaching approach for the general lecturing approach used at DUT, as described in Van Dijk *et al.* [12].

For each course, a quasi-experimental design was used which can be characterised as a 'post test only between subjects design'. First, data were collected when the lecturers used the traditional lecturing style to which they were accustomed. Then, both lecturers were trained in a workshop and received individual consultation with respect to activating instruction in lectures. The format of the workshop consisted of four half-day meetings. Working methods consisted mainly of a series of presentations, demonstrations, discussions, assignments and practice sessions with feedback. Additional time investment for the participants in the workshop consisted of two hours preparation time for each meeting. After the workshop, both lecturers received individual consultation, which ranged from discussion sessions with an experienced mechanics lecturer and an educational researcher to on-the-job coaching using observation of lectures, followed by feedback sessions. Due to the illness of lecturer I, only lecturer II received on-the-job coaching prior to the lectures for the experimental group. To minimise differences between the consultation processes of both lecturers, lecturer I received on-the-job coaching during the series of experimental lectures.

Both lecturers adapted their lectures to an interactive teaching approach, for instance by incorporating assignments, questions and peer instruction in their lectures. The next year, data were collected during the same two courses on mechanics, which were now given using an interactive teaching approach. For both courses, the format of the experimental course was similar to that of the control group course, the difference in lecturing approach (interactive versus traditional) being the only exception.

It is important to note here that, due to the illness of lecturer II in the year of the control group measurement, another lecturer gave the majority of the lectures in course II. It was, therefore, not possible to use the data of these lectures as a control group measurement. In the previous year, however, similar data were obtained in course II as part of a naturalistic case study. We chose to use the data of the previous year as the control group measurement, because this data adequately reflects the 'natural' lecturing approach of lecturer II.

For each course, comparison of the results of the two cohorts (control cohort and experimental) will provide insights into the effects of activating instruction. Such comparison is based on the assumption that, for each course, students in both the experimental and the control cohorts are similar on aspects that may influence the effects of activating instruction. The assumption of similarity of the experimental and control groups was tested using students' prior knowledge and their conceptions of teaching. The results are presented in the next section.

SIMILARITY OF EXPERIMENTAL AND CONTROL GROUPS

Students' prior knowledge was used to compare the similarity of the control group and the experimental group, as this significantly influences the interpretative framework of students. It may thus have a significant influence on the students' perception of a course. Prior knowledge influences students' decisions to focus on certain aspects of a course, their ability to understand messages and their judgements on the relative importance of messages [22–23]. As the course studied was the students' first university course on mechanics since their graduation from secondary school, their final grades in mathematics and physics for the Dutch secondary education exam were used as an indication of relevant prior knowledge for the course.

Differences between the control group and the experimental group in the students' mean grades on mathematics and physics were tested using independent-samples t-tests. Test results showed that, for course I, both groups were similar in terms of prior knowledge. For the second course, a significant difference was found in the students' mean grade in physics, the students in the control group having a higher grade ($t = 3.03$, $df = 306$, $p < .01$).

In addition, prior to the first lecture the students completed a questionnaire concerning their expectations of the didactic approach in lectures. The literature suggests that student expectations significantly influence their interpretation of the instruction offered, as they focus students' perception on different aspects of a situation [24]. The same teaching context may thus be perceived by different students in different ways. Students' expectations not only influence their perception of the learning environment but also their performance. Lonka *et al.* found that congruence between the teaching conceptions of the students and the teaching approach adopted by the teacher is also related to better student performance [25]. As these studies show that students' conceptions may influence the effect of activating instruction, it is important to ascertain whether the expectations of the students in the control group are similar to those of the experimental group.

Students' conceptions of teaching were measured using a questionnaire consisting of three scales (see Fig. 1). The first scale refers to a traditional lecturing approach in which the teacher explains the subject matter. The second scale refers to an activating lecturing approach. This approach can be considered more process-oriented, as the lecturer stimulates students to employ suitable learning activities to construct, change and utilise their knowledge. Finally, the third scale, the 'orientation' approach, refers to teacher-centred instructional activities aimed at facilitating students' processing of subject matter (e.g. presenting an outline or highlighting main points).

The response in the control groups was 72% ($N = 108$) and 47% ($N = 294$) respectively for course I and II. For the experimental groups the response was 78% ($N = 82$) and 68% ($N = 282$). The reliability of the questionnaire can be considered fairly good, with $\alpha = .76$ for the total questionnaire and $\alpha > .60$ for the three scales.

Again, independent-samples t-tests were conducted to test the differences between the

Scale	Example item	Number of items	α
Traditional approach	I expect the lecturer to explain the material in detail.	7	.61
Activating approach	I expect the lecturer to stimulate me to think about the subject matter.	6	.66
Orientating approach	I expect the lecturer to highlight the main points.	5	.62

Fig. 1. Scales and specification of the teaching conceptions questionnaire.

control group and experimental group with respect to the mean scale scores of the questionnaire. The results showed that, for course I, both groups had similar teaching expectations, as the differences between the control group and the experimental group were not significant. For the second course, however, significant differences were found. Students in the control group had significantly less preference for activating instruction ($t = 7.11$, $df = 300$, $p < .01$), more preference for traditional lecturing ($t = 9.31$, $df = 307$, $p < .01$) and more preference for orientation on subject matter ($t = 5.25$, $df = 308$, $p < .01$).

From these results, it can be concluded that the two groups of course II were not similar in terms of prior knowledge and teaching conceptions. This implies that tests for the effects of activating instruction should statistically correct for the observed differences, using analysis of covariance.

INSTRUMENTS

To measure the effect of interactive lecturing, the following instruments were used in this study: an observation instrument, a student questionnaire and a questionnaire on student self study. These instruments will be described in the following section. Finally, student results in the mechanics exams of the courses were used as a measure of their learning results. For each course, the lecturer designed the exams for the control group and the experimental group. Both lecturers indicated that the exams for the control group and the experimental group were similar.

Observation instrument

All lectures were observed by an observer, in order to verify whether 'objective' differences could be discerned between the control group lectures and those for the experimental groups. The observer made field notes, which were translated into an observational table in which all the didactic events taking place were recorded each minute. In this way, the observation instrument was a combination of both time and event sampling. The same instrument had already been used in a previous case study conducted by the authors [26], and it had proved to be sufficiently reliable (Cohen's $\kappa = .72$).

The observational instrument discerns five categories. The first category, 'explaining subject matter', concerns all those situations in which lecturers explain theory or provide sample assignments on the blackboard or overhead projector. The second category, 'activation by lecturer', are those instances in which the lecturer tries to elicit the active participation of students by means of questions, discussion or classroom assignments. The third category, 'activation by students', concerns student-initiated interaction, such as questions or comments. 'Stimulation of self study' is the fourth category, which refers to the advice given by lecturers concerning the independent study of lecture material. Finally, periods of silence, as well as other situations not related to the subject matter, were grouped in the category 'other'.

Questionnaire

In the final lecture of the course, students completed a questionnaire in which the lectures were evaluated. The response in the control groups was 44% and 47% respectively for courses I and II. For the experimental groups, the response was 43% and 38% respectively. The questionnaire contained questions concerning the lecturer and questions concerning the students. The students rated the lecturer on the following aspects: stimulating student involvement, stimulating self study,

Scale	Example item	Number of items	α
Quality of the lecture	The lecturer explains the subject matter clearly.	5	.63
Positive atmosphere	The lecturer shows interest in the students.	6	.71
Stimulating student involvement	The lecturer stimulates us to ask questions.	8	.79
Stimulating student self study	The lecturer gives advice on how to study something.	8	.62
Motivation for the lectures	The lectures are interesting.	4	.84
Quality of study behaviour	When I study, I try to relate new knowledge to material I already know.	5	.62

Fig. 2. Scales and specification of the evaluation questionnaire.

	Information transmission	Activation by lecturer	Activation by students	Stimulation of self study	Other
Course I					
Control group	67%	10%	8%	7%	8%
Experimental group	58%	23%	8%	5%	6%
Course II					
Control group	71%	4%	8%	7%	10%
Experimental group	59%	27%	4%	4%	7%

Fig. 3. Observation results using time sampling.

creating an interactive atmosphere and the quality of the lecture. In prior case study research, the two latter aspects of lecturing performance were shown to be necessary preconditions for activation in lectures [26]. The questions concerning the students related to their motivation in terms of the lectures and the study approach used. The reliability of the questionnaire can be considered fairly good, with $\alpha > .60$ for all scales (see Fig. 2).

In the second section of this paper, it was described how the control group data in course II were obtained from the year prior to the start of this study, due to illness of the lecturer. As a result of these practical considerations, the questionnaire administered to the control group of course II differed slightly from the questionnaire described above. Therefore, only those items from the control group questionnaire that matched those of the questionnaire used in course I and the experimental group of course II were selected. As a result, the questionnaire administered in the control group of course I measured the same concepts as the questionnaire used for the other groups, but contained less items ($n = 28$) and had slightly less reliable scales ($.40 < \alpha < .83$).

Measuring time spent on studying

Time spent by students on study activities was estimated by asking the students to record weekly the hours spent on attending lectures as well as the hours spent on self study activities. Participation in the study was voluntary. Response to this method of data collection is known to be a problem. In order to maximise response, the procedure was facilitated at the cost of obtaining less information. Instead of detailed accounts, students were asked to give rough estimates of time spent on study behaviour. In addition, students who participated took part in a prize draw in which book tokens could be won. Response rates were, however, disappointing. For the control group, the response rate was 18% and 23%, respectively. For the experimental groups, response rates were 23% and 19%, respectively. These rates imply that the results must be interpreted cautiously and can only be considered as anecdotal.

DIFFERENCES IN LECTURING BEHAVIOUR BEFORE AND AFTER TRAINING

Comparison of the observational results before and after training shows that, for each course, lecturing behaviour became increasingly more activating after the training (see Fig. 3). The table shows that, in the experimental groups in both courses, more time was devoted to activating instruction that was initiated by the lecturers themselves. The extra time used for activating instruction in the experimental groups of both courses I and II was mainly at the expense of time devoted to explaining subject matter. Equally, the time spent on stimulating students' self study decreased slightly in both courses. In addition, event sampling showed that both lectures used a greater variety of interactive instructional activities, instead of just asking questions.

	Course I		Course II	
	Control group ($N = 34$)	Experimental group ($N = 35$)	Control group ($N = 122$)	Experimental group ($N = 108$)
Quality of lecture	3.20 (.57)	3.37 (.50)	3.11 (.85)	3.20 (.64)
Interactive atmosphere	3.30 (.54)	3.64 (.51)*	3.42 (.69)	3.36 (.53)
Activating lecturing	3.25 (.56)	3.87 (.50)**	3.03 (.59)	3.74 (.48)**
Stimulating self study	3.16 (.44)	3.28 (.44)	2.75 (.60)	2.61 (.48)*

* p-values significant at $\alpha = .05$; ** p-values significant at $\alpha = .01$

Fig. 4. Evaluation results on the student questionnaire: mean scale scores and standard deviations on a scale of 1 (very poor) to 5 (very good).

The student questionnaire results show that the students before the training (i.e. students in the control groups) evaluated the courses rather moderately (see Fig. 4). After the training, results differed, most markedly for the scale 'activating lecturing'.

For course I, differences between the scale scores of the experimental group and the control group were tested using t-tests. The test results for course I indicate that students in the experimental group perceived the attended lecture as a more activating one. They also indicate that the experimental lectures had a more positive atmosphere. The lectures were scored fairly similarly, where stimulating self study is concerned. This coincides with the observational results of this course.

For course II, the analysis differed from the analyses described above, as prior analysis revealed that the experimental group and control group were not exactly comparable (see also the section 'Similarity of experimental and control groups', above). Consequently, the differences between the scale scores of the experimental and control groups were tested using analysis of covariance. Test results showed that, for course II, students in the experimental group perceived the attended lectures as significantly more activating.

From these results, it can be concluded that both observers and students noted a significant difference in interactive instructional behaviour. It is assumed that comparison of the control group lectures with the experimental lectures will generate valid results on the effect of activating instruction in lectures.

EFFECTS OF ACTIVATING INSTRUCTION

The previous section established that, for both courses, the experimental lectures differ from the control group lectures. The effect of activating instruction in lectures was subsequently studied by comparing, for each course, the control group data with the data collected in the experimental group. This section describes the effect of activating instruction on students' motivation, study behaviour and learning results.

Student motivation

The scores on motivation show that students in the control group of course I were not highly motivated to attend the lectures. The experimental group of course I was more motivated to attend the lectures (see Fig. 5). For course II, the control group and the experimental group reported rather 'neutral' scores where motivation for the lectures is concerned.

Again, differences between the experimental and the control group were tested for each course using independent-samples t-tests. The test results for course I indicate that students in the experimental group were significantly more motivated to attend lectures in comparison to the students in the control group. For course II, the difference between interactive and traditional lectures was tested using analysis of covariance, correcting for differences in students' prior knowledge and teaching conceptions. The test results indicate that the overall difference in student motivation was not significant. For two of the items, however, the difference between the groups of course II reached a significant level at $\alpha = .05$, showing that the students considered interactive lectures significantly more interesting ($F = 5.70$, $df = 1$, $p = .018$) and useful ($F = 6.10$, $df = 1$, $p = .014$).

	Motivation	
	Control group	Experimental group
Course I	2.55 (.69)	3.26 (.71)**
Course II	2.82 (.84)	3.10 (.76)

* *p*-values significant at $\alpha = .05$; ** *p*-values significant at $\alpha = .01$

Fig. 5. Motivation results: mean scores and standard deviations on a scale of 1 (very poor) to 5 (very good).

Study behaviour

The effect of activating instruction on student study behaviour was studied with respect to three aspects of study behaviour: total time spent on studying, the regularity of the study pattern and the quality of the approach used.

The results with respect to time spent studying are displayed in Fig. 6. These results show that, for course I, students in the experimental group spent the same amount of study time as students in the control group. The students in the experimental group of course I display a slightly more regular pattern compared to the control group of this course. The high amount of student self study in the control group in week 8 can be explained by the approaching exam for the course, which was programmed for week 9. The students in the experimental group also increased their amount of self study in the weeks prior to the exam. This increase was, however, markedly less compared to the increase in the control group. Analysis of variance with repeated measurements showed, however, that the difference in study patterns is not significant ($F = 1.37$, $df = 7$, $p = .256$).

	Quality of self study	
	Control group	Experimental group
Course I	3.45 (.69)	3.24 (.54)
Course II	3.22 (–)[a]	3.57 (.43)

[a] Due to circumstances, the questionnaire administered to the control group only contained one item concerning the quality of student study behaviour.

Fig. 6. Results with respect to the quality of self study: mean scores and standard deviations on a scale of 1 (surface) to 5 (deep).

	Student results on mechanics exam	
	Control group	Experimental group
Course I	5.6 (1.98)	6.4 (1.69)*
Course II	6.2 (2.21)	6.6 (1.96)**

*p-values significant at $\alpha = .05$; **p-values significant at $\alpha = .01$

Fig. 7. Student results for mechanics exam: mean scores and standard deviations on a scale of 1 (very poor) to 10 (excellent).

In course II, the students of the experimental group and the control group displayed a similar study pattern. Both groups have a fairly regular study pattern, which is probably a result of the weekly tests, for it is generally accepted that assessment is one of the most critical influences on student learning [27]. The total time spent by students differed significantly between the groups of course II, the control group spending markedly more time on self study compared to the experimental group ($t = 2.29$, $df = 115$, $p = .02$). However, when the study time is statistically corrected for differences in students' teaching conceptions and prior knowledge, the difference between the control group and the experimental group of course II is not significant ($F = 2.96$, $df = 1$, $p = .09$).

The evaluative questionnaire distributed in the final lecture also contained a scale to assess the quality of the students' self study. The items of this scale reflect the well-known distinction between the two levels of processing: deep and surface learning [28]. Surface learning implies taking information literally, and not looking for the meaning behind the text, whereas looking for the meaning of the text is the departure point of deep learning. The students' mean scale score was used as an indicator of the quality of their study behaviour. Mean scale scores could range between 1 and 5, with high scores being indicative of a deep approach to learning and low scores being indicative of a surface approach.

With respect to the quality of students' study behaviour, no significant differences were found in course I between the control group and the experimental group (see Fig. 7). For course II, differences between the control group and the experimental group with respect to the quality of study behaviour could not be tested. Due to the practical circumstances described in the 'Design' section above, the questionnaire for the control group of course II contained only one item relating to the quality of study behaviour.

Student results

The effect of activating instruction on student learning was estimated by comparing student results in the mechanics exams. According to the lecturers, the exam for the control group was equivalent to the exam for the experimental group. Comparison of the student results in each course shows a significant difference between the experimental group and the control group (see Fig. 8). In both courses, the students in the experimental group have higher exam results than the students in the control group. It should be noted here that for course II the difference in student results was tested using analysis of covariance. The students' final grade in physics in secondary education was used as a covariate to correct for initial differences in prior knowledge between the two groups of course II.

From Fig. 8 it can be concluded that, for both courses, activating instruction seems to improve students' learning results. The significant difference in student results in course II is particularly notable. Course II students in the experimental group spent markedly less total time on self study activities compared to the control group of course II. Despite this, they still had significantly higher exam results.

CONCLUSION

This paper reports the results of a study into the effect of activating instruction in lectures on

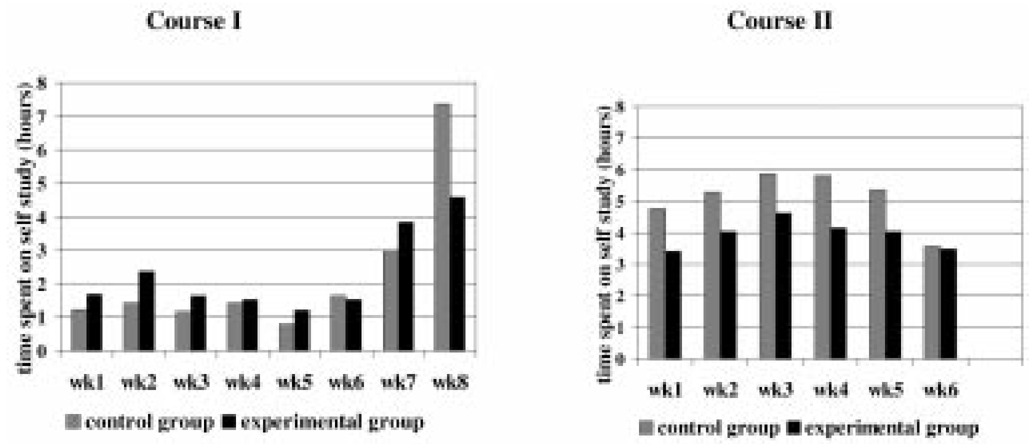

Fig. 8. Time spent on self study activities (mean time of students in hours per week).

student motivation, student study behaviour and student learning from a course. From the results, it can be concluded that a change from the traditional teaching approach in lectures towards a more interactive approach can be considered beneficial to the students.

With respect to student motivation, the study showed that, in engineering education too, activating instruction increases student motivation for the lectures. This result coincides with the results of other studies into the motivational effect of activating instruction in lectures, which found that students clearly appreciate activating instruction [1, 29]. Students' preference for activating teaching methods has been explained by Ramsden [27]. Ramsden points out that, in research on student ratings and perceptions of favourable environments, the significance of independence and choice on the part of students repeatedly emerges. Teaching methods that necessitate student activity, problem-solving and cooperative learning permit a degree of student control over learning and can thus accommodate individual differences in their preferred ways of reaching understanding.

With respect to student self study, no effect of interactive instruction was found. Students' study behaviour in the control group that attended traditional lectures was similar to that of the students attending activating lectures. This result does not confirm the results reported in the literature [8–9], but can be explained by the results of a longitudinal study by Vermetten *et al.* [7]. In that particular study, students' learning strategies were assessed in the first two years of their studies. The results showed that learning strategies are susceptible to changes in the learning context, but also display an individual *consistency*. Various studies in higher education have shown that students appreciate instruction that fits their own learning habits [30–31] and are not inclined to change their habitual patterns.

Powerful and profound educational reforms may, however, create 'constructive friction' between teaching and learning [32], inducing students to develop more advanced learning strategies. Constructive friction can be regarded as a transitional phase in the learning patterns of students in which the students become accustomed to a new way of teaching and develop more advanced learning conceptions and learning patterns. In this transitional phase, the effects of activating instruction on students' study behaviour may not be immediately apparent but will emerge after a while, when students have grown accustomed to the instructional approach used. Indeed, Vermetten *et al.* found that changing from one type of education to another resulted in more diffuse patterns of learning orientations, learning conceptions and learning strategies of students after the first semester compared to the patterns after the third semester [7]. This suggests that it may be possible that a time span of only one course, as used in the study presented here, may have been too short to adequately study the effects of activating instruction on students' study behaviour.

Despite the absence of any effect of activating instruction on student self study, the study indicated that student results improve when students are more involved in lectures. It can, therefore, be concluded that students benefit more from lectures they attend when they are actively involved in the learning material during the lectures. Lecturers' concerns that activating instruction would result in a disimprovement in student results is contradicted by the results of this study.

From a constructivist perspective on learning, the higher student results in the activating lectures are not surprising. In traditional lectures, typically consisting of a monologue delivered by the lecturer, students are predominantly concerned with knowledge acquisition. Often the pace of the lecture makes it difficult for students to do more than just listen and take notes. Comprehension of the subject matter (*really* understanding it and knowing how to apply it) requires, however, greater depth of processing by the students. It is exactly this kind of information processing that is stimulated by activating instruction [4]. The results of this study, therefore, empirically confirm the assumption that students who are activated in lectures will learn more from these lectures and, consequently, will have higher learning results compared to students attending traditional lectures.

Student learning is closely tied to motivation: students will learn what they want to learn and will have great difficulty in learning material in which they are not interested [33]. The fact that, in both courses, activating instruction increased students' interest may, therefore, have contributed to the positive influence of activating instruction on student learning. It should, however, be mentioned that, in this study, the positive influence of students' increased motivation seems to be limited to the lecture hall and does not yet extend to student self study.

A final comment with respect to activating instruction in lectures pertains to staff development initiatives. This study has shown that changing a traditional teaching approach in lectures towards a more interactive approach is not simply a utopian ideal but, instead, that it is possible. The two lecturers involved in this study had an engineering background and no particular teaching qualifications. In this respect, the two lecturers involved are representative of most lecturers at their university, where it is not compulsory to possess teaching qualifications in order to teach at an academic level. In addition, the lectures of courses I and II before the training can be considered characteristic of an average lecture at the university studied, where lecturers tend to concentrate on covering the course content and only occasionally pose questions or allow students to ask questions [12]. In sumary, the two lecturers involved in this study can be considered typical of the average lecturer at their university and had no characteristics indicating that they are more susceptible to professional development.

The professional development of the lecturers involved in this study was stimulated using an individual consultation process for both lecturers. Various studies show that individual consultation can have powerful and long-lasting effects on the teaching performance of the consultees [34]. The study presented here showed that adapting one's teaching approach to a more interactive format is feasible. It should be noted here that the two lecturers received a fairly intensive form of consultation. This does not imply, however, that adapting one's teaching approach necessarily requires an intensive intervention.

In a study by Piccinin *et al.*, the intensity of the consultation intervention differed according to the pre-consultation student ratings of the teachers; the group with the lower mean student ratings receiving the most intensive consultation and the group with the highest ratings receiving the least intensive intervention [34]. Although the intensity of the consultation differed between the groups, all groups in the study by Piccinin *et al.* showed significant teaching improvement. Even brief consultation (i.e. one interview in which the consultant engages in discussion with the professor concerning topic[s] that the latter wishes to raise) resulted in statistically significant teaching improvement. This result points to the appropriateness of using different intervention approaches to meet the individual needs of the consultee.

A final point we would like to raise here pertains to the support of the professional development of lecturers. In this study, the two lecturers received individual consultation that was supported by an external educational expert. Professional development does not, however, always require such formal support. More informal support and feedback from colleagues (e.g. peer coaching, [electronic] discussion groups on teaching, senior teachers mentoring junior teachers) can also be considered a fruitful and powerful means of supporting professional development [35]. Quality improvement in education requires continuous reflection by teachers about what they do and why they do it.

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