Impact of problem-based, active learning on graduation rates for 10 generations of Dutch medical students

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Impact of problem-based, active learning on graduation rates for 10 generations of Dutch medical students

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OBJECTIVES We aimed to study the effects of active-learning curricula on graduation rates of students and on the length of time needed to graduate.

METHODS Graduation rates for 10 generations of students enrolling in the eight Dutch medical schools between 1989 and 1998 were analysed. In addition, time needed to graduate was recorded. Three of the eight schools had curricula emphasising active learning, small-group instruction and limited numbers of lectures; the other five had conventional curricula to varying degrees.

RESULTS Overall, the active-learning curricula graduated on average 8% more students per year, and these students graduated on average 5 months earlier than their colleagues from conventional curricula.

CONCLUSIONS Four hypotheses potentially explaining the effect of active learning on graduation rate and study duration were considered: (i) active-learning curricula promote the social and academic integration of students; (ii) active-learning curricula attract brighter students; (iii) active-learning curricula retain more poor students, and (iv) the active engagement of students with their study required by active-learning curricula induces better academic performance and, hence, lower dropout rates. The first three hypotheses had to be rejected. It was concluded that the better-learning hypothesis provides the most parsimonious account for the data.

KEYWORDS *problem-based learning; Netherlands; *education, medical, undergraduate; curriculum; multicenter study [publication type]; student dropouts/statistics-&-numerical data; interview, pyschological.

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INTRODUCTION

Is small-group, problem-based learning (PBL) 'better' than conventional teaching with its emphasis on lectures? The discussion about this issue has been narrowed down to the question of whether medical students in PBL curricula learn more than students in conventional curricula. This question has generally been answered with: 'No'. Most studies demonstrate that students in PBL schools on average do not know more about medicine than do other students.[1–4]

However, student-related variables, such as the students' level of knowledge, their interpersonal competencies,[5] or their reasoning abilities,[6] are by no means the only dimensions on which curricula can be compared if one wishes to assess the value of a particular approach to learning and instruction. The quality of a curriculum also expresses itself in other ways. For instance, *institutional* variables play a role, such as the quality of the school's teaching faculty, or the depth and breadth of learning experiences offered.

This article concentrates on the effects of PBL-type curriculum characteristics on two such institutional variables: graduation rates and study duration of medical students. Graduation rates and study duration are often considered measures of the effectiveness and efficiency by which a curriculum succeeds in preparing graduates for professional practice. Study delays and inadequate graduation rates are seen as problems within higher education all over Europe.[7]

How do active-learning strategies such as PBL affect graduation rates? Most studies in this area follow Tinto's theory of college student persistence in explaining the effects of active learning.[8,9] According to Tinto, students persist in higher education in line with the extent to which they feel themselves to be socially and academically integrated within their college. This psychological state will emerge if sufficient opportunities are provided to interact with peers and staff, both formally and informally. As active-learning curricula often employ small-group instruction, thereby enabling these interactions, these curricula are seen as being more successful in retaining students.[10–12]

In this article, we will offer a more straightforward explanation. We will assume here that active-learning curricula encourage students to engage more extensively with their studies, which leads to better performance on examinations and hence higher graduation rates and shorter study duration. To elucidate this point of view, we will briefly summarise the main characteristics of the most common variant of active learning in the health sciences: PBL. Problem-based learning has six defining characteristics:

1 it uses problems as the starting point for learning;
2 it requires small-group collaboration, and
3 it requires the flexible guidance of a tutor.[13–15]

Since problems steer the learning in such curriculum:

4 lectures are sparse.

The latter is in line with the notions that:

5 learning is to be student-initiated, and that
6 ample time for self-study should be available.

For instance, in the three Dutch active-learning curricula to be discussed below, students on average did not receive > 3 hours of lectures per week and spent an average of 27 hours per week on independent study, whereas in the five other curricula, lecturing amounted to an average of 11 hours and self-study represented 18 hours per week (the remaining hours in both types of curricula were spent on practicals, rotations, skills training, etc.).[16] Thus, we can hypothesise that, as students in PBL curricula are more actively involved in their own studies, better learning will ensue. Better learning, in turn, will result in better performance on examinations, followed by lesser delays and fewer dropouts. Note that at least two assumptions are involved here. The first is that PBL leads to better learning – which it does according to experimental studies,[17–19] but not according to curriculum-level studies.[1–4,20] The second is that better learning results in higher graduation rates.

There is some evidence to suggest that PBL does influence to some extent the numbers of students graduating.[21,22] However, these studies have limited themselves to comparing graduation rates within a particular school before and after its move towards PBL. In the present study, we will report on the graduation rates and study duration of 10 consecutive generations, or classes, of medical students entering all Dutch medical schools between 1989 and 1998, which in total represents > 13 000 students. Some of these students studied in active-learning curricula, whereas others graduated from more conventional approaches to medical education. To test the hypothesis that active learning increases graduation rates and decreases study duration, we compared graduation rates for graduates from three active-learning curricula programmes with graduation rates for graduates from five conventional curricula.

METHODS

The medical curricula

The Netherlands has eight medical schools. The medical curriculum at Maastricht University, established in 1974, was the only PBL medical school in the country for many years. However, in 1993 a second school, Groningen University, took up a PBL curriculum. The Groningen curriculum has adopted many of the features that characterise PBL: learning starts with problems; tutorial groups form the backbone of the approach; basic sciences are taught integrated with clinical sciences, and lectures are relatively few. However, students have less freedom to pursue their own learning goals than in the 'classical' Maastricht PBL curriculum. In 1995, Nijmegen University introduced another variation to this theme. Lectures are few and students meet in tutorial groups; learning, however, does not start with problems, but concludes with them: problems in this curriculum are primarily used for application-of-knowledge purposes. In addition, students spend much time on self-study, but the study assignments are teacher-provided rather than student-generated. Therefore, this curriculum can be described as non-PBL, with an emphasis on active learning. The five other medical schools in the country can be portrayed as conventional to varying degrees in terms of their approach to teaching: they continue to emphasise lecture-based formats, although many employ an integrated-teaching approach and bring students together in tutorial groups. The adjective 'conventional' is thus used here in a relative sense. Table 1 summarises the six main distinguishing features of these eight curricula between 1989 and 1998. As stated above, Groningen and Nijmegen changed their curricula in the course of the period studied, so they appear twice in the table. The table's contents are derived from two reports of external review committees that visited all schools twice in the particular period. In these reports, the curricula are described in considerable detail.[16,23] As can be seen, the active-learning curricula distinguish themselves

Table 1 Features of Dutch medical curricula 1989–1998

Curriculum	Classification of curriculum	Hours of lectures per week	Hours of tutorials per week	Modular organisation	Integration between basic and clinical sciences	Use of problems as starting point for learning	Self-directed learning
Maastricht	Problem-based	3	4	Yes	Yes	Yes	Yes
Groningen 1993–1997	Problem-based	5	4	Yes	Yes	Yes	To some extent
Nijmegen 1995–1997	Active learning	2	10	Yes	Yes	No	No
Groningen 1989–1992	Conventional	12	0	No	No	No	No
Nijmegen 1989–1994	Conventional	14	0	No	No	No	No
Leiden	Conventional	11	4	Partial	Partial	No	No
University of Amsterdam	Conventional	8	6	Partial	Partial	Occasionally	No
VU University Amsterdam	Conventional	10	4	Partial	Partial	Occasionally	No
Rotterdam	Conventional	12	3	Partial	Partial	No	No
Utrecht	Conventional	11	6	No	Partial	No	No

Numbers of hours of scheduled activities are averages. 'Modular organisation' implies that subject matter is offered in a sequential rather than a parallel fashion. 'Self-directed learning' refers to the extent to which students are encouraged to formulate and pursue their own learning goals[16,23] fairly consistently on most of these features from their conventional counterparts.

Admission to Dutch medical schools is dealt with at the national level, employing a weighted lottery procedure based on achievement on a national university entrance examination. This procedure (inadvertently) results in groups of students across the different schools who are similar in terms of past performance, age, gender and motivation to study medicine.[24] For instance, students entering the various schools between 1989 and 1998 had extremely similar high-school national examination scores, reflected in their grade point average. The range among schools was only 0.2 on a 10-point scale. Consequently, comparisons between Dutch medical schools come as close as one can get to running real randomised control trials in educational settings. In addition, all schools employ a 6-year curriculum and the subject matter taught is largely overlapping. Again, this facilitates comparisons between different curricula.

Finally, all eight medical schools have applied mutually agreed standard graduation criteria since the late 1980s.[25] This framework describes in considerable detail the final objectives ('eindtermen') in terms of the knowledge and skills that every graduate must be able to demonstrate. It is updated on a regular basis. As there are no national licensing examinations in the Netherlands, each school ensures that the examination system covers the final objectives. An external accreditation committee, which visits all medical schools on behalf of the government, checks that this is so every 5 years. It may therefore come as no surprise that examinations are highly similar, even in schools with different didactic philosophies, and that the curriculum comparison studies in which these schools have been involved have consistently failed to find differences in knowledge attainment between students of conventional and active-learning curricula,[26–30] thereby attesting to the fact that, on average, all graduates from different schools have a similar level of knowledge.

Participants

Participants in the study were 13 845 medical students, which represents the entire population of students entering any one of the eight medical schools in the Netherlands between 1989 and 1998. These represent the 10 most recent generations for which data are available (the 9-year graduation rates for the 1998 generation became available in 2007). The data are publicly available.

Procedure

Graduation rate data for all medical schools in the Netherlands were computed using data obtained from the Vereniging van Samenwerkende Nederlandse Universiteiten [Association of Dutch Universities] (VSNU). The graduation rate of a programme is defined as the number of students who graduated, divided by the number of students who entered the programme initially, multiplied by 100. This index was computed for each generation of medical students who entered university between 1989 and 1998 for the first time. As students often do not complete their training in the nominal period of 6 years, 7-, 8- and 9-year graduation rates were also computed. In addition, a small number of students graduated in < 6 years, so 5-year graduation rates were also computed. Based on the 5–9-year graduation rate data, the mean time needed to complete was computed.

Statistical analysis

The dependent variables were 9-year graduation rate and study duration of those who graduated. The unit of analysis was generation, or class, of students entering each school since 1989. *Generations* rather than individual students were used as units of analysis because our main variable of interest, graduation rate, is a characteristic of a *class* of students rather than of individual students because it denotes the percentage that graduated of an entire class in medical school. However, to ensure that non-independence between students within generation and school was explicitly dealt with, the data were analysed with school and generation as nested variables. The resulting 10 (generations) times 8 (schools) data matrices were analysed using factorial analysis of variance. The critical analysis was conducted with school nested in active versus conventional curriculum, and generation nested in school. As both Nijmegen and Groningen fell into both categories, they were nested in both active learning (with 4 and 6 levels, respectively) and conventional learning (with 6 and 4 levels, respectively). The critical *F*-test of the effect of active versus conventional curriculum used school : active/conventional with 1 and 8 degrees of freedom, respectively.

RESULTS

Table 2 shows mean 9-year graduation rates and study duration for each of the medical schools' generations of students entering between 1989 and 1998 (with standard deviations [SDs]). Note that, in 1989 and

*Table 2 Mean study duration and final graduation rates for 10 generations of Dutch students entering medical school between 1989 and 1998**

Curriculum	Classification of curriculum	$n^{\dagger}$	Graduation rate, %		Study duration, years‡	
			Mean	SD	Mean	SD
Maastricht	Problem-based	10	91.24	3.64	6.92	0.13
Groningen 1993–1998	Problem-based	6	85.50	0.85	7.09	0.13
Nijmegen 1995–1998	Active learning	4	86.49	2.79	7.01	0.14
Groningen 1989–1992	Conventional	4	83.08	4.82	7.58	0.36
Nijmegen 1989–1994	Conventional	6	85.31	5.31	6.86	0.16
Leiden	Conventional	10	80.34	4.41	7.67	0.29
University of Amsterdam	Conventional	10	79.40	3.81	7.49	0.26
VU University Amsterdam	Conventional	10	77.74	3.89	7.45	0.10
Rotterdam	Conventional	10	79.19	5.15	7.24	0.16
Utrecht	Conventional	10	82.62	3.11	7.52	0.19
Total		80	82.61	5.73	7.31	0.33

* The table provides data for each of the curricula involved
† *n* = number of generations involved in the analyses
‡ Study duration is expressed as the number of years needed for graduation
SD = standard deviation

subsequent years, Groningen and Nijmegen still belonged to the pool of conventional schools, so they appear twice in the table.

Table 3 contains means and SDs of study duration and graduation rate averaged over active-learning versus conventional curricula.

Students in active-learning curricula needed less time to graduate and also graduated in greater proportions (graduation rate: $F[1, 8] = 10.99$, $P < 0.01$; study duration: $F[1, 8] = 5.35$, $P < 0.05$). The error term in the analyses can be used to compute the SD of students, assuming no differences by graduation year and an average class size of 173. For graduation rate, the SD is 54.19, so the effect size is approximately 0.15; for study duration, the SD is estimated at 2.7, also equating to an effect size of 0.15. Interestingly, the Nijmegen conventional curriculum did almost as well as its active-learning counterparts. This was largely attributable to two generations, the scores for which were almost 2 *z*-scores above the means for their respective groups. Why these two generations were so different is presently unclear. Omitting them leads to somewhat increased effect sizes.

*Table 3 Mean study duration and final graduation rates for 10 generations of Dutch students entering medical school between 1989 and 1998**

Curriculum	$n^{\dagger}$	Graduation rate, %		Study duration, years‡	
		Mean	SD	Mean	SD
Active learning curricula	20	88.57	3.92	6.99	0.15
Conventional curricula	60	80.62	4.79	7.42	0.31
Total	80	82.61	5.73	7.31	0.33

* The table summarises data for active-learning versus conventional curricula
† *n* = number of generations involved in the analyses
‡ Study duration is expressed as the number of years needed for graduation
SD = standard deviation

The remaining effects of school nested in active or conventional curriculum were calculated for graduation rate ($F[8, 70] = 3.38$, $P < 0.01$) and study duration ($F[8, 70] = 10.15$, $P < 0.01$). These findings suggest that schools also significantly differ from one another, independently of whether their curricula are active learning-based or not. Effects of generation were non-significant.

DISCUSSION

The hypothesis proposed here was that curricula that promote active learning among students achieve higher graduation rates and shorter study duration. To test this hypothesis, graduation rate data for all (> 13 000) medical students entering medical school in the Netherlands between 1989 and 1998 were analysed. These data show positive effects of active-learning curricula on graduation rates and study duration. The active-learning curricula graduated an average of 8% more students per year and these students graduated an average of 5 months earlier than their counterparts from conventional schools.

What do these findings imply? According to Cohen,[31] effect sizes in the range of 0.15–0.20 are typical for educational interventions in a naturalistic setting, where the investigators have no direct, experimental control over the data. This implies that the average student graduating from an active-learning curriculum would have been in the 56–58th percentile of the group graduating from a conventional curriculum, reflecting a 6–8% gain. It is perhaps informative to compare these outcomes in terms of the costs of educating medical students in the Netherlands. It costs about €40 000 to train one student. Therefore, relative to its active-learning counterparts, each conventional school loses at least €1.3 m every year through larger dropout rates and longer study duration.

Why are the active-learning curricula doing a better job of retaining students?

Dropout is often explained by Tinto's theory of student social and academic integration.[8,9] According to this theory, the persistence of students is primarily a function of the extent to which these students involve themselves socially and academically in the university environment. Engaging in direct contacts with peers and faculty would be a major factor in promoting persistence. From this point of view, active-learning curricula are successful because they enable these social contacts through small-group tutorials. The Tinto explanation of dropout and retention, although supported by the literature, can hardly account for the differences between the conventional and active-learning curricula involved in *this* study because, as Table 1 demonstrates, conventional curricula *also* employ small-group instruction, enabling social and academic integration. In fact, differences between these types of curricula with regard to the number of hours assigned for small-group work are so small that they are not helpful at all in explaining the differences in graduation rates.

As there is a straightforward and well-known relationship between academic performance and persistence – the more students pass their examinations, the fewer will drop out – we believe the hypothesis outlined in the Introduction to be a more parsimonious one. Active learning, with its emphasis on student agency, self-directed learning, sparse lecturing and ample time for independent study, leads *more* students to attain sufficient levels of academic performance and therefore results in fewer delays and higher graduation rates. This interpretation is supported by a study by Severiens and Schmidt.[32] They demonstrated that study progress in three psychology curricula with different emphases on active learning was explained to a larger extent by differences in the instructional approaches of the curricula themselves than indirectly via differences in measured social and academic integration of students.

The study reported here was observational in nature. Randomisation of participants over treatment conditions was, of course, impossible, and the treatment itself necessarily represented natural variation among schools rather than being the result of investigator manipulation. Such study, of course, leaves room for possible confounders, the most obvious of which are possible pre-existing differences in ability among students ('the smarter students went to the active-learning schools') and possible differences in examination practices ('the active-learning schools did not fail poor students to the same extent as the conventional schools'). However, in the Methods section, we argued that, as a result of the characteristics of the national admissions procedure, no differences existed among the eight schools in terms of the average ability of students entering them.[24] It is, therefore, unlikely that pre-existing differences among students have invalidated our findings. In addition, we have already explained that there are strict, nationally agreed upon graduation criteria to which all schools have committed themselves, irrespective of their didactic approaches. It is, therefore, unlikely that active-learning curricula used more lenient criteria to establish who was entitled to graduate. More importantly, if active-learning curricula use more lenient standards, this would imply that students from such curricula would demonstrate overall poorer performance in curriculum comparison studies. This is, however, not the case.[26–30] This latter finding suggests that students who would have performed poorly in a conventional school achieve acceptable levels of performance in active-learning schools and are no longer distinguishable from the average conventional-school student. In fact, higher graduation rates and shorter study duration, while maintaining standards of academic achievement, demonstrate the powerful role of instruction in helping students succeed.

Our interpretation of the data rests on the assumption that active learning leads to better achievement, an assumption that finds support in experimental studies,[17–19] but is currently not supported by curriculum comparison studies.[1–4] However, that there are differences in graduation rates in the absence of differences in performance suggests something else: differences in study duration and graduation rates may actually *mask* positive effects of active learning in these latter studies. Curriculum comparison studies only compare those who have survived the curriculum up to the point of the outcome measurement and discard those who have dropped out. Because active-learning curricula, as defined in this study, are less likely to lead to dropout, a potentially positive effect of active learning on performance may be masked because the active-learning sample contains students whose performance would have been lower in a conventional curriculum, and who would not have survived in such curriculum.[33]

CONCLUSIONS

The study reported here demonstrates the effects of curriculum type on study duration and graduation rate. Students from active-learning curricula, of both the PBL and non-PBL varieties, needed less time to graduate and graduated in larger numbers than students from conventional curricula. We explain these findings by suggesting that students in active-learning curricula are more involved in their learning and therefore learn more, which leads to fewer and lower delays and higher graduation rates. Three alternative hypotheses, potentially explaining the effect, can thus be ruled out.

The present study shares a shortcoming with other curriculum comparison studies in that it suffers from the inability to locate the exact source of the effect because curricula tend to differ in more than one way. Therefore, more research is needed to elucidate the role of active learning in academic achievement, study delay and graduation rate.

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