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Transition from Longitudinal to Block Structure of Preclinical Courses: Outcomes and Experiences

Darko Marinović[1], Darko Hren[2], Dario Sambunjak[1], Ivan Rašić[3], Ivan Škegro[4], Ana Marušić[5], Matko Marušić[5]

[1]University of Zagreb School of Medicine, Zagreb, Croatia

[2]University of Split Faculty of Philosophy, Split, Croatia

[3]Sisters of Mercy University Hospital, Zagreb, Croatia

[4]Koprivničko-križevačka County Medical Center, Đurđevac, Croatia

[5]University of Split School of Medicine, Split, Croatia

Aim To evaluate the transition from a longitudinal to block/modular structure of preclinical courses in a medical school adapting to the process of higher education harmonization in Europe.

Methods Average grades and the exam pass rates were compared for 11 preclinical courses before and after the transition from the longitudinal (academic years 1999/2000 to 2001/2002) to block/modular curriculum (academic years 2002/2003 to 2004/2005) at Zagreb University School of Medicine, Croatia. Attitudes of teachers toward the 2 curriculum structures were assessed by a semantic differential scale, and the experiences during the transition were explored in focus groups of students and teachers.

Results With the introduction of the block/modular curriculum, average grades mostly increased, except in 3 major courses: Anatomy, Physiology, and Pathology. The proportion of students who passed the exams at first attempt decreased in most courses, but the proportion of students who successfully passed the exam by the end of the summer exam period increased. Teachers generally had more positive attitudes toward the longitudinal (median [C]±interquartile range [Q], 24±16) than block/modular curriculum (C±Q, 38±26) (P=0.001, Wilcoxon signed rank test). The qualitative inquiry indicated that the dissatisfaction of students and teachers with the block/modular preclinical curriculum was caused by perceived hasty introduction of the reform under pressure and without much adaptation of the teaching program and materials, which reflected negatively on the learning processes and outcomes.

Conclusion Any significant alteration in the temporal structure of preclinical courses should be paralleled by a change in the content and teaching methodology, and carefully planned and executed in order to achieve better academic outcomes.

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Correspondence to:
Darko Marinović
University of Zagreb School of Medicine
Šalata 3
10000 Zagreb, Croatia
darko.marinovic@mef.hr

The adoption of the Bologna Declaration on the European Higher Education Area in 1999 (1) initiated a wave of curriculum reforms at universities across Europe (2). The process of modernization of higher education supported by the European Commission has begun in countries surrounding the European Union even earlier, in the beginning of 1990s, and has since expanded to a total of 27 countries, including some in Central Asia, North Africa, and Middle East (3). Medical schools joined the process at a slower pace (4), taking into account their specifics, such as costliness of medical education and the long, one-tier structure of medical curricula (5). Changes in the curriculum design mostly related to the integration of preclinical and clinical courses and the introduction of problem-based learning (PBL) (6).

While an increasing number of European medical schools accepted a combination of subject-based and integrated problem-based approaches (6), medical schools in the Southeast Europe mostly retained the traditional curricula with Anatomy, Physiology, and Pathology as dominant courses in the first 3 years of medical study (7). The School of Medicine at the University of Zagreb, Croatia, was the only school in the region delivering some case-based modules with a degree of integration, but only in the last (clinical) year of the study (7). Despite the expected reluctance of the teaching staff to accept reforms of the curriculum (8), the leadership of the Zagreb University School of Medicine decided in 2001 to change the structure of preclinical courses in the first 3 years of study from the longitudinal, spread-out form to block/modular form. Clinical courses in the last 3 years of study had already been taught in blocks. The change in the structure of preclinical courses was intended to be the first step in a broader process of the curriculum reform initiated and conducted in cooperation with the Harvard Medical International and the Ludwig Maximilian University from Munich, Germany (9) and a part of the general modernization of medical curricula in Croatia (10).

Many reports have dealt with the curricular reforms in medical schools, mostly describing the introduction of PBL (11,12) and integration of preclinical and clinical courses (13). Previous studies have compared PBL and traditional curriculum (14,15), PBL and a hybrid form of curriculum (16,17), or PBL and some other type of interactive learning (18). No study has yet explored the effects of the transition from the longitudinal to block/modular structure of preclinical courses, without any other substantial change in the curriculum design or content. The case of University of Zagreb School of Medicine is representative of adjusting traditional curriculum to the requirements of the Bologna Process doing the least changes possible. As this phenomenon may occur in other medical schools, especially in the Southeast Europe, it is important to explore its effects and the related experiences of all involved educational actors.

The first aim of our study was to compare the outcomes of 2 curriculum structures (the longitudinal vs block/modular) in the preclinical years of medical study and to identify their advantages and drawbacks. The second aim was to assess the attitudes of the teaching staff toward the longitudinal and block/modular form of teaching.

METHODS

Context

Preclinical courses at the University of Zagreb School of Medicine are delivered during the first 3 years of the six-year study. All courses consist of lectures, seminars, and practical laboratory work. The change from the longitudinal to block/modular structure of preclinical courses was introduced at the beginning of the 2002/2003 academic year. Before the change, all courses were delivered in parallel and were spread out throughout the year. For example, in the first year of study, the average teaching time per week was 4 teaching hours of Anatomy, 3 of Biology, and 2 of Medical Chemistry and Biochemistry; together with other courses, the total number of teaching hours per week was 30 (Table 1). The courses began in October and ended in mid-June, with winter exam terms in February, summer exam terms from mid-June to mid-July, and final, fall exam terms in September. During the examination periods, no courses were delivered.

With the introduction of the block/modular structure, the courses began in October and were delivered sequentially in time blocks, with the exam immediately after each of the courses. The structure and the content of the examinations did not substantially change. Additional exam terms were offered to students throughout the year. The study year ended in mid-July, with summer exam terms ending by August, and with fall exam terms in September. Courses were delivered in 2 or 3 rotations so that each student can attend all the required courses in a year.

Outcomes and data sources

We analyzed the academic success of students from 11 preclinical courses traditionally considered the most important and demanding for students (Table 1 and 2).

We compared study outcomes of 3 generations who began their study before the introduction of the block/modular structure of preclinical curriculum and 3 generations who enrolled after it. Thus, the study included a single generation of students who had the whole preclinical education delivered in the longitudinal form, 1 generation whose first 2 years of study were in the longitudinal and the third year in the block/modular form, 1 generation whose first year of study was in the longitudinal form and the second and third in the block/modular form, and 3 generations who had their whole preclinical education in blocks/modules (Table 2).

We used 4 variables to quantify the study outcomes. The first was the grade students earned in each course. Grading system in Croatia includes 4 passing grades: 2 – sufficient, 3 – good, 4 – very good, and 5 – excellent. For each of the courses, we calculated a combined average grade of all the students who received the course in longitudinal structure of the curriculum and compared it with a combined average grade of all the students in the block/modular structure.

The second outcome was the number of attempts it took students to pass an exam. Croatian higher educational system allows students 3 attempts to pass the exam, with an additional one before a 3-member committee. If a student fails all 4 attempts he or she has to repeat the whole course. Our main question was how many students managed to pass the exam in their first attempt. The rationale for the introduction of the block/modular curriculum was that it allowed students to focus on a single subject at any given time, which should make it easier for them to master it. If that was true, the percentage of students who passed

TABLE 1. Number of class-hours for courses included in the study

		Hours per year in longitudinal curriculum (academic years 1999/2000 to 2001/2002)	Hours (weeks) per year in block/modular curriculum in academic year		
Study year	Course		2002/2003	2003/2004	2004/2005
First	Anatomy	165	210 (10)	210 (10)	210 (10)
	Medical Chemistry and Biochemistry I	82	90 (3)	100 (4)	100 (4)
	Biology	120	120 (4)	120 (4)	120 (4)
Second	Physiology and Immunology	210	210 (10)	210 (11)	210 (10)
	Medical Chemistry and Biochemistry II	158	158 (5)	120 (5)	110 (4)
	Principles of Neuroscience	100	100 (4)	100 (4)	100 (4)
	Histology and Embryology	135	135 (5)	135 (5)	135 (5)
Third	Microbiology	90	90 (3)	90 (3)	90 (4)
	Pharmacology	135	135 (5)	135 (5)	135 (6)
	Pathology	180	180 (7)	180 (9)	180 (16*)
	Pathophysiology	135	135 (5)	135 (5)	135 (16*)

*Pathology and Pathophysiology courses were delivered in parallel during 16 weeks.

TABLE 2. Generations of students and courses included in the study*

		Generations (year of enrolment to medical school)					
Study year	Course	1999/2000 (n=362)	2000/2001 (n=239)	2001/2002 (n=240)	2002/2003 (n=266)	2003/2004 (n=264)	2004/2005 (n=266)
First	Anatomy						
	Biochemistry I						
	Biology						
Second	Physiology and Immunology						
	Biochemistry II						
	Principles of Neuroscience						
	Histology and Embryology						
Third	Microbiology						
	Pharmacology						
	Pathology						
	Pathophysiology						

*Shaded areas represent the longitudinal structure and non-shaded areas represent the block/modular structure.

the course in their first attempt should be higher in the block/modular curriculum.

The third outcome was the percentage of students who passed the course by August, ie, by the end of the summer exam period of the year in which the course was taken. Sequential delivery of courses in the block/modular curriculum is designed so that it allows students to take the exam immediately after completing the course. In this way, the pile-up of exams at the end of the study year is to be avoided. If this was true, the percentage of students who pass the course by August should be higher for the courses taken in the block/modular than in longitudinal curriculum.

Finally, we assessed the percentage of students who passed the course by the end of the study year in which they took it. Passing all courses was mandatory for the enrolment into the next study year, so this analysis also revealed the proportion of students who failed a year.

We encountered a difficulty in the analysis of the Anatomy course because this course underwent changes in its structure prior to the introduction of curriculum changes. Generations 1999/2000 and 2000/2001 had 2-semester anatomy course, called Functional Anatomy, followed by 1-semester Clinical Anatomy course. Students received separate grades for each course. Beginning with the academic year 2001/2002, this system was changed, so Anatomy and Clinical Anatomy were merged into a single, 2-semester course with a single grade. Therefore, for the generations 1999/2000 and 2000/2001, we calculated the average of the grades received in Anatomy and Clinical Anatomy and used this average as the Anatomy grade. Also, because these 2 generations could not pass Anatomy before the end of the third semester, we used different dates to calculate the time needed to pass the course. Instead of August 1, which was the end of the exam period after the second semester, we used March 1, the end of the winter exam term. In this way, we always calculated the number of students passing the exam by the end of the first exam period following their completion of the Anatomy course. Finally, when we analyzed the differences in the number of students who passed the exam in their first attempt, we had to exclude the students from these 2 generations from the analyses because they had to take 2 exams and were not comparable with those who could pass the Anatomy course on a single exam. In spite of these difficulties, we chose not to exclude Anatomy course from the study, as it is one of the largest and most demanding preclinical courses in the curriculum.

The data were gathered from Zagreb University School of Medicine's computer database (Information System for Universities). It was introduced in 1998, but was fully implemented only in 2001, so to complete the database, 2 of the authors (IR and IS) went through the files of individual departments. In some cases, it was not possible to identify data for every student, so the numbers reported do not always add up to the official number of students per academic year in Table 2.

Attitudes of teachers

Apart from students' outcomes, we were also interested in attitudes teachers held toward 2 different structures of the curriculum. To assess this, we composed a semantic differential scale consisting of 15 pairs of opposite adjectives (Appendix). Semantic differential scale was used because such scales are particularly useful when asking respondents to evaluate their perceptions of an issue (19). Between the pairs of opposite adjectives there were 6 points and the items were scored so that 0 reflected a point closest to the negative adjective (eg, boring) and 5 reflected a point closest to the positive one (eg, interesting). Therefore, the possible range of summative scores was from 0 to 75, with higher values reflecting more positive attitude.

Authors IR and IS approached each teacher from 11 departments, explaining briefly the purpose of the investigation and asking them to fill in the scale. To assure the anonymity, teachers were given a day to fill the scale in private and then were asked to drop the survey into a sealed box provided by the authors.

Statistical analysis

Grades earned in the courses were presented as means and 95% confidence intervals. Differences in the average grade for each course and in the number of attempts needed to pass the exam between students who attended it in the longitudinal or block/modular curriculum were tested using Mann-Whitney test. Differences between the longitudinal and block/modular curriculum in the number of students who passed the exam in their first attempt as opposed to those who needed more than one attempt were tested using χ^2 test with Yates continuity correction. The same procedure was used to test the differences in number of students who passed the exam before the end of the summer exam period, as well as in number of students who passed the exam before the end of the year. Kruskal-Wallis test and post-hoc Mann-Whitney test

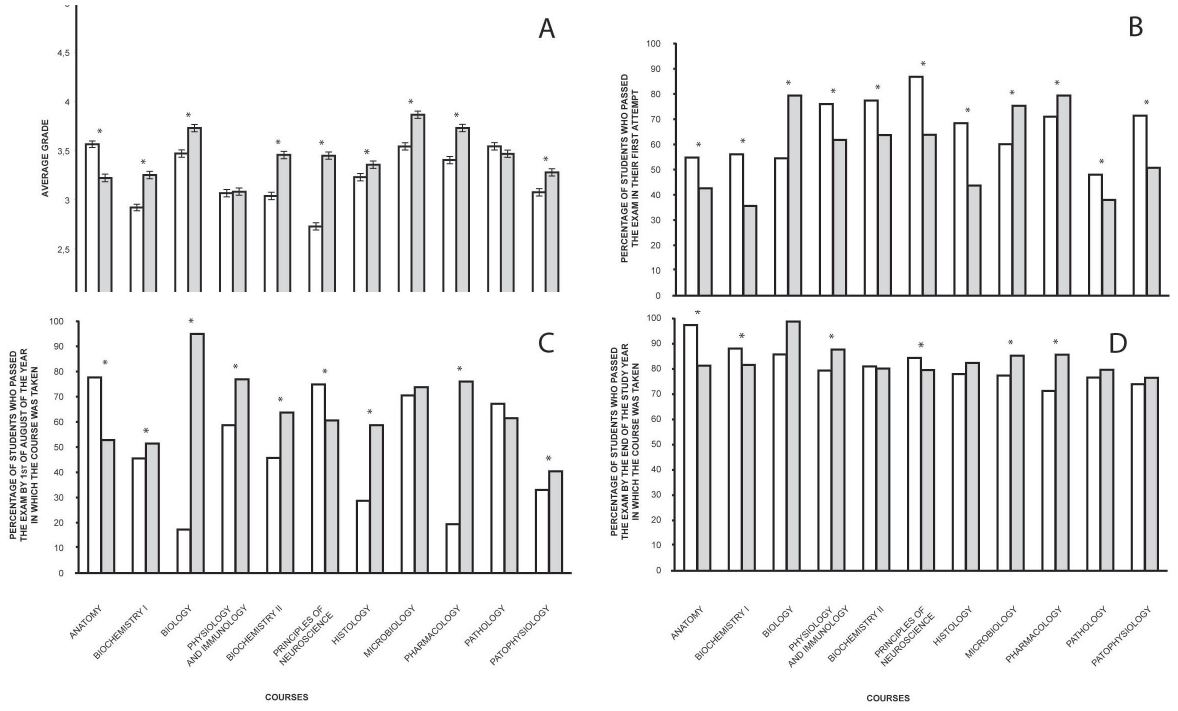
were used to investigate differences in the attitudes toward the 2 curriculum structures between teachers from 11 investigated departments. Bonferroni correction was used to adjust for 55 pairwise comparisons using Mann-Whitney test (each of the 11 departments vs all other departments), so $P<0.001$ was used as a level of statistical significance. Wilcoxon matched-pairs test was used to investigate differences in attitudes (expressed as median and interquartile range) toward 2 curriculum structures within all teachers and within groups of teachers from each department. Statistical significance was set at $P<0.05$ and all procedures were performed using SPSS 16.0 for Windows (SPSS Inc., Chicago, IL, USA).

Qualitative inquiry

Qualitative research methodology was used to explore the experiences of students and preclinical teachers with the longitudinal and block/modular curriculum. We convened a focus group with students from the 2001/2002 generation, who had experienced both the longitudinal curriculum structure in their first year of study and the block/modular structure in their second and third year of study, and 2 focus groups with preclinical teachers. All courses except Biology were represented with at least one teacher in either of these focus groups. All participants signed a written informed consent to take part in the study.

The same facilitators (primary facilitator – DS and observer – DH) conducted each focus group, using the following question as a prompt: "What has changed in your study/teaching with the transition from the longitudinal to block/modular curriculum?" After half an hour of discussion, the participants were shown the figures of the preliminary study results (Figure 1A-D) and asked to comment on them. The focus groups lasted 60 to 90 minutes and consisted of 5 to 8 participants. Audiotape recordings of the discussions were made and subsequently transcribed

Figure 1.



Quantitative outcomes of the longitudinal and block/modular structure of curriculum: A) average grades (mean±95% confidence intervals [CI]) earned by students in 11 courses; B) percentage of students who passed each of 11 courses at first attempt; C) percentage of students who passed each of 11 courses by August 1 of the study year in which the course was taken; D) percentage of students who passed each of 11 courses by the end of the study year in which the course was taken. Open bars – the longitudinal curriculum, gray bars – the block/modular curriculum. Asterisks represent significant difference ($P<0.050$, Mann-Whitney test for A and χ^2 test for B, C and D).

verbatim by the primary facilitator. Participants were assured that all comments would remain anonymous to anyone other than the facilitators, and that specific comments would not be attributed to individuals in any publication of the data.

The transcripts of the focus groups were analyzed using a general inductive approach (20). The primary facilitator carefully read the scripts, identified meaning units in the text, rephrased them as condensed meaning units (21), and labeled the condensed meaning units into categories. The primary facilitator continued to analyze the 20 categories that emerged in the labeling process, refining them further, looking for possible horizontal interconnections, and condensing them to avoid overlap and redundancy. A draft of findings was shared with the second facilitator who had a detailed insight into the transcripts and was able to suggest other possible interpretations and revisions of the draft. The emerging themes were discussed among all the authors for consensual validation. Finally, 5 thematic categories, divided in different subcategories, were described and illustrated with quotations from the focus group transcripts. In an attempt to verify the findings, they were presented at a joint meeting of the School's committees for graduate study and quality assurance in teaching. The members of the committees, who are all teachers at the School, were invited to comment on the findings and their comments were addressed in the final write-up.

The study was performed as a part of the research grant for which ethical approval was granted by the Research Ethics Committee of the Zagreb University School of Medicine.

RESULTS

Outcomes of the longitudinal and block/modular structure of curriculum

Average grades. Except Anatomy, Physiology, and Pathology courses, the average grades were significantly higher in the block/modular curriculum ($P<0.001$ for all, Mann-Whitney test; Figure 1 and Table 3). No significant difference was found for Physiology and Pathology ($P=0.946$ and $P=0.204$, respectively, Mann-Whitney test; Figure 1A) and average grades in Anatomy were significantly lower in the block/modular curriculum ($P<0.001$, Mann-Whitney test; Figure 1A).

Passing the exam at first attempt. The percentage of students who passed the exam at first available attempt was lower in the block/modular than in the longitudinal curriculum in all investigated courses except Biology, Microbiology, and Pharmacology, where the opposite was true ($P<0.001$ for all comparisons except for Pharmacology and Pathology where $P=0.002$, χ^2 test; Figure 1B and Table 3).

Passing the exam before the end of summer exam period. More students in the block/modular than in the longitudinal curriculum passed the exam before the end of the summer term (Figure 1C, Table 3; χ^2 test) for the majority of investigated courses: Medical Chemistry and Biochemistry I ($P=0.035$), Biology ($P<0.001$), Physiology ($P<0.001$), Medical Chemistry and Biochemistry II ($P<0.001$), Histology and Embryology ($P<0.001$), Pharmacology ($P<0.001$), and Pathophysiology ($P=0.027$). More students in the longitudinal than in the block/modular curriculum passed

TABLE 3. Summary of teachers' attitudes toward the longitudinal and block/modular structure of curriculum and the direction of change in students' average grades and exam pass rates*

Course	Teachers' attitudes	Average grades	Passing the exam in first attempt	Passing the exam by the end of the summer term	Passing the exam by the end of the year
Anatomy	Longitudinal	–	–	–	–
Biochemistry I	0	+	–	+	–
Biology	Block	+	+	+	+
Physiology and Immunology	Longitudinal	0	–	+	+
Biochemistry II	0	+	–	+	0
Basics of neuroscience	0	+	–	–	–
Histology and Embryology	0	+	–	+	0
Microbiology	0	+	+	0	+
Pharmacology	0	+	+	+	+
Pathology	0	0	–	0	0
Pathophysiology	Longitudinal	+	–	+	0

*For teachers attitudes, "Block" denotes higher scores for the block/modular structure of curriculum, "Longitudinal" denotes higher scores for the longitudinal structure of curriculum, and "0" denotes no significant difference. For students' average grades and exam pass rates, + denotes increase, – denotes decrease, and 0 denotes no difference with change from longitudinal to block structure of curriculum.

Anatomy and Principles of Neuroscience before the end of summer exam period ($P<0.001$, χ^2 test for both courses), whereas no such difference was found for Microbiology and Pathology ($P=0.310$ and $P=0.087$, respectively).

Passing the exam before the end of the study year. For Biochemistry II, Histology and Embryology, Pathology, and Pathophysiology, there was no change in the number of students who passed the exam before the end of the school year in which they took the course ($P=0.778$, $P=0.060$, $P=0.294$, and $P=0.417$, respectively, χ^2 test). More students in the block/modular than in longitudinal curriculum passed Biology, Physiology, Microbiology, and Pharmacology ($P<0.001$, for all comparisons except Microbiology where $P=0.003$, χ^2 test) before the end of school year in which they took the course. The opposite was true for Anatomy ($P<0.001$, χ^2 test), Chemistry and Biochemistry I ($P=0.001$, χ^2 test), and Principles of Neuroscience ($P=0.036$, χ^2 test; Figure 1D and Table 3).

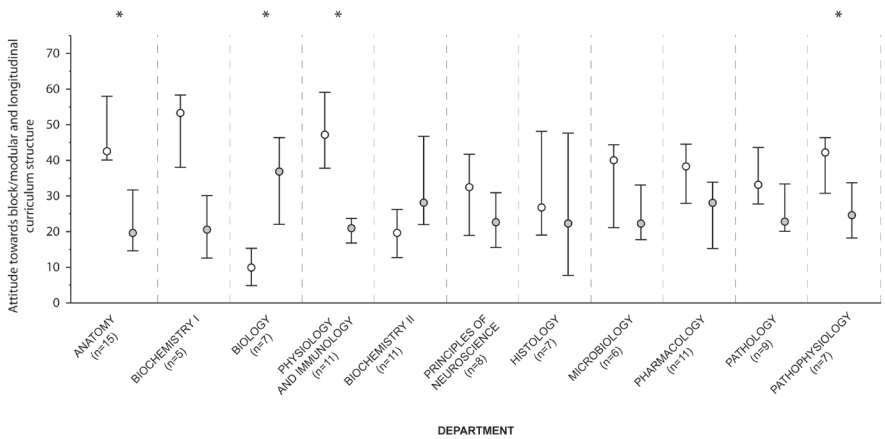
Teachers' attitudes toward 2 different forms of curriculum

Out of 127 approached teachers, 97 (76.3%) filled the semantic differential scales for the longitudinal and block/modular curriculum structure. To investigate the validity of the instrument, we performed 2 principal component analyses, one for each format. In both cases, we found a single component that explained a significant portion of variance – 66% for the block/modular and 53% for the longitudinal form. All items loaded highly on this single component (between 0.5 and 0.9 for all items in both cases). Internal consistency of the scale was also high ($\alpha=0.96$ for the block/modular and $\alpha=0.93$ for the longitudinal form); we therefore considered the summative score obtained from the semantic differential scale to reflect teachers' attitude toward the 2 forms of curriculum.

We found no difference between teachers from 11 departments in their attitude toward the block/modular curriculum ($P=0.200$, Kruskal-Wallis test). All the scores were in the lower half of the possible range, indicating relatively negative attitude toward this structure of curriculum (Figure 2). Attitudes toward the longitudinal structure of curriculum differed between teachers from different departments ($P=0.001$, Kruskal-Wallis test). Biology teachers had significantly lower scores than teachers of Anatomy, Physiology, Pharmacology, Pathology, and Pathophysiology ($P<0.001$ for all comparisons, Mann-Whitney test with Bonferroni correction).

Generally, teachers had more positive attitudes toward the longitudinal (C±Q, 24±16) than the block/modular structure of curriculum (C±Q, 38±26; $P=0.001$, Wilcoxon signed rank test). When we compared these scores within separate groups of teachers from each department, we found more positive attitude toward the longitudinal curriculum in teachers of Anatomy ($P=0.006$), Physiology ($P=0.004$), and Pathophysiology ($P=0.028$). Biology teachers had more positive attitudes toward the block/modular curriculum ($P=0.028$) and we found no differences among teachers from other departments.

Figure 2.



Teachers' attitudes toward the longitudinal (open circles) and block/modular (gray circles) structure of curriculum. Scores are presented as medians (circles) and interquartile ranges (error-bars). Asterisks represent significant differences ($P<0.050$, Wilcoxon matched pairs tests).

Focus group findings

During focus group discussions, both students and the faculty paid most attention to the block/modular structure of curriculum, contrasting it occasionally with the longitudinal structure. We identified 5 thematic categories which encompassed the range of experiences and opinions brought up during the focus group discussions: Implementation of New Curriculum (Table 4), Learning and Teaching (Table 5), Course Examinations (Table 6), Acquired Knowledge (Table 7), and Responsibility (Table 8).

Implementation of New Curriculum. The transition from the longitudinal to block/modular structure of curriculum was done hastily, by a top-down decision, despite some faculty's resistance, and without substantial adjustment of the teaching plan or literature. As one participant pointed out, teaching basically remained the same as before, but only instead in 2 semesters, it was delivered in several weeks. Participants

TABLE 4. Themes and citations related to the "Implementation of New Curriculum" category of focus group findings for student (S) and teacher (T) participants*

Inadequate preparation	
Block/modular structure of curriculum introduced under pressure	*...this was done "ad hoc." Because there was pressure: "Let's go with this" (S1)* *...god decided about it, we all knew who was god at that time – dean (T1)*
Unprepared and resisting teachers	*... at the introduction of block curriculum there was a very strong resistance by the colleagues in my department, because we thought it would be too demanding (T2)* *...at my department each and every person was explicitly against it, initially (T1)* *... it is questionable if teachers were ready for block curriculum (S2)*
Insufficient time for preparation	*...the decision about the introduction of the block curriculum was made in the beginning of July, and you know when* [the school year] *starts* [in October]. *It is impossible to prepare anything during summer holidays (T1)*
Compressing courses without reducing teaching materials or adaptation of the curriculum delivery	*...basically, the program of the longitudinal curriculum was compressed into blocks, which is not normal because it ought to have been reduced (S1)* *...I think that was like jumping head-first into block curriculum, without any adjustment of literature (S3)* *...course programs were not adapted to block curriculum (S4)* *...teaching plan and the form of curriculum delivery should have been changed prior to introduction of block curriculum(T3)* *...teaching remained the same as before 50 y, only instead in 2 semesters, it was compressed in 10 weeks (T2)*
Struggle for additional course weeks	*...it is very difficult to change anything, because people fight for themselves, for their existence, their department (S1)* *...our department managed to win a week-long pause in the middle of our course, but immediately another department jumped in that week with their exam (T3)* *...we now managed to secure 8 weeks for our course (T4)* *...everyone wants to have as much hours as possible. When it is decided that [additional weeks] will be given to certain course... then everyone start to demand it. If it will be given to that course, others also want it, everyone wants it (T2)*
Possible ways of improvement	
More facilities and teachers	*...problem with block curriculum is in the organization of time and space (S3)* *...we think that* [block curriculum] *could succeed with better infrastructure... and more teaching staff (T1)*
Reorganizing courses	*...when we speak of Harvard, they have problem-based learning, they don't learn facts, but problem-based cases; it is not based on learning by heart and then examining factual knowledge (T2)* *...difference between their* [American] *and our block system is that their courses are horizontally connected – they learn systems, they learn the heart, they learn the kidney (T5)* *...block curriculum can succeed only with organ-related courses (S4)... but, then knowledge will not be integrated, one has to look at human being as an organism, not as an organ (S1)*
Combining block/modular and longitudinal curriculum	*...I think it's great the way we had it: first year of the longitudinal curriculum, where one can adapt* [from high-school] *and get into study, and than block curriculum in the second year and until the end of study (S2)* *...there should be such a combination that a demanding course goes together with an elective course (T4)* *...perhaps it would be better if a big course would go in parallel with medical psychology, social medicine, with that kind of* [small] *courses, so that it can be stretched over longer period (T6)*

*Clarifications and explanations of the terms used by participants are provided in square brackets.

TABLE 5. Themes and citations related to the "Learning and Teaching" category of focus group findings for student (S) and teacher (T) participants*

Advantages of block/modular structure of curriculum	
Allows better focusing	*...block curriculum is better because students can organize themselves for a single course (S3)* *...from the moment the course starts, student can sit and learn exclusively that subject matter (S3)*
Helps students to timely understand the amount of materials to be learned	*...my impression is that* [block curriculum] *is a positive development, that [students] can timely understand how much there is to be learned and how long they have to learn it (T7)*
Unburdens students and enables them to complete a study year more quickly	*...[block curriculum] was a relief for us* [students] *(S3)* *...I finished my first year in mid July, and second on May 21: it was fine to me – I had 5 mo of free time (S4)* *...if one wants to disburden students as much as possible, so that they can have their private lives besides study... then block curriculum is ideal (S2)* ...[block curriculum] *makes life easier because it gives students more free time during study (S4)*
Offers more exam terms	...[in block curriculum] *we actually had more exam terms (S3)* ... [students] *can take the exam immediately after the course, that's the first term. By August 1, they have 2 more regular exam terms, and sometimes even a third one (T4)... Yes, they have more exam terms (T1,T2, simultaneously)*
Block/modular structure of curriculum is adequate for clinical courses	*...say, on clinical courses, I think block curriculum is ok (S5)* *...clinical courses can be organized only as block curriculum, you can't be on internal medicine ward in the morning, then on surgery ward in the afternoon, and on neurology in the evening (S4)* *...there's no point if you're today for 2 h on internal medicine ward, and then you're elsewhere until Thursday, Friday, or next Monday – you can't follow a patient or do anything useful (S1)*
Disadvantages of block/modular structure of curriculum	
No continuity	*...for me, continuity is much more important than intensity; therefore, I prefer the longitudinal curriculum (S6)* *...[in the longitudinal curriculum] one learns, but less intensively, over a longer period of time (S7)*
Insufficient time for study	*...if someone has to learn whole anatomy in 10 weeks, it is simply impossible... students just skip many things (S4)* *...the concept* [of block curriculum] *ruined my motivation because I didn't have enough time and I didn't feel that my knowledge... (S6) that it is important at all (S4)... Yes (S6)*
Overlapping courses/learning/exams	*...it happened so many times – I learned for a previous course and could not follow the course I attended (S5)* *...if students learn for a previous course during the next course, then there's no point in block curriculum (T4)* *...if one is absent due to illness, or if one wants to take a vacation, than it is more difficult* [in block curriculum] *because one misses a course for too long (S2)*
Satiation and boredom during a course	...[in block curriculum] *there is satiation, fatigue (S3)* *...nobody speaks about a psychological aspect... capability of focusing on a single matter for 10 weeks from morning to evening (T6)* *... it was terribly boring for me to go for a few weeks in a row to the same place, to have the same routine, look at the same faces (S6)*
Sequence of courses affects learning and success on exams	*...we have 3 blocks in a year and the first block generally consists of best students, "crème de la crème," and the exam pass rate is very high... as year progresses, the level of students' activity and knowledge decreases... the worst is the last, summer block (T9)* *...we have great differences... our course also has 3 blocks a year, and students who come in third block are the best (T6)*
Increased burden of teaching	*...on our course we had 3 blocks per year, and that was terrible for us teachers. We were totally overburdened, when you have to start repeating the same thing third time in a year, you feel you're going nuts (T4)* ...[in block curriculum] *we have increased teaching burden, especially since we are working also as clinicians, we have much routine work* [with patients] *and therefore when we have a block course in a short time period, that's a bit strenuous (T10)* *...previously* [in the longitudinal curriculum] *it was easier, now the burden of teaching is much greater (T11)*

*Clarifications and explanations of the terms used by participants are provided in square brackets.

indicated that the problems of transition were especially prominent in the first few years after the introduction of the block/modular curriculum, but that the situation improved with time, as some adjustments were gradually made. The transition period was also marked by the struggle of the departments to get more weeks allotted to their courses. Suggestions for further improvement point out the need for the build-up of infrastructure, changes in course organization, or combining block and longitudinal teaching.

Learning and Teaching. From the teachers' point of view, the block/modular curriculum increased the burden of teaching, despite the fact that the number of teaching hours did not significantly change. The feeling of increased burden was especially present among teachers of Pathology and Pathophysiology, who have to balance their preclinical teaching obligations with clinical work. In a situation where preclinical courses have to be delivered intensively and in a shortened time span, it became diffi-

TABLE 6. Themes and citations related to the "Examinations" category of focus group findings for student (S) and teacher (T) participants*

Loosening criteria and making it easier for students to pass the exam	*...so that 95% of students would not fail the exam – because they really could not learn it properly, it's not their fault, but the block system is not allowing them – then they're given only a part of the subject matter to learn, or exam-takers give them the questions in advance, or they give students the questions* [during exam] *and then briefly leave the room (S4)* *...we all knew that criteria were loosened on exam terms immediately following a block (S6)... Yes, that's just what S4 has talked about, that criteria were loosened (S8)...Yes, criteria are always more relaxed after a block (S3)... because exam-takers understood that this concept* [block curriculum] *is a kind of violence on our knowledge and our potential, so they were considerate: "all right, you made some effort, you took the exam immediately after the block, we will not be so strict" (S6)* *...in block curriculum, in my experience, people regularly get a higher grade than it would be realistic (S4)* *...now we have loosened the criteria to make sure that the exam pass rate is the same as before (T3)* *...at our department the criteria have also loosened (T8)* *...[students in block curriculum] can learn enough to get a minimal passing grade, but excellent grades have disappeared, so we adjusted our scale on exams – not for passing the exam, the threshold for passing remained the same – but we changed the scale so that we get excellent students... so that the School authorities would be satisfied, otherwise we would have a problem (T2)* *...we abandoned some exam questions, because they proved to be too difficult. Simply, there's not enough time... (T4) And in the longitudinal curriculum they were not too difficult* [Moderator]*? No, previously they were manageable (T4)* *...we gave up a single exam. Instead, we introduced Pathology I and Pathology II as separate exams, to make it easier for students... You had a similar system... (Tpat) Yes, Physiology I and Physiology II (Tphys). Yes, and Histology and Embryology (Thist)†* *...students get additional points on seminars, and we have to give them a higher grade based on these points... I am against it, but that's the decision of our department, that those who prepared a seminar have to get a higher grade (T8)* *...a great number of students pass those small weekly or fortnightly exams, and those who do it, they in the end have to take only practical and oral exam* [they are exempt from taking written exam] *(T3)* *...In my opinion, if we would have normal criteria, half of students would fail the exam, that means only 40%-50% of students would pass the exam if we would demand that they answer each question – to show at least basic understanding and know basic facts (T6).*
Questionable objectivity	*...criteria of different examiners are different (T3)* *...in our department, now there are also extremely different criteria. Some examiners ask only 2-3 questions, others ask 30 questions; some expect knowledge for each question, others are satisfied if they hear only 2 or 3 words. (T4)* *...I have to admit that we are rather subjective* [on exams] *(T10)*
Taking exams unprepared	*...I couldn't catch the exam terms immediately after blocks, because I didn't want to take an exam if I thought that the quality of my knowledge is insufficient (S6)* *...how many of us and our colleagues took the less important exams without preparation just to get it over with! And especially in block curriculum.* *...in the longitudinal curriculum one would not go for exam if one was not well-prepared (S3)... That's because there was not so many exam terms (S8)*
Role of mid-term exams	*...in the longitudinal curriculum, mid-course exams helped us a lot to prepare ourselves for the final exam (S1)* *...in the longitudinal curriculum, students had mid-course exams over the year, and that forced them to keep the continuity in learning (S3)* *...mid-course exams* [in the longitudinal curriculum] *kept the students' knowledge at certain level, which was than upgraded before the final exam (S3)*

*Clarifications and explanations of the terms used by participants are provided in square brackets.
†We changed the codes to protect the anonymity of the participants (ie, to prevent connecting other citations with specific departments); here Tpat is teacher of pathology, Tphys is teacher of physiology, and Thist is teacher of histology and embryology.

cult to adequately care for both students and patients at the same time.

As for the students, the block/modular curriculum allowed them to focus on a single subject. However, the intensity of this form of study may have induced satiation and boredom, which adversely affected the motivation for study. The participants agreed that the block/modular structure lessened the burden placed on students and enabled them to finish a study year more quickly by offering more chances to take exams. However, the rapid turn of courses did not allow enough time for thorough study. Since there were rarely any pauses between subsequent courses, learning and taking the exam from a previous course often overlapped with attending the next course, so some students started to lag behind. The sequence of courses itself affected learning and may have introduced some inequalities in studying that had not existed in the longitudinal teaching. For example, better students were allowed to choose their course rotation schedule at the beginning of each year, so they sometimes grouped in the first or in the last rotation of a course. Thus the rotations were "filtered" according to the quality of students, resulting in different teaching environments between the rotations.

There was a general agreement among student participants that clinical courses, for practical reasons, could be better taught in the block/modular curriculum. However, this topic was not elaborated, as the discussions were focused on preclinical and not clinical courses.

Course Examinations. Students reported that the limited amount of time allotted for each course was not sufficient for adequate preparation for the exam. To prevent the doubt-provoking decline in the exam pass rates and grade distribution, the teachers tended to lower their criteria for exams. Other adjustments were also introduced to make it easier for students to pass the exam, eg, splitting the final exam into 2 parts or using mid-course exam results to add some extra "stimulation" points at the final exam. A single

TABLE 7. Themes and citations related to the "Acquired Knowledge" category of focus group findings for student (S) and teacher (T) participants*

Insufficient knowledge	*...for me, the longitudinal curriculum is much better for overall knowledge... especially, for example, Anatomy, which is a huge course, I don't think one can learn it properly in a block (S5)* *...we were forced into block curriculum so that it was, like, quickly go for exam, quickly pass the exam and get it over with. And have a free time in summer (S5)...And, what's so bad about that? (S2) ...Well, that's great, but I think that quality of knowledge is worse (S5).* *...I bet that we* [after the longitudinal curriculum] *knew anatomy better than those students who had block teaching (S4)* *...my impression is that students know less* [in block than in the longitudinal curriculum] *(T3)* *...is the knowledge of students in block curriculum, in comparison with those in the longitudinal curriculum, better or worse?* [Moderator]*... No, I think it's worse (T10)*
Short-term memorization	*...you attend a course for 3 weeks, cram it in a week, and then you learn another course for a month and you totally forget the previous one (S8)* *...there is no chance that in such a short time one can save anything in long-term memory... it all boils down to a kind of cramming in short-term memory, and then they forget it all, literally in 15 to 20 d, as if they never heard it (T2)* *...students definitively don't have enough time. And then they try to compensate by memorizing, I would say, mindlessly, without using any logic of thinking (T4)*
Grade does not necessarily reflect knowledge	*...average grade has increased, but you haven't measured knowledge. I doubt that the grade reflected real knowledge (S6)* *...increase of average grade reflects a better knowledge (T7)... It's not better knowledge, I wouldn't agree, it's just higher grade (T2)*
Importance of previously acquired knowledge	*...physics and chemistry courses begin with an assumption that students already have certain knowledge. And then in a few weeks they just have to build on assumed knowledge acquired in high school and, of course, that's a disaster (T5)* *...for pharmacology it is important if students have previous knowledge of, for example, microbiology, that is especially important for antibiotics (T9)*
Relativity of knowledge	*...the question of how much knowledge we acquire, that's very individual (S2)* *...one will know what's interesting to him or her. You speak how one should take all that knowledge, but if we took all the knowledge that was offered to us, that we should have taken according to the course programs, our heads would be bigger than... (S2) It's impossible, impossible to know everything from the first to last page (S1)*

*Clarifications and explanations of the terms used by participants are provided in square brackets.

TABLE 8. Themes and citations related to the "Responsibility" category of focus group findings for student (S) and teacher (T) participants*

Perspective	Condition	Features	Citations
Students	Ideal	self-motivation, self-discipline, personal responsibility	*...students have to set their own criteria, what they want to be, regardless of the structure of curriculum (S2)* *...I liked what S2 said – he always starts from himself, and he does not blame or gives credit to block or the longitudinal curriculum for his knowledge (S6)* *...it's not that we are taught by the School, we learn by ourselves (S1)*
	Real	weakness, laziness, avoiding obligations	*...It's easy for us now to speak how one should learn diligently, but when we were here* [as students], *we didn't look it that way, we just tried to find the ways to pass exams with as little learning as possible (S2)* *...it's difficult to control yourself (S5)* *...in the longitudinal curriculum, everything would pile up in summer and then what? We are all made of flesh and blood, and basically lazy (S3)*
School of Medicine	Ideal	deciding what students have to know, helping and compelling students to learn, capacitate even below-average students	*...school of medicine has to decide what I need to know when I finish my study (S4)* *...business of a school of medicine is to make me learn something (S4)* *... if the job of a school of medicine is to produce working force, people who are able to perform their job, then even the worst of them* [as students] *has to become good enough (S6)*
	Real	disproportion of teaching material and course length, encouraging students to learn quickly and superficially, faculty council preoccupied with administrative matters and not teaching	*...I couldn't know what I need. The School is responsible if I have to learn 1000 pages of microbiology that I don't need, and only 150 pages would be enough. The School is responsible if I have only 3 weeks to learn something that needs 7 weeks to be learned. (S4)* *...we were forced into block curriculum so that it was, like, quickly go for exam, quickly pass the exam and get over with it. And have a free time in summer (S5)* *...the Faculty Council, which should thoroughly discuss teaching, talk it over, doesn't have time for that (T1)*

*Clarifications and explanations of the terms used by participants are provided in square brackets.

teacher claimed that the exams criteria on his course have not changed with the introduction of the block/modular curriculum.

Acquired Knowledge. Block/modular structure of curriculum forced students to quickly memorize many facts, which were easily forgotten soon after the exam. A strongly voiced opinion was that the level of acquired knowledge in the block/modular curriculum was lower than in the longitudinal curriculum. However, some respondents pointed out that the level of acquired knowledge was very individual and depended on the personal interest and ability of students.

Responsibility. The success of study was the responsibility of both students and the faculty. In an ideal situation, where students are self-motivated, disciplined, and properly guided by faculty through well-prepared courses, both the block/modular and longitudinal curriculum should yield good results. Reality, however, was different from the ideal, so the existing system of the block/modular curriculum structure suffered from serious shortcomings. A teacher participant suggested that the Faculty Council should discuss more how to improve the quality of teaching.

DISCUSSION

Our study showed that the transition from the longitudinal to block/modular structure of preclinical curriculum was paralleled by an increase in the average grades of students, except in 3 major courses, where the average grades either lowered (Anatomy) or remained the same (Physiology and Pathology). For most of the courses, the proportion of students who passed the exam at first attempt decreased with the introduction of the block/modular curriculum, but the proportion of students who successfully passed the exam by the end of the summer exam period increased.

For the majority of investigated courses, there was no difference in the teachers' attitudes toward the longitudinal and block/modular curriculum. In 3 major courses – Anatomy, Physiology, and Pathophysiology – teachers were more inclined toward the longitudinal curriculum, and in a single course – Biology – teachers were more inclined toward the block/modular curriculum.

The qualitative inquiry indicated that the block/modular preclinical curriculum was introduced hastily, under pressure, and without much adaptation of the teaching program and materials. The advantage of the block/modular curriculum was that it enabled students to focus on a single subject at a time. Furthermore, it allowed students to finish the study year more quickly, which may be an advantage from an economic point of view for the university, but not necessarily from the educational point of view. Identified disadvantages of the block/modular curriculum were the lack of continuity and insufficient time for study, more frequent cramming for exams, questionable quality of long-term learning, students' satiation with a single subject, and a feeling of increased teaching burden for the faculty.

The finding that average grades mostly increased with the introduction of the block/modular curriculum is not consistent with a recently published study conducted at the same school (22). This inconsistency may have resulted from the differences in the sample, as the study by Salopek et al was limited to 2 generations of students and included only the students with best academic performance, ie, those who passed the course at the first available exam term (22). The increase in average grades observed in our study can be explained in several ways. First, with the introduction of the block/modular curriculum, students may have been able to better focus on the courses, especially those that were considered "smaller" or "minor" and often neglected in the longitudinal curriculum, where major courses such as Anatomy, Physiology, and Pathology were students' priority throughout the study year. Second, there is a general trend of upward shift in medical students' grade-point average (23,24). The third explanation is based on the finding of our qualitative inquiry that the introduction of the block/modular curriculum may have forced teachers to lower or adjust their grading criteria to accommodate for the fact that students' knowledge was less than satisfactory. Given that assessment drives learning (25), lowering the criteria on exams may have far-reaching consequences on the level of knowledge and competencies of graduate physicians. This qualitative finding of our study therefore invites further exploration and confirmation.

Another important finding of focus group discussions was that course content and study materials were not adequately adapted to the new structure of curriculum. Both the former dean and vice dean for undergraduate education of the University of Zagreb School of Medicine acknowledged that the block/modular curriculum structure require substantial changes in course plans, particularly cutting down on the volume of textbooks (26,27). This requirement is also in accordance with the British General Medical Council call for the reduction of the burden of information on students (28). In the UK, a considerable improvement has been achieved with the introduction of integrated and system-based programs in many schools (29). Without such reduction, students in the block/modular curriculum were overwhelmed by the material they had to learn within the few weeks of a course module. Inevitably, some of them turned to rote learning, which is based on more or less mechanical memorization, and results in a high immediate verbatim recall, but relatively low problem-solving performance (30). Long-term recall also remains low without sufficient time for memory consolidation (31). The need for longer course duration was reported by teachers in our study, who described how departments struggled to get additional weeks for their course blocks. The participants in focus groups also suggested that by delivering more than one course at a time (eg, having a major course delivered in parallel with one or more "smaller" courses or electives), the problem of the overly compressed curriculum may be alleviated. Only a few of the focus group participants discussed the change in the content of the courses instead of its duration.

An unexpected finding of quantitative analysis was that the exam pass rates have mostly declined with the introduction of the block/modular curriculum. The assumption was that students would be able to focus on a single course at a time and successfully pass the exam at first term, immediately after the course completion. Focus groups findings indicated that many students were unable to adequately prepare for the exam within the few weeks of the course duration. Nevertheless, they took it, counting on their crammed knowledge and examiners' leniency. In the longitudinal curriculum, students were more reluctant to take exams without being well-prepared for it, as there were not that many additional exams terms.

The finding that teachers of Anatomy and Physiology expressed more positive attitudes toward the longitudinal than block/modular curriculum can be explained by the fact that these courses are the largest and generally considered as the most important courses in the first and second year of medical study, respectively. In the longitudinal curriculum, learning for these courses remained students' priority throughout the study year, which ceased to be the case with the introduction of the block/modular curriculum. Furthermore, big courses may have had to face greater challenges and difficulties in the transition from one

form of the curriculum to the other, including the constant drain of young teaching staff at basic science departments (32). At the same time, teachers of Biology, which is a relatively small course in the first year of study, were very positive toward the block/modular curriculum, as this structure brought them the "protected time" when students could focus exclusively on their course – which was rarely the case in the previous, longitudinal curriculum.

The limitation of this study is that it did not assess the long-term learning outcomes and recall, which is an important outcome in the assessment of curriculum reform. Examination grade is primarily a reflection of students' ability to pass the exam and cannot be taken as a sufficient measure of courses' learning outcomes. Another limitation is that the study included only a single generation of third-year students who participated in the longitudinal form of teaching. However, the number of students in this generation was high enough to allow a meaningful comparison. Low number of teachers who completed the attitude scales may have resulted in underpowered comparisons and, therefore, failure to detect statistically significant differences. However, this problem could not be adequately solved due to small absolute numbers of teachers within the departments.

The strength of the study is the large number of students included in the analysis and the mixed-method study design that allowed a better insight into the processes occurring in the period of curriculum change. Although it was performed in a single school, the results of the study are important contribution to the evidence base for curriculum reform, particularly in smaller academic communities.

This study focused on a transitional period in the development of preclinical curriculum, looking only at 3 years before and after the change from the longitudinal to block/modular structure. In order to explore long-term developments, future research may look at the generations of students enrolled more than 3 years after the curricular change.

In conclusion, transition from the longitudinal to block/modular structure of curriculum should be followed or accompanied by significant changes in course plans and programs, introduction of some forms of problem-oriented education, and certain level of course integration. These changes can be implemented only with a continuing commitment of school administration and additional effort of teachers. Education of faculty members on different aspects of curriculum development may be effective in overcoming their resistance and improving their ability to design and implement new curricula (33). Without substantial changes in the curriculum design and content, a shift from the longitudinal to block/modular delivery of courses may prove to be only a "facelift" – formal measure taken with good intentions but without clear vision and purpose.

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