EFFECTS OF REDUCING THE TIME SPENT ON TRADITIONAL LECTURES

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ABSTRACT

This paper describes the outcome of a completely revised course implementation for the course Thermodynamics (15 ETCS), a standard physics course at basic level. Historically, this course has been taught in a traditional way, i.e. almost daily lectures combined with a week of lab classes and a written examination concluded the course. Hence, during the roughly 25-30 lectures during the course, most parts of the literature was covered. However, analyzing the results over a 10 year period, where different lecturers has been teaching the course, it can be observed that there are no significant differences in the examination results due to the teacher effort. This observation is not new and of course somewhat disappointing for an enthusiastic lecturer that has a belief in that he/she can make a big difference for the student. With these observations in mind, we set out to do something radically different where the key question is how we get the student to devote sufficient time to pass the exam. Thus, in the revised course implementation, only eight lectures of overview character were given, usually at the start of a week. After each lecture, the students were given eight assignments that they should prepare for, and be able to present, at a seminar that usually occurred at the end of the week. To increase the students' willingness to actually fulfill the assignment, they were rewarded with a bonus that gave credit at the written exam. The student group performed roughly similar to previous groups on the written exam, but there were a number of differences in the overall performance that will be thoroughly discussed in the paper.

KEYWORDS

Course redesign, Active learning, Problem solving, Seminar approach, Standards: 2, 8, 11.

INTRODUCTION

The engineering students at Umeå University that focus on energy technology of course have to take a course in Thermodynamics. During this course, all basic terminology of the subject is dealt with as well as an introduction to the classic power cycles, i.e. Rankine, Diesel, etc. It is a fairly comprehensive course that extends over a 10-week period on full time (15 ETCS), which means that it is important to start taking the course material seriously from the very beginning – it is almost impossible to grasp the course content if the student starts too late and think that the material can be learned in just a few weeks before the written exam. This obvious fact has always been pointed out at the course start. However, there has, every time, been a bulk of students that do not take the advice seriously and do not put in the necessary effort that was needed. These students usually end up failing at the written exam at the end of the course. This observation is common among the lecturers that have been responsible for the course over the years – the major reason for failing is that the students do not put in enough amount of work at an early stage of the course. Also, when discussing the reason for failing with the student, he/she almost always agree; “The reason I failed was because of starting to late/didn’t do the work needed…”.

Consequently, the objective of this paper is to investigate and analyze if there is a method to encourage the student to start working immediately at course start and avoid becoming one of the failing students. This paper is firmly rooted in the CDIO Standards (CDIO, 2010) of Learning outcomes (Standard 2), Active Learning (Standard 8) and Learning Assessment (Standard 11) as well as the CDIO Syllabus (Crawley, Malmqvist, Lucas & Brodeur, 2011; Crawley, Malmqvist, Östlund & Brodeur, 2007). To test the effect of changing the amount of lectures and increase the active learning, some changes to the course described above were done. Looking at various teaching techniques and educational tricks we settled on a method where the lectures are brought down to a minimum and the main focus will be on the students own work. Here, one should point out that the course has always been taught in a very traditional way, i.e. lectures have been delivered almost every day, only interrupted by a laboratory week at the end of the course. Basically the whole course literature has been covered during the lectures and the students are probably able to clear the course by working the examples and listen to the lectures – no need to study the course literature on their own.

PURPOSE AND GOAL OF THE MODIFIED APPROACH

There were a number of reasons why we felt a strong urge to change the course outline. One is mentioned in the introduction; can we find a way to “force” or encourage the students to start working as soon as the course start? We experienced that this was one major reason why students that previously had done good results suddenly had problems here. A reason for that may be that this is the first course they encountered that spans over a 10-week period. Another important purpose was to find out if it was possible to diminish the input from the teacher and at the same time improve, or at least keep, the level of student performance. This is very important since the grants to Swedish Universities are decreasing and the teachers get less and less time assigned for a particular course and are at the same time expected to maintain the quality. A development that may exist in other countries as well.

We are aware that the results presented in this paper should be regarded with healthy skepticism. One single “experiment” does not give scientific credibility to the results that we will present and discuss, but we think nevertheless that the observations made are interesting enough to support repeated experiments and can fuel further discussions about educational/pedagogical methods. We will definitely repeat our experiment and collect more data that hopefully will support the conclusions and discussions presented here.

COMPARISON OF METHODS

The traditional way to manage the course was to provide a two hour lecture almost every day during the 10-week period. About one and a half week was dedicated to laboratory work, the number of lectures did normally reach a total of 25 to 30. No requirements existed on the student workload.

The new way consisted of a radical change in course layout. Only eight lectures that gave an overview of the course material was given. Also an extra lecture were given just before the written exam where the teacher went through a number of examples that the students had questioned about along the way. The lecture at the beginning of the week also provided the students with a number of (typically eight) calculation examples that they had to present for each other at a seminar on Friday the same week. In order to encourage the students to actually do the work and show up at the seminar, they were rewarded with bonus points at the written exam. Figure 1 illustrates a typical weekly schedule comparing the two methods described in the paper.

	Monday	Tuesday	Wednesday	Thursday	Friday
8 -10 am	Lecture				
10-12 am	Lecture	Lecture			Lecture
12- 1 pm	Lunch	Lunch	Lunch	Lunch	Lunch
1-3 pm				Lecture	Seminar
3-5 pm					

(green)	New method
(yellow)	Old method

Figure 1. Weekly schedule of the two different methods

This means that the number of times the student meets the teacher during the course is substantially reduced compared to previous years, which is illustrated in Table 1.

Table 1. Comparison of teacher-student interaction

	Old way	**New way**
Number of lectures	28	8+1
Number of seminars	0	8
Number of times where lecturer meets students	28	17

The reduced number of meetings between the students and the teacher could itself be an argument against the new method, since the amount of teacher-student interaction generally is one factor of the students' success. However, one should also take into account the quality of the interaction. During the weekly seminars there is real interaction when students show how they solved the weekly problems. Both their fellow class mates and the teacher provide input and discussions that enhance the understanding of the problem in question (cf. Elmgrem & Henriksson, 2010). The interaction is simply of higher quality compared to the one-way communication characteristic of a traditional lecture-based course. Hence, this is an increase in the active learning of the students as suggested by e.g. Meyers & Jones (1993) and encourage the students to be involved in the classroom and think about what they are learning (cf. Astin, 1993).

PREVIOUS RESULTS

The course in its current form has existed since 2006. This means that the teaching method as well as the course literature has been the same and that the students have had a very similar learning experience and environment since then. Thus, there are reasons to believe that the results on the written exam should be very similar.

Figure 2 illustrates the amount of students that did not pass the exam at the first opportunity. A linear trend line is included in the figure. There are of course many factors that influence the statistics here. The wildly fluctuating numbers between the first four years is probably mostly due to the fact that there were only 10-17 students taking the written exam at the first opportunity while there were more than twice as many students (30-45) the last four years. Therefore the statistics become somewhat more consistent 2010 - 2013 and one can see that the share of failing students seem to stabilize around 20%.

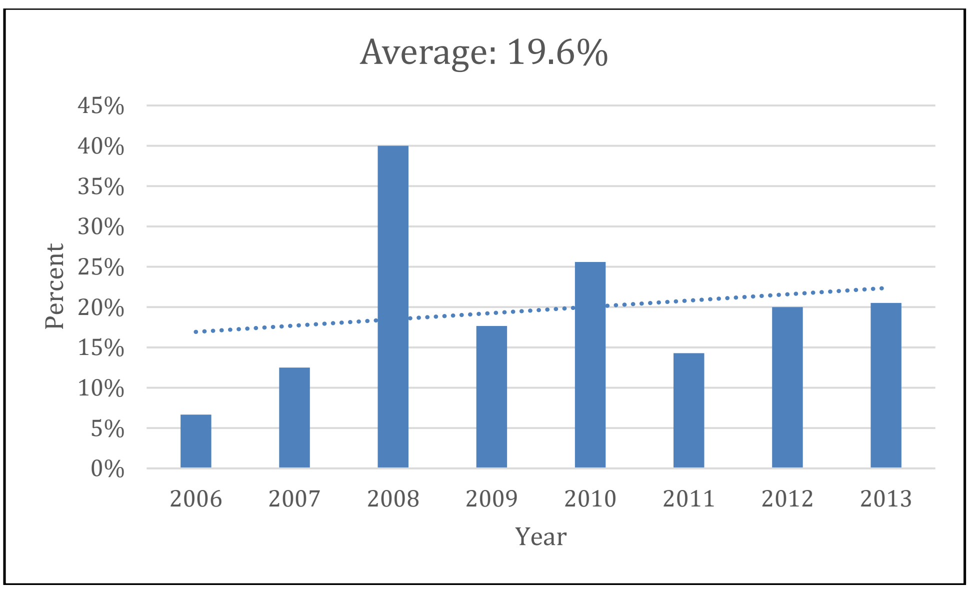

Figure 2. Percentage of students who did not pass the exam at the first opportunity

The course is graded, where a student passes with grade 3 if 50% of the maximum score on the exam is reached. Grade 4 is achieved for > 65% of the maximum score and grade 5 for > 80%. Table 2 shows the distribution of grades as well as the average value during the period.

Table 2. Grading between 2006 - 2013

Year	Fail [%]	Grade: 3 [%]	Grade: 4 [%]	Grade: 5 [%]
2006	6.7	26.7	33.3	33.3
2007	12.5	50.0	25.0	12.5
2008	40.0	10.0	30.0	20.0
2009	17.6	29.4	29.4	23.5
2010	25.6	46.5	7.0	20.9
2011	14.3	34.3	37.1	14.3
2012	20.0	33.3	33.3	13.3
2013	20.5	33.3	28.2	17.9
Average:	**19.6**	**32.9**	**27.9**	**19.5**

It should be noted that, on the average, around 20% has failed at the exam, but at the same time a similar share of students have achieved the highest grade, 5.

NEW RESULTS

The results presented here is only from the written exam. The bonus that was given for attending the seminars is not included in order to compare results.

The written exam

During the last year, there were about the same number of students that attended the course as the previous 4 years. Thus, it should make sense to compare results with the reservation that the student group as a whole was an outlier, i.e. extremely good or extremely poor. We do not know if the results should have been the same if the group had been exposed to a traditional course layout. The only way to reliably believe in the results presented here is to repeat the experiment which, as previously mentioned, we intend to do. There were, however, a number of significant differences that we think are interesting to further discuss.

First, in figure 3, the results from the written exam with the new course outline is shown. The share of failing students was roughly the same (20%) as the years before, so this simple observation itself encourages us to continue with the experiment next year.

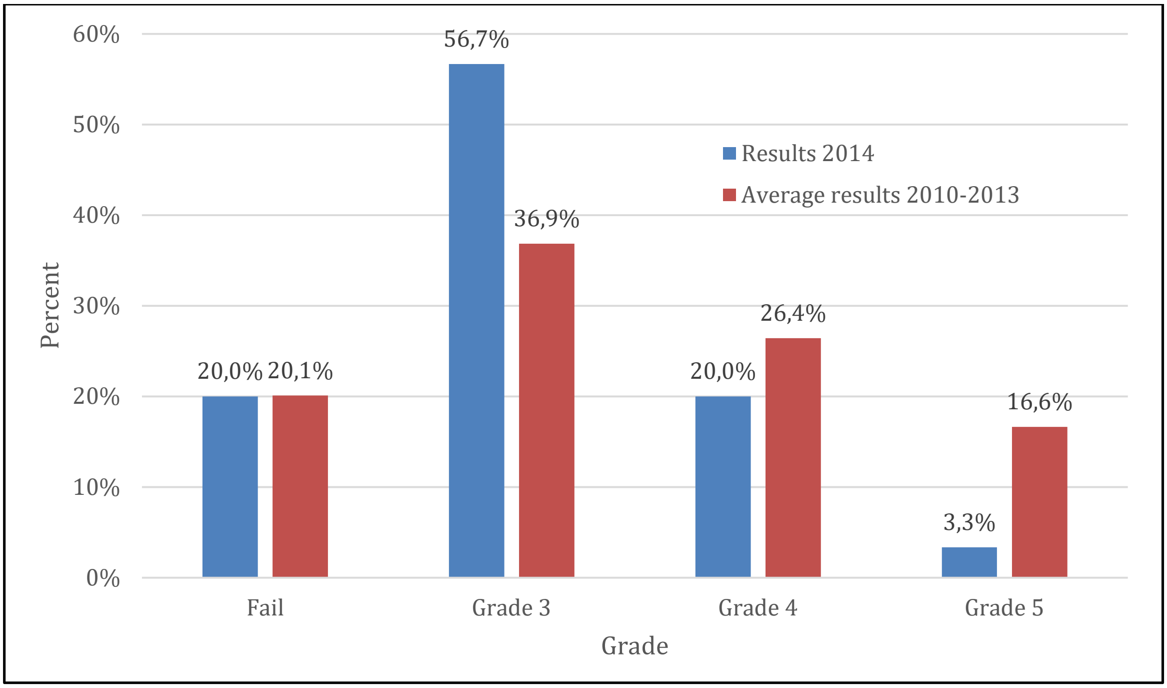

Figure 3. Results with the new course outline compared to average results 2010-2013

There are, however, two other numbers that stand out. First, there is a significantly larger share of students that "only" performs enough for grade 3 (pass). A typical result here has been roughly 30-40% but here a major part of the students, or almost 57%, performs at this level. Second, there is a significantly smaller proportion of students that performs good enough for grade 5. Usually this is close to the same number as the failing share, around 20%, but here only 3% managed a grade 5 result. This is of course discouraging even though the results where bonuses are added are comparable with previous results and the share of failing students actually turned out to only be around 10%. But, the overall result on the written exam is worse than before and this calls for a more thorough analysis.

An observation when correcting the written tests was that there was not a strong correlation in the results, i.e. there were no specific type of problem that everyone had problem with and there were neither any problem that most students solved easily. The results were more irregular, i.e. one student may have missed the three first problems while another may have had problems solving the last three. One type of problem the student should be able to solve is a power cycle problem (i.e. a Diesel cycle or Rankine cycle). That type of problem is always present on an exam since that is a central part of the course.

Looking at the results for these types of problems during the last four years, one can see that students do fairly well. In figure 4, the results from those types of problems are shown. Typically the average score is about 65% of the maximum score. This year, however, the score on similar problems were only 40%, i.e. they performed significantly worse on a central part of the course. However, they got their score more evenly distributed, i.e. the total score summed up from all type of problems, not only the central ones. Our interpretation of this observation is that the group had not been trained to solve "typical" problems to the same extent as before. The lectures did not contain a lot of problem solving techniques and the students were left to themselves finding their own way of handling the course content. We believe that, as a lecturing teacher you tend to focus on certain key elements in a course. This is quickly picked up by the students and they become somewhat selective in where they put their effort (cf. Bränberg, Gulliksson & Holmgren, 2013). Hence, the results on the written exam show that the active approach to students' learning have somewhat randomized the learning compared to having lectures covering the different subjects. On the other hand, with the new approach, the students seemed to have knowledge of many various topics of the course without becoming very skilled in any particular subject or any solving technique.

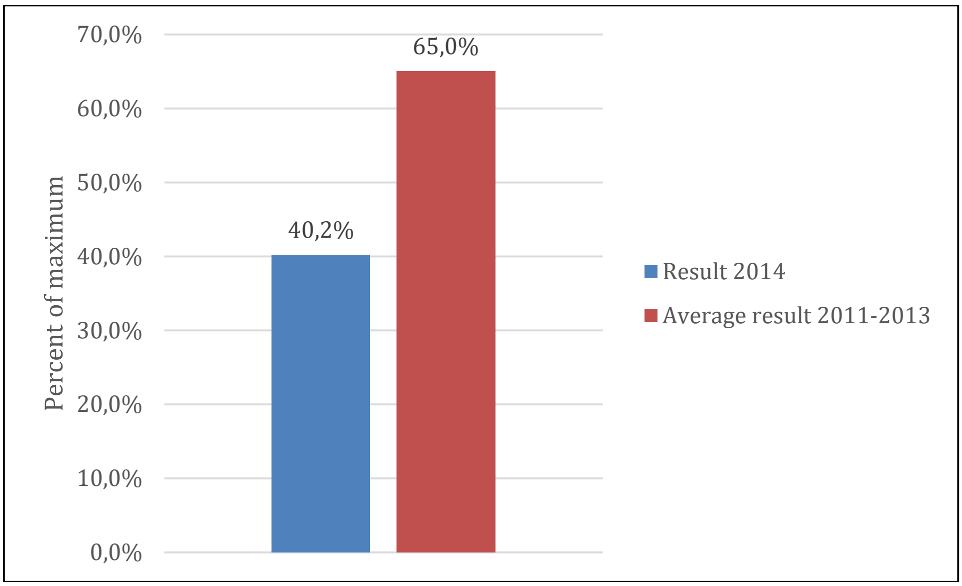

Figure 4. Results on typical, central problems.

Laboratory week

A spontaneous comment from the instructors was that the student group were much more self-sufficient compared to groups from previous years. They did not need that much help and they did not ask that many questions during the laboratory sessions. Instead they just entered the laboratory and started to do what they were supposed to do. If this was an effect of the "no-lecturing" approach or if it was a coincidence remains to be seen, the experiment will be repeated.

STUDENT EVALUATION

At the end of the course an evaluation were conducted online where one of the questions gave the students the following alternatives;

A) I think that the course layout was OK.

B) I would have preferred the traditional layout, i.e. a lot of lectures and no seminars.

C) I would have preferred something completely different, namely (and here, the student could write whatever he/she wants)

Also, the students were encouraged to give a comment about the course at the end of the survey. We were somewhat surprised to get a result where alternative A ("I think that the course layout was OK") got 90% of the votes, i.e. the students really appreciated the new course layout and did not mind the quite radical revision that had been made. Furthermore, many students gave positive comments, some of which are cited below:

"Good layout with lecture at the start of the week and seminar at the end. It forced you to keep up with the phase of the course"

"Good layout of the course – maybe one more lecture before the exam with problem solving had been a good thing"

"The seminars were good"

"The course layout was OK but I would have liked an afternoon per week where we could meet the teacher and discuss problem solving"

"The seminars were very good"

"The layout forced you to start working immediately and be in phase with the course all the time"

The students' positive input encourages us to continue with the new course layout next year, maybe with some minor adjustments. For example, several students asked for more help with problem solving techniques.

REQUIREMENTS ON THE TEACHER

In order to set up a course like this the responsible teacher must know the course content thoroughly. We do not think the concept will work if, for instance, a teacher will lecture on a course for the first time. There are two main reason for this. First, it is difficult to prepare the "overview lectures" if you are not familiar with the course content and literature. It requires a great deal of course knowledge to prepare those since you need to know where to put your effort and know which parts are easier for students to grasp themselves. Second, during the seminars anything can happen. All types of questions and discussions may emerge during these sessions and it is definitely an advantage to have encountered similar questions, which you usually have by previously lecturing on the course.

RESULTS FROM ANOTHER WAY OF REDUCING THE TEACHER WORKLOAD

Immediately after the "experiment" discussed in this paper, a similar course was given, by the same teacher, to another group of students. The basic course material of 10 chapters in the book was identical except that this group of students also covered 5 more chapters in the course.

This time, the way of reducing the teachers' workload was done by simply reducing the number of traditional lectures during the course without adding any session to increase the active learning in the classroom. The students were informed about this fact at the start of the course – "You have to do a much greater deal of self-studying. I, the teacher, will not be around to the same extent as previous years." In practice, the number of lectures were cut with roughly 30%.

In figure 5 the outcome from this revised course outline is shown. An interesting observation from this course revision was that the results from the exam were significantly polarized, i.e. the share of students that either failed or performed at the highest level (grade 5) compared to previous years were significantly increased. The “good performers” of grade 4 and 5 were similar as before. Our interpretation of this is that there are students that are unaccustomed to read the course literature and obviously have problems grasping the course material by themselves without extensive guidance. On the other hand, the students that can do this took the information seriously and seem to have learned at least equally much as when they spent time listening to lectures. The results from this course are very recent and no real follow-up has been made. Nevertheless, the results were significantly different from previous years and a more thorough analysis will be made later on in order to see if this was just a coincidence or that maybe we can learn something from it.

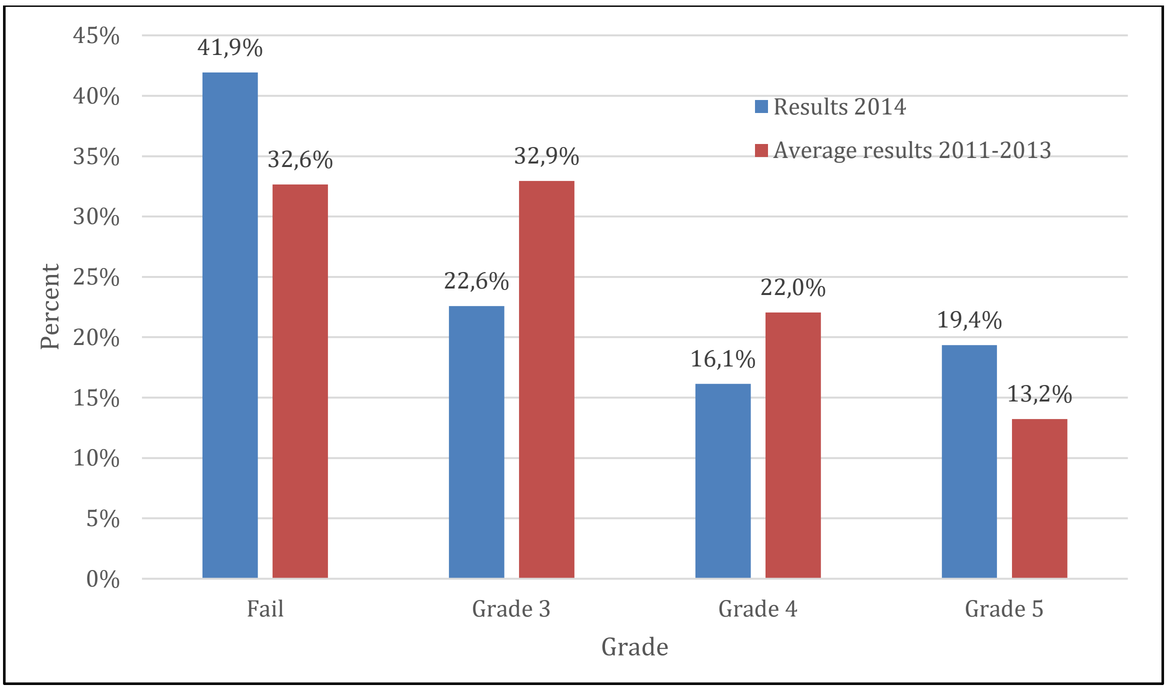

Figure 5. Results from reducing number of lectures compared to average results 2011-2013

CONCLUSIONS

This project has been based on improving the students’ performance according to the CDIO Standards of Learning outcomes (Standard 2), Active Learning (Standard 8) and Learning Assessment (Standard 11). The project of revising the course, and changing the amount of lectures given, had two main purposes. The first purpose was increase the amount of active learning and to encourage students to start working with the course material early on and not wait until the final weeks before the exam. The goal was that this should lead to fewer failures and overall better results. The second purpose was of a more pragmatic nature since the amount of time assigned to university teachers in Sweden for a specific course has gradually decreased. Thus, is it possible to decrease the teachers’ workload on a course and at the same time keep, or enhance, the student performance?

The results from this study show that the first purpose is partly fulfilled. The students started to work from the very beginning and got a more even workload during the length of the course. However, the exam result did not indicate any improvement over previous years result, rather the opposite. Investigating the results more thoroughly indicate, however, that very few students performed really poor this year and those students never attended any seminar. Those who regularly showed up at the seminars all had a descent score where even the failing students were very close to a passing grade. Furthermore, comparing the performance of the student groups, looking at previous years and other courses, indicate that the group of 2014 has performed poorer than the groups of 2011-13. In light of this, the performance of the 2014 group actually was pretty good. It would, however, be wrong to draw too much conclusion out of this single experiment, but we find nothing that supports that this year's test results are worse than previous years. Nevertheless, the focus on active learning of the students has decreased the dependence on the teaching assistant during the laboratory exercises.

The second purpose is also partly fulfilled. The workload on the teacher did not decrease to the extent that could be expected. A change of the course layout, preparing the assignments for the seminars and extra administration connected with the seminars summed up to a workload that was not significantly less than previous years. This is to be expected the first time a course revision is made. However, using the same layout next year will significantly decrease the teacher workload.

To summarize, we are encouraged to continue using the revised course layout, with some minor changes based on this years' experience and the students input. One such change may be to include some kind of problem solving sessions.

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BIOGRAPHICAL INFORMATION

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