

OR/MS in A New MBA Program

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Abstract

The University of Iceland launched a two-year executive MBA program in September 2000. The chairman of the program's three-person board (the author) is a professor of OR and together with the director of the program had primary influence on the planning and development of the program. The paper describes how OR/MS (Operations Research / Management Science) was included in the program.

OR was taught to some extent in five courses, in two of eleven compulsory courses and in three of ten elective courses. These courses are described in the paper, which concludes with a discussion.

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1. Introduction

The University of Iceland launched a two-year executive MBA program in September 2000. As the chairman of the three-man board of the MBA program, I had, together with the director of the program, primary influence on the planning and development of the program. As I am also a professor of OR, I was in an interesting position, being able to fight for the inclusion of OR/MS in the program.

From the time when we decided to establish the MBA program, in December 1999, the main objective was to create the best possible program for the students. A second personal objective of mine was to maximize the extent of OR/MS in the program but not at the cost of the quality of the program. As it turns out, I did not have to fight for my views and hence the inclusion of OR in the program was as I thought best, given the circumstances. After thorough study and discussion the director (a professor in management and strategy) and I agreed on the subject of the 11 compulsory courses that we both found a very sound base for the program. The others on the board accepted our proposal. The electives were driven by student demand.

This paper starts with some background information, then goes on to a general description of the MBA program, followed by a description and discussion of the

courses with OR/MS content. Finally, the paper concludes with a general discussion of OR/MS in MBA programs.

2. Background

In order to make it easier for the reader to evaluate the MBA program in context and to draw conclusions, some background information of a different nature is needed. First, my personal background is covered, then, there is some information about Iceland, since all the students are Icelandic, and finally basic information about the University of Iceland is given.

2.1. Personal background

My first university degree was in mathematics and I finished my Ph.D. in optimization from the Royal Institute of Technology in Stockholm, Sweden, in 1984. After working for 6 years at the University of Iceland Science Institute, I moved to the Faculty of Economics and Business Administration. Since then my students have almost exclusively been business students but before that my students were mainly in computer science and natural sciences.

After I graduated in 1984 I soon became involved in a few real world projects concerning the application of OR in different situations. My interest in studies of

mathematical methods decreased and all my work was driven by the application aspect of the projects. Because of the small population in Iceland, applications of OR are sparse and of varying nature. Therefore I got involved in very different problems and one might say that my specialty became to be a generalist.

After reading Eden et al. (1983) in the late 1980s I became interested in the so-called soft-OR, or problem structuring methods (see e.g. Rosenhead, 1989 and 2001). I am still very much interested in these methods and they have played a great role in my teaching, research and consulting.

Soft-OR seems to play a much bigger role in the UK than in USA but the difference between OR in the UK and USA is not at all limited to soft-OR. Ackoff (1995) discusses this difference and says among other things: "American operations research is very largely methods-and-technique oriented. Most of the papers which are published or given in Britain tend to be general discussions or case studies rather than theoretical papers dealing with the mathematical exploration of some type of problems that arises [sic] in operations research. The literature in the United States is heavily balanced in the other direction." My personal view of OR lies between the UK and USA conventions/perspectives, not because of Iceland's geographical location between the two, but because I feel that both are needed. (See Appendix B for my version of the OR-process.)

Since 1990 I have been teaching a compulsory course for undergraduate business students called Operations Research. When I began teaching it, it was a standard OR course with emphasis on models and algorithms. Because of my interest in soft-OR I put more emphasis on problem formulation in the OR course than was typical. Over the next few years I gradually modified the course, trying to make it more suitable for the students. See Appendix A for a description of the content of the course in 1992, and Ólafsson and Hannibalsson (1996), and Ólafsson (1998) for a discussion of its development in the next few years thereafter. The main development was that soft-OR and the use of the software Excel and SIMUL8 replaced methods-and-techniques.

2.2. Iceland and the University of Iceland

The population in Iceland is less than 300,000. Thus Iceland has few and small companies compared to most countries although the living standard in Iceland is among the highest in the world. Fishing has been the backbone of the Icelandic economy for decades. Energy production and energy intensive industries are important and growing fast. OR activity in Iceland takes notice of this and has been described by Ólafsson (1995).

One can say that the University of Iceland is the only research based university in Iceland. Now several other universities, all much smaller than the University of Iceland, offer programs in diverse fields. The number of students at the University of Iceland is about 9000, most of them undergraduate students, but the number of graduate students has grown from 170 in 1994 to 1000 in 2003. The University of Iceland is state funded and students do not pay tuition, except for the students in the MBA program described in this article.

The Faculty of Economics and Business Administration has about 1000 undergraduate students and 250 graduate students. 10% of the students are studying economics and 90% business administration, either in a broad program or in some specialization like finance, management, marketing or human resource management. The faculty has grown fast in number (currently 33) and qualifications in the last 5 years.

The faculty has traditionally been strong in quantitative subjects like economics (with mathematical emphasis), finance, accounting and operations management. Its strength in management has grown much since 1993.

3. Description of the MBA program

The program is essentially an executive MBA program although some of the students have limited management experience. Classes are held on Mondays and Thursdays between 4 pm and 8 pm and in addition there are some extra classes, company visits and other activities for about 2 hours every week on average. Sometimes there are one or two whole days of study, e.g. when foreign experts are visiting.

The MBA program is a two-year program, 10 months in the first year and 9 months in the second year. Each student takes 15 courses, 11 compulsory (see Table 1) and 4 electives (see Table 3). Usually, two courses are taken simultaneously for 9 weeks. The students can replace one elective course with a project and they can take extra courses (25% of the first group took an extra course). Two of the 11 compulsory courses and 3 of the electives have some OR/MS content and are described below.

Table 1: Compulsory courses in the MBA program

Time	Course	Course
Sept. - Nov.	Organization Theory and Design	Micro- and macroeconomics
Nov. - Feb.	Marketing	Analyzing issues and decision making (see description below)
Feb. - April	Operations management (see description below)	Accounting
April - June	Finance	Leadership, management and communication
Sept. - Nov.	Strategy	Entrepreneurship
Nov. - Dec.	International business	

Only one group of 45 students is enrolled in the program at any given time so the second group started in September 2002. The students in the first MBA group ranged in age from 28 to 58, the average age being 38. The average working experience was 10 years. One student had a Ph.D., five had a master's degree and the others basically a first university degree. Three of the students did not have a university degree, but were admitted to the program because of extraordinary working record (CV and references). About 80% were working full time, many as managers but the diversity of jobs was great.

Table 2 shows the educational background of the first two groups of students of the MBA program described here. As a comparison, the results of a survey, made by the Association of MBAs, is in the last column as it was presented on the Internet in 2000.

The board discussed the teaching methods before the first group started. We decided that all students should use laptops in classes and be connected to the Internet, as one of the objectives of the program was to make the laptops a powerful tool in their hands. WebCT is used mainly for distributing information and teaching materials and for discussions. Using cases is seen as an important but not extensive part and many teachers use no cases. Real world projects are viewed as very important and are part of most courses.

Table 2: Background of MBA students.

	First group	Second group	AMBA
Engineering	30%	14%	32%
Computer Science	11%	2%	3%
Other Science	9%	2%	24%
Humanities	20%	11%	12%
Social Science / Law	9%	25%	13%
Business Studies	11%	27%	8%
Other	9%	20%	9%

The development of the elective courses (listed in Table 3) took place in several steps. All teachers in the department were free to offer a course. Meetings were organized where teachers could present their ideas and students respond. In fact, some course-ideas came from the students. Then a survey was made where the students would report how likely it was they would take each of 16 courses for which descriptions had been made. Later, a second round was presented after some of the course ideas had been changed or merged and some new ones were offered. Finally, ten courses were offered; basically those that we could expect at least 10 students to select. It turned out that the most popular courses had more than 30 students and the smallest course 13 students.

Table 3: Elective courses in the MBA program in 2002.

Time	Course
Jan. - March	Human resource management
	Finance II
	Operations management II (see description below)
	Project management and consulting (I proposed the idea of combining these two subjects in one course and taught the project management section. The course focuses not on the mathematical aspect of project management but on the management aspect. It has no OR content.)
	Analysis of financial statements
March - May	Knowledge management
	Financial markets
	Managerial accounting

People's view of how students choose electives varies. I have had the opportunity to learn much about how our MBA students do that, but of course I don't know the whole truth. I would say that the most influential factor is how interesting the subject of the course is to the student and that includes both how much the student enjoys the subject and how important he or she thinks it is. This is closely followed by the importance of who teaches the courses. Many students may prefer an uninteresting subject with a great teacher to a very interesting subject with not so good a teacher.

No formal evaluation of the quality of the MBA program has been undertaken. The main reason is that we believe it is almost impossible to get valuable information by a survey using closed questions (well defined measurements) amongst our MBAs or employ-

ees. One reason for that is the small sample size (45 MBAs) compared to the huge variety, coupled with the difficulty of finding useful foreign comparison as the job market is unique in Iceland. We have, though, made an effort to evaluate our program informally in many ways. We are satisfied with the results, basically for two reasons. Almost without exceptions the students speak very positively of the program, and we have seen many examples of great career moves as a result of the MBA education.

4. A closer look at some courses

We will now describe and discuss the five courses with substantial OR/MS content.

4.1. Analyzing issues and decision making

The English title of the course is a direct translation of the Icelandic "greining viðfangsefna og ákvarðanir", but does not carry the same connotations. The subject is essentially statistics and OR and thus it might as well have been called *Statistics and OR*. There are several objectives for the course, both preparing the students for other courses and independent objectives.

One of the main objectives is to provide the students with elementary skills in statistics. The students have very different backgrounds; some have completed several statistics courses at the university level while others have never learned anything in statistics. This makes it difficult to plan the course. This is a well-known problem; see e.g. Robinson et al. (2003). I have taught business students statistics for many years, used several textbooks and looked at many statistics books, but never found a book I was fully satisfied with. I have through the years tried to learn how managers, both in Iceland and elsewhere, use statistics, directly and indirectly. The main conclusion is that most managers never or very seldom use statistics, except for descriptive statistics (there are some exceptions, e.g. some managers in the finance sector). This hopefully explains why I find it extremely difficult to plan and execute a good statistics course for MBA students.

The first time I gave the course I used the textbook *Statistics, Data Analysis, and Decision Modeling* by Evans and Olson (2000). That book was basically suitable for the course but, as with most statistics textbooks, I was

not fully satisfied with it. The second time (November 2002 to February 2003) I decided to use a fairly typical statistics textbook by Newbold et al. (2003) which is now used in the undergraduate program. I made it clear from the beginning that only small parts of the book would be covered in the course and the book was partly seen as a handbook of statistics for the students. This was not a very good decision and I will not use a typical statistics textbook again in the MBA program. There is far too much emphasis on formulas in such textbooks for a course with emphasis on working with numbers in the statistics part of the course. Also, in retrospect, the idea of a textbook in statistics as a handbook for MBA students is probably not good. Next time, I will use the second edition of the book by Evans and Olson.

Although statistics was an important element of the course, it had many other objectives. The main objective was to increase the students' skills in analyzing issues and in contributing to and making decisions. Of course, other courses in the MBA program also contributed to this objective. Although I had a fairly clear picture of the course as a whole, some students found it difficult to understand what the course was about. In order to make this easier I drew and presented the cognitive map in Figure 1, but one element of the course was to teach the students to use cognitive maps as a tool to analyze issues. When the issue at hand is a strategy, the cognitive map is called strategy map, e.g. in the Balanced Scorecard methodology.

The coverage of soft-OR was an essential part of the course. This included the coverage of the OR-process (in the spirit of the Strategic Choice Approach, see Friend & Hickling, 1987), cognitive mapping and Soft Systems Methodology. The emphasis on soft-OR was, though, more clear in the course projects.

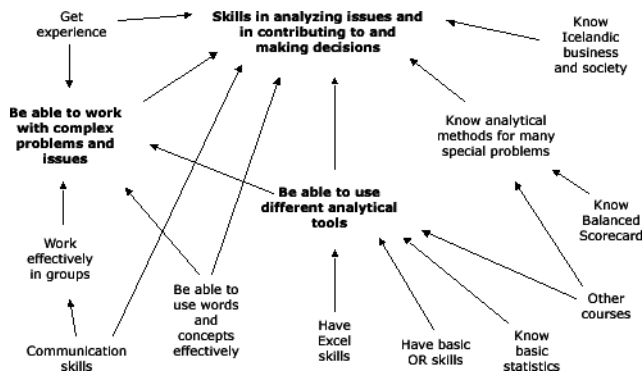


Figure 1: Description of the objectives of the course "Analyzing issues and decision making" with a cognitive map. An arrow signifies "leads to".

The students worked on two projects in the course. In the first one groups of 6 students had to analyze some complex issue and form and support some decisions. Examples of such issues are "Suggestions for the government in the fight against drug use" and "Ways to decrease the cost of food in Iceland". See Appendix B for further description. The second project was completed either individually or in pairs. This was a very open project but it had to include some OR or statistics. Examples of projects are, "Study of a queuing situation at a hospital department", "Should I buy or lease a car" and "Assessment of the security situation in Videy (a small island with a museum)".

I believe I must lower the demands in the course slightly, mainly because too many students found them overwhelming. One possible solution is to take some of the statistics out of the course and require a remedial statistics course for those with limited statistical skills. Another possible solution is to cut, or somehow simplify, one of the projects.

4.2. Operations management

This course is similar to the Operations Management course at the MBA program of Northwestern University's Kellogg School of Management, based on the textbook by Anupindi et al. (1999). Emphasis is on understanding processes and process flow, analyzing the process's effect on economic results and determining the levers that can be used to improve economic results. As processes transform inputs into outputs, the process' design determines the competitive position of the firm. The students study cases in the course, mainly from Harvard Business School Publishing. Frequently the cases require some model building that

the students are supposed to do in Excel. Most of the Excel models use Solver, decision trees, Queueing ToolPak or statistical analysis.

4.3. Operations management II

Early in the process of developing the elective courses some students voiced their interest in learning more in operations management. The instructor of the first course, and I discussed this but didn't find it easy to define such a course that would suit a large enough number of the MBA students. It was not until I got the idea to take the view of different managers, that I could see the possibility of defining such a course. Another important feature of the course would be extensive inclusion of modeling in Excel because that was clearly what some of the students were seeking.

Soon it was decided that a professor in the department of Industrial Engineering, with extensive experience in OR related consulting in industry, would be the main instructor. The title of the course was *Operations management II*, but it was in fact an OR course. The main textbook was *Practical Management Science* by Winston & Albright (2001) but a book by Brown, Blackmon, Cousins & Maylor (2001) was also on the reading list. The structure of the course was such that for each week the theme was one job (the production manager, the finance- and marketing managers, the service manager, the supply chain manager, the purchasing manager, the general manager). During the course, the students solved many problems from the textbook and thus made many OR models in Excel. Each student, or a pair of students, also worked on a practical problem; those problems varied greatly, some including Excel models and others not. For the second student group, only the book by Winston & Albright was used.

4.4. Marketing engineering

Another elective course with OR content was *Marketing Engineering*. Gary L. Lilien, one of the authors of a book of the same title (Lilien and Rangaswamy, 2003), came to Iceland and taught the course over three days, 6 hours each day. The book presents many OR models and comes with specialized software. In the course the students also learned how Icelandic companies are collecting and using data as part of marketing. I initiated the course and was one of the supervisors.

4.5. Performance measurement

I both developed this course and taught the greatest part of it. I call the course "Mat á árangri" which can be translated either as "Performance measurement" or "Evaluation of results/success". Early in the development I planned to cover several methods that can be used to evaluate results, some of them OR/MS methods and others not, e.g. MCDM, DEA, Balanced scorecard (BSC), EVA, and even market research. When I had finished developing the course, and had read extensively on the different methods, I decided to put the main emphasis on the BSC.

The BSC methodology includes two main tools; strategy maps and scorecards, see e.g. Kaplan and Norton (2001). I first learned about strategy maps, as a version of cognitive maps, from *Messing about in problems* (Eden, Jones, and Sims, 1983) and have been teaching cognitive mapping in my OR course since 1993. BSC is all about finding what is important to measure and how to measure it and that is one of the core aspects of OR. Thus, to me, the BSC is a natural development from OR or even a part of OR.

Different development of the course would have been possible and perhaps *Performance management* would be a more suitable title. The paper by Smith and Goddard (2002), might be of interest in this matter.

5. Discussion

Grossman (2001) says, "Why has management science declined so precipitously? Why have courses of long standing suddenly become threatened with reduction or elimination? The answer is simple: there is a large gap between what is taught in the traditional business school management science course and the requirements of MBA programs and MBA students." This is, I believe, a fair description of too many courses in the past. This has, though, been changing very fast in the last few years as many papers in this journal (*INFORMS Transactions on Education*), *Interfaces* and *OR/MS Today* tell us, see e.g. Liberatore and Nydick (1999), Powell (2001) and Robinson et al. (2003).

How OR/MS courses are included in the various MBA programs must differ for a number of reasons. Among influencing factors are the objectives of the program, the students, what is taught in other courses, the views

and experience of the faculty and the job market for the MBAs. Also, the courses need to change with changing times. Therefore, it is difficult to come to some general and lasting conclusion.

It is possible and necessary to learn from each other about good ways to include OR/MS in MBA programs. A concise summary of views can be found in Horner (2003), where "a panel of recognized leaders in OR/MS education" (all from North-America!) give their top 10 reasons why management science belongs in business schools and top 10 topics or skills that should be taught in an introductory MS/OR-oriented course for business students.

It is hardly reasonable to teach much about mathematical models/formulas or algorithms in compulsory MBA courses, since few students see this as helpful for managers. Since this subject was an essential part of many OR courses in MBA programs, the decline of business school management science courses may have been a natural and good development. One of the main reasons for the decline was that in 1991 the business school accreditation organization AACSB revised its standards, removing OR/MS from its protected position as part of the MBA common body of knowledge. This has now changed for the better, since the new (2003) AACSB MBA guidelines require the coverage of "statistical data analysis and management science", see e.g. two papers by Grossman (2003).

The emphasis on the needs of the students has always been the driving force when I have been preparing courses. An example of this, which others might see as relevant for them, is how the elective *Operations management II* was structured. In each week the theme was one type of manager's job, even though the subject was mainly Excel-models. This forces the teacher to choose models and examples that he or she can link to the job of that type of manager and it makes it easier for students to see the relevance of the models. It is, though, intrinsically difficult to know what the students' needs are and I am usually uncertain of that (as are the students).

It is more difficult to define the content of an OR/MS course in an MBA program than of most other courses, mainly because it is not one of the functions in companies, unlike e.g. marketing and finance. OR/MS has links to most of the other subjects and the nature of the links varies. The OR/MS course often serves as a

preparation for courses in other subjects, especially the statistics part. Other types of relations are also common and overlapping can be an issue. This makes it more complicated to define the first course in OR/MS than in most other subjects.

There is a lack of good teaching materials to use in OR/MS courses in MBA programs, especially there is a lack of good textbooks. This situation is gradually but slowly changing for the better, e.g. as a result of INFORMS' commitment. The lack of good teaching materials is partly because it is extremely difficult to write such a book. What teachers want to do in their courses varies greatly and some of the good teaching material is only suitable for few, like the Excel-focused textbooks and OR/MS cases.

The compulsory course on OR/MS in the MBA program presented in this paper had substantial element of soft-OR or problem structuring methods. This is, one might say, emphasizing model formulation to the extreme where the models usually have few and simple mathematical formulas (e.g. AHP, multiple regression or Excel models) or no mathematical formula at all (e.g. cognitive maps or discrete event simulation). This approach will certainly not fit in all MBA programs but perhaps it might be worthwhile for some teachers to take some steps in this direction. Probably, the inclusion of problem structuring methods in MBA programs is and will be more common in Europe than in USA because of the different OR/MS culture.

A related question, and perhaps an important one, is: Is OR/MS more or less the same as "quantitative methods"? Obviously, my answer is NO. On the other hand, it seems that in USA the typical answer would be YES. For example, in a survey in 1994 (see Anonymous, 1997) a subcommittee of the INFORMS Business School Education Task Force asked MBA program administrators questions like "How does your school view the needs for 'quantitative competence' in its graduates?" as if it were a question about OR/MS.

One interesting possibility is to place emphasis on strategy in an OR/MS course, as was done here in the form of the Balanced Scorecard, but has been done in many different ways by others.

The only sure thing about the inclusion of OR/MS in MBA programs is that it will continue to change. This paper reports on the inclusion of OR/MS in a specific

MBA program that is probably smaller in scale than most MBA programs. Still, this experience might be of some relevance to others.

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Appendix

Appendix A - The undergraduate OR course in 1992

The following is the description of the course as it was in the spring semester 1992. The course Operations research is a compulsory course in the third year in a four-year program (between B.Sc. and M.Sc. degree) in business administration. Each year students take 10 courses. Before the OR course, they have taken two courses in statistics and two in operations management.

The textbook used was by Winston (1991) and that book was the basis for 11 of the 13 weeks. The last two weeks were devoted to problem structuring methods (The year 1993 was the first time the students had to draw a cognitive map in the examination). Following is the curriculum and the main messages to the students.

Ch. 1. Introduction to OR. Students should read the whole chapter.

Ch. 3. Introduction to linear programming. This is the most important chapter of the book. The chapter is about modeling.

Ch. 4. The simplex algorithm. Students need only read 4.1, 4.2 and 4.12, in order to understand the principles of the method but not the technical details.

Ch. 5. Sensitivity analysis: An applied approach. They don't have to read ch. 6 Sensitivity analysis and duality.

Ch. 7. Transportation, assignment, and transshipment problems. Read 7.1 well and parts of 7.2, 7.5 and 7.6.

Ch. 8. Network problems. Read parts of the chapter.

Ch. 9. Integer programming. Read 9.1 (Introduction to IP) and 9.2 (Formulating IP problems).

Ch. 20. Deterministic dynamic programming. Read parts of the chapter.

Ch. 22. Queuing theory. Read parts of the chapter.

Appendix B - Mixing "soft" OR and quantitative methods (statistics).

One of the assignments in the course Analyzing Issues and Decision Making was a group project where students tackled some complicated issue. The instructor presented a list of issues that are likely to lend themselves to soft OR and quantitative methods, especially descriptive statistics. Each group of six students then chose one issue and worked on it for several weeks. One of the issues, "Suggestions for the government in the fight against drug use", will be used here as an example, but two groups chose that issue.

In the course, an unusual version of "the OR process" is given, one that the author finds common to soft and hard OR and is in the spirit of the Strategic Choice Approach (Friend & Hickling, 1987). The author has used this version of the OR process in OR courses since 1996. Let's now look closer at the process. Each step is described, followed by some general comments on the inclusion of OR in the steps based on my experience, and finally there are some comments about the issue that is used here as an example.

Stage 1: Shaping the problem.

This can include describing the problem, deciding how to approach the problem and refocusing by first expanding the problem and then restricting it again.

General comments: Often the "real problem" is not what people think at first glance. Sometimes the focus is too narrow or too broad. Sometimes people are not talking about the same thing, even though they use the same words.

This issue: What drugs will we study? Should we include alcohol? Shall we focus on laws, police activity or social work? Can we write down a short description of the problem? One group focused on laws but the other on local police and social aspects.

Stage 2: Formulation of the problem.

This can include defining appropriate goals, defining options or alternatives and describing main concepts and relationships.

General comments: Goals should be as clear as needed. Sometimes the use of a system of goals is appropriate, e.g. as in MCDM or in strategy maps. Clear definition of key concepts is needed. Relationships might e.g. be found with regression analysis or Porter's five forces and described with a function or a cognitive map.

This issue: Is minimizing the use of drugs the main objective? Is the main objective to minimize the problems that are a result of drug use? Is freedom of the individual a relevant objective? What can be done - What are the alternatives? Are there some relevant and reliable numbers available?

Stage 3: Evaluating alternatives.

This can include directly estimating results of alternatives or comparing alternatives.

General comments: Here we might use optimization, simulation or statistical methods. We might also use AHP or other multi-criteria method. We might use cognitive maps, influence diagrams or systems dynamics. We might use some financial model and much else.

This issue: Both student groups found a lot of data and spent time discussing them and analyzing. A very small portion of the data turned out to be useful. Most of the evaluation can be described as verbal arguments. One of the groups worked hard and used some statistical analysis to show that harder sentences for possessing a small amount of drugs did not result in less use of drugs.

Stage 4: Making and implementing the decision.

Variety is what characterizes this stage. Good presentation of solutions or suggestions can be an element here.

General comments: When working on stage 1, think of this stage. Usually students don't get to this stage. Often, in my OR and other courses, the basis of projects is that the students are to make a suggestion to some real person or persons.

This issue: Here it was not a question of direct implementation, but the students were supposed to formulate, describe and substantiate some suggestions for the government.