PERIODICA POLYTECHNICA SER. SOC. MAN. SCI. VOL. 8, NO. 1, PP. 67–76 (2000)

IMPROVEMENT OF THE STUDENTS' MANAGEMENT SKILLS BY TEACHING OPERATION RESEARCH BASED MODELS AND METHODS IN THE TECHNICAL TEACHERS' TRAINING

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Received: May 20, 2000

Abstract

There is a new principle in the economic and technical theory nowadays. All of the processes seem as elements of more complex processes, all of the systems are subsystems of more completed systems. Every element of processes and systems has own relation with others. This type of approach is called logistics.

From logistical point of view every process has its own managing part. It has specific tasks:

1. to receive information by the exploited parts of the system and from the other elements of the environment;
2. to store information related to the normal exploitation;
3. to analyse information;
4. to prepare decision making process;
5. to select from the possibilities of interventions;
6. to intervene in the exploitation of the process.

For the successful performance of these tasks the managing part-system uses positive and/or negative feedback, automatic receivers, data-storage and special methods of process management. These special methods are built on operation research models.

Everyone, who leads very important processes, needs to have correct mathematical procedures to select the optimal decisions.

The teacher is one of them, who leads the most important processes: education of our children, who are the most expansive ones of the world. This is why he or she has to be aware of the possibilities of the best optimizing tools.

The technical trainer is the only among the educators in Hungary, who can be prepared for these tasks during his technical-professional training.

Keywords: technical teachers' training, technical trainer, curricula of logistical training, management oriented teachers' training.

1. Characters of Development of the Technical Trainers' Training in the Transport Job Family

This type of teachers in Hungary starts his studies of teaching after the secondary vocational school. So the learning material is based on graduation of secondary level general and vocational knowledge.

Tasks of the high level vocational teachers' training can be divided into two groups depending on the characteristic teachers' skills. The first one is the educational area of the training. It contains subjects of psychology, education, history of education, educational systems, methodology etc. The second one of this training is the vocational and professional area. Its task is the improvement of students' technical knowledge for the successful teacher-engineer dialogue and ability to follow the results of technical development. Although the subjects are almost similar in the first one for everyone, subjects in the second one are depending on the previous technical studies.

This is the reason for that our department has formed job families of individual professions in its training for technical trainers' education.

For the last decades – in synch with 'The Youth Vocational Training Programme and Educational Documents' of World Bank Project for the Human Resources Development – training has based on the most popular professions and job families such as:

- mechanics;
- transportation (car industry);
- chemistry and
- light industry.

Until the last years the transport-oriented training took part in two places of the country. Teachers working on the fields of train service and managing transport were trained by the Pedagogical Department of the Széchenyi István Transport and Technical College in Győr, and in the field of automotive industry there was a strong engineering based education with the involvement of the Car Department of our University.

The socio-economic changes of the last ten years in Hungary have transformed the structure of the economic system and the demand for the vocational supply. As a result of this change new professions have appeared at our students' qualifications. Nowadays, the most popular professions are based on information technology, automatics, computer technics and industrial or transport management.

As the result of these changes composition and number of the students at our department have changed. There is an increasing number of people having management oriented professions like transport exploitation, and a decreasing number of students having traditional professions like automotive or mechanical jobs.

For example at the beginning of this process the number of students' group for transport oriented job family was 20–25 in a year only by studying car service curriculum. Nowadays, it has two sub-groups: one of them has its own traditional car industrial subjects including 10–15 students, the other one has a new essential content with chapters about transport economy, transport exploitation, management and logistics with participation of 45–50 students in a year.

It is interesting, that these students were different from the others. Although they finished secondary school and after it many of them studied in high level professional schools at the State Railway Academy, against this fact they achieved

bad results in their traditional studies in car industry. They had not relationship with mechanical subjects in their earlier studies, so they could not achieve better results in mechanics based subjects. The whole training is characterised by this ambivalent nature: they achieved better results than the others in pedagogical and psychological subjects, but in the professional studies they had worse marks than the average.

To solve this problem the Department of Technical Education had executed a project for making a new own curriculum for the professional training of transport oriented trainers.

Tasks of this work had the following methodical and pedagogical parameters:

- the curriculum must have its own aspects, which makes it different from the curricula of other jobs and job families in the teachers' training;
- the subjects should not be attached to any fields of transport, it results that the new curriculum will not disintegrate in the future to car, railway and/or materials handling transport curricula;
- the subjects should include interesting chapters for those students, who came from different areas of transport education;
- the curriculum should include professional novelties for those, too, who were graduated as highly qualified students;
- the chapters of the subjects must give an outlook from the area of transport and the knowledge of this curriculum must be able to adapt for other fields as well, such as industry, economy or education;
- the subjects of professional studies must give a basis for the methodological studies of teachers' training;
- the chapters of the curriculum must be united, closed and able to be completed in the future;
- the curriculum must contain more mathematical chapters than the other curricula, to make sure that the application of the methods of computer aided engineering is demonstrated.

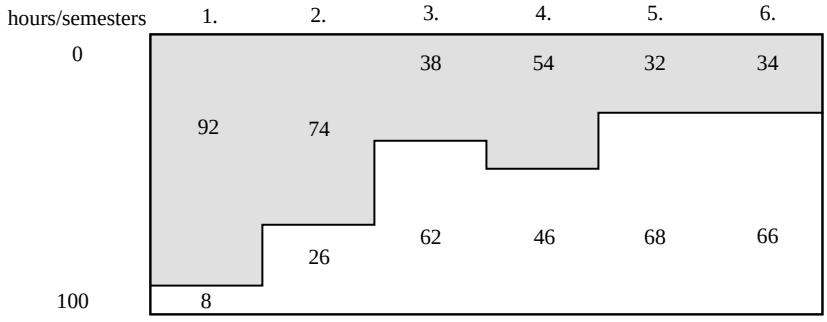
To meet these requirements the staff of our department established the new curriculum based on logistics. The essence of this scientific area is interdisciplinarity, so the professional horizon of students grows continuously parallel with their studies. During the training they will be able to look out of their profession more and more. In their projects they solve problems and questions not only from transport theory and practice, but from industry, economy, commerce, sociology and pedagogy as well, even politics.

2. Technical and Economical Training of Technical Trainers at the Transport Job Family

Teachers' training at this level of education contains 6 semesters. The education takes place every semester in two fields. The first part of the training contains mainly

professional subjects, but the number and duration of the educational subjects grows as follows:

In the professional part of training each of the students studies the same knowledge of the next subjects:



- Computer programming 12 hours
- Economics 16 hours
- Informatics 12 hours
- Mathematics 56 hours
- Physics 40 hours
- Prevention of accidents 8 hours
- Professional-technical fundamentals 32 hours
- Protection of the environment 8 hours

There is a possibility for teaching special professional knowledge only in the following job family based subjects:

Subject/semester	1.	2.	3.	4.	5.	6.
Professional knowledge I.	16	16				
Professional knowledge II.			20	20	12	
Professional knowledge III.				20	20	12

In the traditional fields of professional training there are traditional subjects of given profession. In the first part of studies the curriculum gives the basic skills of a given profession. After it the students can survey the required general knowledge of their job, and in the last period they can study special up-to-date problems of their profession. For example the training for teachers in car industry contains the next chapters:

Professional knowledge I:

- metallurgy;
- testing of materials;

- measurement technology;
- statistics of measurement.

Professional knowledge II:

- theory of mechanical planning;
- static-style machine parts;
- dynamic-style machine parts;
- driving gears.

Professional knowledge III:

- parts of cars;
- exploitation of cars;
- car-service technologies;
- diagnostic methods in car industry.

Planning the new curriculum of management oriented transport job family our department had possibility to take new special chapters into the education only at this part of the training. The new subjects have the transport and the management oriented chapters in mixed form for showing to the students the mixed character of logistics based transport engineering. The structure of this curriculum is built differently from the former ones. The first part of the studies gives basic information about technical and economical processes, in the second phase those problems can be studied, which are out of logistical systems, but have important relationships with them. The last part of training has special chapters about the logistical problems in the field of transport, warehousing or manufacturing.

This structure of curriculum gives a new chance for students to improve their high level skills not only in the area of technical sciences, but in other fields of logistics or management as well. This is the most important thing in the new version of our education and this is the reason for the phenomenon, that this training is more popular than the other job families.

3. General Characteristics of the Professional Module in Transport Job Family

The new subjects are built on students' earlier studies in the field of transport and their studies in high level mathematics and economics.

In the first part of the training (in subject Professional knowledge I) students are engaged in the bases of their profession. This is characterised by a novel professional approach which is called system oriented technical view point. During

this part of the education students specialise on various general themes of industrial organisation, production and operations management. The most significant chapters of this subject are:

- Characteristic features of system engineering;
- Methods for the research of parameters of exploitation in producing and servicing processes;
- Time and capacity norms;
- Research of capacity resources in system exploitation;
- Basic general elements of measurement technology;
- Methods for measuring and qualifying of packages and freights;
- Measuring methods for research of traffic systems.

The second part of the education (in subject Professional knowledge II) contains themes which are at first sight far from transport engineering. Traditionally they used to be part of the economics' studies, but we think they are definitely required for an up-to-date educated transport specialist for his logistics oriented work. Students make studies here about the following problems:

- Cost analysis and financial measures;
- Cost elements of logistic systems;
- Planning of investments;
- Theory of production systems' organisation;
- General planning and guiding methods of systems;
- Control of non-physical work;
- Technics of storing in production;
- Marketing and marketing logistics.

The third part is the last one of the educational process, so it finishes the training. As the top of the professional knowledge it demonstrates different kinds of mathematics oriented planning methods, automated production processes as up to date result of industrial logistics, and the most important principles, realisations and developmental fields. This subject includes the following significant chapters:

- Mathematical algorithms of operation research in the transport exploitation;
- Production and operation management;
- Logistical systems in production and distribution;
- Basic information about city, recycling and military logistics;
- Basic characters and methods of transport systems' development.

To achieve a higher quality of training and more competitive skills of our students among the other job families we realise a very strong mathematics based curriculum.

As most of the students in engineering or technical teaching, members of these groups will also attain the basic chapters of high level mathematics as theory of functions, calculation of differential coefficients and functions or integral calculus. It takes three semesters, which is not enough for further mathematical

studies, therefore the education of applied mathematics in transport engineering and management continues in the professional subjects.

Almost every subject of this training contains mathematical or mathematics oriented chapters in mixed form with the non-mathematical elements of learning material. They are shown not only as tools of engineer's planning work, but our students can work in other fields of technical or economical life with them. This part of training contains the following chapters:

- Calculation of time norms in the case of having more products;
- Rules for finding averages and standard deviations of data base;
- Determination of confidency intervals;
- Definition of the required number of the measures;
- Methods of ranking investments;
- Accounting of likelihood for a system exploitation;
- Elements of waiting line theory;
- Statistical accounts to determine correlations between parameters;
- Algorithms to determine efficiency of complex systems;
- Methods of network planning;
- ABC analysis for optimising stored products;
- Linear regression;
- Transportation method;
- Assignment method;
- Algorithm to determine optimal stuff organisation;
- Travelling salesman's problem;
- Methods for optimal layout planning;
- Methods for locating facilities.

As a result of our planned mathematics oriented education, by the end of the training our students will be able to solve problems not only in their own job family, but also in sociology, in household economy, and what is the most important, during their teaching experiences.

This structure of curriculum gives also a possibility for a new, own version of pedagogical side in the teachers' training. It has a new subject 'Methodology' with reformed content based on logistical material, which helps every student in the unified learning. With introducing the new curriculum the base school of the job family was changed as well: earlier our students could do their educational practice in a car-service based school, but at this time they are doing this work in a logistics-oriented shipping school.

The new version of the professional training makes it possible to increase efficiency of the pedagogical and psychological studies: students' knowledge in other forms of management can help in their work at the school, too.

This is the only group of students for teachers in Hungary, which can achieve many chapters of applying pedagogy in their base studies. Others can study these problems only in facultative subjects (like 'Research and development in education') or in postgraduate studies (like 'Management in education').

This unique quality of the training raises a new problem during the work of the department. The training's target is to make new generations for the staffs of vocational schools. Other traditional training forms of vocational teachers do not want to compete with engineering colleges and universities in their content, level, target and methods. But this new kind of transport job family training has become a centre of Hungarian training system for logistics. More than 10% of logistics oriented students in the country are learning at this (not for engineers organised!) training. The significant reasons for it are the level, duration, financial conditions.

As the result of these reasons our students can look for a job not only in secondary vocational schools for a teacher's salary. Some (and more and more!) of our former students make their career at small or great enterprises, multinational companies as middle or high level managers. This is not thanks only to our training, but our students' personal abilities, previous studies and pedagogical-psychological education, too, but unfortunately these colleagues are lost for the vocational education.

4. Introduction and Consequences of the Changes in the Professional Training of Transport Job Family

The new reformed version of transport (exploitation) training has not been introduced at a moment. It was a result of a few years work started in 1993. As a first step our department made a slight correction in the training in consequence of the change of students' number and composition. That time we had in the first year of the training 80 students in a year. They were classified in the following job families:

- Mechanics 20 students
- Transport (car industry) 20 students
- Chemistry 15 students
- Light industry 10 students
- Transport (exploitation) 5 students
- Other (electronics, architecture etc.) 10 students

For transport (exploitation) job family a little reform was made. In the transport job family these students had the same courses as the other transport oriented students, but at the end of training they got a special subject called 'Introduction to logistics'. As the result of this reform a number of high and middle level educated (mainly from vocational jobs in the railway exploitation) applicants to training has increased. Due to the fact that they had higher qualification than the other candidates, they could get into the courses more easily than the others. So the mixture of students has changed. In 1996 it was the following:

- Mechanics 10 students
- Transport (car industry) 15 students
- Chemistry 10 students
- Light industry 10 students
- Transport (exploitation) 20 students
- Other 15 students

Since this year the number of exploitation oriented students has been increased to a level which requires an independent students' group. At this moment the management of the department had to make decision about its own curriculum of this job family. There were two alternatives to make a specialised railway based program or a generalised logistics based one. The second version was chosen because it can be more up-to-date, more interesting for students from other fields of transport (car exploitation, airlines or shipping) as well, and also for other job families (in this year the number of this kind of students was more than earlier and their distribution was changed: informatics, trade, industrial management).

After the introduction of the new curriculum further changes were in the number and mixture of students. In 1999 we had 120 students in a year in the first semester. Their distribution is the following:

- Mechanics 5 students
- Transport (car industry) 25 students
- Chemistry 10 students
- Light industry 20 students
- Transport (exploitation) 40 students
- Other 20 students

Since this year the number of the students of exploitation oriented professions has been increased dramatically, therefore we had to organise two groups together with the 'Other' (it means mainly informatics or management oriented professions) job family with similar curriculum.

5. Consequences of Teaching Management Oriented Topics in the Teachers' Training Curriculum

There are a few positive consequences of our new curriculum in the preparation of the students for teacher's work.

First of all the more competent knowledge of the students in solving teacher's problems must be mentioned like the planning of curriculum, being able to make decision and being aware of the choosing the best one from possibilities, seeing the consequences of the decision. We have a firm conviction that having management knowledge and skills a teacher can do his or her all days work better, than without them.

The second one is that there is an increasing demand of teachers, who can teach subjects and knowledge in the area of enterprise, management or economics in the middle level technical schools, like transport teaching institutions.

The third thing is that in every year we have a few students who want to continue his or her career not in the educational, but in the technical area. They can get such knowledge in the management skills, that they can build their career in a middle level manager job at an industrial company, too.

Similarly to the previous one the forth consequence is the possibility of the continuation of educational studies at a postgraduate level. More and more student can continue the studies in the postgraduate course of Educational Management, organised by our department. There are some parts in its subjects, which are already not new for our former students, so they can take those examinations easier than the other students.

The fifth consequence is the students' ability of this management oriented education for teaching not only in the field of transport, but also in the field of manufacturing, shipping and trading systems.

In result of this a new training system called General and Information Management was established by our department in 1999. In this training the technical part of the curriculum can provide management and information knowledge and skills independently from the professional area. Therefore in this course the professional base of the students is not important, everyone can learn these subjects.

If it will be successful, then it can be the next form of the technical teachers' training in Hungary, thanks partly to its reformed transport job family training part.

References

[1] CHASE, R. B. – AQUILANO, N. J.: *Production and Operation Management*, Homewood Illinois, 1985.
[2] SMEKHOV, A. A.: *Logistika*, Moscow, 1990.
[3] FELFÖLDI, L.: *Anyagmozgatásai folyamatok tervezése*, Budapest, 1983.