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Synergy of teaching and research activities

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ABSTRACT

When considering the output quality of university graduates, it is important that universities themselves are able to generate a new quality of knowledge through research, stimulated by their teaching staff. This new knowledge can then help the graduates develop their understanding and provide a platform for their future careers. A secondary yet significant contribution to student education is a systematic effort to understand the natural field of study in a broader context, which is a crucial factor for the effectiveness of their own creative work. The educator, whose role is to encourage students to give a critical opinion of the submitted facts, can sometimes be unpleasantly surprised. There is invariably a small group of students who confuse a critical position with an unprincipled position. It is this dichotomy that forces educators and students to cooperate and more than outweighs the problems associated with this integration. From the practical viewpoint, innovative, previously unconsidered areas are more difficult to respond to during lectures as they interrupt the planned flow of the lecture; a teacher is only able to cover a smaller portion of the planned subject matter, however the teacher and students together are able to create new knowledge by spontaneous brainstorming on the germ of a novel idea during their studies. Thus both parties are able to mutually improve their knowledge and skills capital, and both groups become more like partners than rivals. By means of this partnership they are able to create the output value of the university which carries the attribute "Synergy" through a time-concurrent optimisation of science and education.

This paper focuses on identifying the concept which encourages the synergistic effect of interaction between teaching and research activities. The methodology is based on the findings, analysis of documents and primary sources of expertise. The research is based on the methodology of linear programming.

KEY WORDS

Research activities, educational activities, synergy, linear programming

Introduction

According to Knight (2004), university education is influenced by social, cultural, economic, and academic drivers. Some commentators have highlighted the exposure of the education sector to market forces as a primary driver (Matthews, 2002; Marginson, 2003). Marginson (2003) also suggests that the profit motive often dominates cross-cultural teaching and learning objectives, cynically noting that the cultural diversity of students is respected up to and including the point at which they hand over their money. After that they have to take what

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they are given. By way of contrast, Bolton (2010) has suggested that transnational higher education partnerships provide an opportunity to identify and capture the value of genuine cross-cultural and relevant global business education from the perspectives of both internal, and external students or stakeholders. This objective is consistent with advice from quality accreditation agencies that university educators adjust their educational goals to meet stakeholder needs (Klimoski, 2007).

Collaborative partnerships offer the opportunity to build unique forms of joint social capital that supports better understanding of stakeholder interests and related value propositions. Amabile (1996) makes a pertinent observation as to why this might be a key benefit of partnership. Her analysis concerns the importance of understanding students (or stakeholders) perceptions of value in cultural contexts, particularly those of service users. She argues that specialised knowledge is required by the user of a service to assess its novelty and appropriateness as a proxy of value, together with an understanding of the meaning of the service in a specific context. This suggests that universities, in developing high-value transnational higher education offerings, will need to understand the relative knowledge of stakeholders, particularly potential users, and the context in which their evaluations take place. This approach requires a unique partner capability in stakeholder management or what might be described as a unique form of social capital.

Material and Methods

The current generation of young people, preparing for their productive professional life, historically considers their educational experience as their happiest period. If the current high school student decides to continue to increase his/her intellectual capital through further education, there are opportunities beyond the imagination of college students that were admitted to universities 15 or even 25 years ago. It is influenced by the increase in the number of study programs accompanied by a greater diversity of specialisations provided by universities and state colleges, which in the second stage of universities transformation has contributed to the higher number of universities.

Another factor is the rapid increase in the number of private schools, colleges and institutes which have gained accreditation to provide a "fully fledged" university education quite quickly, and have recently introduced postgraduate studies into their portfolios. In terms of convenience for students, during the change-over process to higher education, that situation is obviously positive. From the perspective of traditional Central European universities, which for many years based their long-term strategies for future development on the excess between the requirement for education and the capacity of universities forming higher education, there is a fundamental change in terms of the impact on the creation of their future strategies. Therefore, traditional universities did not experience this situation. Universities have to compete for state aid for research, and need to obtain a sufficient number of students with appropriate prerequisites to manage the demanding programmes of studies provided by universities.

Because operating conditions have changed, universities need to maintain their influence on the level of knowledge of the potential population of their country, and to react by modifying their long term strategies. Because their future existence is mainly affected by the demands of the market (in addition to the requirements of the EU directorates and conditions defined by the Ministry of Education), a methodological apparatus, originally created for business, is only an illusory idea. It can be expressed as the pressure to increase efficiency in the effective transfer of knowledge (teaching students), and in their own scientific activities.

For the purposes of mathematical formalisation of these ideas on time distribution among individual activities, a standard linear programming model is used. The model finds the maximum of the linear objective function *z*, subject to linear constraints and non-negativity constraints. Formally, the model is defined as follows (Jensen and Bard, 2003):

$$\max\left\{z(\mathbf{x})\middle|\ \sum_{j=1}^{n} a_{ij}x_j \le b_i,\ i=1,\ 2,\ ...,\ m;\ \ x_j \ge 0,\ j=1,\ 2,...,n\right\}$$

The simplex algorithm is used as a calculation method (Jensen and Bard, 2003).

Results and Discussion

The application part of the paper is illustrated by using linear programming (LP). This LP could be used for the planning of working activities of three academic lecturers who are simultaneously working on two types of tasks:

- either they work on their teaching processes,

- or they work in scientific research.

We suppose that the value of the contract for one taught subject is CZK 150,000. However, these three academic workers are involved in the value of $^2/_3$ of each subject, which they are participating on. Thus, we calculate CZK 100,000 as the net income per one subject.

The value of a published paper is CZK 60,000 measured by the income from the Ministry of Education of the Czech Republic to the university (according to the methodology of the scientific results application).

Furthermore, when considering time distribution of the staff during one semester, i.e. 3 months. The total capacity of working time available is 480 hours per worker (3 months, 20 working days per month, 8 hours per working day).

The challenge is to design the load time for each of the three academic staff so that in the next semester they can contribute to the maximum output value of their teaching and research activities. We acknowledge the differences in the involvement of individual kinds of workers into scientific or teaching activities, see table 1.

Number of hours per one output	One published paper	Teaching in one course	Total capacity
Course supervisor (G)	60	25	480
Grant Researcher (N)	55	48	480
PhD student-teacher (D)	40	75	480

Table 1: Time requirements for each academic staff member for one output

There are two additional considerations. During the semester, the group of workers should be involved in at least one course and produce at least three scientific papers.

Based on the above-mentioned conditions, the linear programming model can be formalised as follows:

Decision variables

x_1 … scientific papers (number scientific papers produced)

x_2 … educational courses (number of courses taught)

Constraints

$60x_1 + 25x_2 \leq 480$ (hours of G, slack variable d_1)

$55x_1 + 48x_2 \leq 480$ (hours of N, slack variable d_2)

$40x_1 + 75x_2 \leq 480$ (hours of D, slack variable d_3)

$x_1 \geq 3$ (papers, slack variable d_4)

$x_2 \geq 1$ (courses, slack variable d_5)

Objective function

$z = 100x_1 + 60x_2$ … MAX (1,000 CZK)

Non-negativity constraints

$x_1 \geq 0, x_2 \geq 0$

Using the simplex algorithm, we obtain the following initial and final simplex tables:

		100	60	0	0	0	0	0	-1000	-1000	
		x1	x2	d1	d2	d3	d4	d5	p4	p5	b
0	d1	60	25	1							480
0	d2	55	48		1						480
0	d3	40	75			1					480
-1000	p4	1	0				-1		1		3
-1000	p5	0	1					-1		1	1
zj - cj		-1100	-1060	0	0	0	1000	1000	0	0	-4000
0	d4	0	0	0,032	-0,02	0	1	0	-1	0	4,336
0	d5	0	0	-0,04	0,04	0	0	1	0	-1	0,595
0	d3	0	0	1,465	-2,33	1	0	0	0	0	66,98
100	x1	1	0	0,032	-0,02	0	0	0	0	0	7,336
60	x2	0	1	-0,04	0,04	0	0	0	0	0	1,595
zj - cj		0	0	0,997	0,731	0	0	0	1000	1000	829,2

Table 2: Solution of the model by the simplex algorithm

Based the definition of the model, we can simply interpret the optimal solution. The group of workers can submit 7 scientific papers into conferences or journals, the eight paper is in progress (about 30% is done). The workers also provide the teaching for one course regularly, and they can participate in another course about 60% of the necessary performance. The course supervisor and grant researcher have all their time capacity scheduled; the PhD. student has slack time of about 67 hours.

The total income for the university is about 829,200 CZK. Of course, the course supervisor or the grant researcher can accept additional work (overtime). In this case, one overtime hour of the course supervisor increases the total income by about 997 CZK (or 731 CZK in the case of the grant researcher). Limited by the labour law, it is a managerial decision, whether the additional income is greater than additional labour costs, or not.

The illustrative example deals with optimising the distribution of working time between tasks in the educational and scientific activities. In the following time period the procedure would

be comparable; there will only be changes in the restrictive conditions (e.g. due to changes in capacity, due to vacation time, etc.).

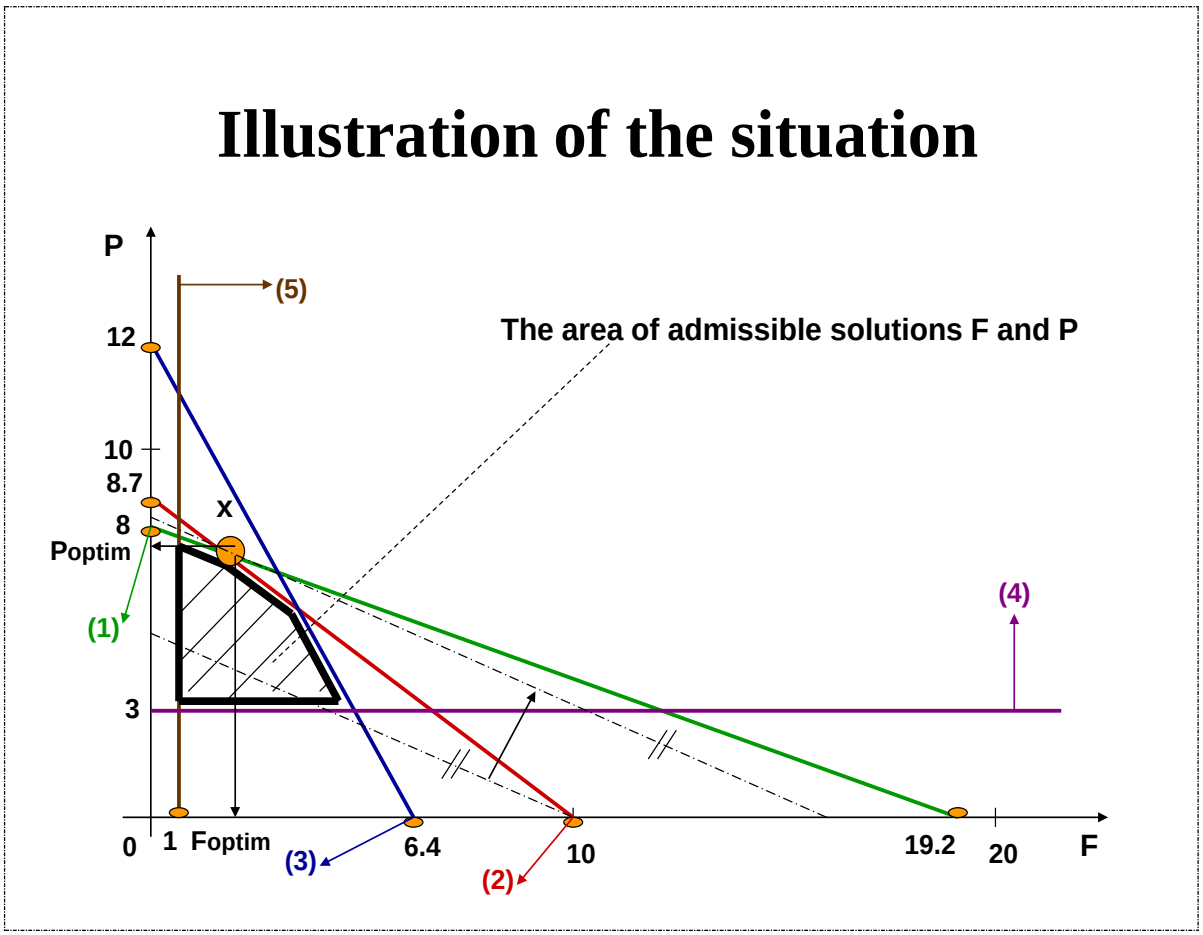

Figure 1: Graphic design of suboptimal solutions

The main purpose of the paper was to show the possibilities (and limitations) of the conventional method of managing teachers' time at a university. Linear programming is used only for showing the conventional way; the work schedule cannot lead to the creation of competitive advantage (in this case by using linear programming). **Competitive advantage is based on the principle of synergy and is associated with the parallel implementation of scientific and educational activities** (e.g. when we are doing science in the classroom). Integer linear programming was not used, because we assumed that small working tasks could be planned to share some unfinished results of the tasks (e.g. a teacher can share 60% of a teaching subject with someone else). The contribution of the application of LP is only used as an example of the limitations of the conventional approach.

Conclusion

In terms of the output quality of university graduates it is very useful when universities themselves generate a new quality of knowledge (through research, their teaching staff). This new knowledge can then take the graduates forward and develop their level of knowledge in an appropriate follow-up period. A secondary (but not minor) contribution to student education is a systematic effort to understand the natural field of study in a broader context, which is a crucial factor for the effectiveness of their own creative work. The educator, who

himself educates students to give a critical opinion of the submitted facts, can sometimes be unpleasantly surprised.

There is almost always a small group of students who confuse a critical position with an unprincipled position. Nevertheless, the effect that brings educators into cooperation with students (including pedagogy and science) more than outweighs the problems that are associated with this integration. New (unconsidered) areas are more difficult in lectures as they reduce the power in the flow of information – a teacher is able to teach a smaller range of the subject matter but he/she and also the students create new knowledge to tune the pilot concept of the foreground as the spontaneous brainstorming during their education. This leads to the mutual improvement of knowledge and skills capital with students and teachers. Both groups are becoming more partners than rivals and through this partnership can create the output value of the university which carries the attribute Synergy thanks to a time concurrent optimization of science and education.

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