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CONTENT AND LANGUAGE INTEGRATED CASE-ANALYSES ON IMPROVING THE QUALITY OF LIFE

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Abstract

The article investigates how the changes in the quality of life can be studied through content and language integrated case-analyses. Interaction between a lecturer in a particular university discipline and a foreign language instructor (English in most cases) when they study socio-economic foundations of sustainable livelihoods is in the focus of the authors' research. The object of the study is the suitability of Content and Language Integrated Learning (CLIL) technology, the essence of which lies in understanding that while learners are studying certain subjects they are also mastering a foreign language. The subject of the research is case analyses in the course of mathematics which is made in English. The case under discussion is connected with improving the quality of life, which requires the use of mathematical tools and encourages discussion. The contents of this paper were inspired by the experience and outcomes of instruction in mathematics intended for international as well as Russian students with all the instruction carried out in English. Yet another aspect that is closely connected with cross-disciplinary approach is building professional vocabulary both in the native and English language. This is where language propaedeutics should be considered. The authors illustrate their hypothesis with the case whose analysis requires the appropriate use of vocabulary, namely, discipline-specific words and word combinations. Case analysis involves an argumentative discussion on improving the quality of life, where reasoning is based on mathematical calculations.

Keywords: Quality of life, content and language integrated learning, case-analyses.

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1. Introduction

The degree to which a country's population feels satisfied regarding its material, spiritual and social needs is of paramount importance for any nation. The notion of the standard of living pertains to both social and financial security and is used by a wide range of professionals from health care specialists to economists, from financiers to marketologists. Today's tendency to switch from teaching English to teaching the content of academic disciplines in English, the most widely used second language on the world, its lingua franca, is closely related to Content and Language Integrated Learning (CLIL). At present there exist a number of definitions for CLIL, however, the authors find Marsh's (2002) description the most precise: "a foreign language is used as a tool in the learning of a non-language subject in which both language and the subject have a joint role" (p. 214). The term Content and Language Integrated Learning will be used as the umbrella term describing how matters pertaining to improving the quality of life can be studied through the medium of English with the application of mathematical tools when mathematics is taught in English (Klimova, Karpova, & Kondrakhina, 2019). Mathematical data provide the frame within which case-analyses are carried out. The quality of life of the population is the degree of satisfying material, spiritual and social human needs. This concept is broader than financial security (standard of living) and an assessment of the human condition, and this estimate is based on one's own satisfaction of these conditions (Forbes, 2013).

2. Problem Statement

There is no denying the fact that social skills can efficiently be mastered at the lesson of a foreign language. Students also learn other skills in a foreign language educational setting, in the case under discussion the use of mathematical apparatus, linear programming, etc. The authors reflect on the ways the quality of life can be studied through content and language integrated case-analyses. One of the underlying challenges is the unavoidable interaction between a foreign language teacher (English in most cases) and a specialist in particular university disciplines pertaining to socio-economic foundations of sustainable livelihoods. The object of the study is the suitability of CLIL, the essence of which lies in understanding that while learners are studying certain subjects they are also improving their language level. The subject of the research is case analyses in the course of mathematics which is made in English. The case under discussion is connected with improving the quality of life which requires use of mathematical tools and encourages discussion.

3. Research Questions

The issues raised are, firstly, the interrelationship between the two disciplines involved and their ratio. Secondly, the approach to progress evaluation should be considered with the view to difference in holistic and competence approaches to assessment. Thirdly, researchers stand to choose which of the modern teaching technologies could be applied and to what extent. Yet another problem concerns the need for language as well as mathematical propaedutics, which are themselves a subject matter of a separate research (Dubinina, Nikolaev, & Stepanyan, 2018).

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4. Purpose of the Study

The purpose of the current research is to develop methodological approach which will help both students and educators to combine several academic disciplines. Moreover, educators cooperate in choosing the materials for case analysis and such interdisciplinary cooperation is undoubtedly efficient. It should also be born in mind that content subjects are taught in a language that is not the mother tongue of the learners (Dubinina, Stepanyan, & Ganina, 2018).

5. Research Methods

Let’s consider the case *Examination of the suburban train cancelation by JSC "Russian Railways» company* designed in order to be analysed in English in the course of mathematics via dual problem of linear programming (Kononenko & Kletanina, 2015). The case allows educators to initiate discussion of pros and contra of the decision in regard to changes in the quality of life and effect on the standard of living in the areas adjacent to the suburban train routs under discussion. Below is the extract from the case.

«JSC "Russian Railways" carries out three strategic activities: long-distance passenger transportation, suburban passenger transportation and freight transportation.

Students are to find out whether measures for reduction and cancellation of suburban trains by JSC "Russian Railways" are economically justified. As a result of case-analysis an analytical report is to be submitted, suggesting the ratio between each type of transportation, so that they could guarantee the company's optimal profit under any level of demand. Students are to use the quarterly reports of JSC "Russian Railways".

Decision.

On the basis of JSC "Russian Railways" quarterly reports (e.g. for 2014) it was revealed that most of the company's funds come from cargo transportation, and the least of it – by suburban transportation.

The analysis of the efficiency of the company is based on the apparatus of game theory, as well as on the methods of duality in linear programming.

Suppose that the company "Russian Railways" -.this is player A, and player B is demand, which in terms of profit optimization in this situation is uncertain. For player B we introduce three components:

– D1 - demand is fully satisfied for suburban transportation. spring-autumn period (summer residents actively use suburban transport);

– D2 – the demand for freight transport is fully satisfied, on long distance routes – in part (the offseason);

– D3 - the demand for freight transportation is fully satisfied and for suburban and long-distance transportation-partially, the tracks are minimally loaded (wintertime).

Data on the company's profit for 2014 are presented in the payment matrix (table 01), where a reduction factor is introduced and conditional units are used.

Table 01. Payoff matrix

A_i / B_j	D_1	D_2	D_3
Cargo transportation	6	12	16
Suburban transportation	18	8	4
Long-distance transportation	14	10	8

Optimal player strategy in game theory is a strategy that, when the game is repeated many times, provides the player with the maximum possible average win (minimum possible average loss). In the original matrix, enter additional rows and columns (table 02). The column is the bottom price of the game, or the maximum win (Maximin) of player A, and the row is the top price of the game, or the guaranteed loss of player B.

Table 02. Extended payment matrix

A_i / B_j	D_1	D_2	D_3	p_i	α
Cargo transportation	6	12	16	p_1	6
Suburban transportation	18	8	4	p_2	4
Long-distance transportation	14	10	8	p_3	8
q_j	q_1	q_2	q_3		
β	18	12	16		$\alpha = 8$ $\beta = 12$

Since $\alpha = 8, \beta = 12$, there is no saddle point. Consequently, the problem is solved in mixed player strategies $S_A = (p_1, p_2, p_3)$ и $S_B = (q_1, q_2, q_3)$, which leads to the solution of the dual linear programming problem.

If player A applies his optimal mixed strategy, and player B applies consistently his pure strategies, then the mathematical expectation of the profit that the firm can get is not less than the price of the game (i.e., the average maximum profit of player A).

Then the following system of inequalities occurs:

$$\begin{cases} 6p_1 + 18p_2 + 14p_3 \geq v, \\ 12p_1 + 8p_2 + 10p_3 \geq v, \\ 16p_1 + 4p_2 + 8p_3 \geq v, \\ p_1 + p_2 + p_3 = 1. \end{cases}$$

Let’s introduce new variables, dividing each of the inequalities by $v > 0$:

$$x_1 = \frac{p_1}{v};\ x_2 = \frac{p_2}{v};\ x_3 = \frac{p_3}{v}.$$

Since $p_1 + p_2 + p_3 = 1$, then $x_1 + x_2 + x_3 = \frac{1}{v}$. Therefore, for player A, maximizing the price of the game V is equivalent to minimizing the amount $\frac{1}{v}$:

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$$\begin{cases} 6x_1 + 18x_2 + 14x_3 \ge 1, \\ 12x_1 + 8x_2 + 10x_3 \ge 1, \\ 16x_1 + 4x_2 + 8x_3 \ge 1, \\ F(x) = x_1 + x_2 + x_3 \to \min. \end{cases}$$

Thus, the Dual Linear Programming Problem takes the following form:

Task 1. *Player A.*

$$\begin{cases} 6x_1 + 18x_2 + 14x_3 \ge 1 \\ 12x_1 + 8x_2 + 10x_3 \ge 1 \\ 16x_1 + 4x_2 + 8x_3 \ge 1 \\ Z(x) = x_1 + x_2 + x_3 \to \min \end{cases}$$

Task 2. *Player B.*

$$\begin{cases} 6y_1 + 12y_2 + 16y_3 \le 1 \\ 18y_1 + 8y_2 + 4y_3 \le 1 \\ 14x_1 + 10x_2 + 8x_3 \ge 1 \\ F(y) = y_1 + y_2 + y_3 \to \max \end{cases}$$

Now let's solve problem 2 (for maximum) by the simplex method. First, you need to bring the matrix to the canonical form by entering the balance variables y_4, y_5 and y_6, and then fill in the simplex tables (table 03-04).

Table 03. Initial simplex table

Basis	b	y_1	y_2	y_3	y_4	y_5	y_6
y_4	1	6	12	16	1	0	0
y_5	1	18	8	14	0	1	0
y_6	1	14	10	8	0	0	1
$F(y)$	0	-1	-1	-1	0	0	0

Table 04. Final version of the simplex table

Basis	b	y_1	y_2	y_3	y_4	y_5	y_6
y_5	$\frac{2}{27}$	0	0	$\frac{44}{27}$	$\frac{1}{27}$	1	$-\frac{14}{9}$
y_1	$\frac{1}{54}$	1	0	$-\frac{16}{27}$	$-\frac{6}{54}$	0	$\frac{1}{9}$
y_2	$\frac{2}{27}$	0	1	$\frac{44}{27}$	$\frac{1}{54}$	0	$-\frac{1}{18}$
$F(y)$	$\frac{5}{54}$	0	0	$\frac{1}{27}$	$\frac{1}{27}$	0	$\frac{1}{18}$

There are no negative values among the index line values in Table 04, so this table determines the optimal task plan for Player B:

$$y_1 = \frac{1}{54}, y_2 = \frac{2}{27}, y_3 = 0, \; F(Y) = \frac{1}{54} + \frac{2}{27} = \frac{5}{54}.$$

It follows from the duality theorem that $X = C \times A^{-1}$, where $A^{-1}-$ is the matrix opposite to the matrix of the components of the vectors that are part of the optimal basis. Let's make matrix A and find the opposite to it:

$$A=(A_5,A_1,A_2)=\begin{pmatrix}0 & 6 & 12\\ 1 & 18 & 8\\ 0 & 14 & 10\end{pmatrix},\qquad A^{-1}=\begin{pmatrix}\frac{17}{27} & 1 & -\frac{14}{27}\\ -\frac{5}{54} & 0 & \frac{1}{9}\\ \frac{7}{54} & 0 & -\frac{1}{18}\end{pmatrix}.$$

As we can see from this plan of the simplex table, the matrix is contained in the columns of additional variables. Next, we find

$$Y=C\times A^{-1}=(0;1;1)\cdot\begin{pmatrix}\frac{17}{27} & 1 & -\frac{14}{9}\\ -\frac{5}{54} & 0 & \frac{1}{9}\\ \frac{7}{54} & 0 & -\frac{1}{18}\end{pmatrix}=\left(\frac{1}{27};0;\frac{1}{18}\right),$$

where we get player A optimal plan and value

$$x_1=\frac{1}{27},x_2=0,x_3=\frac{1}{18};\ Z(X)=\frac{1}{27}+\frac{1}{18}=\frac{1}{54}.$$

Thus, after rounding up the results, the final optimal strategies have the form of: for player $A:(0,4;0;0,6)$, for player $B:(0,2;0,8;0)$.

Thus, the optimal percentage of "Russian Railways". implementation of each type of transport is as follows: 60% of long-distance passenger transportation, 40% of freight transportation, and no passenger transportation in suburban traffic to be carried out.

The expert examination shows that the decision to reduce and cancel the suburban trains was an economically and mathematically sound measure. As an option to optimize the profits of the "Russian Railways". Without incurring loss, it is possible to suggest carrying out suburban transportation by attaching suburban railcars to long-distance trains.

6. Findings

The given case is based on the mathematical apparatus of two sections of higher mathematics: game theory and linear programming. Game theory is an elective course at the Financial University, where the authors practised the above case-analysis; however, it was carried out with the underlying reason that elements of game theory are popular tools for managers and economists when they make effective decisions. The problems of Linear programming are considered at the end of the first year and the case can be offered to undergraduate students of financial and economic disciplines in order to illustrate the possibilities of higher mathematics in solving applied problems, including those aimed at improving the quality of life.

The findings highlighted the fact that students experience a lack of not only mathematical terminology but also need soft skill, especially when discussion is launched. Thus the authors deduce that the content of the training, when it is carried out in English, should be based on the context of the subject, the context of scientific knowledge, socio–cultural context. These are presented by case–analysis or study of specific professional situations. Educators working collaboratively should plan thematic units and lesson plans if they intend to provide a more supportive environment for students. A key to success in the authors' perception lies in careful language propaedutics for all the educational activities, where the coherent set of exercises helps student to get prepared for quazi-professional activity (e.g. case-analyses, role-playing, business games, brain-storming, etc.)

The case under discussion is saturated with widely used terminology. That is why in such format it can be used not only at the faculties where all the instruction is carried out in English, but also at the faculties where instruction is realized in Russian. In this situation the English language teachers' support is required. Furthermore, such cases offer students critical thinking tasks and can be used by senior students for further more sophisticated analyses and even decision making during disciplines of economic cycle or risk analysis. The findings revealed that content and language integrated instruction should be carried out in the quasi-professional language setting. The instruction should be based on the principles of communicativity, interdisciplinarity and problematicity.

7. Conclusion

Nowadays the emphasis on learning academic disciplines in English instead of learning a foreign language at large, without integration with any particular professional environment, is calling for new dominants and new educational technologies. To begin with, content and language integrated learning requires cross-disciplinary cooperation. Cross-disciplinary approach allows instructors to make the learning process more intense and interactive, as students are offered the accumulated knowledge of several disciplines. (Stepanyan, Dubinina, Nikolaev, Kapranova, & Pashtova, 2017). Moreover, the formation of interdisciplinary teams of educators helps to increase students' sense of membership (Rumsey, 1999). Furthermore, the need for propaedeutics concerns not only the English language component, but also the language of mathematics and some other formalized languages.

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