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ONLINE EDUCATION IN THE ESTIMATES OF RUSSIAN UNIVERSITY STUDENTS: PRIOR TO AND DURING THE PANDEMIC

[1]Natalya Leonidovna Antonova, [2]✉Sofya Borisovna Abramova, [3]Natalia Popova

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Abstract

The article discusses online learning in the context of the emergency transition of universities towards the format of remote learning occurred during the Covid-19 pandemic. The aim was to compare students' opinions concerning online learning prior to the onset and during the pandemic. The methodology was based on a standardized survey of students studying at the Ural Federal University in 2019 ($N = 150$) and 2020 ($N = 150$). The results show that students' satisfaction with online education during the pandemic decreased compared to the pre-pandemic period, which led to a decrease in the level of life satisfaction in general. The respondents mentioned the following disadvantages of online learning: a lack of direct interaction with professors, a decreased quality of education and insufficient organization of conditions for online learning.

Keywords

Covid-19, education digitization, higher education, online leaning, pandemic, undergraduate students

Introduction

The modern world has faced a global challenge: the Covid-19 pandemic is having an impact on all areas of human life, transforming daily practices and changing the activities of social institutions. The system of higher education has been forced to undergo urgent transformations in transitioning towards online learning. Responding to the situation, all subjects of the education system began to apply new technologies to move beyond conventional practices. Both professors and students had to interact remotely in the digital environment (virtual classrooms) in order to adapt quickly to the new requirements associated with the spread of the virus.

In this context, the question of implementing mass online learning has become particularly relevant (Liguori and Winkler, 2020). This process also raised the problem of education quality. All universities faced the challenge of revising the existing curricula to meet the requirements of online learning. Some researchers (Hodges et al., 2020) noted that the emergency introduction of distance learning contradicts the very idea of high-quality and effective online education, which should be introduced gradually within the framework of organized learning models. Due to the crisis caused by the coronavirus epidemic, innovations in academia and higher education, which would have normally taken several years, are now being introduced promptly, in a matter of days (Strielkowski, 2020).

Online education is conventionally understood as a process of using technological devices and the Internet for educational purposes (Means et al., 2013). Tallent-Runnels et al. (Tallent-Runnels et al., 2006) noted that online learning allows students to study at their own convenient

pace while achieving the same level of training as via traditional classes. However, Joshi et al. (Joshi et al., 2020) believe that, since online learning does not involve direct interaction, the problems of academic integrity and cyber fraud come to the forefront. Students, for example, may enter a virtual classroom without turning on their video cameras and turning off the sound, simultaneously doing household chores or communicating with friends. Some Internet users hack into virtual classes and display presentations, which may contain profanity/obscene language or indecent pictures.

Some authors estimate that online training during such crisis periods should be seen as 'emergency remote teaching' (Bozkurt and Sharma, 2020; Vlachopoulos, 2020). The authors note that, under the new conditions, the prior positive experience of online education was abandoned. It can be argued that the online format of education has failed to fulfil its inherent positive functions during the pandemic.

Since the end of the last century, universities have been actively involved in digital transformations, following new educational technologies and innovative solutions (Antonova et al, 2017). However, the degree of immersion in the digital educational space can be different. Accordingly, it is possible to distinguish "weak" and "strong" universities, whose experience of functioning during the pandemic turns out to be different.

Another factor is that both students and young professors can be referred to as digital aboriginals, i.e. those who were born and raised in the digital age (Prensky, 2001). Such people are expected to be more flexible and dynamic, open to the development of new digital technologies. However, as some researchers (Bennett et al., 2008) discovered, for a significant number of young people, the digital educational environment is still challenging, requiring specific digital skills. According to A. Ferrari (Ferrari, 2012), digital competencies are a set of knowledge and skills necessary when using information and communication technologies and digital devices to manage information, perform duties, collaborate and make decisions. T. Shariman et al (Shariman et al., 2012) argue that mastering online learning technologies requires a certain level of digital literacy. This was the reason why students and professors had to spend more time adapting to remote learning during the Covid-19 period.

Another pressing issue during the pandemic was associated with the availability of technological equipment (computers, laptops, tablets) and the quality of Internet connection. Such problems, as poor Internet access and weak computers, have created social inequalities in online learning (Dhawan, 2020).

The above analysis suggests that additional research, including comparative studies (prior to and during the pandemic), into online education as a modern practice in a digitalized society is needed. Therefore, the aim of this article is to present the results of a pilot study conducted to investigate students' experience of online learning obtained prior to the spread of Covid-19 and during the introduction of restrictions. Such a study may be helpful in revealing students' attitudes towards online learning, as well as in identifying the advantages, disadvantages and prospects of this educational format.

Materials and Methods

The study was conducted using the method of standardized survey in two stages: at the end of 2019 (N = 150, face-to-face hand-out questionnaire) and in June 2020 during the period of self-isolation caused by the spread of Covid-19 and forced transition of students and professors to distance learning (N = 150, online questionnaire). Students majoring in hard sciences (25%) and humanities and social disciplines (75%) were questioned. All the students were taking Bachelor's and Master's degree programmes at the Ural Federal University (Ekaterinburg, Russia). Due to the pilot nature of the study, the results cannot be considered fully representative

of the entire population of Russian students. However, the findings are useful in identifying trends emerging in the context of dissemination of online technologies among educational activities.

The questionnaire included 15 questions at the first stage (prior the pandemic) and 22 questions at the second stage (during the pandemic). The majority of the questions were formulated in a similar manner, which allowed us to compare the results. The average duration of completing the questionnaire was 20 minutes. The obtained information was processed using the SPSS program and frequency and cross-tabulation analysis followed by calculation of percentage and average values, as well as correlation coefficients.

Results and Discussion

Prior to the pandemic, only 15% and 37% of the surveyed students had acquired the experience of online learning in more than 5 and 1–4 courses, respectively. 48% of the respondents declared no such experience. For the period April–May 2020, 33% of the surveyed students used online technologies to study 1–4 university subjects, 47% of the students completed 5–9 disciplines, 20% of the respondents indicated 10 or more online courses.

Against the background of a sharp increase in the number of classes conducted online, 30% of the respondents expressed worsening attitude towards this format. Such a change was observed both among those having had no prior experience of distance learning before the pandemic (34%) and among those having had the experience of online education before the period of self-isolation (22%). 32% of the respondents surveyed before the pandemic were completely satisfied with the results of online learning; only 11% of the respondents surveyed during the pandemic expressed satisfaction with online learning.

The identified trends have two significant implications. First, a third of students experienced psychological discomfort when forced to use online education, which affected not only their educational results, but also their social wellbeing as a whole. Secondly, a significant core of students is being formed, who demonstrate a negative attitude towards online learning. This attitude can be a barrier to selecting online educational programmes in the future. It seems that additional efforts will be required from universities in terms of restoring a positive image of online education.

Before the pandemic, 30% of the students indicated that traditional (classroom) education was the most effective model. During the urgent transition to distance learning, this subgroup decreased to 21% due to an increase in the proportion of those ready for blended learning. At the same time, the number of those supporting online education did not change, remaining at the level of 1.5%.

It seems interesting to compare the advantages and disadvantages of online education based on the results of the undertaken empirical studies. Full immersion in remote learning led to changes in the respondents' experience and, accordingly, their value judgments.

When analysing the disadvantages of online learning, the respondents mentioned fewer behaviour-related characteristics (Table 1). Thus, the presence of distractions in learning online (social networking sites, games, etc.) was chosen as a serious disadvantage by 52% in the first survey (prior to the pandemic) and by 29% in the second survey (during the pandemic). The possibility of deception (to connect to a lecture and return to other matters, etc.) and the inability to focus on classes due to poor self-discipline, were mentioned by 8% and 16%, and by 44% and 35% of the respondents, respectively. The observed decrease in the significance of these factors can be explained by the following reasons. First, through direct experience of online learning, the students realised that the abovementioned problems could be resolved by applying conscious, focused efforts on their part. Interestingly, university administrations

in Ekaterinburg declared an increase in academic performance following the results of the pandemic examination session. Second, the significance of the mentioned disadvantages of online education diminished against the background of more pressing problems, which had been less evident previously.

A comparison of the survey results obtained prior to and during the pandemic showed that the following disadvantages of online communications came to the forefront: a lack of live communication (an increase in the number of choices by 15%), decreased quality of teaching (low efficiency of knowledge acquisition, a decrease in the volume of knowledge gained – an increase in the number of choices by 14%), a lack of feedback from professors (brevity of answers, delays in answering questions and assessing the homework - an increase in the number of choices by 13%). In addition, some respondents mentioned an increasing sense of social isolation (+ 16% relative to the first study period), a difficult learning regime and difficulties in understanding the essence of assignments (+ 14%).

Disadvantages	Poll results (at %)		Difference between Stage 1 and Stage 2*
	Stage 1 (pre-pandemic)	Stage 2 (pandemic period)	
Sense of social isolation	13	29	+16
Lack of live communication	48	63	+15
Difficult learning regime	7	21	+14
Decreased quality of teaching	33	47	+14
Lack of feedback from educators	28	41	+13
Internet access problems	20	27	+7
Inability to focus on classes due to poor self-discipline	44	35	–9
Presence of distractions	52	29	–23
Possibility of deception	48	16	–32

** Positive values demonstrate an increase in the number of selected answers at the second research stage; negative values – a decrease in the frequency of selected answers*

Table 1: Disadvantages of online education mentioned by the respondents

Significant changes were observed when assessing the positive aspects and opportunities of online learning (Table 2). The sharpest decline occurred in terms of the possibility of downloading lectures and their asynchronous study. Only 45% of the respondents during the 2nd survey stage considered this possibility as an advantage, compared to 72% before the pandemic. The use of modern technologies and the development of digital skills, attributing to the benefits of online learning, decreased by 10% (to 27%); the number of those who had mentioned the possibility of gaining relevant knowledge as an advantage decreased by 20% (to 6%); fewer people believed that online learning contributes to deepening the existing knowledge (a decrease by 21% to 1%). In addition, the possibility of implementing virtual mobility was mentioned as an advantage of online education less frequently (accessing lectures from different countries, cities, universities – a 12% decrease).

An increase in the number of students' positive assessments occurred in terms of such characteristics as more flexible forms (from 13% to 31%) and higher results (from 7% to 12%) of performance assessment. Thus, in almost all aspects related to the advantages of online education, a decrease in the number of selected answers was observed. The observed decreased satisfaction of students is obviously associated with inadequate institutional support of online education during the emergency transition. The formed unfavourable experience can become a significant obstacle to the development of a sustainable digital educational environment.

Advantages	Poll results (at %)		Difference between Stage 1 and Stage 2
	Stage 1 (pre-pandemic)	Stage 2 (pandemic period)	
More flexible forms of control	13	31	+18
Formation of independence and responsibility	44	49	+5
Higher results of performance assessment	7	12	+5
Increased motivation for achievement	6	9	+3
Ability to communicate with other students	4	6	+2
Freedom to choose the place and time of study	91	86	–5
More attractive design of educational materials and presentations	24	19	–5
Use of modern technologies and the development of digital skills	37	27	–10
Possibility of virtual mobility	37	25	–12
Possibility of gaining relevant knowledge	26	6	–20
Opportunity to gain deeper knowledge	22	1	–21
The possibility of downloading lectures and their asynchronous study	72	45	–27

** Positive values demonstrate an increase in the number of selected answers at the second research stage; negative values – a decrease in the frequency of selected answers*

Table 2: Advantages of online education mentioned by the respondents

Discussion

The urgent transition towards online learning as the main form of the educational process during the pandemic has become a serious challenge for all universities across the globe (Bozkurt and Sharma, 2020). The results of our research show that the most significant difficulties were associated with organizational problems, insufficient preparation of educators to online learning and a lack of flexibility in adapting to new conditions. At the same time, Indian researchers found that, since the beginning of the pandemic, university lecturers have improved their digital skills significantly, particularly in such disciplines as physics (Chakraborty et al., 2020). This process was facilitated by specialized courses and workshops for lecturers on new teaching and learning technologies (Mishra et al., 2020).

Based on the results of a survey among Chinese students, Sun L. *et al* noted a great demand for increased self-discipline and concentration on the part of students due to the problem of distractions in online courses (Sun L. et al., 2020). In our survey, students also noted the need for such skills as time management, independence and responsibility.

A survey among university students in Bangladesh conducted during the pandemic found the presence of health-affecting fears and concerns: 15% of the respondents suffered from a moderately severe depression, while 18.1% reported a great state of anxiety (Islam et al., 2020). In our research, the students also reported health problems as a result of adapting to the new form of education. Romanian researchers concluded that students experience the feeling of deprivation due to a lack of direct interaction with both educators and each other (Coman et al., 2020).

In our study, the problem of Internet access and its stability was not mentioned among those most significant. This may be explained by the fact that the survey was conducted in a large city with a population of over one million people. However, some researchers highlighted the importance of this problem. Thus, a study conducted at the University of Malaysia identified such limitations as Internet access, a high cost of Internet traffic and a lack of computer

devices (Mohamad et al., 2020). In some countries, similar problems were addressed by providing mobile hotspots or broadcasting educational materials via local public stations (Lockee, 2021).
Undoubtedly, all the problems faced by educators and students during the pandemic should be comprehensively studied so that online learning could become an indispensable part of the higher education system (Adedoyin and Soykan, 2020).

Conclusion

Our findings indicate that there are 4 main problematic zones in the field of online learning that can increase educational risks and affect the willingness of students to select remote learning. Although our study covered respondents studying at one university, the findings can be useful for administrative bodies of Russian universities in demonstrating typical issues related to online education.
The first zone is associated with social isolation, the impossibility of direct and effective mediated/remote interaction of various subjects of the educational process. The second zone is concerned with a decrease in the quality of education, which is determined by a lack of self-organization, honesty, time management and responsible behaviour, as well as by the absence of learning skills necessary for online training. The third zone involves issues related to organization of the educational process by university administrations and activities of educational entities (professors, parents, etc.). The conditions (technical, personnel, infrastructural, financial) created at a particular university affect the quality and timeliness of online courses, as well as students' trust in such programmes. The fourth zone covers changes required on the part of students in transforming their lifestyle and working practices (including those related to health preservation that compensate for an insufficient level of physical activity, excessive eye strain, etc.), providing a workplace with modern technologies, ensuring access to the Internet, agreements with neighbours on the observance of silence, etc.
Our findings demonstrate that even the representatives of the "digital native" generation (M. Prensky), whose daily practices are determined by the digitalization of all spheres of life, may experience significant stress associated with full immersion in online education. In the structure of everyday life, educational activities are increasingly determining the social wellbeing of young people. Satisfaction with online education during the pandemic has decreased, which has led to a decrease in the overall satisfaction with life. As a result, additional compensatory mechanisms are required both at the personal, administrative and social levels (family, state, media).
Further research into attitudes towards online education should cover the post-pandemic period, when students have the opportunity to independently select the form of intra-university and extra-university programmes. It would also be interesting to investigate the level of digital skills acquired during the pandemic, as well as changes in the value structure of the younger generation.

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FINANCIAL LITERACY OF UNIVERSITY STUDENTS IN THE CONTEXT OF THEIR KNOWLEDGE OF EXTERNAL FINANCING

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Abstract

An understanding of this issue and the knowledge related to it are becoming increasingly important in the context of financial literacy as well as other contexts. The objective of paper is to examine, based on data collected from primary research, the awareness and understanding of leasing and credit and credit and debit cards among students from three selected universities in the Czech Republic. The primary research was conducted with the participation of 1 437 respondents (n = 1 437). Their understanding of the terms of leasing and credit were investigated. The difference between these two terms was correctly described by 38.00% (546) of respondents while the remaining 62.00% (891) failed to explain the difference correctly. Of the total number of respondents, 72.09% (1.036) assume they know the difference between the credit and debit cards and more than a quarter, or 27.91% (401) admitted that they did not know the difference.

Keywords

Finance, inflation, price literacy, student, university.

Introduction

People make a number of economic and financial decisions in their daily lives and throughout their lifespan. An individual's incorrect or incompetent choice can become a risk to them and their immediate community (Klapper, Lusardi and van Oudheusden, 2015). Ruiz-Dotras and Mitrega-Niestrój (2020) emphasize the importance of social interaction and the level of financial literacy in the context of financial decision-making. This is also confirmed by Lusardi and Mitchell (2014) who associate financial literacy with the ability to assess economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions. A good level of financial literacy has a positive effect on the ability to keep finances well organized and achieve financial prosperity in the long term (Andriani and Nugraha, 2018, Ječmínek et al., 2018).

Stolper and Walter (2017) see the low level of financial literacy as an obstacle to economic growth at both national and international levels and note that a country's wealth is, among other things, influenced by financial literacy of its citizens. Potrich and Vieira (2018) hold the same opinion and consider financial competency to be an essential tool for promoting growth in the 21st century. Fornero and Lo Prete (2019) investigated voter turnout in elections in view of financial literacy and concluded that turnout is higher in countries where the majority of the population is financially literate. In this respect, she considers the level of education as a suitable indicator for the assessment of human capital and an important factor in assessing the social and economic attitudes of the population in a particular country.

In the past two decades, financial markets have become more complex and investment opportunities have expanded significantly. Financial institutions have a wide range of new and rather complicated

products in their portfolios (de Bassa Scheresberg, 2013). The current form of the world of finance and investments is considerably affected by the rapid development of digitization and information and communication technologies. These facts place increased demands on each individual and affect members of all generations in one way or another (Hong et al., 2020).

Lusardi, Mitchell, and Curto (2010) put an emphasis on the importance of understanding financial literacy among young people in the context of formal policy-making, especially in terms of the development of suitable and effective financial education programmes. An understanding of the principles of credit processes and costs associated with them becomes the basis of how an individual acts in modern society (Lundlum et al., 2012). Chauhan and Indapukar (2020) add that identification of financial behaviours, the depth of financial knowledge, and financial rationality are widely discussed topics among policy makers and academics.

The objective of this paper is to assess, based on data collected from primary research, the awareness and understanding of external financing – particularly the difference between leasing and credit – among students from three selected universities in the Czech Republic. Additionally, the difference between the assumed and real knowledge of the difference between the credit card and the debit card as tools which can be used for external financing is also examined.

Materials and Methods

The theoretical framework of this article has been elaborated through the method of document research using scientific articles.

Primary data were collected using a questionnaire survey. The questionnaire survey was conducted in 2018; the data on printed questionnaires were manually transferred into an electronic format for further processing. The questionnaire included 32 questions. The respondents were full-time students at three selected universities in the Czech Republic focused, among other things, on agriculture, forestry, and veterinary science. These were the University of South Bohemia in České Budějovice (hereinafter referred to as USB), Mendel University in Brno (hereinafter referred to as MEU), and the Czech University of Life Sciences in Prague (hereinafter referred to as CZU). At each university, the researchers approached both respondents studying at faculties focused on economics (at USB this was the Faculty of Economics, at MEU it was the Faculty of Business and Economics, and at CZU it was the Faculty of Economics and Management) and respondents studying at faculties not specializing in economics (at USB this was the Faculty of Agriculture, at MEU it was the Faculty of Agri Sciences, and at CZU it was the Faculty of Environmental Sciences). In total, 1,437 respondents took part in the primary research. The sample was determined based on quota sampling and represented 14% of the total number of students at the selected faculties.

Basic sociodemographic factors of the reference group of respondents were as follows (at the same time, each of these characteristics stands for one investigated variable):

Gender	Female	57.48
	Male	42.52
Level of study	Bachelor's degree (BD)	66.32
	Master's degree (MD)	33.68
Field of study	Economics studies (ECO)	63.40
	Non-economics studies (NON-ECO)	33.60
University	CZU	59.29
	USB	18.02
	MEU	22.69

Table 1: Sociodemographic factors of respondents in % (source: own research, 2018)

Statistical Tools for Analysis

The contingency table is used for transparent visualization of mutual relations of two statistical variables. The type of the contingency table is given by the number of rows r and the number of columns s, it means $r \times s$ *(Hindls et al., 2007). Obviously,* χ^2 is a measure of the overall dissimilarity of n_{ij} and m_{ij}. The bigger the difference between the observed and the expected values, the higher the test statistic χ^2.

$$m_{ij} = \frac{n_i n_j}{n} \tag{1}$$

$$\chi^2 = \sum \frac{(\text{frequency observed} - \text{frequency expected})^2}{\text{frequency expected}} \tag{2}$$

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{s} \frac{(n_{ij} - m_{ij})^2}{m_{ij}} \tag{3}$$

i and *j* are indices of rows and columns, nij are observed marginal frequencies, ni and nj are marginal totals, *n* is grand total of observations, m_{ij} are expected frequencies. We compare χ^2 to the critical value χ^2 with a chi-square distribution of (r - 1) (s - 1) degrees of freedom at the chosen level of significance. We reject the hypothesis if χ^2 is larger than the table value. This test is valid asymptotically and, thus, can only be applied if there are enough observations. All expected values ought to be higher than one (Hendl, 2009); at the same time, the table should not contain more than 20% theoretical incidence rates (frequencies) of less than 5. Where zero values occur in any of the fields, we proceed to analyse a derived table, created by merging a small number of categories (Hendl, 2009). Cramer's *V* was used to determine the degree of association between the variables. Additionally, the method of adjusted residuals was applied. The calculation of adjusted residuals indicated precisely the location of the dependency. The results of adjusted residuals are included in the tables for zero hypotheses. The principle of adjusted residuals is based on comparing the values in the cells of the contingency table with the critical value of 2 (or 1.96). The comparison was performed and, considering that wherever the value in a cell equals or exceeds 2 (-2) a statistically significant difference exists, the dependency was confirmed. This method was enhanced by the sign scheme. Information on where the assumption of independence of both the compared characteristics was violated could be obtained through this method.

The data analysis was focused on the following tested hypotheses.

- $H0_1$: Knowledge of the difference between credit and leasing is independent of the respondent's gender.
- $H0_2$: Knowledge of the difference between credit and leasing is independent of the university attended by the respondent.
- $H0_3$: Knowledge of the difference between credit and leasing is independent of the specialization of the respondent.
- $H0_4$: Knowledge of the difference between credit and leasing is independent of the respondent's level of study.

Subsequently, attention was focused on identifying the assumed and real knowledge of the concepts of credit and debit cards (credit/debit card is a tool that is tied to the products). This knowledge builds on the concepts tested through the hypotheses as this terminology is related to external financing.

Results

This chapter presents the results of the primary research focused on students' financial literacy – the field of macroeconomics, including comments. The sample was determined based on quota sampling.

The question asked to respondents inquired about different sources of finance. The question encouraged respondents to indicate the basic difference between credit financing and leasing. The difference between a loan and a lease was correctly characterized by 38.00% (546) of respondents, the remaining 62.00% (891) did not describe the difference correctly. As to the incorrect answers, "a loan is only used to finance housing and leasing is used to finance a car" was the most frequent answer. Four zero hypotheses were tested in terms of this question.

Number of hyp.	Wording of hypotheses	$\chi 2$	Critical value	H0 can be rejected	Cramer s V
$H0_1$	Knowledge of the difference between credit and leasing is independent of the respondent's gender	0.04	3.84	-	-
$H0_2$	**Knowledge of the difference between credit and leasing is independent of the university attended by the respondent**	**34.95**	**5.99**	**X**	**0.16**
$H0_3$	**Knowledge of the difference between credit and leasing is independent of the specialization of the respondent**	**17.29**	**3.84**	**X**	**0.11**
$H0_4$	**Knowledge of the difference between credit and leasing is independent of the respondent's level of study**	**35.90**	**3.84**	**X**	**0.16**

Table 2: Statistical values for $H0_1$ – $H0_4$ in relation to the investigated variables (source: own research)

The relation between the knowledge of the difference in the forms of financing through credit and leasing and the university attended by the respondent, the specialization of the faculty and, also, the respondents' level of study has been proved. For the dependencies and structures of responses please refer to the tables below (Table 3, Table 4, Table 5).

University / response	Correct		Incorrect		Total	
	Absolute frequencies	Relative frequencies within university	Absolute frequencies	Relative frequencies within university	Absolute expression	Relative frequencies within university
USB	66	4.59%	193	13.43%	259	18.02%
MEU	105	7.31%	221	15.38%	326	22.69%
CZU	375	26.10%	477	33.19%	852	59.29%
Total	546	46.56%	891	53.44%	1 437	100%
	Value of adjusted residuals /sign notation				Statistics	
USB	-4.58	---	4.58	+++	χ^2 > Critical value	
MEU	-2.45	-	2.45	+		
CZU	5.67	+++	-5.67	---	34.95 > 5.99	

Table 3: Summarized responses to $H0_2$, relation to university studied (source: own research)

The value of statistics χ^2 is higher than the critical value with 2 degrees of freedom at level 0.05. The zero hypothesis can be rejected. The knowledge of the difference between the methods of financing by credit and leasing depends on the university attended. The dependency determined by Cramer's *V* reached the value of 0.16, which means that it is rather weak. The analysis performed by the method of adjusted residuals implies that a statistically significant difference compared to the theoretical frequencies (the level of significance 0.001) is shown mainly among students of CZU who gave the correct answer more often while, statistically, USB students answered incorrectly significantly more frequently.

Specialization of the faculty / response	Correct		Incorrect		Total	
	Absolute frequencies	Relative frequencies within faculties	Absolute frequencies	Relative frequencies within faculties	Absolute expression	Relative frequencies within faculties
ECO	383	26.66%	528	36.74%	911	63.40%
NON-ECO	163	11.34%	363	25.26%	526	36.60%
Total	546	38.00%	891	62.00%	1 437	100%
	Value of adjusted residuals /sign notation				Statistics	
ECO	4.16	+++	-4.16	---	χ^2 > Critical value	
NON-ECO	-4.16	---	4.16	+++	17.29 > 3.84	

Table 4: Summarized responses to HO_3, relation to specialization (source: own research)

Of the total number of respondents who answered correctly (38.00%, 546), 26.66% (383) study at a faculty specializing in economics and 11.34% (163) of them study at a non-economics faculty. Of the total number of respondents who answered incorrectly (62.00%, 891), 36.74% (528) study at a faculty specializing in economics and 25.26% (363) of them study at a non-economics faculty. After assessing the value of statistics $\chi 2$, which is higher than the critical value at the level of significance 0.05, the zero hypothesis can be rejected. The dependency between the knowledge of the difference in the methods of financing by credit and leasing and the specialization of the faculty has been proved. The value of Cramer's *V* is at 0.11 and, therefore, shows a weak dependence. Upon closer examination with the help of adjusted residuals, a statistically significant difference at the level of 0.001 was revealed between the theoretical and empirical frequencies which proves that respondents from faculties oriented on economics displayed a markedly higher knowledge in this area.

Level of study/ response	Correct		Incorrect		Total	
	Absolute frequencies	Relative frequencies within levels of study	Absolute frequencies	Relative frequencies within levels of study	Absolute expression	Relative frequencies within levels of study
BD	310	21.57%	643	44.75%	953	66.32%
MD	236	16.43%	248	17.25%	484	33.68%
Total	546	38.00%	891	62.00%	1 437	100%
	Value of adjusted residuals /sign notation				Statistics	
BD	-5.99	---	5.99	+++	χ^2 > Critical value	
MD	5.99	+++	-5.99	---	35.90 > 3.84	

Table 5: Summarized responses to HO_4, relation to the level of study (source: own research)

The value of statistics χ^2 is higher than the critical value at the level of 0.05. The zero hypothesis can be rejected. The respondents' knowledge of the difference between the methods of financing by credit and leasing depends on the specialization of the faculty where they study. The dependency

determined by Cramer's V is weak (0.16). Statistically significant differences between the theoretical and real frequencies were tested by means of the method of adjusted residuals and complemented by sign notation. The residual between the empirical and theoretical frequencies expresses at the level of significance 0.001 that respondents studying at faculties specializing in economics answered significantly more correctly.

Following the investigation of the terms leasing and credit, respondents were asked a question concerning the credit and debit cards and the principle of using them. The difference between the assumed and real knowledge of the difference between the credit card and the debit card as tools which can be used for external financing is also examined. The first thing to find out was whether the respondents believe they know the difference between the credit and debit payment card. Respondents who answered that they believe they know the difference were asked in the next question to explain the difference. Of the total number of respondents, 72.09% (1,036) of respondents believe they know the difference between the cards, while more than a quarter of respondents (27.91 % 401) answered that they did not know the difference.

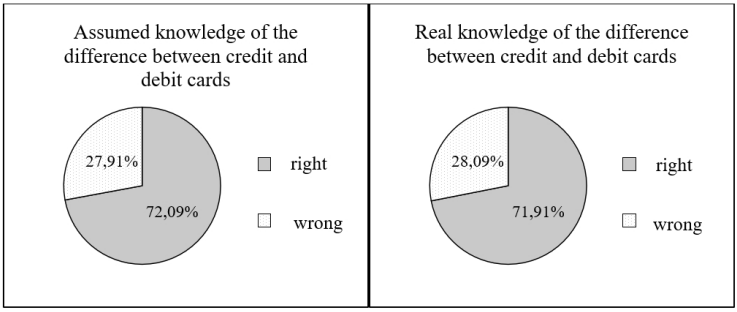

Figure 1: Comparison of assumed and real knowledge of the difference between credit and debit cards, (source: own research)

A follow-up question was asked to find out how many respondents were able to correctly explain the difference between credit and the debit payment cards. Only 1,036 respondents answered this question. When responding to the previous question, these respondents declared they knew the difference. Of this number, 71.91% (745) of respondents gave the correct answer, while the remaining 28.09% (291) of respondents failed to identify the difference correctly. It follows from the above that of the total number of respondents (1,437) approximately one half (51.88%, 745) of respondents can identify the difference between credit and debit payment cards. Obviously, students are convinced that they know what the terms mean but when asked to describe the difference in detail, they are unable to answer correctly.

Discussion

The results show an alarmingly high lack of knowledge of the difference between the concepts of leasing and credit. The sample was determined based on quota sampling. As many as 62% of respondents are unable to define the difference between them. In this case, a statistically significant dependence between the respondents' knowledge of these concepts and specialization of the faculty, university and the level of their study was proved. The correct answer was most often given by respondents from CZU. As assumed, students of the faculties specializing in economics answered correctly significally more often than students from non-economics faculties. Having conducted their research, Rafinda and Gal (2020) came to the same conclusions. They state that students of economics show better knowledge than students

specializing in non-economics subjects. They attribute this to the fact that, due to the focus of their studies, students of economics encounter finance in their major subjects and these courses provide them with a good general insight into this issue. On the other hand, based on their research on the use of credit cards among college youth, Lundlum et al. (2012) state that, no matter what field they study, university students do not understand the costs associated with loans.

Differences were also observed in the level of study. Students of master's programmes demonstrated better knowledge. The same opinion is confirmed also by Mouna and Anis (2017) who, when examining the determinants of financial literacy, arrived at the conclusion that financial literacy, and knowledge of the specific contents of certain financial concepts in particular, are influenced by the degree of study and the attained level of education.

Knowledge of finance is particularly important in the times when increasingly complex financial products are easily available to a wide range of the population (Klapper, Lusardi and van Oudheusden, 2015). In order to improve financial literacy, integration of economic topics and personal finance issues into all academic domains, and especially into non-economics directions of university study, is a necessary prerequisite. To improve financial education, it is inevitable to examine the relation between the students' knowledge of finance and their view of personal finance and financial decision-making (Mändmaa, 2019). It is essential to apply specialized courses in personal finance in an appropriate way within the process of university education as a tool for improving financial literacy (Rafinda and Gal, 2020).

Low financial literacy is often accompanied by unhealthy borrowing behaviour (Ottaviani and Vandone, 2017), over-indebtedness, and defaults (Artavanis and Karra, 2020). It is also important to observe enhancement of financial literacy in older generations as this contributes to well-being, a sense of security, and improvement of family relationships (St. Pierre and Shreffler, 2013). The behaviours and decision-making of a young person are influenced by a number of factors and, in addition to their studies, it is primarily their family. It can be assumed in this context that financially literate parents will pass on responsible financial behaviour to future generations (van Campenhout, 2015).

Conclusion

The research dealt with financial literacy of university students in the Czech Republic. The data were collected by a questionnaire survey performed at three selected universities in 2018. The sample was determined based on quota sampling. Attention was focused on the terminology related to the use of external financing and the assumed and real knowledge of the concepts. The difference between credit and leasing was correctly characterized by 38.00% (546) of respondents, while the remaining 62.00% (891) explained the difference incorrectly. Of the total number of respondents, 72.09% (1,036) assume they know the difference between credit and debit cards and more than a quarter, or 27.91% (401) admitted that they did not know the difference. A follow-up question was asked to find out how many respondents were able to correctly explain the difference between credit and the debit payment cardy. Only 1,036 respondents answered this question. When responding to the previous question, these respondents declared they knew the difference. Of this number, 71.91% (745) of respondents gave the correct answer, while the remaining 28.09% (291) failed to identify the difference correctly. It follows from the above that of the total number of respondents (1,437) approximately one half (51.88%, 745) can identify the difference between credit and debit payment cards.

The research was performed at three selected universities in the Czech Republic only, which may be considered as a limitation. Further research can focus on high schools to assess the development of financial literacy towards universities.

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COVID-19: DISTANCE LEARNING AT FEM CZU PRAGUE FROM THE PERSPECTIVE OF STUDENTS (SPRING 2020)

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Abstract

This article focuses on distance learning during the COVID-19 pandemic at a selected public university. The main objective of this article is to evaluate the advantages and disadvantages of distance learning at the FEM CZU Prague during the first wave of the coronavirus pandemic (spring 2020) from the perspective of students. Primary data were obtained through a quantitative survey (n = 292). The survey showed that distance learning suited students. The main advantages included time savings, flexibility, accessibility, home environment, financial savings, and independence. The main disadvantages included the loss of social contact, loss of direct contact with the teachers, loss of personal presence when explaining the subject matter, and the greater demands placed on their responsibility. The survey also showed that there is a relationship between the overall evaluation of distance learning and the form of study, age, attendance at lectures, and self-evaluation.

Keywords

COVID-19, distance learning, evaluation, pandemic, spring 2020, students

Introduction

In early 2020 higher education institutions around the world were affected by the COVID-19 pandemic (Ebner, Schön and Braun, 2020). Many countries around the world decided to close schools as a consequence of the pandemic. This led to teaching taking place online to an unprecedented extent and without prior testing (Burgess and Sievertsen, 2020). The pace of transition to this form of teaching was unprecedented and astounding (Hodges et al, 2020). In March 2020, when the outbreak of the pandemic reached Europe, students were unable to attend schools and universities and teaching was provided in the form of distance learning, which requires Internet access and technical equipment (Drinóczi and Bień-Kacała, 2020).

In the Czech Republic, primary and secondary schools and higher education institutions were closed at the beginning of March 2020 and teaching occurred in distance form. Classical in-school teaching was not renewed until the next school/academic year - i.e., in autumn 2020, but only for a few weeks and in connection with specific levels of education. On 24 April 2020 Act no. 188/2020 Coll., under which higher education institutions could make full use of forms of distance learning, was published in the Collection of Laws of the Czech Republic (Ministry of Education, Youth and Sports, 2020). The transition to distance learning was therefore unexpected and took place practically overnight. This form of teaching was not common in the Czech Republic. As was also the case in Hungary, Poland, and Austria, students were not prepared for the transition to this form of teaching and encountered problems, be they technological or personal (Drinóczi and Bień-Kacała, 2020; Ebner, Schön and Braun, 2020). The number of countries in which teaching was completely suspended worldwide peaked on 1 April 2020, when classic teaching was completely suspended in

193 countries worldwide, equivalent to 91.2% of the total number of enrolled students (UNESCO, 2020). The COVID-19 pandemic caused a sudden, massive dependence on online learning (Sandars, Correia and Dankbaar, 2020) and required the rapid transformation of the educational process, as the current educational model was inadequate in the given situation (Wargadinata et al, 2020). A key aspect is a feedback from students, who can be the perfect source of information. The effects of the COVID-19 pandemic will change the nature of higher education substantially and forever (Laplante, 2020). The situation presents a significant challenge for the higher education community around the world, as it has created unexpected and urgent demand for online teaching, instead of traditional face-to-face teaching (Crawford, Butler-Henderson and Rudolph, 2020; Rapanta, Botturi and Goodyear, 2020). During the COVID-19 pandemic, higher education institutions in the Czech Republic were advised to use remote education tools as much as possible to ensure that teaching took place. On 24 April 2020 Act no. 188/2020 Coll., under which higher education institutions could make full use of forms of distance learning, was published in the Collection of Laws of the Czech Republic (Ministry of Education, Youth and Sports, 2020).

The main objective of this article is to evaluate the advantages and disadvantages of distance learning at the Faculty of Economics and Management of the Czech University of Life Sciences Prague (FEM CZU Prague) during the first wave of the coronavirus pandemic in spring 2020 from the perspective of students. A partial objective is to examine the relationships between selected qualitative variables to verify the conclusions made. The article is structured as follows. The first part of the article concentrates on theoretical background. The second part describes the research methods. The third part is dedicated to an evaluation of the outcomes of the survey. Subsequently, the relationships between selected qualitative variables are examined. The fourth part discusses results. The fifth part focuses on the overall conclusion and the sixth part consists of a list of references.

Materials and Methods

Primary data were obtained through a quantitative survey using a questionnaire, to which a total of 292 students responded. Participants in the survey were selected through a deliberate choice, during which students from seven study programmes at FEM CZU were contacted. The survey focusing on distance learning during the coronavirus situation was carried out in the period from 02/2020 to 09/2020 - i.e., the survey focused on the evaluation of distance learning during the first (spring) wave of the COVID-19 pandemic. The structure of the respondents is shown in Table 1.

Gender	Male			Female		Total
	84 (28.8%)			208 (71.2%)		292 (100%)
Age category	18-22 years	23-29 years	30-39 years	40-49 years	Over 49 years	Total
	75 (25.7%)	144 (49.3%)	34 (11.6%)	31 (10.6%)	8 (2.7%)	292 (100%)
Form of study	Full-time			Distance		Total
	192 (65.8%)			100 (34.2%)		292 (100%)
Study programme	Bachelor's degree			Master's degree		Total
	132 (45.2%)			160 (54.8%)		292 (100%)
Occupation	Work while studying			Do not work while studying		Total
	261 (89.4%)			31 (10.6%)		292 (100%)

Table 1: Structure of respondents, 2020 (source: own survey)

After clarification of the key-dependent and independent variables, we formulated 6 null hypotheses that assume no relationship between the overall evaluation of distance learning and basic identification variables ($H_0$1-$H_0$6). The data have been processed using absolute and relative frequencies using the IBM SPSS Statistics 26. Testing was done by Pearson's chi-square test of independence. The level of significance was set at 0.05. The strength of the relationship was examined using the Cramer's *V* coefficient using the scale given by De Vaus (2014) as follows: 0.10-0.29 (low to moderate), 0.30-0.49 (moderate to substantial) and 0.50-0.69 (substantial to very strong).

Results

The results of the survey showed that students most often spent 2-5 hours per week (74, 25.3%) or 5-10 hours per week studying (69, 23.6%). 44 (15.1%) students spent only 1-2 hours per week studying, while 40 (13.7%) students spent 10-15 hours per week studying. The number of study hours per week in absolute and relative frequencies is shown in Figure 1. As part of the self-assessment, almost half of the students rated their work in distance learning as very good (142, 48.6%), 93 (31.8%) students good, 36 (12.3 %) excellent, 17 (5.8%) sufficient and 4 (1.4%) insufficient.

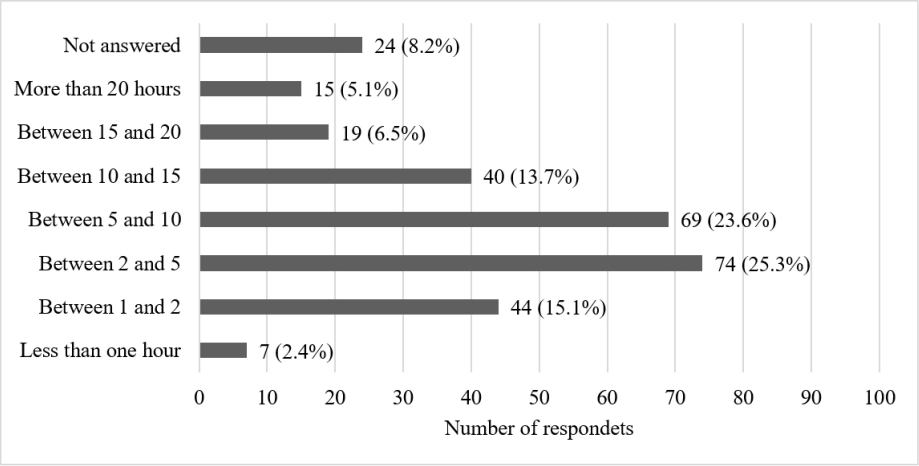

Figure 1: Number of study hours per week, 2020 (source: own survey)

Advantages and disadvantages of distance learning

Students were also asked whether distance learning suited them and what the advantages and disadvantages were to them of this form of teaching. Distance learning suited the majority of students (169, 57.9%), 74 (25.3%) students felt that it was half-and-half, and it did not suit 49 (16.8%) students. The main advantages and disadvantages of distance learning are shown in Table 2.

Among the main advantages of distance learning, students mentioned time savings (especially in terms of commuting to university), time flexibility, accessibility (option of studying from anywhere), home environment, financial savings, and independence. The main disadvantages for students included the loss of social contact, loss of direct contact with the teachers, loss

of personal presence when explaining the subject matter, and the greater demands placed on their responsibility. Students were also asked what complications they encountered in distance learning.

Surprisingly, the students did not find any significant complications that would be caused by inadequate technical equipment, inadequate working facilities and insufficient IT skills. Students found complications particularly in the fragmentation of teaching into a large number of different online tools and applications (97, 33.2%), insufficient feedback from teachers (88, 30.1%), lack of teaching materials (86, 29.5%), insufficient motivation to study (72, 24.7%), and a high workload in their jobs (66, 22.6%). Students most often used e-mail, video calls (MS Teams, Google Meet, Zoom, Skype etc.) and LMS Moodle to communicate with teachers.

Advantages	Absolute frequency	Relative frequency	Disadvantages	Absolute frequency	Relative frequency
Time savings	258	88.4	Loss of social contact	172	58.9
Time flexibility	230	78.8	Loss of direct contact with the teachers	166	56.8
Accessibility (option of studying from anywhere)	203	69.5	Loss of personal presence when explaining the subject matter	150	51.4
Home environment	178	61.0	The greater demands placed on their responsibility	102	34.9
Financial saving	144	49.3	Long time spent on the computer	89	30.5
Possibility to choose the pace of teaching	127	43.5	Lower motivation	70	24.0
Independence	125	42.8	Increasing the study load	56	19.2
Individual approach	83	28.4	Higher mental effort	46	15.8
Freedom	78	26.7	Faster pace of teaching	40	13.7

Table 2: Advantages and disadvantages of distance learning, 2020 (source: own survey)

The impact of basic identification variables on the overall evaluation of distance learning

Pearson's chi-square test of independence showed that there is a relationship between the overall evaluation of distance learning - i.e., whether distance learning suited students, and the form of study, age, attendance at lectures and self-evaluation. Furthermore, it was found that the variables of the respondent's gender and occupation (i.e., whether the students had a job during their studies) do not affect the overall evaluation of distance learning. Based on the above, $H_0 2$ and $H_0 4$ were not rejected on the level of significance threshold $\alpha = 0.05$. Hypotheses $H_0 1$, $H_0 3$, $H_0 5$, and $H_0 6$ were rejected. The strengths of the relationships are low and moderate. The results are shown in Table 3.

In summary, distance learning suits students more with increasing age. Likewise, distance learning is evaluated better by students in the distance form of study, by students who attend lectures, and by students who rated their work in contactless teaching as excellent or very good. This can be explained by the fact that the chosen form of teaching suited these students, and thus led to them working better.

No.	Variable	Pearson's chi-square	*df*	*p*-value	Cramer's *V*	Strength of relationship
$H_0$1	Form of study	11.841	4	0.019	0.201	Low
$H_0$2	Gender	6.350	4	0.174	-	-
$H_0$3	Age category	11.841	4	0.019	0.142	Low
$H_0$4	Occupation	3.423	2	0.181	-	-
$H_0$5	Attendance at lectures	19.309	8	0.013	0.182	Low
$H_0$6	Self-evaluation	77.956	6	0.000	0.365	Moderate

Table 3: Results of Pearson's chi-square test of independence for hypotheses $H_0$1-$H_0$6, 2020 (source: own survey)

Discussion

COVID-19 has revealed vulnerabilities in education systems around the world (Ali, 2020). The overall impact of the pandemic, especially on higher education, cannot yet be determined, but this pandemic will change the way we live, work, and learn (Hossein, 2020). Given the unpredictability of the future, it is clear that society requires flexible, resilient education systems. Higher education institutions around the world are therefore increasingly moving towards online learning or e-learning (Ali, 2020). According to Allen et al (2016), the academic staff of the institutions with the largest number of students enrolled in distance learning (10,000 or more distance students in autumn 2014) have a very positive view of the relative quality of online education. 41.7% rated it as better than in-person teaching, 42.3% rated them as being of relatively equal quality, and only 16.0% considered online teaching to be worse than traditional in-person teaching. Olszewska (2020) confirms that online teaching serves its purpose as an alternative to traditional teaching. However, she points out that, although in the given situation, students appreciated the opportunity to study in an online environment, they normally prefer traditional learning at the university. In the future, it will be important to examine the possible use of online teaching and learning so that we do not simply go back to the traditional face-to-face teaching routine. It will be necessary to determine the advantages and limitations of the new approaches (Sandars, Correia and Dankbaar, 2020). Particular attention should also be paid to improving the technological preparation of higher education institutions for distance learning, as there are indications of problems in this area (Olszewska, 2020). According to Ali (2020), COVID-19 essentially allowed us to adopt online education systems.

The theoretical contribution of the article lies in gathering information about the current situation in the field of distance learning during the first wave of the COVID-19 pandemic and examining the relationships between selected qualitative variables. The practical contribution of the article represents the evaluation of distance learning during the first wave of the COVID-19 pandemic in spring 2020 at a selected public university from the perspective of students. The article is limited by the sample. The analysed sample is adequate for obtaining the data and makes it possible for the authors to describe the situation but not to generalise the results. The follow-up research will focus on the evaluation of distance learning during the next waves of the COVID-19 pandemic and the examination of the relationships between selected variables.

Conclusion

Distance learning has been constantly evolving and improving during the pandemic. Although distance learning cannot completely replace ordinary contact learning with all its aspects (the social aspect, in particular, is highly problematic), its importance lies in the possibility of continuing study despite the impossibility of participating in regular contact learning. The survey showed that students perceived distance learning rather positively during the

first wave of the pandemic and distance learning suited them. Among the main advantages of distance learning, students mentioned time savings, time flexibility, accessibility, home environment, financial savings, and independence. The main disadvantages for students included the loss of social contact, loss of direct contact with the teachers, loss of personal presence when explaining the subject matter, and the greater demands placed on their responsibility. Students were also asked what complications they encountered in distance learning. Surprisingly, the students did not find any significant complications that would be caused by inadequate technical equipment, inadequate working facilities and insufficient IT skills. The survey conducted also showed that there is a relationship between the overall evaluation of distance learning and the form of study, age, attendance at lectures, and self-evaluation. Furthermore, it was found that the variables of the respondent's gender and occupation (i.e., whether the students had a job during their studies) do not affect the overall evaluation of distance learning.

The COVID-19 pandemic is undoubtedly a major challenge for adaptation and transformation for both teachers and students. At the same time, however, it represents an important opportunity for change in the established education system. The COVID-19 pandemic has changed the world. The education system needs to evolve with it.

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THE EFFECTS OF PREPARATORY COURSE ON THE MATHEMATICS EXAM RESULTS: CASE STUDY

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Abstract

In this paper, we verify the relation between the score from the final test held in preparatory course and the exam success rate of undergraduate mathematics in the winter semester 2020/2021 at the Faculty of Business and Economics of Mendel University in Brno. There is a strong need to support success rate of undergraduate mathematics courses because of low mathematics knowledge obtained at high school reported by many sources. The environment where the preparatory course has been introduced is described. Logit model with subsequent threshold optimization is employed to test the effect of preparatory course. This is significant, as well as the form of study, the type of high school and gender. Finally, we can recommend preparatory course or similar activity for improving success rate of mathematical courses, although this cannot be the main cause of student success.

Keywords

Exam failure rate, high school education level, preparatory course, undergraduate mathematics

Introduction

For years, universities in the Czech Republic have faced the problem of persistent decline in students' knowledge of high school mathematics. This phenomenon is caused by many factors. According to Bauer and Matulová (2012), the key ones are the overall reduced level of mathematics in secondary schools, including grammar schools, the implementation of the state high school leaving examination, and the absence of university admission examinations in mathematics. The individual preparation of students for admission exams used to serve as a tool to fill the gap between the mathematical skills of students and those needed for undergraduate study in Science, Technology, Engineering and Mathematics (STEM). In these closely related academic disciplines, the number of students is decreasing considerably and the lack of interest in studying these issues led to the emergence of the STEM concept following the philosophy of polytechnic education. The importance of the STEM concept is also captured in the initiative Industry 4.0. Contrary to the goals just mentioned, mathematics is generally perceived by many authorities as a necessary evil without keeping in mind that the process of mathematical education contributes to the development of logical, structural, spatial, and numerical thinking.

These circumstances result in a growing failure rate in undergraduate mathematics courses. Universities face this alarming fact in a variety of ways. The Faculty of Economics and Management at the Czech University of Live Sciences Prague came up with a concept of so called Big-test (see Brožová and Rydval, 2020). The Faculty of Economics and Administration of Masaryk University Brno does not allow students enrol in the undergraduate mathematics without passing an entrance test, and those who fail are encouraged to attend optional paid compensatory course (Bauer and Matulová, 2013). The Department of Mathematics at the

College of Polytechnics Jihlava has introduced the combination of the entrance test of the compulsory mathematic courses, optional compensatory course and the intensive summer or winter workshops in mathematics (Zámková, Prokop and Stolín, 2016a; Zámková, Prokop and Stolín, 2016b). The issue of the support of transition of students to university undergraduate mathematics is discussed abroad as well. Büchele (2020) describes the problems of unprepared freshman students of mathematics in German university education system and distinguishes short-term and medium-term effects of preparatory courses. Matthews at al. (2013) give the evaluation of high-school mathematics support centres in the universities in UK and many other countries. Authors Pell and Croft (2008) mentioned that many of student using support activities are not students in danger of failing, but students who simply "want to do better". We follow the efforts of universities to make it easier for students to start their studies not only in the case of mathematics, but in all STEM fields. For example, Fisher at al. (2019) discusses this issue in the context of chemistry.

Until recently, the Faculty of Business and Economics at Mendel University in Brno required applicants for study to take the admission test in mathematics, which, despite a slight decrease mathematical knowledge of students, guaranteed the maintaining level of undergraduate mathematics at the faculty. The effect of the admission examinations was that even though a lot of students were admitted even with worse score, they were preparing for the math exam and deepened their knowledge. Two years ago, the management of the faculty decided to replace the classic admission field tests (including the mathematics test) with a form of the scholastic aptitude test. At this moment, the exam in undergraduate mathematics has begun to substitute the role of the admission test in mathematics. The Department of Statistics and Operation Analysis responsible for the teaching of mathematics has decided to organize an intensive one-week preparatory high school math course, which takes place in early September before the start of the semester. This preparatory course of high school mathematics is offered to all students who are going to enrol in any of the courses of undergraduate mathematics. The preparatory course was held for the first time in September 2020, in the traditional form in the classroom at the University Campus. Students had to pay a fee of CZK 1,500 for participation in prep course. If they successfully pass the selected courses of undergraduate mathematics at the first enrolment, they will be refunded the amount of CZK 1,000 in the form of an extraordinary scholarship.

The objective of our research is to assess whether the mentioned preparatory course is significantly effective in improvement the success rate in undergraduate mathematics for coached students over their uncoached peers. For objective assessment of the possible effect of the prep course we are dealing with other factors that affect the student's success in university course, such as the type of high school, gender, and the score from the admission procedure.

Materials and Methods

At present, the Faculty of Business and Economics teaches mathematics in several undergraduate courses within newly accredited study programs. In the first semester of study, these courses are Mathematics 1 (MT1), Mathematics (MT) and Applied Mathematics (AMT). Students are enrolled in a course that corresponds to their study program. Mathematics 1 has a traditional curriculum (linear algebra and differential calculus of one variable) and is followed in the second semester by the course Mathematics 2 (MT2) introducing integral calculus of one variable, differential calculus of two variables, basics of probability and random variables. Emphasis is placed on applied examples. MT concentrates all the content from the courses MT1 and MT2 into one unit while doubling the number of scheduled hours and credits. The study program

involving the course of AMT represents a new trend of so-called professional study programs focused more on practice when students are not expected to continue in the follow-up master's study. The difficulty of the AMT is then, of course, significantly reduced, even regarding the number of scheduled hours.

In winter semester 2020–21, there were enrolled approximately 1,000 students in undergraduate mathematical courses. For the purpose of our analysis, we have data describing 953 students. All the courses MT1, MT and AMT were organized in similar way, the resulting grade was given by the score from mid-term multiple-choice test, the score from homework during the semester and the score from the final written examination. Only students who passed the mid-term test could take the final written exam. The MT course is the sole course attended by part-time students (MT comb) in addition to full-time students (MT pres). In our research, we pay special attention to students of the newly accredited study program Economics and Management (MT EAM). Students of this study program must have enrolled MT course. Due to the possibilities of the students to change their previous program to this new one, MT EAM has already several students repeating undergraduate mathematics.

The pre-semester preparatory course was attended by a total of 98 students (male 25, female 73) mainly from the Czech Republic (80), then from Slovakia (15), Serbia (2) and Ukraine (1). 41 students of the prep course graduated from grammar schools (G), 25 students from business academies (OA), 15 students from the secondary schools of technical or informatics field and from the secondary vocational schools (SOS). For 17 students this information is not given (Not specified). 84 students enrolled in the university in a given year, 13 students entered the 2nd year of study and 1 student the 3rd year. The prep course was attended by 63 students enrolled in MT, 9 students in MT1 and 26 students in AMT. Only 4 students were part-time. At the end of the preparation course, students took the final multiple-choice test consisting of 6 questions. Each question was scored a single point, so students could get a maximum of 6 points. 38 students receive score 5–6 (Above average), 16 students score 3–4 (Average), 10 students score 1–2 (Below average). 34 students did not participate in the final test at all (Absent).

The success rate of a course is based on the underlying binomial variable. We can model such type of variables by generalized linear model for binomial proportions, which is known also as logit model (see Agresti, 2007). For this purpose, we employ a set of student characteristics as gender, nationality, the type of high school, the mathematics course at University, the form of study (full-time, part-time), the year of enrolment to University, and the characteristics of the main interest – the score of the preparatory course test. Logit model characteristics are elaborated in accordance with Klepáč and Hampel (2017). Threshold optimization techniques were employed to show predictive power of the model, see Beneš and Hampel (2020); ROC curve and the distance to corner metrics were used for determination of logit model optimal threshold. All calculations were performed in computational system Matlab R2020b and Genstat 20. The level of significance was set to 0.05.

Results

Table 1 shows basic characteristics of elaborated datasets. It is visible, that courses MT, MT1 and AMT differ in gender proportion as well as in structure of high schools visited by students. These differences can be at least partially explained by the fact, that MT1 course is compulsory for informatics programmes (lower proportion of female) and that AMT is professional study program (higher proportion of OA and SOS types of high schools). Majority of students are coming from the Czech Republic and the Slovak Republic, but also students from eastern European countries mainly creates up to 13 % of the course (note that we deal with courses taught in the Czech language only).

Characteristics	Total	MT	MT1	AMT	MT pres	MT comb	MT EAM
Count	953	465	201	287	379	86	416
Female	55	57	35	66	59	53	57
G	39	44	37	34	44	44	45
OA	16	19	10	15	21	14	19
SOS	27	20	30	35	18	30	20
CZE	82	82	77	84	81	87	82
SVK	11	13	10	8	14	12	13

Table 1: Selected characteristics of datasets. Except Count, all values are in percent. CZE means share of students from the Czech Republic and SVK is the share of student from the Slovak Republic. (source: own calculation)

Final logit model for the dependent variable success in mathematics course is presented by analysis of deviance output, see Table 2. Score of prep course test is statistically significant factor. As illustrated in Figure 1, the level "Above average" score demonstrates significant influence, which means higher success rate in mathematics course (43% vs 22-28% success rate). The factor Form of study points to significantly lower success rate for part-time students (16%) than for full-time students (28%). Both Type of high school (G 32%, Not specified 34%, OA 22% and SOS 18%) and Gender (20% male and 33% female) have a crucial influence on the success rate. Note that unrecognized type of high school is the case of abroad students, where we can assume high quality high school. Finally, the Course factor is significant tightly, where MT resulting to significantly lower success rate 24%, while MT1 32% and AMT 30%. This is given by the fact of big amount of curriculum condensed to one semester in the case of MT course.

Factor	d. f.	Deviance	Mean deviance	Deviance ratio	p-value
Score prep course	3	9.612	3.204	3.20	0.022
Form of study	1	10.273	10.273	10.27	0.001
High school type	3	20.033	6.678	6.68	<.001
Gender	1	21.789	21.789	21.79	<.001
Course	2	5.993	2.996	3.00	0.050
Residual	942	1049.304	1.114		
Total	952	1117.004	1.173		

Table 2: Analysis of deviance for generalized linear model for the Total dataset (source: own calculation)

The quality of estimated model can be verified by the total accuracy rate of 73.4%. This is good result, but when we look deeper, the accuracy of successes is only 5.8% while accuracy of fails is 98.7%. This problematic result of the logit model is known generally, the cause lies in unbalanced proportion of successes and fails. As a remedy we can use techniques related to ROC curve describing the model. AUC characteristics result is 0.671, which means a model with eligible classification power. We can use threshold optimization methods to improve the accuracy of successes. In our case we employ "distance to corner" metrics which points to the optimal threshold 0.284. Based on this, the total accuracy decreased to 63.1%, the accuracy of successes increased visibly to 59.2% and the accuracy of fail decreased to 64.5%. This model setting still does not provide a perfect classification, but at least it is usable.

When assessing results of particular datasets, the score from the preparatory course test is the significant factor in the Total dataset only. Nevertheless, Figure 1 shows that the "above average" result from the prep course means higher probability of success in general. Note that the "below average" level is missing in MT1, and for MT comb we have only the "absent" level, which is not

enough to make predictions. Apart from MT comb, there were always significant differences in gender, where the chance of success for female was always at least of 12% higher.

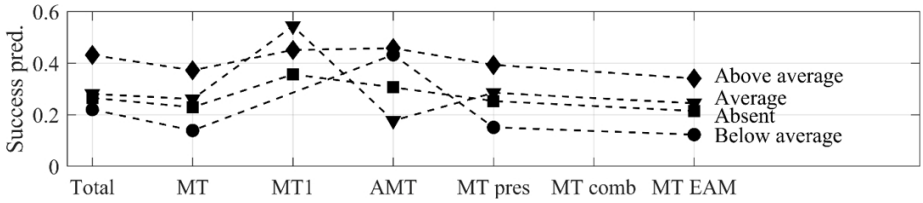

Figure 1: Predicted probability of success in a mathematics course based on score of the preparatory course test for different datasets (source: own calculation)

Except of MT comb and MT1, success prediction significantly depends on high school type, see Figure 2. Regarding the course MT1, the category SOS mostly represents students from technical and informatics fields. For this reason, here the success rate of mathematical courses may be higher than for the whole wide range of SOS. Some of characteristics were close to be significant in models: for MT comb it is the year of enrolment to University with predicted success rate 10% for students enrolled in 2020, 19% in 2018 and 46% in 2018 and before. This may indicate the following fact: if part-time students do not leave the University in the first year of studies, they will endeavour to successfully complete their studies in view to the jobs they are already doing. Further, "nationality of student" is almost significant for MT1 (where 23% of students are outside CZE) with success rate 22% for the Czech students and success rates 78–100% for students from eastern European countries.

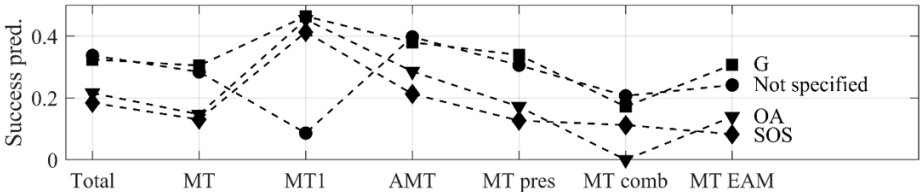

Figure 2: Predicted probability of success in a mathematics course based on high school type for different datasets (source: own calculation)

Discussion

Many studies focus on the relation between the admission exams and the prediction of math exam success or study success as a whole, see e.g. Hrubý and Staňková (2019), Klůfa (2020), Kučera, Svatošová and Pelikán (2015), Linda and Kubanová (2013), Měsíček, Petrus and Kovářová (2019), Poláčková and Svatošová (2013), Zvára and Anděl (2001), but possible effects of "support" for student of mathematics courses are not elaborated there. Shahbazi and Cheng (2013) implements surveys to assess students' perception of the preparatory course. The modern method of admission process as scholastic aptitude tests (SAT) is analysed in Kubanová and Linda (2012). They point out that hypothesis about dependence between SAT score and students study results at the Faculty of Economics and Administration of the University of Pardubice was not proved. This is in line with our research, where SAT was not significant in our model.

The employed logit model seems to be appropriate for analysis we provide; the same method for assessment of success at university is used in Zvára and Anděl (2001), but in another context. Simple analysis of dependence in contingency tables is not suitable in our situation, where more important factors exist. For example, we can calculate odds ratio 1.4 (1.4times higher chance for mathematics

course success for the preparatory course participants), but this odds ratio is not significantly different from 1. Further, predictive quality of our logit model for Total dataset is eligible only. This is given by the fact we have no information about the level of the students' entrance mathematical knowledge, nor about their morale and will. When we employ further characteristics – participation in a midterm test in the course – in our model, we reach AUC 0.761. It can be interpreted, that many students (roughly 250) did not engage in courses at all. The reason can be the fact, that a certain group of students does not really want to study, but only requires a certificate of study. Another cause is the COVID-19 pandemic, where we can assume that especially part-time students, who typically work and have families, were affected, and consequently forced to substantially reduce the fulfilment of study obligations.

Regression techniques were used also in Laging and Voßkamp (2017) to identify the determinants of mathematics performance. It turns out that the type of school graduation is one of essentials determinants, which is consistent with our findings. Büchele (2020) applied probit regression to assess the impact of variables describing students' personalities on the decision whether to participate in the preparatory course. Logistic regression assessing the influence of variables on the student success in the mathematic course was also performed. In both cases, the author finds gender to be really significant, but the medium term effect of attending the preparatory course was not found at all.

Conclusion

Based on our results, it is possible to declare that the preparatory mathematics course has a positive effect on success rate in undergraduate mathematics courses. This effect is not strong and requires not only visiting the prep course, but also preparing and studying – only students with above average results from the prep course test have significantly higher success rate. In general, we recommend providing preparatory course or some other support to improve students' ability in high school mathematics with the goal at least maintain the level of mathematical competencies required for Industry 4.0. The challenging online form of the preparatory course will be required probably. For further research, better information about high school mathematics level of individual students will be necessary to know. We will elaborate ways how to get it, what is conditioned by the willingness of students – and these we can motivate to some extent, for example, through a scholarship.

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ONLINE VERSUS CONTACT CLASSES AT UNIVERSITY: THE PERCEIVED MENTAL LOAD

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Abstract

The paper brings forward a pressing issue of the perceived mental load of a forced transformation of the university classes into a completely online environment due to the Covid-19 restrictions. The objective of this paper is to evaluate the demands of online education from a psychologist's perspective, to examine the subjective mental load. To reach this, the perceived mental load of the online and contact classes was compared by 107 students at the Faculty of Economics and Management at the Czech University of Life Sciences (FEM CULS) in Prague. The obtained results proved high demands of current settings, mainly drawing attention to the direction of a high negative aspect of perceived psychic monotony during the online lectures, which was established to be a setback to attention and the learning process in general. The implications for the design and form of future classes are discussed.

Keywords

Attention, contact classes, mental load, monotony, online classes, university students

Introduction

Contemporary education is no longer based on a traditional way of studying from books in the classrooms, online study materials and platforms have become a new norm over the last few decades. The transition from traditional to more or less blended way of learning lasted a considerable period, until recently it has become quite common at least among tertiary educators (Stein and Graham, 2020). The year 2020 brought together with the new anti-COVID-19 measures a vast number of restrictions in every area of everyday life. According to the UNESCO (2020) research, all levels of schools were for various period closed in more than 160 countries all over the world, that affected more than 90% of all learners' population, that means around 1.4 billion learners. The unprecedented new situation required also new measures in the sector of tertiary education, some see it as a challenge to both the educators and the students as well (Bakker and Wagner, 2020). With no preceding warning nor time to prepare for it, the virtual contact became the main and in a majority of the cases the only way of education at the universities overnight (Moser, Wei and Brenner, 2021), while up till then teachers used the digital means during their lessons depending on the character of the taught subjects (Záhorec and Hašková, 2019), lecturers in humanities subjects are reluctant to apply the methods of blended learning in their teaching practices, largely due to the lack of respective skills and insufficient institutional support (Antonova, Merenkov and Popova, 2019). The educators, therefore, had to face new challenges, next to the technical side of the issue, also the shift in the content of the information delivering through the online environment should be necessary to keep the high standard of tertiary education. Mishra, Gupta and Shree (2020) have already reported preliminary outcomes of the study about online teaching-learning experience in higher education during the lockdown period of the Covid-19 pandemic with the

results showing that students experience a lack of interest and attention during the online classes as they were not accustomed of learning with smartphones and computers turned into the major setback for them.
Next to the fact that contact classes provide the students with more stimuli than the online ones, most recent studies also reveal that students generally benefit more from contact classes due to the higher level of all interactions involved in the learning system: not only student-teacher and student-content interaction but also very importantly student-student interaction (Meulenbroeks, 2020).
As these novels and originally interim measures became a stable component of education practice, the issue of motivation to follow the teacher's instructions and paying the attention to the lectures became more dominant in the learning process. According to Reynolds and Shirey (1988) the processes such as identifying important information, attention allocation, and comprehension students go through while studying are as important as traditional study skills themselves. Techniques such as note-taking, underlining, summarizing and others are mere attempts to integrate and understand information that applies only after these processes. Also, Dehaene (2020) stresses out the attention as the fundamental part of learning; it is present in at least three major attention systems in the brain as it is now being integrated into most contemporary artificial neural networks. That is the background of the reason, why students must pay attention to have a chance to reach the deeper lexical and conceptual representations that support comprehension and semantic memory. Paying attention consists also of suppressing unwanted information, which may be especially difficult in a non-school environment.
Attention is usually defined as the activation added to a structure that facilitates the processing of information. One of the simplest notions is embodied in the theory of attention, by which filtering operates on channels of information input (LaBerge, 2014) - the selection of information to pay the attention to and maintain it for a definite time to be able to process it and learn, as is required from their role of students.
In each human occupation, there can be evaluated the impact of work activity and its demands in terms of neuropsychic load. From the viewpoint of work and organizational psychologists, we can categorize each profession according to its mental load and subjective response of a person to it (Židková, 1993). Subjective evaluation of mental load through Meister's questionnaire is unequivocally used as a reliable method for measuring mental load at various workplaces (Židková, 2002; Mrhálek a Kajanová, 2018). We have used it to measure perceived mental load in the academic environment, as we believe, that full-time students experience the comparable levels of the stress connected with the mental load arising from study demands as other people at their work usually do.
The objective of the paper is to evaluate the demands of online education from a psychologist's perspective, to examine the subjective mental load of students at FEM CULS in Prague. To reach this, the perceived mental load of the online and contact classes is going to be compared. The following hypotheses will be tested to ascertain the plausibility of the hypothesised concept of the increase of demands laid down on students during current restrictions:
H_{01}*: The mental load of online education and contact classes are perceived as equal.*
H_{02}*: The perceived mental load of online classes is equal to the normal average level of the mental load of the workers.*

The present paper is divided into the following sections: it offers a brief description of the current state of the art in the Introduction, above. Materials and methods describe a group of respondents, methods for data collection and used statistical analysis. Section Results is dedicated to the most important findings arising from the statistical analysis of the data. Next, the section Discussion

compares results with other relevant researches together with their applicability. The Conclusion of the paper summarizes the most important findings and also provides for the use of the outcomes in an academic environment in current settings.

Materials and Methods

Participants

The research was conducted on a convenient sample of 107 students of the second year of bachelor (n = 41) and the first year of master (n = 66) programmes of the Faculty of Economics and Management at the Czech University of Life Sciences in Prague, during the winter semester of the academic year 2020/2021. The gender structure mirrors the predomination of women to men at Economical faculties (according to CZSO, 2020), there were 20 males and 87 females in the sample. All the students cooperated voluntarily with the use of MS Teams online environment.

Method

The data were gathered with the use of the standardised psychological questionnaire: the Czech version of the *Meister questionnaire for the assessment of neuropsychic load*. The questionnaire is considered to be a universal method created originally by Meister (1975). The psychometric qualities of this questionnaire were repeatedly evaluated and the critical value of the excessive psychic load has been stated (Židková, 2002; Židková, 2005). The questionnaire consists of 10 items (focusing for example on time pressure, low joy from work, tiredness), such as: '*I experience difficulties to concentrate attention on a work, as there is nothing new happening over a long period.*' The assertions could be assessed on a 5-point Likert style scale. The outcomes could be evaluated as three separate factors (*Overload, Monotony, Unspecified factor*), or all the items together resulting in one overall score of the *Mental load* in general. Each student completed the questionnaire two times – the first one assessing the perceived mental load of current online classes and the second one assessing, in the same way, the previous contact education.

The descriptive statistics of the group of respondents was computed first, followed by the description of separate *Mental load* factors – *Overload, Monotony and Unspecified factor* for online as well as for contact classes (its means, standard deviations and standard error means).

Later, the paired samples tests for online and contact classes and one sample T-tests (using as a test value the average value of the large Czech sample from Židková, 1993 and 2005) were executed.

The data were processed with the use of software IBM SPSS Statistics, version 27, all the results are to be found in the respective section.

Results

The comparison of the online and contact classes was determined by the comparison of the results of the two of the Meister questionnaires filled by each student.

Paired sample statistics were run, comparing the assessment of online and contact classes by each student. The average values of each *mental load factor* for both means of teaching were computed and are displayed in Table 1.

As can be seen straight from the average values of the *mental load*, there is a noticeably higher level of *monotony* perceived by the students during online classes.

For the comparison of an average value for contact and online classes within each factor, the paired differences were computed via paired T-test (Table 2). As it was already expected from descriptive statistics results, *online monotony* is perceived significantly (at 0.01 level) higher than the one at contact classes. The rest of the *mental load factors* are perceived on a similar level for both forms of education, even though online education shows slightly lower overload and slightly higher unspecified mental load factor than the contact one.

Mental load factors	Mean	*N*	Std. Deviation	Std. Error Mean
Online overload	7.37	107	2.53	0.25
Contact overload	7.71	107	2.19	0.21
Online monotony	8.45	107	2.56	0.25
Contact monotony	7.71	107	1.83	0.18
Online unspecified factor	11.82	107	3.54	0.34
Contact unspecified factor	11.37	107	3.11	0.30

Table 1: Descriptive statistics of the Mental load factors, 2021 (source: own calculation)

Mental load factors	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		*t*	*df*	Sig. (2-tailed)
				Lower	Upper			
Online overload Contact overload	-0.34	2.88	0.28	-0.89	0.22	-1.21	106	.230
Online monotony Contact monotony	0.75	2.87	0.28	0.20	1.30	2.69	106	**.008***
Online unspecified factor Contact unspecified factor	0.46	4.38	0.42	-0.38	1.30	1.08	106	.282

***The significance level is <.01*

Table 2: Paired differences in the Mental load, 2021 (source: own calculation)

To address the hypotheses stated earlier, we reject the H_{01}: *The mental load of online education and contact classes are perceived as equal.* The mental load of online education is perceived to be higher than the one of contact classes, namely at the factor of the *monotony* of online classes (at the significance level of 0.01).

The average *mental load* of online classes was compared to the average values (further referred to as a test value) of a large sample of workers of various professions done by the Czech work hygiene service (Židková, 2002) by one-sample *T*-test. The results can be seen in Table 3. Average levels of *mental load* of online classes significantly differ at all the factors compared to the working population (with average levels: 9.5 for overload, 7 for monotony and 11 for unspecified factor). The difference is most significant for perceived *overload* and *monotony*, where overload is perceived to be significantly higher by the workers than by the students.

Mental load factors	Average value	*t*	*df*	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Online overload (test value = 9.5)	7.37	-8.73	106	**.000*** **	-2.14	-2.62	-1.65
Online monotony (test value = 7)	8.45	5.86	106	**.000*** **	1.45	0.96	1.94
Online unspecified factor (test value = 11)	11.82	2.41	106	**.018***	0.82	0.15	1.50

** The significance level is <.05, *** the significance level is <.001.*

Table 3: One-Sample T-test, 2021 (source: own calculation)

The H_{02}: *The perceived mental load of online classes is equal to the normal average level of the mental load of the workers* is therefore to be rejected, as it is displayed in Table 3, these levels differ significantly in all the factors. Next to the significantly higher level of the *monotony* not only in contrast to the contact classes but also compared to the norm sample (at the 0.000 level of significance), we may notice a higher level of *unspecified mental load factor* of online education compared to other professions (at the significance level of 0.05). Contrary to these

findings, students perceive the overload of online classes significantly lower (at the 0.000 level of significance), than is usual. That states the significant disbalance of the workload of online education, which is going to be discussed further.

Discussion

The current situation at tertiary education is unprecedented and should be handled as such. It is not surprising then, that not many studies were already done in this field. On the other hand, we may find a considerable number of researches concerned with the advantages and disadvantages of online learning. According to some (Bernard et al., 2014), the blended learning approach could result in significantly higher learning outcomes in comparison to more traditional forms of classroom education, some (Chenoweth et al., 2006) even brought a piece of evidence that blended learners scored as well on achievement tests as those in traditional classes and in some instances outperformed them. Thus, we may hope to take advantage of the current situation and approach it as a challenge enabling us to get out of it better equipped with the experience of virtual learning to improve the future education of students.
In a study by Shu and Gu (2018), students' face-to-face and online interactions within the same university course were ranked according to their perceived quality and strength of interactions. Unsurprisingly, it was found that the level of interactions appeared to be significantly higher in the offline part. When offered a choice, students opted for online education of subjects they judged as easier, whereas they preferred contact education of the more difficult or important subjects (Jaggars, 2014).
Even though the case study of Meulenbroeks (2020) proved that students generally prefer offline lectures, if small group work, especially outside of class, is a part of the course design, students recommend that this could very well, and even preferably, be done in the online realm. This could have implications for the course design of future planned classes.
Moser, Wei and Brenner (2021) share educators' comments on so-called 'emergency' online classes during Covid-19 pandemia, they report difficulty keeping students accountable and sustaining their motivation and interest, as an additional clarity related to their assumptions of lower student outcomes.
Monotony is defined as: 'slowly appearing state of lower activation, which can appear during longer-lasting uniformed tasks, and may lead to feelings of drowsiness, lowering of performance and reactive readiness' (Hladký, 1993:46). The psychic monotony of certain tasks influences to a great extent the performance of a person specifically leads to a decrease of the activation level of CNS, loss of attention, increase errancy and decrease performance (Židková, 2005). That is why Mishra, Gupta and Shree (2020) felt important to develop the soft skills of the students, especially listening skills online, as early as possible. Another way of enhancing the positive impact on students' activity, motivation, and their level of output knowledge from online education was confirmed to be the use of personalized e-course (Mudrák, Turčáni and Reichel, 2020).
Bravo-Agapito, Romero and Pamplona (2021), as a result of a five-year study, stated that among other variables, the age of students is an important negative predictor in academic performance at completely online learning. That could be a factor worth considering not only for the University of the third age but especially for the number of combined students and students at consultation centres in regions.
On the other hand, when discussing the pros and contras of online education, especially from developing countries (Oyedotun, 2020) or poorer parts of the globe (UNESCO IESALC, 2020) is often reported the crucial problem of low or no internet connection at all.

Conclusion

The findings point to the direction of high levels of mental load during online education when compared to contact classes the monotony arises as to be the most prominent factor. When compared to the mental load of other occupations, it is also perceived as considerably higher, in all the three dimensions in question. We may conclude, that studies could be and are seen as

demanding, the online classes especially. The teacher should bear in mind the dangerous level of monotony perceived in online classes and need to effectively target this area.
As is recommended, we should see the crises as a challenge and as such we should be able to draw upon beneficial changes to the pre-Covid settings to use the best of both forms of education and create an environment rich in contacts, transferable and accessible knowledge and skills for those who wish to educate themselves not only in current settings but more importantly for the future when all the forms and means of education will be optional and hopefully fully accessible.

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THE ROLE OF SOCIAL NETWORKING SERVICES IN HIGH SCHOOL STUDENTS' LIVES

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Abstract

This paper investigates the relation between using social networking sites and different aspects of students' well-being.
The dataset consists of 3841 high-school students from the Czech Republic, Italy and Slovenia. The analysis was performed using two non-linear logistic regression models.
The results show there is a positive relation between social networking and self-trust for the limited time spent on social networks. If students devote too much time to using social networks, there is potential for quite high negative effects. Further, social networking has no impact on students' life satisfaction.
Our study indicates both the potential positive and negative impacts of using social networking services. The negative effect can be especially significant if students spend too much time on social networks.

Keywords

Social networks, happiness, self-trust, youth, Facebook

Introduction

The use as well as the impact of social network sites and of social media on people is the subject of intensive research. General impacts on well-being were summarized by Verduyn et al. (2017). Youth life satisfaction is an important topic that has been studied by many researchers for decades and from several points of view and fields. (Proctor, Linley, and Maltby (2009), gathered a comprehensive literature review. King, Reno, and Novo (2014), summed up literature from a socio-economical perspective.
A study by Lai, Hsieh, and Zhang (2019) showed that Facebook use was positively related to the subjective well-being of both male and female students and supported the idea formulated by Frison and Eggermont (2016) that students with a greater need to belong to a peer group and explore their identity spend more time on Facebook.
It is known that social networks affect the social life of people. (Burke, Marlow, and Lento (2010) have found that: "People who feel a discrepancy between the social interactions they have and those that they desire tend to spend more time observing other people's interactions. Whether it is the loneliness that causes the clicking or the clicking causes the loneliness is left for the future waves of this study.".
Cheng, Burke, and Davis (2019) found that young peoples' (under 25) subjective report of Facebook use as problematic is twice as likely than by other age groups.
As is apparent from this section, social networking has been investigated in much detail. Although there are articles describing the effects of using social networks, there has not yet been any study that would investigate the connection of this phenomenon with self-trust and life satisfaction in so

much detail. The added value of this study also stems from the specific choice of countries: Czech Republic, Italy and Slovenia.
Personal relationships, quality of nutrition, being with friends and many other factors influence peoples' psychological well-being. Therefore, it is important and natural to focus on factors influencing these aspects be it in science or one's own personal life.
The impact of social networks on human life is increasing. Content generated by users is shared, viewed and interacted with by other users; this could affect peoples' lives either in a positive or negative way.
The aim of this paper is to investigate the role of online social networking in the lives of high school students in comparison with other free-time activities.
The hypotheses of this paper are:

1. Social networking decreases the self-trust of the students;
2. Using social networks has a negative impact on the life satisfaction of the students;

This paper is organized as follows: Section 2 is concerned with the literature review, Section 3 deals with the methodology of the presented research, Section 4 contains the results and a discussion while Section 5 concludes this article.

Materials and Methods

Our study is based on data collected in a questionnaire survey among 3841 students from three countries: 1564 students from the Czech Republic, 800 students from Italy and 1477 students from Slovenia. Data was collected in November 2017. We selected these three countries because they lie relatively close to each other and have similar values and way of living (Helliwell et al., 2019). Therefore, we can work with our dataset as a whole and conduct statistical analysis on the whole sample. Data was gathered in high schools in the Czech Republic, Italy and Slovenia. The selection of the schools was subject to legal conditions in each country. Also, the selection in each country was not random, we made sure that all schools offered the same type of education (general education) and all schools educated both boys and girls. Therefore, our dataset can be thought of as a good representation of our target group which is regular high school students from schools with general education.
The questionnaire consisted of 26 questions. We inquired about different areas of students' lives in order to control the different influences on the variables that we investigated in this paper. In this article, we focus on the part of regression results concerning self-trust, life satisfaction, social networks and different free-time activities. Regression results show the relations of all independent variables purged of the effect of other variables. Therefore, in this respect the results are unbiased.
The question regarding the dependent variable in the questionnaire concerning the variable Self-trust was: To what extent is this statement true for you: "In my life I am and I will be able to take care of myself and make a living"? This way we studied the self-confidence of the students.
As for the second dependent variable (Life satisfaction), we selected a standardized question that is used widely among researchers in the field of economics of happiness (see e.g. Frey, 2008). The question was: "How would you evaluate the quality of your current life on a scale from 0 to 10 where 0 is the lowest quality and 10 is the highest quality?" This question is also used in an annual inquiry conducted by the United Nations called the World Happiness Report (Helliwell et al., 2019, 2020). It studies the happiness levels and factors of most countries in the world. Thus, our results are comparable to the findings of other studies. Although the terms Life Satisfaction and Happiness are strictly separated in many scientific fields, in this article, we follow the practice of the economics of happiness (see e.g. Frey and Stutzer, 2012) and use these terms interchangeably.

In the regression analysis, we use 4 additional dummy variables. The first two are Population Medium (for 3000<=Population<100 000) and Population Large (for 100 000<=Population). The reference point is Population<3000. In this way, we distinguish students in villages, from small towns and in big cities. The other two variables are Country2 Italy and Country3 Slovenia. Here, the reference point is the Czech Republic. Variable Breakfast Regular was included as a proxy variable for leading a structured life in the same way as in the research by Peltzer and Pengpid (2013).

Coefficients for the variables Social Networking Time, Alcohol and TV Time were included both in linear and squared form (SocNetworksTime2, Alcohol2, TVTime2), because non-linear dependency with a peak of the effect could be expected.

To study the relations between different life aspects of the students, we created two non-linear regression ordered logit models. Logistic regression is used because the dependent variables are discrete.

Different students use social networks for different purposes. For instance, some use them to organize meetings with their friends, some students use them to share photos and experiences from their travels while some use them to fill their spare time by chatting with their friends. The effects of these activities can be different and future research should assess this issue. Also, there is the possibility of studying the impact of using different social networks (Facebook, Twitter, etc.). In this study, we do not go into much detail. We study using social networks in general. This way, a more straightforward and clear comparison is possible. However, we encourage other researchers to investigate the aforementioned aspects in future research.

Our models are based on the whole dataset. A different approach would be to construct separate models for all three countries. In this way, possible differences between countries could be discovered as far as relations between various variables are concerned. This is not a part of this study. We take advantage of creating complex models because this way the coefficients and their significance are estimated with more precision. Thus, the results reflect reality better. Using this method, general trends are reflected in the models with more accuracy. This way we follow the approach of other authors in this field such as Engelbrecht (2009) and Richards et al. (2015).

It is necessary to emphasize that regression models do not show one-direction causalities but rather relations. If an independent variable is significant, the causality direction can go both ways. However, it has been shown that even in this case, regression models serve as a good approximation and that many theoretical difficulties do not cause significant deviations as well as distortions on a practical level (Kahneman & Schwarz, 1999).

Results and Discussion

Firstly, we present a descriptive analysis concerning our sample and variables which we focus on in table 1.

		Mean	Median	Std. Deviation
Self-trust	0-10	7.08	8.00	2.55
Life satisfaction	0-10	7.25	8.00	1.96
Social Networks Time	hours per week	23.92	15.00	24.41
Sport Time	hours per week	6.47	5.00	5.57
TV Time	hours per week	6.55	5.00	7.12
Friends Time	hours per week	11.08	8.00	11.93
Reading Time	hours per week	3.77	2.00	5.98
Art Time	hours per week	2.90	1.00	5.37

Table 1: Descriptive analysis (source: own calculation)

Table 2 shows the regression results.

	Dependent variable	
Explaining Variable	Self-Trust	Life Satisfaction
Soc Networks Time	0.014933000***	-0.006979160*
Soc NetworksTime2	-0.000119000***	4.6487e-05
Sport Time	0.013343800**	0.013764600**
TV Time	-0.051760000***	0.005374960
TV Time2	0.000941000***	-0.000212214
Friends Time	0.013499000***	0.009160000***
Reading Time	-0.005743440	-0.012180600**
Art Time	-0.013764800**	0.010213200*
Health Physical	0.051414000***	0.099199000***
Population Medium	-0.076096100	0.141845000**
Population Large	0.091354000	-0.034585000
Commuting Time	0.000160336	-0.005148000***
Cigarettes	0.000506904	-0.021682000***
Alcohol	-0.024626900	0.002346040
Alcohol2	0.000582583	-0.000557971
Allowance Log	-0.010266100	0.030699100
Earnings Log	0.047109000***	0.044651000***
Relationship Parents	0.044888000***	0.186839000***
With Parents Live	0.277218000***	-0.360896000***
House Own	0.070528300	0.057958900
Partner	0.215266000***	0.311282000***
Religious Spiritual	-0.001957620	0.045574000***
Breakfast Regular	-0.000610503	0.032168000***
Gender Female	-0.014638000	-0.161554000***
Age	0.074998000***	-0.044670400*
Country2	-2.091310000***	-1.386290000***
Country3	-1.170370000***	0.329183000***
Number of cases correctly predicted	25.6%	27.7%

Table 2: Regression models output. Ordered logit, 2017, ***: 1% level significance, **: 5% level significance, *: 10 % level significance (source: own calculation)

The first column presents the independent variables. Other columns each show the estimated coefficients of one regression model. Each column is related to one model with a dependent variable in the second row of the table. Along with the estimated coefficients, we also show the significance of the coefficients. These are related to the p-value of the corresponding test whose null hypothesis is that the coefficient in question is equal to zero.

The portion of correctly predicted cases for the logit models is relatively low. This is due to the fact that all of the dependent variables are based on reported information of the students, which can fluctuate with time and is influenced by many unobserved variables. Nevertheless, the low values of the models' criteria are not a problem in this case – our goal is not to forecast the values of the dependent variables but to find general trends and relations for which our models, along with their criteria, are sufficient. When interpreting the results, we also focus on the role of other free-time activities and compare these with social networking.

Self-trust

In the regression model with the dependent variable Self-Trust, the linear coefficient of the social networks variable is positive and the squared coefficient negative. This indicates that the effect (if this causality direction applies) of social networking on self-confidence is positive for a limited number of hours spent online and negative for large amounts of time. To find the breakpoint, we need to find the maximum of the function $0.014933x - 0.000119x^2$ (the numbers are the coefficient of the linear variable social networks and the coefficient of the squared variable social networks, respectively). The maximum at 62.7 tells us that increasing the time on social networks up to 62 hours per week has a positive effect on self-confidence and going beyond this number of hours has a negative effect (hypothesis no. 1 confirmed only for larger amounts of time spent on social networks). A similar pattern in the case of watching TV was discovered by Frey and Benesch (2008). In their case, a limited amount of time spent watching TV was shown that it could bring about a positive effect but large amounts of time potentially decreased happiness. The fact that social networking has the potential to increase self-trust is important since there are many studies which emphasize the importance of psychological attitudes (see, e.g., Peltzer & Pengpid, 2013) of which self-trust is one example. The specific number (62.7 hours per week) is intuitively very high. However, taking into account the shape of a quadratic function, the benefit of using social networks for more than 40 hours per week is very low. Also, it is possible that students overestimated the time spent on social networks. It is likely that they did not do this on purpose. Rather, it is possible that since they have their mobile phone with them at all times – even when they are not using it. Then, they count this time as spent on social networks. If it is so, then in future research these two types of using social networks (active and passive) should be distinguished.

The results also show a negative relationship between art time and self-trust. In this case, we believe that the causality direction goes from self-trust to art: people who are less self-confident participate more in artistic activities. It is possible that by creative activity they can increase their self-esteem.

Life Satisfaction

We constructed the model with the dependent variable Life Satisfaction in order to measure the relationship between free-time activities and life satisfaction of the students. The results showed no relation of social networking with one's life satisfaction. With no significant relation in general, it is certain that there is no direct impact. Therefore hypothesis no. 2 is refuted. Only a potential negative relation is indicated by the linear coefficient – if this potential relation turned out to be true and to reflect reality, then we would state that there is a possible negative effect of social networking on life satisfaction. However, there are studies which say that using social networks has positive and negative aspects (see, e.g., Rook, 2015). If these effects cancel each other out, then the relationship between using social networks and life satisfaction could be neutral which would correspond with our results and also with the results of Janáček and Šťastný (2018).

The output shows a positive relationship between sport and life satisfaction as well as between friends time and life satisfaction. It is likely that the causality direction from independent variables to the dependent variable applies and both of the explaining variables affect students' life satisfaction in a positive way. This would correspond to the studies of Abedini and Majareh (2015) and Zarei (2013).

The model results also show a negative relationship between reading and happiness. We believe that the reverse causality direction applies in this case: students who are less happy strive to make their lives better and look for information in books. Yet, this is again only a hypothesis.

Conclusion

In this article, we investigated the relationships between using online social networking services and different aspects in the life of high school students from the Czech Republic, Italy and Slovenia. A regression analysis was performed by constructing two ordinal logit models.

The results indicate that spending a limited amount of time on social networks can increase the self-confidence (self-trust) of the students. If the time goes beyond a certain number of hours per week (the approximation of our analysis is 62.7), then self-trust decreases. Further, our statistical outcomes show no relationship between social networking and students' life satisfaction.

Our study shows that the use of social networks is connected with potential benefits and also with dangers. Negative effects are especially likely when the time on social networks is very high. Students should be aware of the potential negative effect of excessive usage of social networks. Since the Italians spend much more time on social networks than Czechs and Slovenians, this recommendation applies to them more. Our study also creates space for future research; especially studying the different purposes for using social networks and using different social networking sites could prove beneficial.

Acknowledgement

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EVALUATION OF ORAL EXAMS IN MATHEMATICS IN COVID TIME

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Abstract

In the winter semester of the academic year 2020/2021, due to coronavirus, students could choose the distance form or the full-time form of the oral examination in mathematics at the Prague University of Economics and Business. Comparison of these two forms of the oral examinations using different methods of mathematical statistics will be performed in present paper. Moreover, relation between results of oral examinations and previous exam tests results will be studied using methods of regression and correlation. All exam tests were performed in distance form with a strictly limited processing time. Results of this paper can be used for improvement of the online education at university.

Keywords

Coronavirus, methods of mathematical statistics, online education, Prague University of Economics and Business

Introduction

Oral exams are becoming more and more important nowadays, when the objectivity of exam tests written in a distance form is not always ensured. Therefore, in this article we shall focus on the analysis of oral exams. We shall study exams in mathematics at the Prague University of Economics and Business. The number of possible points from the mathematics exam is in interval [0, 100]. These points are the sum of points from the mid-term test, the exam test and the oral exam. In winter semester of the 2020/2021 academic year, due to coronavirus, students could choose the distance form or the full-time form (with personal participation) of the oral exam in mathematics. The distance form of the oral exams was performed using MS Teams. Structure of the oral exams in the course Mathematics for informatics (ident 4MM106) and in the course Mathematics for economists (ident 4MM101) is in Figure 1.

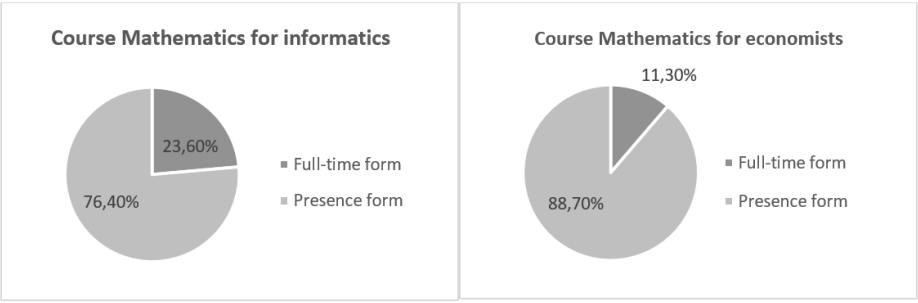

Figure 1: Oral exams in % in winter semester of the 2020/2021 academic year (own construction)

Fraction of students with the full-time form of the oral exam in mathematics in course Mathematics for informatics is greater than fraction of students in course Mathematics for economists. Therefore, we shall use the results of exams in the course 4MM106 to compare the

forms of the oral examination. In the second step, we shall study the dependence of the oral exams on the results of exam tests. These tests are standard tests, no multiple choice question tests (see e.g. Klůfa (2015a), Klůfa (2015b), Klůfa (2016)) are used at the time of coronavirus. The exam tests were performed in distance form with a strictly limited processing time. The oral examinations follow the exam tests within two days after the exam tests. The number of possible points in the exam tests and in the oral exams is the same (the number of points is in interval [0, 40]). The oral exams are also studied in some scientific papers. In Akimov and Malin (2020) is shown that oral examination can assist in overcoming some of the challenges associated with online learning. In Okada, Mendonca and Scott (2015) are mentioned practices on the use of a web videoconferencing application to quality control student assignments through online oral examination. Comparison of online and traditional assessments is mentioned in Rovai (2000). A study of students' experience of oral presentations is in Joughin (2007). Students described the oral presentation as being more demanding than the written assignments, more personal, requiring deeper understanding, and leading to better learning. The oral presentations at the University of Extremadura, Spain are studied also in Murillo-Zamorano and Montanero (2018). Student performance in and attitudes towards oral and written exams were compared in Huxham, Campbell and Westwood (2012). This study suggests that oral assessments may be more inclusive than written ones and that they can act as powerful tools in helping students establish a 'professional identity'. Oral examinations in German universities are analysed in Kehm (2001). Similar problems are solved also in Joughin (1998), Haque et al. (2016), Fluck (2019). Results of this contribution can be used for improvement of the online education at the Faculty of Informatics and Statistics at the Prague University of Economics and Business.

Material and Methods

The analysed data are the results in mathematics of 377 students in winter semester of the academic year 2020/2021 in the course Mathematics for informatics (ident 4MM106). These data are sorted according to ways of oral exam – see Table 1.

For study the differences of the full-time form and the distance form of the oral examination in mathematics we shall use t-test for independent samples and the same variance. Statistic t is (see e.g. Anděl (1978))

$$t = \frac{\bar{x} - \bar{y}}{s\sqrt{\frac{1}{m} + \frac{1}{n}}}, \tag{1}$$

where

$$s = \sqrt{\frac{1}{m+n-2}\left[(m-1)s_x^2 + (n-1)s_y^2\right]}$$

($\bar{x}$ is average number of points in the full-time form of the oral examination, $\bar{y}$ is average number of points in the distance form of the oral examination, s_x^2 is variance of points in the full-time form of the oral examination, s_y^2 is variance of points in the distance form of the oral examination, $m = 89$ (the sample size), $n = 288$). When

$$|t| > t_\alpha(m+n-2),$$

where $t_\alpha(m+n-2)$ is critical value of student t distribution with $(m+n-2)$ degrees of freedom and significance level α, the hypothesis "mean number of points in both forms of oral exam is the same" is rejected at significance level α.

For the study the dependence of the number of points in the oral examination on the number of points in exam test we shall use methods of correlation a regression analysis, e.g. we shall use test of significance of correlation coefficient r. We shall verify the validity of the null hypothesis "the number of points in the oral examination does not depend on the number of points in exam test". When $|t| > t_\alpha(m-2)$, where

$$t = \frac{r}{\sqrt{1-r^2}}\sqrt{m-2} \tag{2}$$

and $t_\alpha(m-2)$ is the critical value of Student t distribution for $(m-2)$ degrees of freedom and significance level α, the null hypothesis "the number of points in the oral examination does not depend on the number of points in exam test" is rejected at significance level α (see e.g. Rao (1973)).

Results

Distributions of number of points in exams in mathematics in winter semester of the 2020/2021 academic year in the course Mathematics for informatics for full-time form and distance form of the oral exams are in Table 1 (see also Figure 2). Some fundamental descriptive statistics of these distributions are in Table 2. For example, average number of points in oral exam for full-time form is $\bar{x} = 25.079$ and for distance form is $\bar{y} = 27.639$. The difference between these averages may be significant or may have occurred randomly. For objective decision we shall use t-test for independent samples.

Number of points in oral exams	Frequency for full-time form of the oral exams	Frequency for distance form of the oral exams	Sum
0 - 5	3	14	17
6 - 10	6	8	14
11 - 15	3	19	22
16 - 20	14	30	44
21 - 25	19	42	61
26 - 30	19	48	67
31 - 35	12	67	79
36 - 40	13	60	73
Sum	89	288	377

Table 1: Distribution of number of points in oral exam (own construction)

	Full-time form of the oral exams	Distance form of the oral exams
Frequency	89	288
Average	25.079	27.639
Median	26	30
Modus	25	35
Std. Deviation	9.6675	10.1998
Kurtosis	-0.019	0.309
Skewness	-0.564	-0.894

Table 2: Descriptive statistics for number of points in oral exam (own calculation)

We shall test null hypothesis

H_o: mean number of points in both forms of oral exam is the same.

For the decision on the validity of the hypothesis we shall compute according (1) statistic t. We have $t = 2.0948$. The critical value of Student t distribution for $m+n-2=375$ degrees of freedom and significance level 0.05 is $t_{0.05}(375)=1.9663$. Because

$$|t| = 2.0948 > t_{0.05}(375) = 1.9663$$

the hypothesis "mean number of points in both forms of oral exam is the same" is rejected at significance level 0.05. The difference between averages $\bar{x}=25.079$ and $\bar{y}=27.639$ is statistical significant. The results of the full-time form and the distance form of the oral exams differ significantly (with probability which is greater than or equal to 0.95).

Remark. For the t test above, we assume that the variance of points in the full-time form of the oral examination and variance of points in the distance form of the oral examination are the same. We shall use the F test to verify this assumption. The value of the statistic F (see e.g. Anděl (1978)) is $F = 1.1132$ and critical value is 1.3460 (p-value is 0.279). Null hypothesis "variance of points in the full-time form of the oral examination and variance of points in the distance form of the oral examination are the same" is not rejected at significance level 0.05. The assumption of the t test is fulfilled.

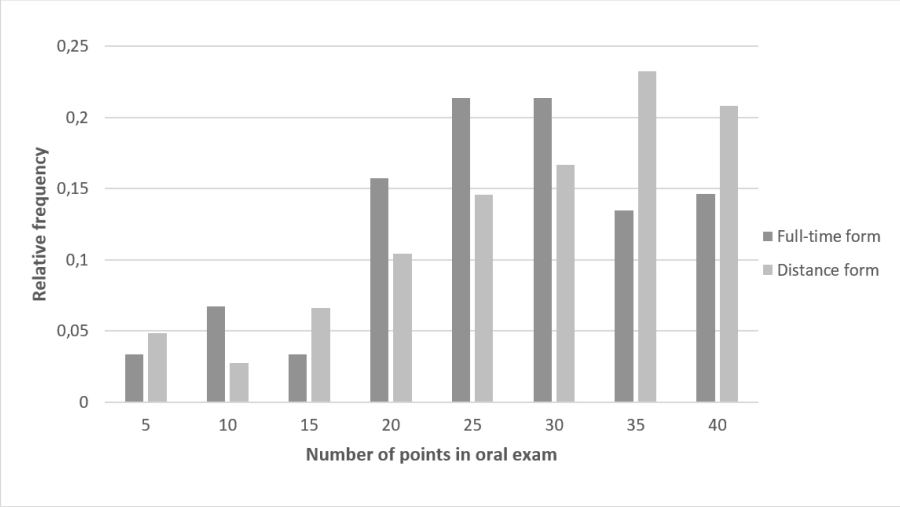

Figure 2: Distribution of number of points in oral exams in math in winter semester of the 2020/2021 academic year in the course 4MM106 (own construction)

In the second step, we shall study the dependence of the oral exams on the results of exam tests. The exam tests were performed in distance form with a strictly limited processing time. The oral examinations follow the exam tests within two days after the exam tests. The minimum number of points to pass successfully the exam is 60. It seems that a student who has a lot of points from the mid-term test and the final test (close to 60) does not pay enough attention to the oral exam. If this hypothesis were true, the dependence of the oral exams on the results of exam tests would be negative.

For objective analysis of the problem we shall use methods of mathematical statistics (regression and correlation analysis). The analysed data are the results of 89 students who passed the full-time oral exam (i.e. the sample size $m=89$). We shall assume a linear trend (see Figure 3), therefore we use correlation coefficient (see e.g. Rao (1973)). The correlation coefficient is

$$r = 0.341.$$

We shall test null hypothesis

H_o: the number of points in the oral exam does not depend on the number of points in the exam test.

According to formula (2) we shall compute statistic t as follows

$$t = \frac{r}{\sqrt{1-r^2}}\sqrt{m-2} = 3.38$$

Critical value of Student's t distribution for $m-2=87$ degrees of freedom and significance level $\alpha = 0.01$ is 2.63. Since

$$|t| > 2.63,$$

the null hypothesis Ho is rejected at 1% significance level, i.e. the dependence of the oral exams on the results of exam tests exists. Since $r = 0.341$, the dependence is weak and positive. Using MS Excel (see e.g. Marek (2013)) we obtain furthermore regression line (see Figure 3)

$$y = 13.312 + 0.393x$$

From this regression line it follows: If the number of points in exam tests increases by 10, then the expected the number of points in oral exams in mathematics increases by approximately 4 (3.93). The hypothesis of negative dependence of the oral exams on the results of exam tests was not confirmed.

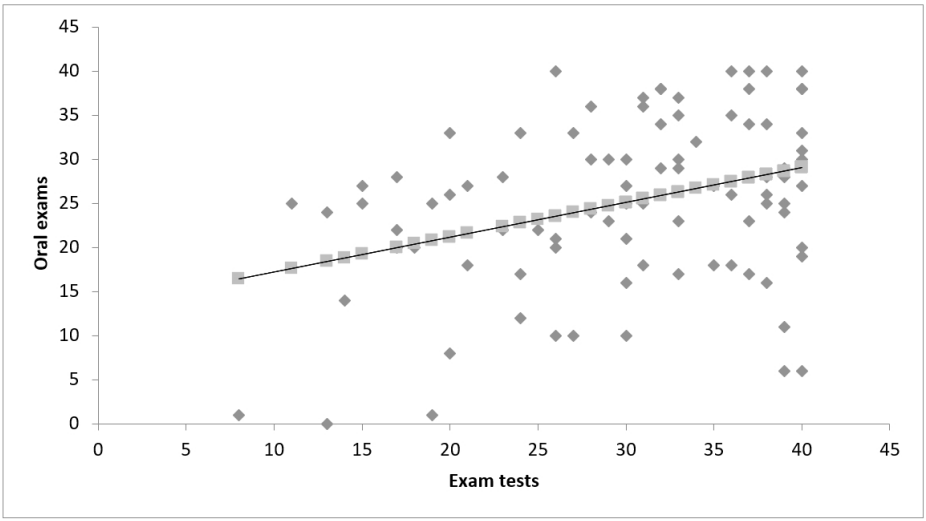

Figure 3: Dependence of the number of points in the oral exam on the number of points in the exam test in mathematics (own construction)

Discussion

A similar problem, which was studied in this paper, is analysed in some scientific works. Analysis of scores from mid-term tests and exam tests at the Prague University of Economics and Business we can find in Otavová and Sýkorová (2014). The authors solve a question, whether the score of the exam tests depends on the score of mid-term tests. Since results show that there is a significant dependence, the results may be used to motivate students to

study continuously. The application of an oral examination as a form of assessment in the online context at the Griffith University in Southport, Australia is studied in Akimov and Malin (2020). The results demonstrate that oral examination can assist in overcoming some of the challenges associated with online learning. However, careful planning is required to ensure that it meets the principles fundamental to a successful assessment strategy: validity, reliability and fairness. Best practices on the use of a web videoconferencing application to quality control student assignments through online oral examination at Brazilian University are mentioned in Okada, Mendonca and Scott (2015). In Iannone and Simpson (2012) we can find the planning and implementation of an oral assessment component in a first-year pure mathematics module of a degree course in mathematics at the University of East Anglia. Results suggest that concerns about staff workload, students' anxiety and fairness were only partially realized and that oral assessments may have a role to play in enriching the current assessment diet in mathematics. Obtained results are similar, but the aim of these papers is a little different.

Conclusion

Students could choose at the time of coronavirus the distance form or the full-time form of the oral examination in mathematics at the Prague University of Economics and Business. From results of the paper follow that there is a significant difference between results of the distance form and the full-time form of the oral exam. The distribution of number of points in the full-time form of the oral exam has a better shape (closer to normal distribution) than the distribution of number of points in the distance form of the oral exam (see Figure 2). Moreover, average number of points in oral exam for full-time form is less than average number of points in oral exam for distance form. The results of the regression and correlation analysis further show that between the results of oral examinations and the results of exam tests there is a weak positive dependence (see Figure 3). The hypothesis that a student who has many points from the mid-term and final test does not pay enough attention to the oral exam has not been confirmed.

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COMMUNICATION IN EDUCATION IN MULTICULTURAL SETTINGS: PROPOSAL OF A NEW METHOD

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Abstract

This paper aims to introduce a new method, which can help to investigate the contents and processes of intercultural communication in an attempt to deepen the effect of education of intercultural students. The process of teaching is accomplished by the communication of a teacher and a student. The teaching facilitates the learning of a student if the teacher and the student understand one another. However, misunderstandings happen easily, because the subjectivity of words' denotation is supposed to be much higher than by the students from the same culture. The sorting experiment is a method, which was originally designed to study the meanings of words. Authors suggest it as a possible mean of studying understandings of words in a multicultural setting, in order to prevent and clear misunderstandings. The outcomes from a pilot done with respondents from two different cultural and language settings are provided to show the feasibility of the method and its possible contributions to the understanding of inter-cultural communication difficulties in education. Special care is given to the implication for education in multicultural settings at universities and for further research and practical use of the method.

Keywords

Education, communication, multicultural settings, sorting experiment

Introduction

Traditionally, the philosophy of education has regarded learning as the acquisition of concepts. Here we will argue that we need to shift the emphasis from concepts to viewing education as interaction, since 'concept' tends to imply something immutable and, ultimately, beyond interpretation and negotiation (Stables, 2013). In this interaction, teachers aimfully enrich students' mental representations resulting in mental models (Sedláková, 2013). Apparently, they build upon already existing mental representations and models, even in the area of words and their meanings. Especially in the education of non-native speakers from the different cultural environment, this 'building upon' may be extremely complicated. Kundrát and Cakirpaloglu (2016) argue that mental representations are the key issue in the field of education for understanding the difficulties with comprehension of the lectures' content and processing the school curriculum.

Any language represents relationships of phenomena, aspects, events, and entities of the world at large in a specific way. However, languages, especially natural languages, differ in how they do it, and so every language does it differently. Wierzbicka (2014) asserts that by committing all the developments of science to English constrains us in our efforts to understand and acquire new knowledge. In the educational setting, the problem may be even more serious. It is common nowadays to find in class students of different cultural backgrounds, whose first languages are diverse. In such a situation, the possibility of misunderstandings abounds. Part

of the problems of this kind is caused by different levels of English language skills of the students. On the other hand, even students who acquired high levels of English language skills retain in their mind's models based on their first languages, and those models may win over and influence how they employ English in their speech, writing and understanding. Most of the intercultural encounters take place in English, nonetheless, it does not have to make cross-cultural understanding any easier (Jackson, 2020). The so-called translanguaging problems of students from the non-English background is in the centre of attention of researchers designing more effective programs for intercultural communication and competences (Jackson, 2018).

As to understand the background of the problem is the first step in order to solve it and prevent further misunderstandings in a multilanguage classroom due to the different language background. Pesce (2010) argues that for construing teacher training it is necessary to adopt the semiotic approach to understand language as action and experience than as glosses on experience, something stable and beyond interpretation. The way these interpretations influence the understanding of communication between individuals of the same culture is indisputable, even stronger this implies on members of different cultural backgrounds.

Theoretically, this paper stems from psycholinguistics (Kolman, 1980; Miller, 1969, 1999; Salvatore, 2016) and linguistic pragmatics (Žegarac, 2011; Verschueren, 1999). Especially, Žegarac's rendering of the linguistic pragmatic concept is important here. His concept employs a qualitative approach to the analysis of intercultural communication. In this paper, we introduce Miller's sorting experiment in a new way, as a quantitative method and moreover, we use it for different languages, which Miller never did

G. A. Miller (1969, 1999) developed the method called 'measurement of semantic distances'. He used simple paper cards on which a noun (or an adjective) was printed. The word on a card supplemented a short description, which specified meaning of a word in question (e.g., water; Water flows in a river.). Usually, he used about 40 cards of this kind. In an experiment, he asked his subjects to sort the cards into groups of words of similar meaning. After repeating this task with a number of subjects, he applied hierarchical cluster analysis on the results of the sorting. The result of this procedure is a hierarchical graph (a dendrogram) in which it is possible to determine what Miller called a 'semantic distance' of any two words from the set. Measurement of semantic distances is recommended also as a new method for text information mining (Zhou et al., 2019) or in a concept map construction (Fuentes-Lorenzo, et al., 2019). The interpretation of the experiment results might be challenged, as meaning is no longer understood as something given and/or static. The accepted position in linguistics today is that words do not have different meanings, but different uses. (Verschueren 1999: 68; Bianchi and Gieri 2009). However, accepting this view does not change much the understanding of the results of the sorting, if we will understand a different meaning as a different use.

The teaching of international students' proceeds in multi-cultural, multi-languages setting and it aims at more, than just conveying knowledge and skills, but also at sharing the cultural values. However, as Josek's (2019) or Zhou et al. (2008) studies show, these aims are quite often missed. Based on that, as well as on our personal experience in teaching international students, we deem that the study of intercultural communication in the field of education will help to improve the results through a better understanding of the content and context of meanings of the same words in different cultures. This assumption is the most general hypothesis, which the authors try to deal with in this paper. A more specific assumption employed in this paper is that this can be attained using the sorting experiment proposed there.

We employed the sorting experiment to find out similarities/differences in understanding of two words (stimulus words) important in economics and management by subjects from different cultural and language backgrounds. Following the study of Zortea et al. (2014) that researched

the role of age in creating a structure of word association networks, we aimed to study also the role of age-related influences. The words for sorting used in the pilot experiment were derived in previous research as free associations to the words 'work' and 'money' (for details see Kolman and de Ponte, 2017). Miller was one of the founding fathers of machine translation, and his use of the sorting experiment was aimed at something like 'maps of meanings'. However, he never tried to compare words of different languages. Just this we tried to accomplish.
The aim of this paper is to introduce the sorting experiment as a method, which may help in clearing misunderstandings and other problems in communication in the multi-cultural, multi-language setting in education, namely in the education of international students.
The hypothesis tested (H0) is, as follows:
H_0: The results of the sorting do not identify any differences in the use of the stimulus words in the subject samples studied.

Materials and Methods

In the pilot experiment culturally and socially similar groups were deliberately chosen - Czechs and Germans are geographically near and for centuries, there was strong cultural and economic exchange and mutual influence going on.
The sorting experiment was carried out with four samples of subjects, chosen by chain-referral sampling technique. Two subjects' samples were of Czech (n = 55; 40 females, 15 males), and two of Germans (n = 44; 38 females, 16 males). In the case of each national sample, one of the sub-samples was composed of younger subjects (students), and one of older subjects (further referred to as the adults) Details of the samples can be found in Table 1.

Subsample	Number of subjects	Average age (years)
Czech students	29 (21 f; 8 m)	23.3
Czech adults	26 (19 f; 7 m)	42
German students	15 (12 f; 3 m)	20.4
German adults	29 (16 f; 13 m)	63.7

Table 1: Description of samples, 2021 (source: own calculation)

The experiment was carried out in the Czech Republic and in Germany, in the national languages. The Czech and German samples were employed, as the cultures differ only slightly and the languages are geographically near. In the case of extreme differences, the interpretation of the findings might be more complicated.
The subjects were asked to sort the words in packs according to the similarity of meaning, as perceived by them.
The list of the words employed:
Money, surety, capital, work, communication, trade, fun, career, shopping, vacation, luxury, wage, freedom, duty, objective, friends, motivation, budget, education, anxiety, assets, business, boredom, satisfaction, glory, self-actualization, future, stress, advancement, ownership, quiet, cooperation, power, economics, travel, investment, bank, tension, experience, illusion, family, employment.
In this paper, we employed Miller's method in the same way, as it was originally described. However, we put the method to a quite different use and proposed a different way of the analysis of data. The similarity measure of the words sorting was calculated via Kendall's τ rank correlation coefficient, which is a measure of similarity of orderings of data.
The IBM SPSS Statistics 27 was used.
All the data described in this paper have been acquired following ethical research standards. The subjects of the experiments were informed on the purpose of the study and agreed with it.

Results

Results of the pilot experiment were processed in two different ways to compare the benefits of the outcomes gained by each of them. Next to the descriptive statistics to describe the frequencies of occurrence of the associated words, the Kendall's τ rank correlation coefficients was applied as a similarity measure of the sorting results for the two stimulus words (displayed in Table 2).

	money				work			
	German students	German adults	Czech students	Czech adults	German students	German adults	Czech students	Czech adults
German students	-	0.754	0.585	0.600	-	0.533	0.406	0.346
German adults	0.754	-	0.563	0.533	0.533	-	0.657	0.346
Czech students	0.585	0.563	-	0.533	0.406	0.657	-	0.762
Czech adults	0.600	0.533	0.533	-	0.346	0.346	0.762	-

Table 2: Similarity of words classification – correlation coefficient, 2021 (source: own calculation)

In each of the four samples for both the stimulus words there were computed the frequencies with which all the words from the main pack of words were sorted in the same pack as the two stimulus words. This way, four rows of numbers (one for every sub-sample) were obtained for each stimulus word. These data enabled quantitative comparison of results of the sorting in the four samples. The comparison was carried out by computing Kendall's τ rank correlation coefficients for all the four samples and both the stimulus words are presented in Table 2.

It can be seen, that in the case of 'money', the most similar was the sorting of words by German students and German adults. Then, quite surprisingly, follows the correlation of German students and Czech adults. The least similarity was found in the case of Czech adults and German adults. In part presenting correlations for the word 'work', the correlations appear to be a bit lower. The sorting was rather similar in the cases of Czech students and Czech adults, on the other hand, Czech adults displayed the lowest similarity to German adults. Rather striking appear considerably lower correlations of sorting of German students with all the others, but still being the closest to the German adults. A possible reason might be an error caused by the small size of the German student's sample.

The correlations were computed to get an overall picture of the similarities/dissimilarities of the sorting of words in the four samples. Another way, how to study the results of sorting is to compare the highest frequencies of appearance of words associated with stimulus words.

In the case of 'money' it was, as follows:

German students – work, budget, assets, and employment;

German adults – capital, budget, assets, and bank;

Czech students – wage, employment, bank;

Czech adults – budget, investment, bank.

In the case of the stimulus word 'work' the most frequently associated words were, as follows:

German students - career, wage, employment;

German adults - career, wage, employment;

Czech students – career, wage, employment;

Czech adults – duty, wage, employment.

While the correlations in Table 2 show clearly, that the subjects from four groups differed in ways in which they sorted the words, the hypothesis H_0 should be rejected.

The comparison of words most often associated with the stimulus words shows another picture. The two ways of analysis bring different results, and this way, the computing of correlations

enables a deeper understanding of the data. Introduction of a quantitative, instead of a qualitative analysis permits a more profound comprehension of the field and a more thorough examination of the processes involved.

Discussion

In the introduction we mentioned that different languages construe world in different ways. This idea is part of a wide theoretical approach to the study of knowledge representation in the human mind. In this paper, this approach is not dealt with in more detail because of a lack of space. Research in the area mentioned is exclusively conducted qualitatively. The aim of this paper is to examine a quantitative way to study related phenomena. Therefore, the aim of this paper is to find out, if the sorting experiment can be applied to this effect, and examine ways of analysing data obtained by its use. The problem of representation of knowledge is highly relevant to the field of education. Besides, as was mentioned in the introduction, there are specific problems concerning the education of international students and employment of sorting experiment should help in dealing with them through deeper understanding of the various concept of words' content at different cultural groups.

Based on the examples presented, it seems that the sorting experiment can be used successfully to identify differences between social and cultural groups, and thus may add to conceptions of cross-cultural psychology and intercultural communication. In a similar way, it can be applied to find out on differences in social/cultural groups in more general cases, as well.

However, several other questions remain open. These concern the use of languages and translation, assessment of error variance of the measurement, and homogeneity/heterogeneity of samples. These problems should be dealt with in the future, in studies of substantially bigger samples.

The methodological problems mentioned stem, at least partially, from the fact that the approach proposed touches on several fields, namely intercultural communication, linguistics, and education. In another related field, cross-cultural psychology, the utility of linguistic data is discussed (Schwartz, 2017; Skrebyte et al., 2016; Venta et al. 2017). However, in intercultural communication linguistic methodology seems generally accepted (Žegarac, 2011). In cross-cultural psychology other approaches are employed which are not based on linguistics. As an example, might serve study by Hřebíčková et al. (2018).

The pilot experiment proved different understanding of the content and context of the stimulus words at groups from different cultural backgrounds. Surprisingly the highest difference was detected between Czech and German students at their understanding of the word 'work', while they were at highest concordance at the meaning of word 'money', even though the same generation with similar opportunities their point of view varies. This might provide an inspiring starting point for further research in the field, at least with the most common groups of students studying at our universities in order to point at most differing areas of inter-cultural communication.

The words 'money' and 'work' are core terms in the studies of economics and management. However, in the commonplace conversation they may acquire diverse and sometimes controversial meanings. The study presented enables comparison of similarities and differences in understanding them in two European languages and, to some extent, in younger and older subjects. Misunderstandings might happen even in the case when both the teacher and the student are of the same nationality and all the teaching is provided in their first language. Teachers quite often use words in a technical way, and students happen to understand the same words in their everyday meaning. As an example may serve the word 'game' in a locution 'game theory'. Game theory is not about playing poker or a football match, but a negligent student can be confused. According to Cahn (2017), the different denotation of crucial expressions that is influenced by the education even influences a mental model of self in a working team. The sorting experiment, the

method employed in this paper, is a mean to get the meanings of words straight and, as a result, to communicate more effectively.

To broaden the language awareness of the teacher (Andrews, 2010), appreciation and accommodation of similarities and individual and cultural differences of the teacher there exist special programs designed by Europe's platform for school education (2018), building the bridge between what teacher needs to know about language and their pedagogical practice, which are highly relevant also to teachers of other than language subjects who are working in multi-language environment.

Some CULS students dedicated their thesis to the same experiment with Czech and Russian students. Nevrlá (2017) used the same set of words. Kendall's τ correlation coefficients for stimulus words money and work were 0.825 and 0.655, respectively. The words Czech students most often associated with 'money' were 'trade', 'ownership', and 'business', Russian students 'assets', 'capital', and 'trade'. The words most often associated with 'work' were, in both the Czech and Russian samples, 'career', 'employment', and 'wage'. Křepelová (2017) conducted a study with words derived as free associations of the word 'education'. The Kendall's τ correlation coefficient was 0.648. The most striking difference was in the words most frequently linked with the stimulus word 'education'. In the Czech group, it was a 'diploma' and in the Russian group, it was 'labour'. So, it can be seen, that in the case of Czechs and Russians, the cultural difference is bigger than the one between Czechs and Germans; even though the difference of languages is smaller. The mentioned distinction between cultural difference and language difference may be a useful lead for education of international students, where these two parameters are often considered equal and the groups of students are treated accordingly, apparently incorrectly.

The results presented above may be useful, even though they were obtained by studies of rather small samples. For example, the findings of Křepelová (2017) lead to the hypothesis that Russian students are longer-term oriented than Czech students. This hypothesis can easily be tested, e.g., by comparing students of the two nationalities by their results in Hofstede's VSM questionnaire (Hofstede et al., 2010).

Nowadays, linguists state that words do not have different meanings, but different uses (see, e.g., Salvatore, 2016: 33). To circumnavigate this methodological quandary, we used another approach to data analysis. This approach ensues from the probabilistic interpretation of the sorting experiment results. The frequency of any two items to be sorted to the same pack is proportionally related to the probability that the same will happen in any new sorting of the same items (in case of a repeated experiment). This interpretation made it possible to analyse the data by computing correlations, and might possibly be employed by advanced analytical methods like SEM (Kline, 2011; Westland, 2015).

The limitations of the paper ensue from the fact that they describe just a beginning of the research of a new, even if possibly promising subject matter. Any further developments of the approach introduced here will necessitate more substantial studies. Even so, we believe, that such an effort is justifiable by the vision of finding the common base of meanings of the most often misinterpreted words, independently on the mother-tongue of the teacher and the students.

Conclusion

The presented paper shows that the sorting experiment may be developed in a quantitative method, which will help to better understand contents and processes in multi-cultural settings. That way it may help in the education of international students through enhancing the methods for better understanding of their concept of words used for communication. This claim is based on results of pilot experiment only, however, the results described support it univocally.

Even though the introduced approach touches on several fields, namely psychology, education,

and linguistics, it is important to develop it, as the multi-cultural settings are paramount in the educational process at the universities of the present day, as there is a substantial number of international students to be approached with deeper understanding. The results show the sorting experiment is promising as an instrument in clearing misunderstanding in the educational setting. Actually, it can be employed not only in the future development of the pedagogy but also in the psychological theory of thinking, as well.

In the globalizing world misunderstandings happen easily. Employment of the sorting experiment might help to identify the differences of meaning, and this might enable to better communication in teaching in general, teaching of management methods for international students in particular. In any case, the sorting experiment should be useful in identifying constrains in understanding, in transfer of knowledge, and consequently in education in general.

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PERCEIVED PARENTAL STYLES AND ACADEMIC ACHIEVEMENT BY UNIVERSITY STUDENTS

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Abstract

The paper follows the lineage of researches that reflect the importance of parental styles for the educational outcomes of their children, even in the stage of early adulthood. The goal of the research is to identify prevailing trends in parenting styles by students of the Czech University of Life Sciences by both of the parents separately, but also their correspondence. For this purpose, the self-reflective questionnaire of parenting styles based on dimensions of emotional relationships, requirements ad permissiveness was used. Moreover, the research aimed at revealing connections between parenting styles and academic achievement operationalized as an average grade from the first year of bachelor study. According to the results, the prevalent parenting styles in our research sample was slightly permissive. A significantly positive correlation between a negative emotional relationship with father and the average grade was found. The interpretations and possible consequences of the results are discussed.

Keywords

Academic achievement, academic self-efficacy, emotional relationship, requirements, parenting styles, permissiveness

Introduction

Parents and other family members play a crucial role in education processes which may be even more important than the role of teachers (Fischer and Lipovská, 2013; Lipovská and Fischer, 2016). Following the idea of responsible educational policy, theorists, as well as counsellors, should deal with the optimization of family impact. Parents influence school achievement of their children not only as 'donators' of the genetic equipment and patterns of behaviour to imitation but also via parenting styles that are more accessible to intentional modification.

In one of the classical works dealing with the relation of parenting styles and school achievement, Grolnick and Ryan (1989) state that the children's school-related behaviour is significantly influenced by parents' style of motivation and support. According to their results, it is especially parental autonomy support that relates positively towards children self-regulation, adjustment, school grades and achievement. The next factor that was proved as important by mothers was involvement, defined as interest and active participation.

More recent studies (Aunola, Stattin and Nurmi, 2000; Spera, 2005; Alt, 2014; Masud, Thurasamy and Ahmad, 2014; Chen, 2014; Waterman and Lefkowitz, 2017; León-Del-Barco et al., 2019; Aldhafri et al., 2020; Garcia et al., 2020; Stavrulaki, Li and Gupta, 2020; Yang and Zhao, 2020) build upon a classical two-dimensional conceptualization of demandingness and responsiveness that defines four parenting styles: authoritative, authoritarian, permissive and neglectful (Baumrind, 1971).

Parents influence children's educational outcomes not only via direct motivation but also as important providers of feedback that form children's educational self-concept (León-Del-Barco et al., 2019). Psychological studies of self-concept are based on the theory of self-efficacy (Bandura, 1986) which was further specified in the area of education as academic self-efficacy which is significantly modulated by parent's attitudes towards a child (Pajares, 1996). Academic self-efficacy expresses itself e.g. in specific achievement strategies (self-enhancing attributions, failure expectation, task-relevant behaviour or activity vs. passivity). Aunola, Stattin and Nurmi (2000) describe more adaptive strategies by adolescent referring to authoritative upbringing style.

According to the study of Chen (2014), parents influence the academic achievement of university students through motivational goals. In this regard, an optimal impact was found by an authoritative upbringing style that tends to support mastery goals and performance-approaching goals. Also, the metanalysis of Masud, Thurasamy and Ahmad (2014) states the best impact on the educational outcomes by the authoritative style which combined high demandingness and responsiveness. Nevertheless, the attitude toward parenting styles may be affected by intercultural aspects. Spanish authors Rodríguez-Fernández et al. (2018) proved the positive impact of permissive style on the school grades, whereas the study of Chen (2014) refers to the beneficial influence of authoritarian style on performance-approaching goals by Chinese students. By Palestinian-Arab young females, Alt (2015) states the negative association between authoritative style and amotivation and positive association between authoritarian style and extrinsic motivation. In this case, the permissive style related positively to amotivation for learning.

Apart from cultural differences, the relationship between educational achievement and upbringing style can be affected also by gender differences. According to Yang and Zhao (2020), the parenting style of the mother plays a more crucial role than the fathers' influence. Presumably, the age of children also matters. Aldhafri et al. (2020) prove that the influence of parenting styles weakens with the increasing age of children. However, it does not lose its importance; the study of Zaff et al. (2016) rates the parenting style between crucial factors for high school graduation. Waterman and Lefkowitz (2017) explain that parenting style influence academic achievement in emerging adulthood even in the case of physical proximity, namely via parental behaviour in past, but also by the quality of current relationships by parents and their adult children. Emerging adulthood represents a specific development stage that enables to research of long-term effect of the early socialization environment (Baier, 2019). Moreover, respondents of this age are more capable of mature self-reflection than younger individuals thanks to highly developed identity exploration (Arnett, 2000).

Considering the previous findings, our research deal with parenting styles and their relationships with the academic achievement of students of CULS. We intend to identify parenting styles by the students and compare them with findings of domestic and foreign research. Moreover, we aim to reveal connections between upbringing styles, assessed by standardised questionnaire of parenting styles (Čáp, Boschek, 1994), and academic achievement, operationalized as the average grade from the first academic year of bachelor study. Our objective is to clarify a relationship between obtained grades and two basic dimensions of parenting styles described by Čáp as emotional relationship and parental management (Čáp, Boschek, 1994). We intend to use this information in the psychological counselling centre of our university; however, the findings can be also used in counselling services for parents of young children to show the connection between parenting styles and future academic achievement. Moreover, our results may also serve as reference data for similar studies at other universities in the Czech Republic and abroad.

Materials and Methods

For the identification of our respondents' parenting styles, we used one of the most common topical questionnaires in the Czech Republic (Čáp, Boschek, 1994). The questionnaire follows two basic components of the parenting styles – the emotional relationship with a parent and the dimension of parental management. The emotional relationship is measured in both positive and negative dimension, assessed by items like 'we often laughed together and were in a good mood' or 'he/she made fun of my opinions'. Parental management involves the component of requirements (e.g. 'he/she strictly requested the best school attainment') and permissiveness (e.g. 'he/she let me go where I wanted'). Our research assesses all these dimensions separately for mothers and fathers, dealing with their relations to average grade from the first academic year of bachelor studies.

Our research sample was constructed by a method of convenience choice and involved 105 respondents (full-time bachelor students of CULS) with mean age of 19.8 years and the gender structure of 57 females and 48 males. 16 respondents were the only children, 60 had 1 sibling, 19 had 2 siblings and the remaining 10 respondents had 3 or more siblings. All students were from Czech study programs, the majority of them of the Czech nationality, some of them from the former Soviet Union (however, the nationality was not asked explicitly to maintain the anonymity of the research data).

For data processing, the software IBM SPSS 27 was used. The strength of association between the variables was tested by non-parametric measure, Spearman's rank correlation coefficient, recommended by De Vaus (2014) for its robustness.

Results

The descriptive dimension of our results aims mainly at the identification of parenting styles by our respondents (see Tab. 1). By mothers, the mean value is 26.9 for the positive emotional relationship (ER+) and 14.3 for the negative emotional relationship (ER-). In the dimension of management, the mean value is 17.7 by requirements (R) and 21.1 by permissiveness (P). Obviously, the parenting style of mothers in our research sample can be labelled as positive in the dimension of emotional relationship and slightly permissive regarding the dimension of management.

By fathers, the mean values by emotional relationship were 24.7 by positive component (ER+) and 14.5 by negative component (ER-). The mean value was 17.2 by requirements (R) and 20.7 by permissiveness (P). Similar to mothers, fathers' parenting style appears as emotionally positive and permissive considering the management.

	Mothers				Fathers			
	EV+	EV-	R	P	EV+	EV-	R	P
Mean	26.92	14.3	17.75	21.1	24.74	14.54	17.21	20.69
SD	3.66	4.35	4.66	3.58	5.12	4.7	5.2	4.3
N	111	111	111	111	105	105	105	15

Table 1: Parenting styles of mothers and fathers, 2020-2021 (source: own calculation)

The correspondence between mothers and fathers was proved also by correlation study that showed strong correlations between all dimensions of parenting style. The most significant correlation between both parents was found by negative emotional relationship (EV-), the weakest (but still significant) by permissiveness (P) (see Tab. 2).

The analysis of mutual correlations between dimensions of parenting style also brings significant findings. Expectably, we can observe a significant negative correlation between

the positive and negative dimension of emotional relationship by both parents separately. Apparently, there is also a positive correlation between the positive emotional relationship (ER+) and permissiveness (P), as well as a positive correlation between the negative emotional relationship (EV-) and requirements (R). Analogically, we found a negative correlation between the positive emotional relationship (ER+) and requirements (R) as well as between negative emotional relationship (ER+-) and permissiveness (P) by both parents, although these correlations are weaker by mothers (see Tab. 2).

Considering the correspondence between styles of both parents, we may observe significant relations between dimensions as by both parents separately. The data analysis found a significant positive correlation between the negative relationship with mother (ER-) and father's requirements (R) and similarly, between the positive relationship with mother (ER+) and father's permissiveness (R). A significant negative correlation may be observed between the positive relationship with the mother (EV+) and the negative relationship with the father (EV-).

		Mothers				Fathers			
		EV+	EV-	R	P	EV+	EV-	R	P
Mothers	EV+	1.000	-0.490	-0.234	0.485	0.510	-0.256	-0.171	0.242
	EV-	1.000	.660	-0.205	-0.177	0.564	0.407	-0.021	
	R		1.000	-0.211	-0.080	0.397	0.513	0.065	
	P			1.000	0.123	0.077	0.017	0.343	
Fathers	EV+					1.000	-0.486	-0.332	-0.611
	EV-					1.000	0.779	-0.396	
	R						1.000	-0.356	
	P							1.000	

Table 2: Correlations between dimensions of parenting styles (Spearman's rho), 2021, (source: own calculation)

Considering the relationship between parenting styles and academic achievement, we found no relation in terms of statistical significance. The only exception is the positive correlation between the negative emotional relationship with father and average grade from the first year of bachelor study (see Table 3). The interpretation and possible consequences of this finding are introduced in the discussion.

	Mothers				Fathers			
	EV+	EV-	R	P	EV+	EV-	R	P
Average grade	0.004	0.027	0.009	0.033	-0.063	0.207	0.146	0.049

Table 3: Correlations between dimensions of parenting styles and average grade (Spearman's rho), 2021, (source: own calculation)

Discussion

The first goal of our study consists of the identification of the prevailing parenting style by students of FEM at CULS. According to our findings, the parenting style of both parents in our research sample is positive in terms of emotional relationship and permissive regarding the management. These results are in a logical correspondence with the study of Gillernová (2009), who proved a shift towards weaker parenting management (more permissiveness, fewer requirements) in Czech society using the same questionnaire as our research.

In classical terms of parenting style (Baumrind, 1971), the prevailing style identified in our research sample can be labelled as slightly permissive. According to the findings of Rodríguez-Fernández et al. (2018), this style has a positive influence on school grades. However, this result is

in contradiction with the study of Chen (2014) who refers to beneficial influence of authoritarian style on performance-approaching goals by Chinese students. Moreover, the meta-analysis of Masud, Thurasamy and Ahmad (2014) describes the best educational outcomes by authoritative parenting style, similarly to the study of Aunola, Stattin and Nurmi (2000).

In our research, we found no significant relationship between parenting styles and grades in the first year of bachelor study (except the positive correlation between the negative relationship with father and grades). The reason may be in a prevailing style of parenting in our research sample that need not be mirrored in grades. The school formal classification is perceived as a kind of external motivation, which is associated more with the authoritarian parenting style, at least according to the study of Alt (2014). The next reason for weak correlations between parenting styles and grades may consist of the age of our respondents. The study of Aldhafri et al. (2020) proved a weakening influence of parenting style with the age of children. Nevertheless, Waterman and Lefkowitz (2017) proved the significance of parenting style for the academic achievement of university students, considering the behaviour in the past as well as the quality of the current relationship. We can deduce that a positive relationship (which was proven also in our research) is important for academic achievement.

Consistently with this finding, we may point out to positive correlation between the negative relationship with father and average grade in our study, meaning that we measured more negative emotional relationship with father by worse grades. Moreover, this result is interesting in comparison with another study that reflects the more substantial importance of the relationship with a mother for educational outcomes (Yang and Zhao, 2020). Thus, our findings support the role of emotional bond with father for academic success.

Considering the process of data collection, the results are plausible only for students of CULS. Moreover, the validity is restricted by the convenience sampling method of respondents' selection. We should also bear in mind that our results are based on the self-reflective assessment of parenting styles, so we cannot observe their pure influence on academic achievement. This fact is interesting in light of the existing positive correlation between the positive emotional relationship (EV+) and permissiveness (P) and analogically, between the negative emotional relationship (EV-) and requirements. This finding may mirror a negative perception of parental requirements from the viewpoint of students. It also relates to the dominant parental style in our research sample that inclines to permissiveness with the positive emotional relationship that is consistent with the development with parental styles in the Czech Republic (Gillernová, 2009).

Conclusion

Parenting styles create a basis for functioning in many areas of human activities, including education. Their significance is obvious even in the stage of early adulthood. The importance of knowledge about the parenting styles for teachers and counsellors is unquestionable. This paper brings information about this phenomenon by students of CULS, but the significance of our results is more general. The counsellors working with parents of younger pupils and students may use our findings as information about the influence of specific parenting styles on academic achievement. Moreover, our results can be used as referential information for similar studies at other universities. Further research should focus on the relationship between parenting styles and other educational outcomes except for formal classification.

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ACADEMIC PROCRASTINATION OF HIGH SCHOOL STUDENTS

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Abstract

The main goal of this study is to expand on the existing knowledge about procrastination among high school students by investigating the prevalence and possible reasons for academic procrastination. The sample consisted of 441 high school students who filled in the questionnaire with two procrastination self-assessment scales (PSS and PASS). Statistical methods were used to evaluate the data. There were no non-procrastinators among the students. The prevalence of procrastination did not differ according to gender, grade level or number of siblings. It appears that non-working students tend to procrastinate more as compared to working students. Students procrastinate mainly because of laziness, task averseness, the tendency to feel overwhelmed and poorly managed use of time. On the other hand, students procrastinate the least because of the fear of success, risk-taking or perfectionism. The proposed recommendations for reducing the effects of procrastination would help students to better manage university studies.

Keywords

Academic procrastination, high schools, postponing tasks for later, statistical analysis

Introduction

The term procrastination comes from the Latin word pro-crastinus, which means belonging to tomorrow (Ludwig, 2013). It is necessary to mention, there is no consensus among researchers on the definition of procrastination (Özer, Demir, and Ferrari, 2009). Procrastination is a common problem, which can be defined as the act of unnecessarily delaying a task to the point of experiencing subjective discomfort (Solomon and Rothblum, 1984). According to Ludwig (2013) procrastination means putting things off intentionally or habitually.

Academic procrastination is considered to be more common among college students rather than among younger students. Nevertheless, studies revealed that the prevalence of procrastination in college students compared to high school students is not much different. Results of Özer's (2009) study revealed that 54% of the participants (high school students) frequently engaged in procrastination, the rest of the students (46%) engaged in procrastination sometimes or rarely. In the study there was the median split used to determinate the procrastinators and non-procrastinators. Some authors estimate that up to 95% of college students engage in procrastination (Ellis and Knaus, 1977, as cited in Solomon and Rothblum, 1984). Another study (Ferrari, Johnson, and McCown, 1995) on the other hand found that about 20% of students reported themself as „problem procrastinators ".

When the frequency of procrastination among high school students and college students is compared, it appears that at least half of the students tend to procrastinate, no matter whether they study on high school or college (Atalayin et al., 2018; Özer, 2009; Özer and Ferrari, 2011; Özer, Demir, and Ferrari, 2009). Khan et al. (2014) found that younger students (below 20 years) tend to procrastinate even more that older students. Based on these finding, this study focused on high school students instead of college students.

Academic procrastination is one of the main reasons for the early termination of university studies right at the beginning. Universities are currently fighting for a sufficient number of successful students. Therefore, they must look for ways not only to attract and enrol students, but also to retain them. The main goal of our study was to determine the prevalence of academic procrastination and its causes in the case of secondary school students, by using a questionnaire survey based on the PSS and PASS scale. In addition to the goals for the study, some recommendations for reducing the effects of procrastination are proposed.

Materials and Methods

The survey took place within high schools, which can be considered an acquisition area for FSE UJEP in Ústí nad Labem. The samples consisted of 441 students (287 females and 154 males) from five different high schools. First to fourth year students were involved (participants purposely did not fill in their age on the answer sheets).

One of our goals was to identify the important causes of academic procrastination. In studies (Ferrari, 2001; Özer, 2009; Sliviaková, 2011; Afzal and Jami, 2018), one of the most frequently cited causes is excitement (risk-taking) arising from postponing tasks. Our first research question was, which causes of procrastination are the most common and which are less common.

H_{01}: There are no differences between the causes of procrastination.

Saplavska and Jerkunkova (2018) state that there are no non-procrastinators among the students, on the contrary, most students are among the strong procrastinators. Our second research question was therefore, what is the structure of the rate of procrastination within the participating schools, whether they differ and whether there are non-procrastinators.

H_{02}: The structure of the procrastination rate is comparable across all participating schools.

Last but not least, we were interested in what other factors may affect the rate of procrastination. From the studies, we chose, for example, gender (Khan et al., 2014; Özer, Demir, and Ferrari, 2009; Patrzek et al., 2014), the year of study (Afzal and Jami, 2018) or the existence of siblings (Rosário et al., 2009).

H_{03}: Procrastination rate does not depend on the factor.

H_{031}: The frequency of procrastination does not vary according to gender
H_{032}: Procrastination rate does not vary according to GPA
H_{033}: The frequency of procrastination does not vary according to the grade level
H_{034}: Procrastination rate does not vary according to the number of siblings
H_{035}: Employment does not have impact on the prevalence of procrastination

All participants completed the questionnaire that contained two self-assessment scales (PSS and PASS). Several identification questions, such as sex, GPA (grade point average), number of siblings, with whom the participants share a room with in the household or grade level (freshman to senior year) were also included.

The first mentioned scale was the Procrastination Scale for Student Population (PSS) designed by Lay (1986), it contains 20 items and students rate the items on 5-point Likert scale (1= *extremely uncharacteristic*, 5= *extremely characteristic*). PSS was used to reveal the frequency of academic procrastination. Half of the items were reversed-scored. According to scale score (from 20 to 100 points), Lay's scale divides students into four groups. The first group consists of students who scored between 20 and 28 points, marked as non-procrastinators. The second group of light procrastinators consisted of a score from 29 to 52 points. Then there is a group of moderate procrastinators with a score between 53 and 63 points and finally, students with 64 to 100 points were marked as heavy procrastinators. This scale has been used, for example, in Starova et al. (2018).

The second used measure was the Procrastination Assessment Scale for Students (PASS) developed by Solomon and Rothblum (1984). The scale is divided into two sections. The first

section measures the frequency of procrastination in six academic areas: writing a term paper, studying for an exam, keeping up with weekly reading assignments, performing administrative tasks, attending meetings and performing academic tasks in general. In the second section of scale, two statements for each reason are listed and students are asked to rate the statements on 5-point Likert scale (1= *not at all reflects why I procrastinated*, 5= *definitely reflects why I procrastinated*). Solomon and Rothblum (1984) identified the following thirteen reasons: evaluation anxiety, perfectionism, difficulty making decisions, dependency and help seeking, aversiveness of the task and low frustration tolerance, lack of self-confidence, laziness, lack of assertion, fear of success, tendency to feel overwhelmed and poorly managed time, rebellion against control, risk-taking and peer influence. For instance, the statements for the reason of averseness of the task and low frustration tolerance are: '*You really disliked writing term papers*' and '*You felt it just takes too long to write a term paper*'.

This scale has been used, for example, in Sedlakova et al. (2014). Although, it is possible to measure the frequency of procrastination with the first part of scale. The first section of scale was not used in this study because of one reason. It was identified that the PSS scale is a more suitable method for measuring academic procrastination in Czech conditions. (Gabrhelík, 2008)

Results

In this study, findings revealed that 40% of students reported a high level of procrastination (marked as heavy procrastinators), 34% of students with a moderate level of procrastination (moderate or middle procrastinators) and 26% students reported a low level of procrastination (marked as light procrastinators).

Figure 1 shows that the histogram essentially copies the Gauss curve, based on that, it can be assumed that data are normally distributed. That corresponds with the findings of Gabrhelík (2008), who says that procrastination is close to the normal distribution in the population, which means that students can procrastinate in certain tasks without this being a problem.

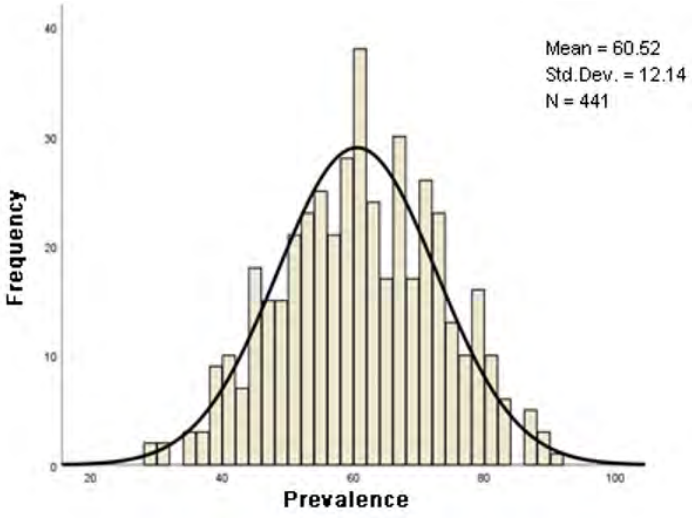

Figure 1: Distribution of scale scores in the studied population, 2020 (source: own calculation using SPSS)

	Friedman test	Mean
Laziness	9.75	3.55
Aversiveness of the task and low frustration tolerance	9.02	3.28
Tendency to feel overwhelmed and poorly manage time	8.98	3.29
Difficulty making decisions	8.56	3.09
Lack of self-confidence	7.53	2.82
Peer influence	6.97	2.69
Dependency and help seeking	6.79	2.58
Evaluation anxiety	6.78	2.59
Lack of assertion	6.74	2.55
Perfectionism	5.72	2.35
Risk-taking	5.36	2.21
Rebellion against control	4.94	2.11
Fear of success	3.85	1.81

Table 1: Average rates of causes of procrastination, 2020 (source: own calculation)

We tested the differences in the level of individual causes of procrastination using the Friedman test and subsequent post hoc analysis. A p-value << 0.01 confirmed statistically significant differences. Table 1 shows that students procrastinate mainly because of laziness, averseness of the task and low frustration tolerance, and the tendency to feel overwhelmed and poorly manage time. On the other hand, fear of success, risk-taking or perfectionism were the least common reasons for procrastination.

Table 2 shows the numbers of different levels of procrastinators. Obviously there are no non-procrastinators among students. Table 2 also indicates that there are no big differences in prevalence of procrastination among different high schools, with two exceptions. Firstly, the first school had as many middle procrastinators as there were heavy procrastinators. And secondly, the fifth school had more moderate procrastinators than heavy procrastinators. In order to confirm or reject the second hypothesis: The structure of the procrastination rate is comparable across all participating schools; the Chi-Square test of independence was used. In this study it was not proved that the frequency of procrastination varies among students from different high schools (p-value 0.12).

High school	Groups of procrastinators				Total
	Non-procrastinators	Light procrastinators	Middle procrastinators	Heavy procrastinators	
1	0	23	33	46	102
2	0	11	25	28	64
3	0	21	35	35	91
4	0	19	20	31	70
5	0	42	35	37	114
Total	0	116	148	177	441

Table 2: Number of procrastinators in high schools, 2020 (source: own calculation)

The Chi-Square test of independence was used to determine whether there is a significant relationship between prevalence of procrastination and gender or not. In this study no significant differences among males and females' frequency of academic procrastination were found (p-value 0.419).

The research also studied the impact of grade level on prevalence of procrastination. The sample included 24% of freshmen, 26% of sophomores, 30% of juniors and 20% of seniors. The Chi-Square test of independence was used to determine whether there is a relationship between the

mentioned variables. In this study no association between frequency of procrastination and grade level was found (p-value 0.169). These findings correspond with the study by Afzal and Jami (2018), who found only nonsignificant differences by comparing the prevalence of procrastination among students with various educational levels.

As mentioned, the participants filled in the questionnaire as to the number of siblings, with whom they share a room with in the household. However, no significant differences were found between frequency of procrastination and the number of siblings.

Significant differences were found in the prevalence of procrastination according to GPA. Some researchers have found that with increasing level of procrastination, study results (GPA) deteriorate (Ariely and Wertenbroch, 2002, as cited in Diepoldova, 2016). Others, on the other hand, did not find significant differences (Blatt and Quinlan, 1967, as cited in Ferrari, Johnson, and McCown, 1995). In this study it was found that students with a higher procrastination score had a significantly worse GPA.

This study also examined the impact of employment on the prevalence of procrastination. Only 30% of students work during the school year, the rest of students do not. Non-working students had a slightly higher average procrastination score (61.28 points) compared to working students (58.73 points). The p-value of the two-sample t-test is 0.042. It means that non-working students tend to procrastinate a bit more than students who work during the school year. However, the difference in the average score is minimal.

Discussion

The tendency to postpone a task for later is not only a problem for college students, but also for high school students (Atalayin et al., 2018; Özer, 2009; Özer and Ferrari, 2011; Özer, Demir, and Ferrari, 2009). The main goal of this study was to examine the prevalence and possible reasons for academic procrastination among high school students. All 441 high school students completed the questionnaire that consisted of two self-assessment scales; several identification questions were also included. The Procrastination Assessment Scale for Students (PASS) and Procrastination Scale for Student Population (PSS) were used to measure the frequency of procrastination and to identify reasons for procrastination.

One of the main findings of this study was the prevalence of procrastination, 40% of students were marked as heavy procrastinators, 34% of students as moderate procrastinators and 26% of students were marked as light procrastinators. There were no non-procrastinators among students. It appears that students procrastinate mainly because of laziness, averseness of the task and low frustration tolerance and the tendency to feel overwhelmed and by poorly managed time. On the other hand, fear of success, risk-taking or perfectionism were the least common reasons for procrastination. These findings correspond with other research like Grunschel et al. (2013) or Özer (2009), who also marked laziness and averseness of the task as the most common reasons for procrastination.

In summary, the prevalence of procrastination did not differ according to gender (like (Kucharova et al., 2019). Also, Atalayin et al. (2018) and others (Ferrari, 2001; Lowinger et al., 2016; Özer, 2009) did not find significant gender differences in procrastination. But some studies found significant differences among males and females' frequency of academic procrastination and revealed that males tend to procrastinate more than females (Khan et al., 2014; Özer, Demir, and Ferrari, 2009; Patrzek et al., 2014). The prevalence of procrastination did not differ according to grade level or number of siblings, with whom the participants share a room with in the household. Rosário et al. (2009) on the other hand found, that procrastination increases along with number of siblings. They claim that, a higher number of siblings is associated with more noise, so for students it is harder to concentrate and to not be distracted.

Like us, Gunes and Owen (2021) dealt with academic procrastination in high school students. Unlike us, however, they focused on the effect of procrastination on career indecision. They used the same selection of statistical methods to evaluate this and found similar factors for procrastination. They provided expert advice as the main recommendations for minimizing the consequences of procrastination. Increased attention to social and organizational factors is recommended by Sarid, Peled, and Vaknin-Nusbaum (2021). More precisely, the formulation of the recommendations was addressed by Svartdal et al. (2020). They distinguished between the recommendations for individuals and the recommendations for institutions. The main recommendations for institutions included reducing unnecessary choices, shortening deadlines for completing tasks, establishing clear responsibility for the given actions, but also to include providing positive feedback.

The limitations of the study result from the fact that they describe only the beginning of new research. The problem can be seen mainly in the complexity of the phenomenon of procrastination. In this study, it was not possible to capture procrastination from all specific points of view. It is necessary also to mention that the researched population was narrowed to only the scope of one university.

In future studies, the relationship between anxiety, depression or stress could also be examined, because according to some researchers (Malik, Ashraf, and Musharraf, 2019; Saplavska and Jerkunkova, 2018) these factors are significant predictors of academic procrastination. Considering the above mentioned factors could further expand the existing knowledge of this field of study.

Conclusion

The main goal of the study was to determine the prevalence of academic procrastination and its causes in case of secondary school students, by using a questionnaire survey based on the PSS scale. The main motivation for this goal was to find ways to reduce and prevent early school leaving at the very beginning. Žambochová (2012) offers a solution to this problem, for example, by adapting the sources of information so that they are user-friendly. Our survey identified the main causes of academic procrastination using the PASS scale. As the main factors influencing the prevalence of procrastination were identified laziness, aversion to the task, frustration of failure and insufficient time management. It turned out that students with a higher level of procrastination had a worse GPA. This study also revealed that non-working students tend to procrastinate a bit more compared to working students.

The main recommendations for minimizing the consequences of procrastination, from the point of view of the institution, can be by the utilization of the introduction of professional advice, reduction of unnecessary choice, shortening deadlines, determining clear responsibility for their actions, though, also by providing positive feedback. The main recommendations for minimizing the consequences of procrastination from the student's point of view can be the involvement in team work, reducing distractions and/or good planning.

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PROCESS PETRI NETS THEORY APPLIED TO MANAGEMENT OF FULL-TIME/DISTANCE FORM OF TEACHING

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Abstract

The beginning of the second wave of the COVID-19 pandemic in the Czech Republic brought very specific requirements for the organization of the teaching process at the Faculty of Economics VSB-Technical University of Ostrava. The teaching process took place simultaneously in full-time and distance form and it was necessary to implement its comprehensive recording available on-line or on-demand. It was not possible to gradually equip selected classrooms with cameras and other systems due to the current situation, but it was necessary to effectively use their existing equipment that could be supplemented with available mobile components to meet the requirements of the teachers for this type of teaching. The design and implementation of the distributed software support that meets the requirements of multimedia recording of the educational process and that was implemented also with the application of the theory of process Petri nets is the subject of this article.

Keywords

Process Petri nets, full-time/distance form of teaching, recording of presentations, 360-degree camera

Introduction

The worldwide coronavirus pandemic COVID-19 caused closure of schools of all the types in a total of 185 countries affecting approximately 90% of all the pupils and students worldwide (COVID-19, 2021). The speed of these changes and the sudden global transition to distance learning form have provided very little time to analyze or reflect on the potential risks to be overcome by this change and the potential opportunities to deploy new methods and forms of the teaching process. The consequences of the changes in the methods and forms of the teaching process are being carried out practically all over the world at present and the decisions are being made on the directions of further progress and preparation for a similar crisis situation and the ways of its coordinated solution.

The beginning of the second wave of the pandemic COVID-19 in the Czech Republic brought very specific requirements in the field of information support for the organization of the teaching process at the Faculty of Economics VSB-Technical University of Ostrava that took place in full-time and distance form all at once. A typical example of this type of teaching process was the implementation of lectures and exercises for the Czech and foreign students at the same time. Full-time teaching took place for the Czech students in the relevant classroom. Foreign students (typically the students from the Slovakia or China) usually could not cross our state borders due to a pandemic and they participated in the teaching process in real time by the distance form of learning. The pedagogical staff formulated the following requirements for the provision of information support for the students participating in this specific form of full-time/distance teaching:

- the need to ensure voice and video communication of the teacher with full-time and distance students in real time and its recording;

- the need to capture and record the movement of the teacher in the classroom and his voice communication with the students present in this location;
- the need to capture and record the teacher's presentation including the content of his record on a classic blackboard located in the classroom;
- the need to display and record the content of workstation screens of selected students present in person within the implementation of exercises in computer classrooms.

It was not possible to gradually equip selected classrooms with cameras and other systems due to the current situation, but it was necessary to effectively use their existing equipment that could be supplemented with available mobile components to meet the above requirements. We will demonstrate the solution used on the example of the classroom of an authorized training center within the worldwide program of Apple Authorized Training Centers for Education (AATCe, 2021) that has been operated at the faculty since 2013 in this article. AATCe classroom equipment includes a wide range of mobile and also non-mobile technologies such as iMacs, iPads, iPhones, Macs Mini, Apple TV, AirPlay, FaceTime, etc., which have been successfully deployed in the teaching process of bachelor, master and doctoral study programs. The solution used organically complements the technologies and procedures discussed in Martiník (2020).
Presentation recordings and "barrier-free" access to informations are the standard part of eLearning services at the universities around the world (Bos et al., 2016; Dona, Gregory and Pechenkina, 2017). Recording of lectures and exercises with using of the rich-media (Mediasite, 2021), MS Teams (MS Teams, 2021), BigBlueButton (BigBlueButton, 2021), FaceTime and AirPlay technologies is therefore an integral part of the educational process in the AATCe training center. It was necessary to design and implement the single-purpose programming support based on Apple technologies determined for the generally distributed computing environment with the stated properties. Mathematical theory of Petri nets was chosen (Diaz, 2009) for that reason. The class of low-level process Petri nets (Huang et al., 2012) was used for these requirements and it has been significantly applied at the design, verification and implementation phases of the necessary hardware and software support preparation.

Materials and Methods

Process Petri nets and their properties

The class of low-level Petri nets process and its properties is discussed in detail in Huang et al. (2012). The original concept of Petri nets process was then extended by the author into the class of process Petri nets whose basic concepts will be described in the following paragraphs.
Let $\boldsymbol{N}$ denotes the set of all natural numbers, $\boldsymbol{N} := \{1, 2, \ldots\}$, $\boldsymbol{N}_0$ the set of all non-negative integer numbers, $\boldsymbol{N}_0 := \{0, 1, 2, \ldots\}$, $\emptyset$ the empty set. **Process net** (PN) is an ordered 7-tuple $PN := (P, T, A, AF, TP, IP, OP)$, where P is the finite non-empty set of the **places** that express the conditions of the modeled process and that are represented by the circles; T is the finite set of the **transitions** that describe the changes in the modeled process and that are drawn by rectangles, $P \cap T = \emptyset$; A is the finite set of the **arcs**, $A \subseteq (P \times T) \cup (T \times P)$; AF is the **arc function**, $AF: (P \times T) \cup (T \times P) \rightarrow \boldsymbol{N}_0$ such that $AF(x, y) \in \boldsymbol{N}$ iff $(x, y) \in A$, $AF(x, y) = 0$ iff $(x, y) \notin A$, i.e., the arc function AF assigns with each arc the natural number (with the default value of 1 if not explicitly indicated in the PN diagram) that expresses the number of removed or added tokens from or to the place associated with that arc when firing of the given transition; TP is the **transition priority** function, $TP: T \rightarrow \boldsymbol{N}$, that assigns with each transition the natural number that expresses its priority (with the default value of 1) and during the transitions enabling and firing process the rule will be followed which determines, informally said, that from the set of enabled

transitions that are in conflict the one will be fired whose value of the transition priority function TP is the highest; IP is the **input place**, $IP \in (P \setminus RP)$ and it is the only one place with no input arc(s), i.e., $\bullet IP = \emptyset$; OP is the **output place**, $OP \in (P \setminus RP)$ and it is the only one place with no output arc(s), i.e., $OP\bullet = \emptyset$; PN is the **connected net**.

Some commonly used notations for PNs are $\bullet y := \{x \mid (x, y) \in A\}$ for the **preset** and $y\bullet := \{x \mid (y, x) \in A\}$ for the **postset** of a net element y (i.e., place or transition). **Marking** M of the PN PN is the mapping $M: P \rightarrow \boldsymbol{N}_0$. Marking M then expresses the current status of the modeled process and it can be written as the vector $M := (M(IP), M(P_1), \ldots, M(P_n), M(OP))$, where $P := (IP, P_1, \ldots, P_n, OP)$, $n \in \boldsymbol{N}_0$. The transition $t \in T$ is **enabled** in the marking M of the PN PN if $\forall p \in \bullet t$: $M(p) \geq AF(p, t)$ and we denote that fact in the form of t ***en*** M. **Firing of the transition** $t \in T$ results in changing the marking M into the marking M', where $\forall p \in P$: $M'(p) := M(p) - AF(p, t) + AF(t, p)$, that is denoted by the statement $M\ [t\rangle\ M'$. We say that the marking M'' is reachable from the marking M iff there exists the finite sequence $\sigma := t_1\ t_2\ \ldots\ t_n$, $n \in \boldsymbol{N}$, of the transitions $t_1, t_2, \ldots, t_n$, such that $M\ [t_1\ t_2\ \ldots\ t_n\rangle\ M''$. The set of all the markings of the PN PN reachable from its given marking M will be denoted by the symbol $[M\rangle$. Let $k \in \boldsymbol{N}$; the following special markings of the PN PN are defined:

- **entry marking** M_e: $M_e(IP) = k$; $\forall p \in (P \setminus \{IP\})$: $M_e(p) = 0$,
- **exit marking** M_x: $M_x(IP) = 0$; $M_x(OP) = M_e(IP) = k$; $\forall p \in (P \setminus \{OP\})$: $M_x(p) = 0$.

Figure 1, illustrates the PN $PROC := (P, T, A, AF, TP, IP, OP)$, where $P := \{\text{IP, P1, P2, OP}\}$, $T := \{\text{T1, T2, T3, T4}\}$, $A := \{(\text{IP, T1}), (\text{IP, T2}), (\text{T1, P1}), (\text{T2, P2}), (\text{P2, T1}), (\text{P1, T3}), (\text{P1, T4}), (\text{T3, OP}), (\text{T4, OP})\}$, $AF := \{((\text{IP, T1}), 1), ((\text{IP, T2}), 1), ((\text{T1, P1}), 2), ((\text{T2, P2}), 1), ((\text{P2, T1}), 1), ((\text{P1, T3}), 1), ((\text{P1, T4}), 1), ((\text{T3, OP}), 1), ((\text{T4, OP}), 1)\}$, $TP := \{(\text{T1}, 2), (\text{T2}, 1), (\text{T3}, 1), (\text{T4}, 1)\}$, $IP :=$ IP, $OP :=$ OP, in its entry M_e and exit M_x markings where $k = 2$. The transition T2 is enabled in the entry marking M_e of the PN $PROC$ (because $(\bullet\text{T2} = \{\text{IP}\}) \wedge (M_e(\text{IP}) = 2 \geq 1 = AF(\text{IP, T2}))$) and it will be fired according to our rule, i.e., $M_e\ [\text{T2}\rangle\ M_1$, where $M_1 := (M_1(\text{IP}), M_1(\text{P1}), M_1(\text{P2}), M_1(\text{OP})) = (1, 1, 0, 0)$. The transitions T1 and T2 are then enabled in the marking M_1 and they form conflict transitions in this marking because $(\bullet\text{T1} \cap \bullet\text{T2} = \text{IP}) \wedge (\text{T1}$ ***en*** $M_1) \wedge (\text{T2}$ ***en*** $M_1) \wedge \neg(\{\text{T1, T2}\}$ ***en*** $M_1)$. The transition T1 will be fired in the marking M_1 according to our rule because $TP(\text{T1}) = 2 > 1 = TP(\text{T2})$, i.e., $M_1\ [\text{T1}\rangle\ M_2$ where $M_2 = (0, 0, 2, 0)$. The transitions T3 and T4 are enabled in the marking M_2 and firing of these transitions changes the marking M_2 into the exit marking M_x of the PN $PROC$, i.e., $M_2\ [\text{T3 T4}\rangle\ M_x$, where $M_x := (0, 0, 0, 2)$ and $M_x(\text{OP}) = M_e(\text{IP}) = 2$.

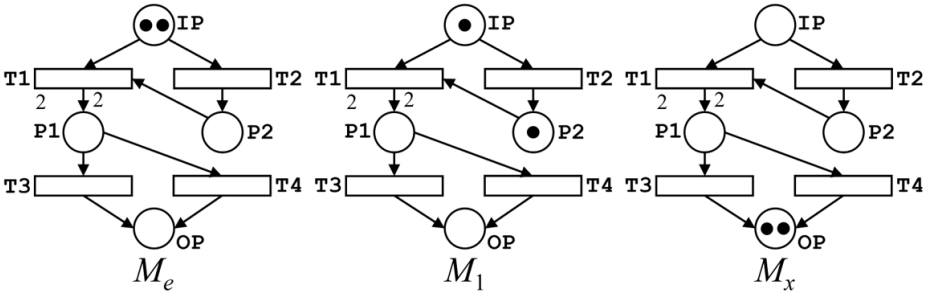

Figure 1: PN *PROC* in its entry M_e, M_1 and exit M_x markings

Process Petri net (PPN) PPN is the ordered couple $PPN := (PN, M_e)$, where $PN := (P, T, A, AF, TP, IP, OP)$ is the PN and M_e is the entry marking of the PN PN.

Let $PPN := ((P, T, A, AF, TP, IP, OP), M_e)$ be the PPN. Then PPN *PPN* is said to be:

- **deadlock-free** iff $\forall M \in [M_e\rangle\ \exists t \in T$: ***t en*** *M*,
- ***k*-bounded** iff $\exists k \in \mathbf{N}_0\ \forall p \in P\ \forall M \in [M_e\rangle$: $M(p) \leq k$,
- **proper-formed** iff $\forall M \in [M_e\rangle$: $M_x \in [M\rangle$.

It can be easily shown that PPN $PPROC := (PROC, M_e)$ in Figure 1, is deadlock-free, 2-bounded and proper-formed.

Technologies installed in AATCe training center

FaceTime is a videotelephony product available on MacOS and iOS devices. **AirPlay** technology enables wireless streaming of audiovisual content among AirPlay devices. **AirPlay Mirroring** (AirPlay, 2021) technology allows streaming of the audiovisual content from various Apple devices to **AppleTV** (AppleTV, 2021). The AATCe training center is equipped with **iMac** computers, **iPad** mobile devices, a large format **65 "NEC MultiSync V651 TM** multi-touch display, **Apple TV** and **AirPort Express** devices, a visualizer **ELMO L-12iD** and a **Kandao Meeting** (Kandao, 2021). Kandao Meeting is mobile 360-degree smart camera equipped with eight omnidirectional microphones and two FullHD lenses that work based on artificial intelligence and it enables a full-fledged recording of lectures and exercises of individual subjects with the use of intelligent monitoring of the teacher and automatic focusing that automatically focuses on active participants in the teaching process. **AirPlay Mirroring** technology is then used extensively during teaching to wirelessly mirror the screen content desktops or mobile devices of students and teacher (all of them are used as AirPlay transmitters) on a NEC V651 large-screen HDTV or the teacher iMac computer (with using of the MacOS **VNC Connect service)** and to share content with other students. It is also possible to record the contents of the teacher iMac screen in real time using the **MS Teams** (MS Teams, 2021) and **BigBlueButton** (BigBlueButton, 2021) video conferencing systems and publish it on-line or on-demand.

Results and Discussion

The technical solution to support the possibility of simultaneous implementation of full-time and distance form of learning in lectures and exercises in the classroom of the authorized training center AATCe (and to a similar extent in other selected classrooms) is in a way an extension of the solution enabling a comprehensive recording of the teaching process in this classroom that was presented in Martiník (2020). The implementation of this solution had to be based on the currently available technical equipment of classrooms that was supplemented by selected mobile components (in this case, an intelligent 360-degree camera Kandao Meeting). The individual requirements for the final technical solution, which were presented at the beginning of this article, were then fulfilled as follows:

- ensuring the voice and video communication of the teacher with full-time and distance students in real time and its recording was carried out using the video-conferencing systems MS Teams and BigBlueButton;
- capture and recording of the teacher's movement in the classroom and his voice communication with the students present was realized by an intelligent 360-degree camera Kandao Meeting that is equipped with a total of eight microphones and the ability to monitor the movement of the teacher; the image from this camera was then transferred to the teacher iMac desktop through which it was transferred online to students in remote locations and simultaneously uploaded to the resulting video recording of the teaching process;

- capture and recording of the teacher's presentation including the content of his writing on a classic blackboard located in the classroom was carried out using an intelligent camera Kandao Meeting or a camera that is the part of the visualizer ELMO L-12iD located in all the classrooms of the faculty (see Figure 3);
- display and recording of the content of the mirrored screens of workstations of selected students present in person within the implementation of exercises in the computer classrooms was implemented in the manner described in the article (Martiník, 2020).

The design, simulation, verification and implementation of a generally distributed parallel software solution that meets all of the above requirements also required the use of appropriate formal methods. Software engineering currently provides number of methods and methodologies designed to implement software systems development (Sommerville, 2016). However, most of these methods and methodologies (e.g., Unified Modeling Language) are not based on a precise mathematical approach and they do not allow formal verification of the properties of the implemented software system and its simulation. Petri nets (Diaz, 2009) are one of the mathematical modeling languages for the description of all the types of parallel systems and represent a popular method combining the advantages of graphical representation of a modeled system with the possibilities of its simulation and formal analyzability. The solution to the above problem then required the use of the class of low-level process Petri nets. However, the use of the standard class of process Petri nets (Huang et al., 2012), which is often used in this context, proved to be too complicated and so their definition was extended to the form of PPN class mentioned in the previous paragraphs. It was then necessary to design a *k*-bounded, deadlock-free and proper-formed PPN for the above objectives. This research goal was achieved and the simplified PPN in its entry marking M_e (detailed PPN covering all aspects of the final solution is much more complicated) that models the programming support functionalities is shown in the Figure 2.

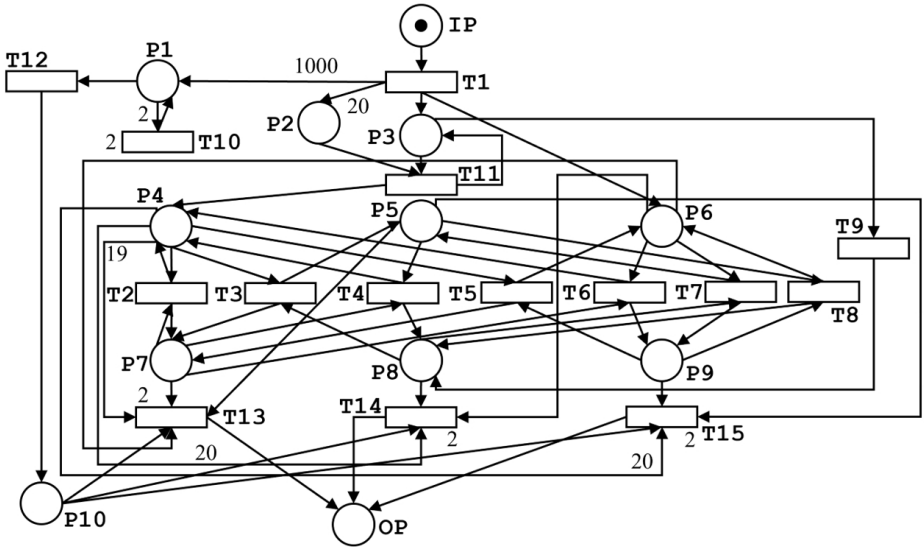

Figure 2: AATCe classroom functionalities modeling with using of PPN

The transition T1 is enabled in the entry marking M_e of PPN and 1000 tokens will be located in the place P1 representing an imaginary time counter delimiting the duration of the given lesson after firing of this transition T1. The only remaining token in the place P1 (after the firing of 999 times the transition T10 has taken) will be located in the place P10 after the firing of the transition T12. This token will allow PPN to achieve its exit marking M_x by firing one of the transitions T13, T14 or T15 (according to the current marking of PPN). Furthermore, a total of 20 tokens representing student iMac workstations will be located in the place P2 and the only token representing the teacher iMac workstation will be located in the place P3 after the firing of the transition T1.

Establishing of the VNC Connect connectivity of individual student iMac workstations with the central teacher iMac workstation is then modeled by repeatedly firing of the transition T11 (i.e., the tokens representing the student computers will be sequentially moved into the place P4) and the token representing the teacher iMac workstation will be then moved into the place P8 by firing of the transition T9 after finishing this process. If the (only one) token in the current PPN marking occurs at the place P8, resp. P9, resp. P7, this marking then expresses the state of recording of presentation and (at the same time) performing remote transmission of the content of the screen of the teachers iMac workstation that contains the content of the teacher presentation, resp. the content of a classic whiteboard captured by the camera of the visualizer ELMO L-12iD or by the intelligent 360-degree camera Kandao Meeting, resp. the content of the screen of the relevant student workstation that actually communicates with the teacher iMac workstation through VNC Connect connectivity. If there is the single token in the current PPN marking in the place P5, resp. the single token in the place P6, resp. 20 tokens in the place P4, expresses this marking of PPN that it is actually not recorded and transmitted the presentation of the teacher, resp. the content of the classic whiteboard, resp. the contents of any of the student workstation screens. The firing of one of the transitions T2, T3,…, T8 then represents the respective change of the content of the teacher iMac screen intended for the recording and remote transmission. It can be shown that the presented PPN in Figure 2, is k-bounded (where $k = 1000$), deadlock-free and proper formed.

Figure 3: Camera of visualizer ELMO L-12iD and 360 degrees camera Kandao Meeting

The following significant results were achieved at the Faculty of Economics VSB-Technical University of Ostrava:

- over 110 presentations and their recordings were realized with the support of AATCe training center equipment and the comprehensive collections of the following subjects are available: Basic Programming (2nd year of Bachelor studies of Informatics in Economics), Dynamic Web Pages Creation (2nd year of Bachelor studies of Informatics in Economics), Graphic Information Processing (2nd year of Bachelor studies of Marketing), Internet Applications Creation (3rd year of Bachelor studies of Informatics in Economics), Software Engineering (1st year of Master studies of Informatics in Economics) and Economic Applications of Artificial Intelligence (2nd year of Master studies of Informatics in Economics); the rich-media recordings were published in the on-demand mode through the LMS system Moodle; statistical data on monitoring students' access to the recordings of presentations show that each student for whom a given record of the presentation was intended within the given taught subject viewed this presentation at least once (on-line or on-demand) and 63% of these students watched the given presentation more than once,
- a total of 16 students with special needs are registered at the faculty this academic year, who use "barrier-free" access to information through recorded presentations;
- various forms of synchronous and asynchronous remote communication between teachers and students were started, which began to be used in the so-called pre-learning process, where students have records of selected topics of the subject before the lesson and they can study them in advance (or communicate with the teacher) and they are already equipped with information on the topic;
- synchronous and asynchronous communication is also actively used in cases where students actively participate in the implementation of the recording of their individual presentations, especially in the defense of their projects.

Conclusion

An extensive survey of students and teachers was conducted at VSB-Technical University of Ostrava concerning selected aspects of the implementation of distance learning in November and December 2020. The survey was attended by 576 students and 81 teachers of the Faculty of Economics. It showed that at this faculty, among other things:

- 47.4% of the students prefer watching of the lectures and exercises remotely in the real time and 52.6% of the students prefer watching of the recordings of presentations;
- 13% of the teachers provide recordings of their presentations before the teaching process, 39% of the teachers provide recordings of their presentations after the teaching process and 48% of the teachers do not make any recordings of their presentations;
- 45% of the teachers are interested in the professional implementation of their recordings of presentation and 55% of the teachers are not interested in this service,
- 68.3% of the students were satisfied with the way in which the distance form of teaching was provided.

The above findings show the high importance of the implementation of information support for the teaching process conducted in the full-time/distance form and the growing importance of the implementation of its recordings at the professional level.

Acknowledgement

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DIFFERENCES IN THE METACOGNITIVE AND DISCURSIVE ACTIVITIES BETWEEN REGULAR AND IBL MATHEMATICS LESSONS

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Abstract

Inquiry-based learning is considered as an effective approach to mathematics education. Teachers often struggle when starting to use IBL in their practice. The courses for professional development of mathematics teachers often involve pedagogical experimenting and subsequent reflection. The differences in metacognitive and discursive activities between regular lessons and the lessons based on the lesson plan designed by the internationally recognised expert taught by the participants of CPD were analysed quantitatively based on the video-recordings of the lessons. The several-step planning typical for the regular lessons was replaced by metacognitive planning during the IBL lessons. The wilful disruption was significantly less prevalent in the IBL lessons indicating the bigger involvement of students. The episodes of the lessons were grouped more according to the type of lesson and type of activity than according to the teacher. The grouping of the episodes suggests that participating teachers might get similar experience when performing the same lesson plan.

Keywords

Inquiry-based learning, mathematics education, metacognition, professional development

Introduction

There is a wide consensus among the mathematics educators that the student-centered, constructivist pedagogies provide the students with more effective opportunities to learn (Steffe and Kieren, 1994). Furthermore, the reported positive effects of solving challenging problems instead of drilling (Boaler 2002, 2015; Bottge, 1999) is seen also after schooling of an individual. Students educated through collaborative problem-solving are more academically successful and subsequently they tend more to choose mathematics oriented careers (Boaler and Selling, 2017). Inquiry-based learning is based on constructivist theories of learning and therefore providing both teachers and students with concrete pedagogies (Bruder and Prescot, 2013). This approach involves the different demands on the teachers as well as students. Students should be actively involved, open-minded, posing questions and collaborating in the problem-solving process. Moreover, teachers should build on the previous students' knowledge, value the students' reasoning, offer the scaffolding and establish a supportive classroom culture, value the mistakes, support sharing of the students' ideas and responsibilities (Artigue and Blomhøj, 2013), offer the opportunities to learn independently and foster students' metacognition (Widodo and Duit, 2004). Metacognition is usually defined as thinking about thinking, as the cognition of one's own cognitive functions (Desoete and de Craene, 2019). According to Flavell (1979), metacognition represents a dual concept, consisting of both knowledge of cognitive processes (metacognitive knowledge)

and knowledge that can be used to control and manage cognitive processes (metacognitive ability). There are only a few attempts to assess the use of metacognitive activities in teachers' practice, in the form of specialized interviews (Wilson and Clarke, 2004) or rubrics to assess the discussion in mathematics classrooms (Nowińska, 2017, 2018).

Every effort to bring more IBL into mathematics education should consider teachers as the "crucial agents of change and critical implementers of innovative teaching approaches" (Maass et al., 2019, p. 304). Evidently, the teachers often do not feel competent to start with an IBL and struggle with setting up the environments for IBL (Windschitl, 2002) and need a consistent frame of support during their first experiences with IBL (Dorier and Garcia, 2013). Their positive experience with IBL may cause shifts in their beliefs and therefore influence their practice (Clarke and Hollingsworth, 2002; Guskey, 2002).

In our previous work (Medová, Bulková and Čeretková, 2020) we investigated differences in the facets of constructivist teachers' practice (Beerenwinkel and von Arx, 2017) of our four participants involved in the course for professional development for upper-secondary mathematics teachers between their regular and IBL lessons. The holders of social interactions and the level of fostering the metacognition differed significantly between the regular and IBL lesson of teachers participating in the study. In spite of a huge body of research devoted to professional development of teachers, particularly aimed at IBL and students' centered pedagogies, little is known how metacognitive and discursive activities differ between transmissive and IBL lessons, particularly how is the quality of metacognitive and discursive activities in class discussions. Based on the nature of IBL according to the PRIMAS definition (Maass and Reitz-Koncebovski, 2013) several differences between regular and IBL lessons are expected.The higher activity of students and more opened tasks more metacognitive activities are expected as the students are not familiar with the typical procedure of the solution. As the students are encouraged to explain and evaluate and teachers should foster and value students' reasoning in the IBL lessons, more mathematical reasoning and argumentation from students is expected in lessons of this type. Since the open-minded classroom culture is typical for IBL, we assume that the evaluation will be focused more on the content than on the persons. Higher amounts of suggestions for discussion and students' independent contributions and lower negative discursivity are also related with the IBL classroom culture.

The structure of the paper is as follows: the introduction is followed by the description of methods including the characteristics of participants and the description of statistical methods. Then the results are presented and analysed. After the discussion of results the conclusions are formulated.

In order to fill this gap in knowledge we sought for the answer to the formulated research questions: **(i) In what facets of metacognitive and discursive activities do the regular lessons differ from the lessons based on the lesson-plan prepared by the relevant expert? (ii) What are the relations between the episodes from the regular and IBL lessons of participating teachers?**

Methodology

The observation of the teachers' metacognitive and discursive activities during the regular lessons and IBL lessons was carried out based on the videotaped lessons submitted within the course for professional development (CPD). All the participating teachers and the parents of their students provided informed written consent. The names of teachers used in the result section are pseudonyms. The CPD aimed at the implementation of IBL in upper-secondary mathematics education (Primas project).

Out of six teachers participating in the CPD, the lessons taught by four participants were chosen for analysis. Each participant recorded their own regular lesson following the national curricula and the lesson following the IBL lesson plan named Counting trees (MARS, 2015) focused on sampling

and estimating. The lesson plan was very detailed and contained comprehensive a priori analysis including the suggested questions supporting students' investigations. All four participants taught mathematics in grade 12 (year 3 of the grammar school) and they had statistics in their plans during the CPD.

All the participating teachers have been teaching at the grammar schools in Nitra region. Matej has been teaching in classes with a special programme in mathematics and prepares his students for different contests. His students have been successful in the mathematics olympiad. He usually provides them with a variety of techniques to be incorporated in the solution of the problems. In his regular teaching he aims at the performance of his students in the annual final examination comparing all the classes in his grammar school. On the contrary, Eva expressed the constructivist beliefs and she likes when the students gain conceptual understanding in mathematics. Greta had been teaching physics for 10 years preceding the CPD, but in the year of CPD she started to teach mathematics again. She presented low self-efficacy, as she stated she does not have her usual methods and piloted problems for the topics. The facilitators understood this as an advantage and hoped for greater willingness in implementation of IBL. Silvia was usually quiet during the group interviews. She is a teacher at a grammar school with the special programme in mathematics, but she does not teach in these classes. Compared to other participating teachers, she was more student-centered. She claimed that her students are active, have opportunities to make their own investigations and they are able to follow the lesson. She was willing to implement more IBL activities in her lessons.

The categories of metacognitive and discursive activities developed by Nowinska (2016) were used for a detailed analysis of the differences between the teachers' practice during regular and IBL lessons (Table 1). The scheme describes together 37 aspects in five main categories: planning, monitoring, reflection and positive as well as negative discursivity. Although the original schema was developed for analysing the interactions between teacher and students, due to the objective of this study the scheme was adapted for observing the teachers' practice.

Planning	Monitoring	Reflection	Discursivity	Negative discursivity
P1a One-step activity **P1b** Several-steps activity or alternative approach **P2** Metacognitive activities	**M1** Subject-specific activity **M2** Terminology and vocabulary **M3** Notation or representation **M4** Planned or modelling approach **M5** Argumentation in statements **M6** Relevance of the result **M7** Revealing a misconception	**R1a** Expression without reorganization **R1b** Expression with reorganization **R2a** Conceptual hierarchy **R2b** Creating the concept **R3a** Identification of the representation **R3b** Creating a specific representation **R3c** Promoting understanding based on R3a or R3b **R4** Effectiveness of tools and methods **R5** Argumentation and reasoning **R6a** Evaluation of the discussion about the content **R6b** Evaluation of the person **R7** Interplay between representation and conception	**D1a** Suggestion for discussion **D1b** Independent contribution **D1c** Repetition of the statement **D1d** Activities for effective discussion **D2** Rules for discussion	**ND1a** Asking a self-answering question **ND1b** Repetition of already said things **ND1x** Wilful disturbing the class **ND2** Inadequate vocabulary **ND3a** Non-explicitly argumentation **ND3b** Lacks in grammar or sentence structure **ND3c** Intentional change in the meaning of repeated statements **ND3d** Uncommented change of the reference point **ND3e** False logical structure of an argumentation **ND4** No intervention, ignoring an objection

Table 1: Reflection in metacognitive and discursive activities (Nowińska, 2016)

The first category describes the planning of the way students are led into a problem situation. The teacher directs here the attention on usable tools or methods by one step or several steps planning activities, or indicates the possibility of an alternative approach. The attention can be directed also to planning the metacognitive activities.

The second category is devoted to the monitoring of the teacher´s expressions during the implementation of the planned activities. Seven aspects aimed at following the specifications of the subject, keeping the proper terminology in teacher's and students' explanations in offered representations, the validity and adequateness of tools and methods are described within the category. Within this category it is considered whether the teachers are careful about their own argumentation, observe if there are some mistakes or gaps in the students' explanations, or whether they are aware of possible misconceptions, conducting a stepwise or global control or using an alternative argumentation which can be new for students. The teacher's question has to be connected with the goal of a task or question and the answer.

The most extensive category aims at reflection expressed by teachers based on students' answers. Teachers' reflection is aimed at all notations, approaches or methods. At first, the analysis of structure of a subject-specific expression is distinguished in two aspects: without taking into consideration any additional rewriting and reorganization or with an additional rewriting or reorganization of the given expression. Reflection on concepts and analogies, result of reflection by representation, reflection of effectiveness and way of the application of the tools or methods, reflection on argumentation, reflection of the interplay between representations and conception are included.

The discursivity category assesses the way the teachers lead students into the discussion about a given problem or assigned situation. Two main aspects of discursivity are described. First part represents the discursivity for effective discussion or for reconnection of sample explanations like: inviting the specific students to fix already used expressions, introduction of a new contribution independently of used ones, repeating of said statements for deeper reasoning or others. The setting rules of the discussion represents the unwritten agreement for enforcing and keeping the fluent discussion.

Teachers' discursivity can also show some negative interferences in the course of the discussion, which influence the management of the metacognitive discourse and make it ineffective. The most common negative interventions are redundant contributions from the teacher like entering with the superfluous contributions described with the first three aspects. The usage of the inadequate vocabulary in explanation requires precise terminology. Even setting up the rules can have negative impacts described in the five aspects. The negative effects for discursivity can be represented by ignoring serious adherence to the rules of discussion by teachers.

The lessons were divided into smaller episodes according to the activity during the lesson (i.e. teacher lecturing, group-work, etc.) at a specific time. Each episode was labelled by the pseudonym of the given teacher, number of lessons (L1 - regular, L2 - IBL) and phase of lesson. The defined facets were assessed for each episode. The values 0 (the aspect was not manifested in the episode of the lesson) and 1 (the aspect was manifested in the observed episode of the lesson) were assigned to the lesson. The weighted arithmetic mean for each facet was calculated for each lesson and the minimum and maximum values were visualised by a radar graph. In order to group together episodes with similar characteristics, the hierarchical cluster analysis (Tan et al., 2019) was performed using the Euclidean distances and Ward's clustering method performed in the R environment (RCoreTeam, 2021). The cophenetic correlation coefficient was used to determine the most accurate clustering method. Hierarchical cluster analysis had previously been used for grouping teachers according to their practice based on analysis of video-recordings of their lessons by e.g. Beerenwinkel and von Arx (2017).

Results

The level of the observed variables related to the teacher and students metacognitive and discursive activities in class discussions varied between the regular and the IBL lessons of participating teachers (Figure 1). The difference in the amount of teachers' action is obvious. In planning, the higher level of planning of several-steps activities was higher during the regular lesson. Oppositely, the planning of metacognitive activities was more prevalent in the IBL lesson. The differences in monitoring the activity were only minor with the exception of controlling of the terminology by the teacher (M2), and revealing the misconceptions (M7). Analysis of effectiveness of the methods (R4) and analysis of interplay between representation and conception (R7) occurred more often in the regular lessons while analysis of structure of a subject-specific expression with additional rewriting and reorganization of given expression (R1b) was more prevalent during the IBL lesson. Furthermore, the reflection-based assessment with regard to both, the content (R6a) and the person (R6b) was observed more often in regular lessons. Teachers tend to improve the discourse more during their regular lessons by naming of the relevant reference points of students (D1a); judging students' contributions (D1b) and structuring the discourse (D1d) while the difference in using the repetition of students' statements as a basis for further reasoning was only subtle (D1c). Intentional disturbing by the students appeared more often during the regular lesson (ND1x) whereas inadequate vocabulary was used more during the IBL lesson (ND2).

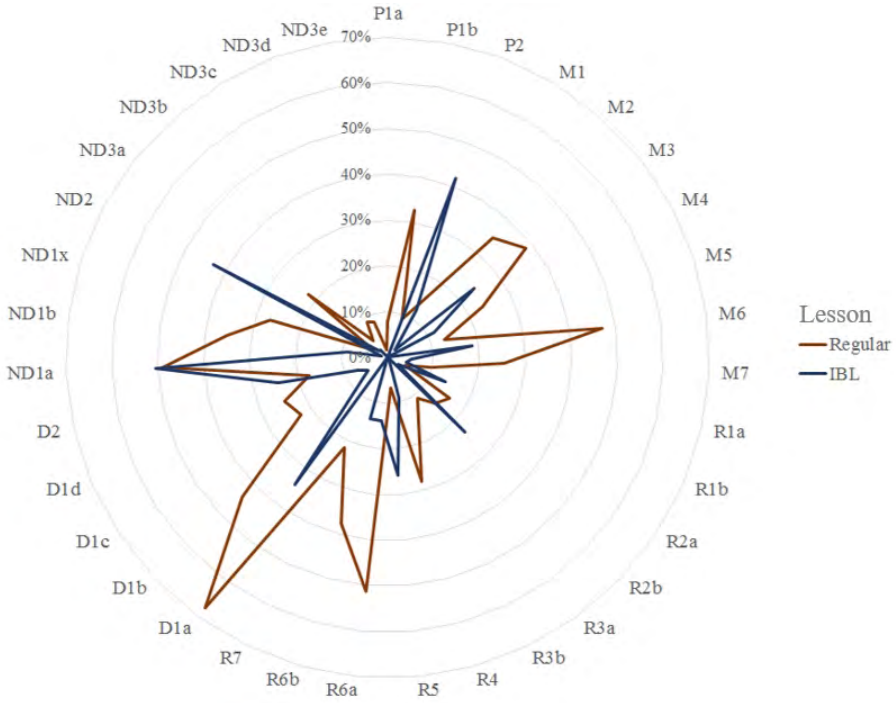
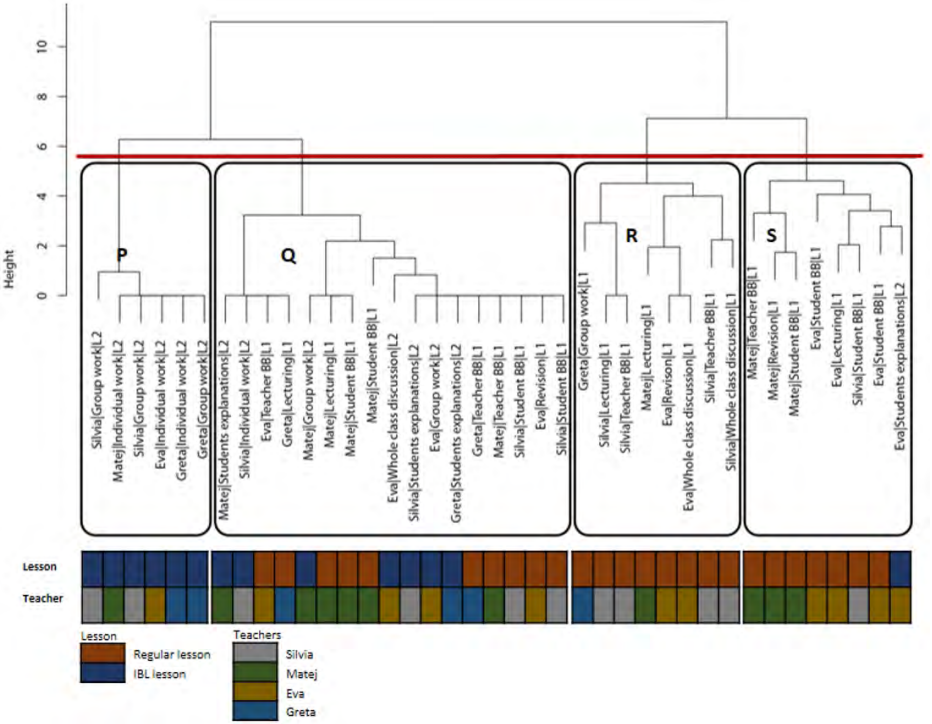


Figure 1: Radar graph of the facets of metacognitive and discursive activities in class discussions

In order to understand better the nature of the difference in the facets of metacognitive and discursive activities between the regular and the IBL lessons the hierarchical cluster analysis was performed. The five grouping methods were used and the coefficient of correlation between the distance in the

dendrogram and the estimated Euclidean distance was estimated. The correlation coefficient was highest for the Ward clustering method for clustering both the episodes and the facets of metacognitive and discursive activities. The episodes were grouped into four clusters (Figure 2) P, Q, R, and S.



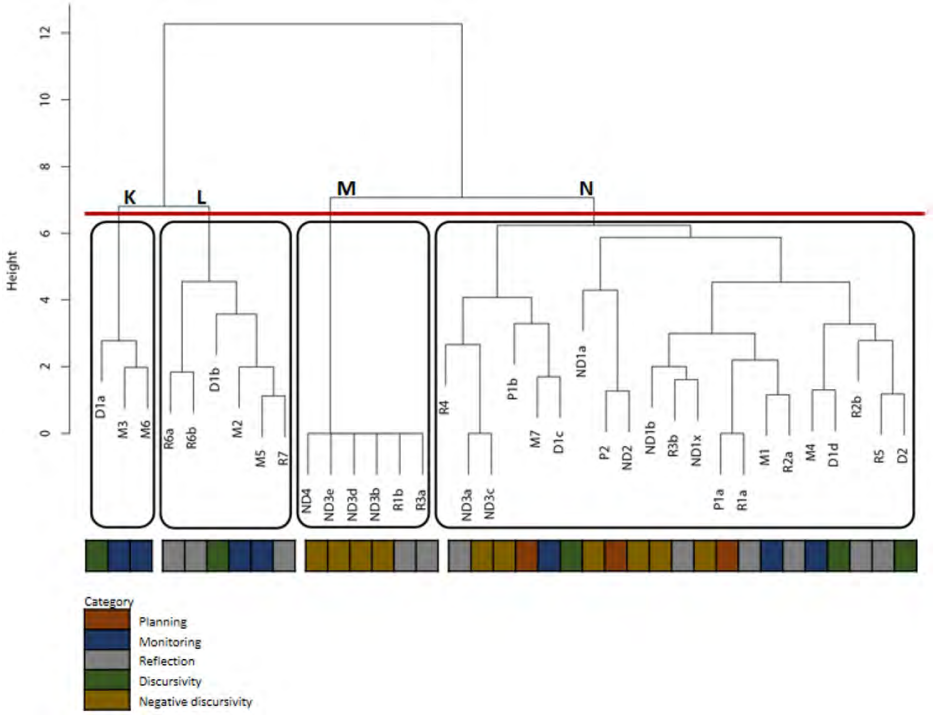
Name of the teacher|Episode of the lesson|Number of lesson; BB means solving a task on the blackboard

Figure 2: Dendrogram grouping the episodes of analysed lessons

The cluster P consisted of the episodes of the IBL lessons, mainly of the group-work and also the individual work of Eva's students. The episodes in cluster Q were from both: the regular and IBL lesson, except the two episodes of group-work, the whole-class activities were grouped in this cluster. The clusters R and S comprised mostly the episodes from regular lessons. There was only one episode (students' explanations during Eva's lesson) from the IBL lesson grouped to the cluster S.

The 36 facets of metacognitive and discoursing activities were grouped into the four clusters (Figure 3) labelled as K, L, M, and N. The clusters were rather heterogeneous and facets describing the same aspect of the metacognitive and discursive activities were clustered together. The planning activities were prevalent in both types of lessons. Planning for several steps and alternative approaches typical for regular lessons was substituted by the metacognitive planning in IBL lessons. The monitoring and reflection were much less observed during the IBL lesson. This may result from the fact that the teachers were not familiar with the form nor with the problem. We hypothesise that the teachers did not feel confident enough to interfere and correct the students. They were also not familiar with possible misconceptions that may appear during solving the problem and therefore they do not have pre-prepared appropriate interventions. The

teachers have to perform less actions related to discursivity during the IBL lesson as this lesson consisted of a large portion of independent work of students, both individual and group-work. The opportunity to contribute to the solution of the problem is reflected in a lower incidence of intentional disturbing of the class.



D discursivity; P planning; R reflection; M monitoring, ND negative discursivity.

Figure 3: Dendrogram grouping the facets of teacher and students metacognitive and discursive activities in class discussions

Discussion

The two different types of lessons performed by four upper-secondary mathematics teachers participating at the CPD focused on IBL were analysed. The first of the two lessons was labelled as regular by the teachers, while the second followed the lesson plan designed by the professional educational designer (MARS, 2015). The differences in metacognitive and discursive activities were evaluated. When analysing the differences in the aspects of metacognitive and discursive activities it should be considered that the lessons varied in structure. The IBL lesson was based on the lesson plan using the group-work and independent work of students whereas the regular lessons were organised mainly in a frontal format. The IBL lessons cannot be considered as exemplary ones, but as the first experiences with IBL for the participating teachers.

The metacognitive activities appear with the proper level of problem's difficulty. Whereas the simple problems do not pose adequate cognitive demands to involve the metacognitive activities in the problem-solving. On the other hand, problems that overreach the students' abilities do not simulate their metacognition, too (Chytrý, Pešout and Říčan 2014). The problem solved during the IBL lesson was an open one in sense (Nohda, 2000) and the students were not aware of

any standard procedure of the solution, the metacognitive planning was more prevalent in the IBL lesson (Chan and Clarke, 2017). Also the expected increase in the level of reasoning and argumentation and reasoning (Maj-Tatsis and Tatsis, 2020) was confirmed. However, the increase was lower than expected. This may be because of the fact that the investigated lesson was the first IBL lesson of the participating teachers (Canavarro and Serrazina, 2020). The hypothesis about the change of focus of the evaluation was confirmed as well as the frequency of teachers' suggestions for discussion and offers to students' independent contributions which may indicate that the teachers tried one of the strategies for managing mathematical discussion presented in the CPD detaily described in by Stein et al. (2008). During the IBL lesson the willful disturbing the class was less observed which may be caused by higher involvement of students (Vondrová, 2019) typical for IBL lessons (Artigue and Blomhøj, 2013).

The activity of teachers was much lower in the IBL lessons as the students were provided by more room for independent work, whether individual or group-work, and therefore for independent learning as reported in our previous study (Medová et al., 2020). The high overall level of students' metacognitive activities indicates that the Counting trees problem has sufficient difficulty for the students and therefore helped to establish a supportive learning environment (Blömeke and Klein, 2013).

Even though the quantitative methods were used, there were investigated the lessons taught only by four teachers, therefore the results should be generalised very carefully. On the other hand, there are almost no studies investigating the practice of teachers using constructivist-based pedagogies including IBL from the perspective of metacognition and discursive activities.

Conclusions

The results of analysis confirmed the material differences between the regular lesson and a lesson based on IBL lesson plan. The episodes of the IBL lessons when students worked independently were clustered together. The affiliation of the episodes of the regular lessons to the clusters depended more on teachers' personality than on the type of the lessons. When solving the unstructured problem the planning of several-step activities was replaced by metacognitive activities. The observed level of negative discursivity was much lower in the IBL lessons therefore we can claim that the students were more involved in the problem-solving process. The evaluation of correctness was replaced by an analysis of the interplay between representation and conception in the IBL lessons. It may indicate the shift in processing the students' errors by teachers towards valuing the mistakes. The carefully prepared lesson plan including comprehensive a priori analysis developed by an expert in IBL enabled the teachers to implement and gain some new experience with IBL. Further research is needed to evaluate impacts of the teachers' experience with the IBL lessons on their everyday practice.

Acknowledgement

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COMPARISON OF STUDENT RESULTS BEFORE AND DURING COVID-19 PANDEMIC

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Abstract

The objective of this paper is to present the results from students taking the course of Mathematics for Economists at the Prague University of Economics and Business during the summer semester of the academic year 2019/2020 when the teaching and assessment was done remotely due to the COVID-19 pandemic and compare these results with the results obtained by the students who took the course in the corresponding semester of the year 2018/2019.

The mid-term test scores, final test scores, and final grades from 669 students taking the course in the summer semester of the year 2018/2019 and from 737 students taking the course in the summer semester of the year 2019/2020 were analysed and compared. The students performed significantly better during the online assessment. Some lessons were learned and certain changes were implemented in the subsequent academic year to make the assessment more comparable to the previous academic years.

Keywords

Assessment of students, COVID-19 education, performance of students, results in mathematics

Introduction

The Department of Mathematics of the Faculty of Informatics and Statistics teaches every semester the course of Mathematics for Economists. The basics of linear algebra and mathematical analysis are taught to students in this course, which is compulsory for most of the bachelor's degree programs at the Prague University of Economics and Business.

The outbreak of the COVID-19 pandemic and subsequent government restrictions in early March 2020 hit the universities in the Czech Republic unprepared. The Prague University of Economics and Business was in the third week of the summer semester of the academic year 2019/2020 when the in-class teaching was forbidden. The rest of the semester continued via distance learning, which was a new challenge for both students and teachers.

Students' performance at assessments depends on the variety of factors. For example, Stareček et al (2017) showed that the performance of students depends on the time of the day when the exam is taken. Fajčíková et al (2020) showed that students from different degree programs score differently. Kiwanuka (2017) showed that student and classroom characteristics influence students' performance and attitude towards mathematics.

The unexpected change in the way of teaching and assessment format caused by the outbreak of the pandemic resulted in many difficulties for students and teachers. Mendoza et al (2021) stated that the anxiety in students increased and that there were significant differences in understanding the mathematical concepts due to switch to the distance learning. Elsalem et al (2020) mention an increased level of stress for medical students during the distance learning while Cassibba et al (2021) describe all kind of challenges for Mathematics teachers when switching to distance learning during the COVID-19 pandemic.

The objective of this paper is to present results of the students who took the course of Mathematics for Economists in the summer semester of the year 2019/2020, verify whether these students scored differently when compared to the students in the summer semester of the year 2018/2019, discuss the differences and come up with some lessons learned.

Materials and Methods

Data description

In order to investigate the changes in the students' performance in the summer semester 2019/2020, the corresponding semester from previous year, i.e. the summer semester 2018/2019, was selected for comparison. The content of the course was the same in both semesters and similar number of students were enrolled: 669 in the summer semester 2018/2019 and 737 in the summer semester 2019/2020.

Course description

The course of Mathematics for Economists used to be taught and assessed in the same way for many years before the pandemic. During the 13 weeks students attended non-compulsory lectures (90 min/week) and non-compulsory exercise sessions (90 min/week). The continuous assessment of students consisted of the mid-term test worth 20 points written around week 9 of the semester, final test worth 40 points written in exam period and theoretical oral exam worth 40 points. All parts of the assessment were closed book. The points were then summed up and final grades were determined using university regulations presented in Table 1. Students had only one attempt to each part of the assessment unless they were graded with 4+, when they could retake the final test and oral exam once more.

Grade		Points
Excellent	1	90-100
Very good	2	75-89
Good	3	60-74
Failed, eligible for retake	4+	50-59
Failed	4	0-49

Table 1: Grading rules at the Prague University of Economics and Business

After the sudden outbreak of the COVID-19 pandemic and closure of the university, the situation the teaching was interrupted for around 2 weeks and the remainder of the semester was then taught via distance learning. As teaching mathematics via distance learning is not straightforward and not every lecturer and tutor had access to the technical accessories, such as graphical tablets and headsets, there were differences in the way the teachers approached distance learning. Some teachers taught online via MS Teams or ZOOM according to the schedule, some pre-recorded videos, while others scanned notes and solved problems with comments and asked students to read the theory and solve selected problems in the textbook (Klůfa, 2019). The content of the course was not reduced and all required topics were covered and examined.

The assessment was modified in the following way. An online mid-term homework assignment, which replaced the usual mid-term test, was assigned to students in Week 10. Students received five problems from their tutor and had to send scanned handwritten solutions within a week. The final test was online and open book as most of the foreign students could not travel to the Czech Republic and simultaneous video control of up to 90 students taking the exam at the same time was not feasible. Students received 8 problems and had to send their handwritten solutions within 70 minutes. The students registered on the same exam date were then split among the examiners for the theoretical part of the exam. Some examiners used similar approach as for the online

final test, i.e. they send 4 theoretical questions via email and students had 15 mins to send these questions answered. Others used video calls and the exam was oral.

Statistical methods and software

Descriptive statistics were calculated for the mid-term test score and the final test score (*mean, standard deviation, median, 1st quartile, 3rd quartile, minimum, maximum*). The distribution of the scores was also visualised using boxplots. The Mann-Whitney *U* test was used to assess whether the scores between the two semesters differ. The null hypothesis of the test states that the distribution of the scores is the same in both semesters, while the alternative hypothesis states that the two distributions differ. For more details about the test see, e.g., Pecáková (2018).
The contingency table showing final grades by semester was assessed using the Cochran-Armitage test. The test tests the null hypothesis that there is no association between final grades and semester vs the alternative hypothesis that the association is present between grades and semester. The grades were also visualised using bar charts. For more details about the test see, e.g., Agresti (2012).
The statistical analyses were performed using the statistical software R 4.0.4 and its packages. All statistical tests were performed at the 5% level of significance.

Results

Mid-term test

Table 2 shows the descriptive statistics for the mid-term test score for both semesters. The distributions of the scores are visualised in Figure 1. The difference in the distribution of scores is noticeable and the students scored much better during the mid-term assignment. The average score during the mid-term assignment in the summer semester 2019/2020 was 17.16/20, while in the regular mid-term test in the summer semester 2018/2019 the average score was 11.31/20. The null hypothesis is rejected using the Mann-Whitney *U* test, hence the difference between the mid-term test scores in two semesters is statistically significant (p-value<0.001).

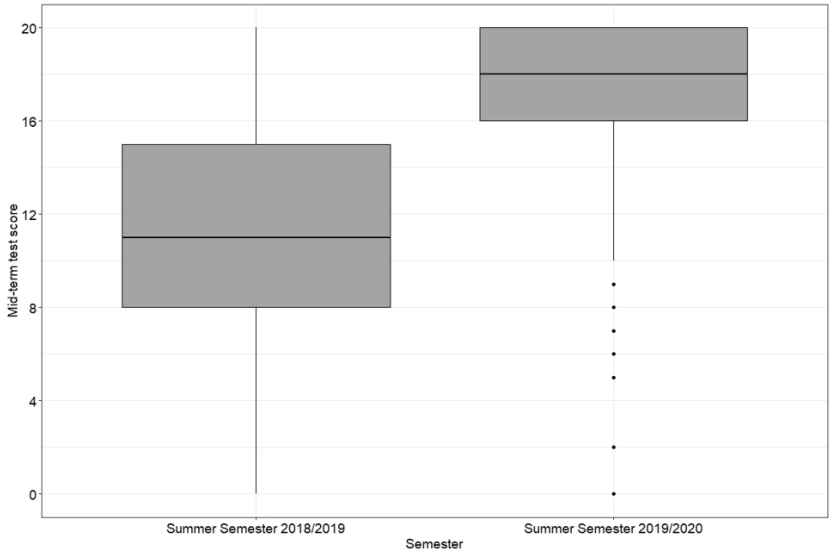

Figure 1: Boxplots for mid-term test score

It should be noted that even though the five problems in the online homework assignment were more difficult and more time consuming when compared with the regular in-class test, students had one week to work on these and they could use textbooks, internet, etc. Also, there was no theoretical question in the mid-term homework assignment. During the in-class mid-term test the time was limited (40 minutes), the test was closed book and there were four problems to solve and one theoretical question. Hence, it was expected that the students will score better in the homework assignment in the summer semester 2019/2020.

Summer Semester	*N*	Mean	Std. Dev.	Min.	1st Quartile	Median	3rd Quartile	Max.
2018/2019	669	11.31	5.01	0	8	11	15	20
2019/2020	737	17.16	3.93	0	16	18	20	20
Overall	1406	14.38	5.35	0	11	16	19	20

Table 2: Descriptive statistics for mid-term test score

Final test

Table 3 presents the descriptive statistics for the final test score for both semesters and the distribution of these scores can be seen in Figure 2. The same observations can be observed as for the mid-term test score, i.e. student performance improved during the online assessment (average score in summer semester 2018/2019 was 23.53/40, while in the summer semester 2019/2020 students gained on average 31.54/40). Using the Mann-Whitney U test we reject the null hypothesis, hence the difference between the final test scores in the two semesters turns out to be statistically significant as well (p-value<0.001).

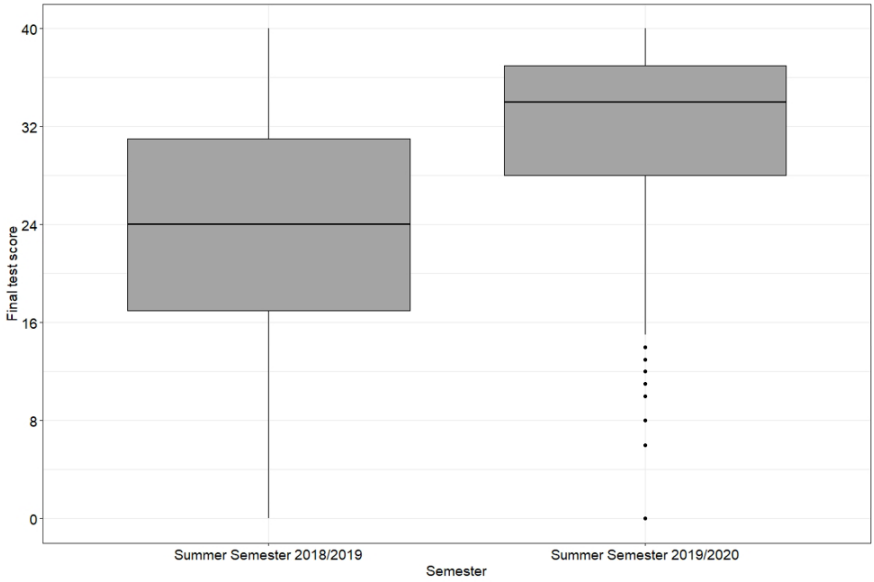

Figure 2: Boxplots for final test score

The standard final test was written in class and was a closed book test. Students had to solve 8 problems within 80 minutes. In the summer semester 2019/2020 the test was open book and online without any video control. Students received 8 problems and had to send their handwritten solutions within 70 minutes. The number of problems and difficulty was comparable but since the

test was open book, students were given less time and had to scan the solutions within this time as well.

Summer Semester	*N*	Mean	Std. Dev.	Min.	1st Quartile	Median	3rd Quartile	Max.
2018/2019	669	23.53	9.51	0	17	24	31	40
2019/2020	737	31.54	7.84	0	28	34	37	40
Overall	1406	27.73	9.55	0	22	30	35	40

Table 3: Descriptive statistics for final test score

Final Grades

The contingency table of semester by final grade is presented in Table 4. These counts are also visualised in Figure 3. It can be observed that the distribution of final grades was different in both semesters and students scored better during the online assessment. The mode grade was 2 in the summer semester 2019/2020, while it had been 3 in the preceding year. The difference between the distribution of grades between the semesters is statistically significant as the null hypothesis is rejected using the Cochran-Armitage test (p-value<0.001).

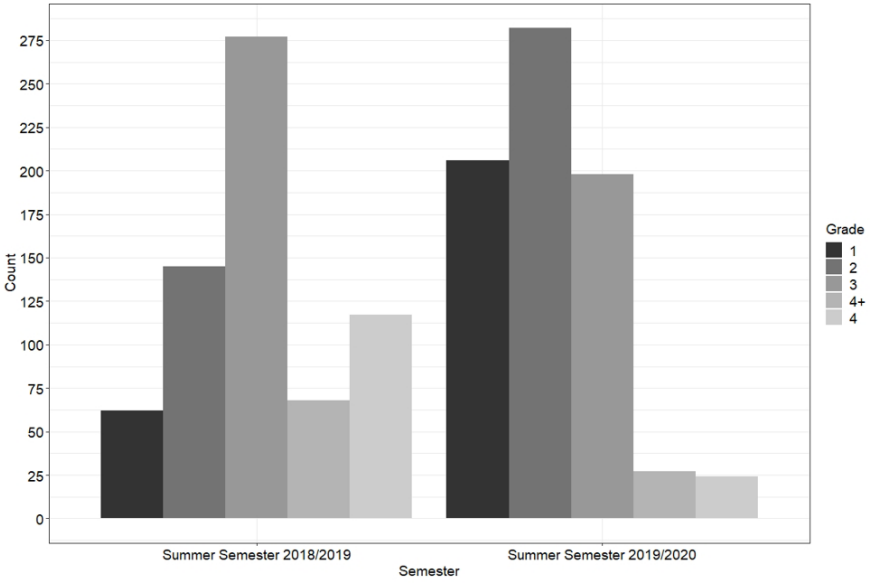

Figure 3: Final grades by semester

Summer Semester	1	2	3	4+	4	Overall
2018/2019	62	145	277	68	117	669
2019/2020	206	282	198	27	24	737
Overall	268	427	475	95	141	1406

Table 4: Contingency table of final grades by academic year

The final grades are determined after summing the scores from all three parts of the assessment and since the average scores of mid-term tests and final tests were higher during the online

assessment when compared to the summer semester 2018/2019, the final grades were better as well, hence the difference in the way of conducting assessment contributed yielded better grades.

Discussion

From the observed differences it can be concluded that students performed significantly better in online assessment. The same trend was observed by Ripoll, Godino-Ojer, and Calzada (2021). Antonova, Abramova, and Popova (2020) describe that virtual classrooms are more enjoyable as students do not need to leave their households for classes. On the other hand, students have more distractions during such classes.

The differences in the student performance could have been caused by the change in the way of assessment and conditions, i.e. from closed book in-class assessment to open-book remote assessment. Similar thing was also observed by Klůfa (2015) where the change in the mathematics tests caused change in the distribution of the test scores. Moreover, Stareček et al (2017) conclude that the type of questions and way of conducting exercise sessions significantly impact the way students score. Měsíček, Petrus, and Kovářová (2017) conclude that the way the questions are asked could alter the performance of the students.

However, Elsalem et al (2020) elaborate on the fact that online assessments and related technical difficulties during the pandemic cause more stress to students when compared to the traditional assessment in class. This was also observed in our course. More specifically, students had troubles sending the attachments, delays occured with email sending, internet connection problems were present, extra time was needed for taking photos or scanning of the solutions, etc.

Hughes (2020) stated that COVID-19 pandemic could be an opportunity to change curriculum and ways of assessing students. As we cannot reduce the curriculum of the basic course, the content of the course remains unchanged. However, some lessons learned were taken from the summer semester 2019/2020 and improvements in the way of teaching and online assessment were implemented in the subsequent academic year. Namely, all tutorials take place via video conferences, tutors and lecturers use graphical tablets, and oral exams take place either in person or via video calls. Busto, Dumbser, and Gaburro (2021) propose an approach for blended learning in order to maintain student-teacher interaction. However, this approach was not feasible in the context of the Czech Republic as students were not allowed to come to school due to the government regulations.

Conclusion

In conclusion, when assessing the online assessment and teaching during the summer semester 2019/2020, the improvement in student scores can be observed for all analysed variables: mid-term test score, final test score, final grades. These differences were mainly driven by the change in the way of assessment and change from closed-book to open-book.

An extended analysis of the student performance using the data from the academic year 2020/2021 including the assessment of implemented changes is being planned.

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EVALUATION OF TEST RESULTS DURING ONLINE AND FACE-TO-FACE LEARNING

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Abstract

During last year all universities all around the world had to switch to online teaching. It was a big challenge for teachers as well as students. This paper presents the results of a comparative research of exam results of students during the winter semester 2019, when we taught face-to-face, and the winter semester 2020, when we taught online using MS Teams. The research was conducted on a course of mathematics at Prague University of Economics and Business. The aim of this paper was to determine whether the online teaching and face-to-face teaching had influenced exam results. Despite the many complications at the beginning of the online period, we found out that students had dealt with the situation.

Keywords

Distance learning, face-to-face learning, mathematics, online teaching, test score

Introduction

The COVID-19 has resulted in schools shut all across the world. As a result, education has changed dramatically, with the distinctive rise of e-learning, whereby teaching is undertaken remotely and on digital platforms. It was a big change for teachers as well as students. Teachers had to convert all their materials in online form in a very short time. Students had to face learning individually and, in addition, take responsibility and learn on their own without supervision.

We can see that this situation has changed the education system across the world. In Dhawan (2020), for example, they discussed about this situation in India. They considered the advantages and disadvantages of the using of technology and e-learning and reminded that no student should getting deprived of education due to his location, social class, ethnicity. In addition, Bozkurt et al. (2020) claimed that students would not remember the educational content delivered, but how they felt during this period. We can find a comparison of face-to-face (FTF) and online teaching in some articles before the COVID-19 period as well. Ananga et al. (2017) emphasized that the learning online required varying of pedagogy and practice to ensure effective learning outcomes. It included theories in distance learning as well as technologies used in distance education. In Gilbert (2015), they discussed whether high school students could benefit from online courses and examined the potential challenges and drawbacks of online coursework.

There are many articles which compare the general dis/advantages or problems with online teaching. In this article, we had more specific goal. The aim of this research was to determine whether the online exam results differed from the results of traditional FTF exams. The paper is organized as follows. The second chapter presents organization of the course and the marking system. The next chapter presents the research results about the evaluations of the first test and the final exam. And the last chapters present discussion and conclusions. All figures, tables and graphs are originally created by the author of the article.

Materials and Methods

Organization of the course

This research was conducted on a course at Prague University of Economics and Business (VŠE) and included 902 students. We compared results of exams in mathematics in the winter semester 2019 and 2020. We were interested if there would be some differences between scores depending on FTF or online learning. We focused on students of the Faculty of Informatics and Statistics (FIS) who had to complete the course "Mathematics for Informatics" (MFI). This course has 2 hours of lectures and 4 hours of seminars a week and it is finished by an exam which consists of an oral and a written part. Students are accepted to study on the basis of tests in mathematics and language tests. Some remarks on the difficulty of test variants in admission process and evaluation of tests can be found in Klůfa (2017, 2018). Thanks to the entrance exams there are not big differences between students´ initial knowledge of mathematics.

All students of FIS have to pass the course MFI and many of them are enrolled in this course during the first semester of their study. The course contains linear algebra and mathematical analysis, as you can see in the syllabus: Propositional and predicate logic, Matrix algebra, rank of a matrix, determinants, systems of linear equations, Limits and their basic properties, Derivative of the function of 1 and 2 variables and their applications, Integral calculus of one variable, Differential equations.

In 2019, teaching took place FTF. Students used written materials, as course books Klůfa (2016), Otavová, Sýkorová (2020). They wrote all tests at school and an oral part of the final exam was FTF. Contrarily, in the winter semester 2020, we taught all the semester online and exams were online as well. During this period, it was possible to use e-learning platform as Moodle or MS Teams. For a discussion of advantages and disadvantages of using these platforms, see Pal et al. (2020) or Mudrák et al. (2020). We used for teaching the platform MS Teams. This platform was already used at some schools before the pandemic period, but it had not been so often, for example Martin, Tapp (2019). In Glivická (2020), was described how the transition to the online teaching in this course at VŠE was made and the process and problems connected with the online teaching.

In the winter semester 2019, there were 424 students of MFI course. In the winter semester 2020, there were 478 students enrolled in the course.

Marking system

During a semester, students had to write one test consisting of four problems. In the case of FTF learning, students wrote this test at school, and they could get up to 20 points. During the period of online learning, students wrote this test at home and they uploaded a handwritten solution in MS Teams. In this case, they could get up to 12 points for this test and another 8 points they gained for homework. Thus, they had to fulfil one exercise every week (for the first 8 weeks in a semester). We included homework in the evaluation to increase students' activity.

We did not use multiple choice tests for online testing, although automated correction makes the job easier for teachers. But we need to see the procedure how students found out solutions. Thus, we used traditional paper-based tests and uploading solutions into the system. There is not any lower limit for tests. These points are sum to the point from the final exam. From each part of the final exam (oral, written) can be obtained 40 points. This means that the grand total of score is 100. To pass the exam students need 60 and more points. Figure 1 is an example of the first test and Figure 2 is an illustration of the second test (final exam).

1) Determine and prove that this formula is a tautology:

$$((\alpha|\alpha)|(\beta|\beta)) \Leftrightarrow (\alpha \vee \beta)$$

2) Solve the system of linear equations using a matrix:

$$x_1 + 4x_2 - 3x_3 - x_4 = 0$$
$$x_1 - 3x_2 - x_3 + x_4 = 0$$
$$x_3 + 2x_4 = 0$$

3) Find matrix X:

$$X + B = 2A - X + AX,$$
$$A = \begin{pmatrix} -1 & 0 \\ -2 & 1 \end{pmatrix} \qquad B = \begin{pmatrix} 0 & 1 \\ 2 & 5 \end{pmatrix}$$

4) Find the local extreme of the function $f(x) = 2 - \frac{\ln x}{x}$ and determine the intervals on which the function is increasing or decreasing.

Figure 1: First test

1) Write the vector u as a linear combination of vectors u_1 and u_2.

$$u = (1, 2, 4), \quad u_1 = (2, 1, 2), \quad u_2 = (3, 2, 4)$$

2) Determine the characteristic roots of the matrix

$$\begin{bmatrix} 1 & 1 \\ -2 & 3 \end{bmatrix}.$$

3) Find all of the possible real values of the parameter a, such that

$$\lim_{n\to\infty} \left(\frac{an^2 + 4}{2n} - 3n \right) = 0.$$

4) Find the second degree Taylor polynomial for the function f with center $a = 0$.

$$f(x) = \ln(3x + 1)$$

5) Find the minimal and maximal value of the function f on the given interval $< 0; 2 >$.

$$f(x) = e^x(x^2 - 3)$$

6) Calculate the second partial derivatives of

$$f(x, y) = x^2 y + \cos 2y.$$

7) Calculate the integral

$$\int_0^1 \frac{6x^2}{x^3 + 1}\,dx.$$

8) Find the general solution of the equation

$$y'' + 2y' = 8.$$

Figure 2: Final test

Research methodology

For testing independence of two categorical variables. we used Chi-square test of independence. The calculation is possible to find, for example, in Hendl (2004). We calculated with a contingency table with the dimension 2x2, where we would calculate the strength of association with the coefficient of association. We did the analyses with the significance level 5%. We state the following hypotheses:

H_0: The success rate of students of MFI does not depend on the type of learning (FTF or online).

H_1: The success rate of students of MFI of mathematics depends on the type of learning.

Results

Evaluation of the first test

We compare the first test in the year 2019 and 2020. In Figure 3, we see how many students received each score in the test in the winter semester 2019. The median and modus value as well as arithmetic mean value was 11. There were 67 students who did not write the test, it presented 15.8% of enrolled students in this course of mathematics.

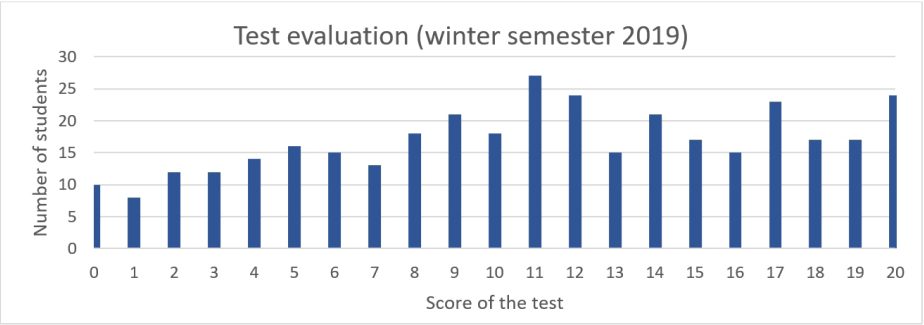

Figure 3: Test evaluation in the winter semester 2019

In Figure 4, we see the situation in the winter semester in 2020. The evaluation is the sum of the score from the test and from homework. The median value was 15. Modus value was 18 and arithmetic mean value was 13. There were 38 students who did not write the test either do any homework, it presented 8% of enrolled students in this course of mathematics.

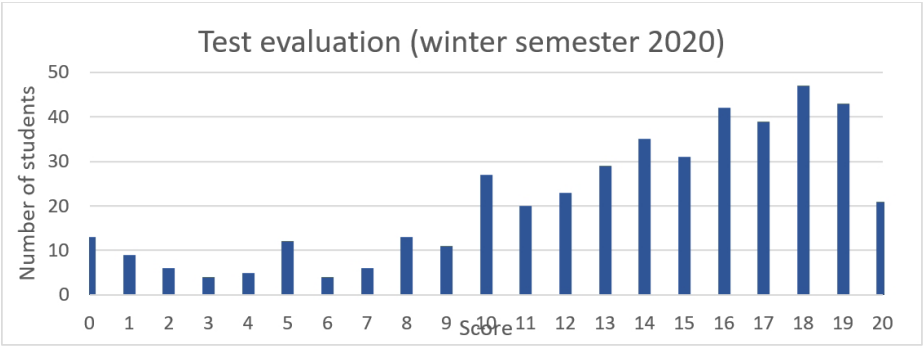

Figure 4: Test evaluation in the winter semester 2020

It follows from the above information that during the online teaching period students were more successful. The mean value goes up from 11 to 13 and the number of inactive students significantly decreased. It implies two possibilities. Students were more motivated by homework and studied more or students abused the situation and copied more. This possibility was reduced thanks to the oral exam, which emphasized the verification of examples from the written part of the final exam.

Evaluation of the final exam

Now we compare the final exams scores. The final evaluation is the sum of all points from the first test, the written and the oral exam. The grade scale is the following:

- mark 1: 90 – 100 points,
- mark 2: 75 – 89 points,
- mark 3: 60 – 74 points,
- mark 4: less than 60 points.

The mark 4 means not passing the exam. In 2019, 29% of enrolled students did not try to pass the exam. These students left the university or did not feel confident to pass the exam and did not come to try it. In Figure 5, we see the scores of the exams of the rest of the students.

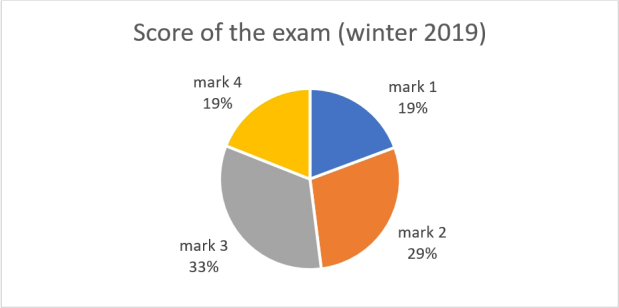

Figure 5: Marks of the exam in the winter semester 2019

We observe that 19% of active students did not pass the exam. The mean value of the exam was 2.5. In the winter semester 2020, 15% of all students did not try to pass the exam. In Figure 6, we observe the distribution of marks among the active students. Comparing with the last year, the mean value increased slightly to value 2.6.

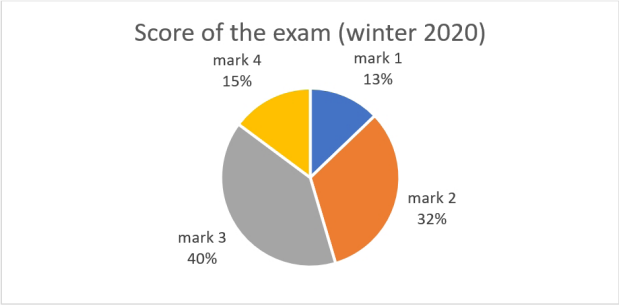

Figure 6: Marks of the exam in the winter semester 2020

In Table 1, we divided students into successful and unsuccessful groups. Successful students are these who passed the exam with the grade 1-3.

Number of students	unsuccessful	successful	sum
2019	57	243	300
2020	60	345	405

Table 1: Number of successful and unsuccessful students in the exams.

Using the Chi-square test with the significance level 5%, we did not refuse H_0. The Chi-square critical value for a significance level of 5% is 3.84 and Chi-square test statistic is 2.18. Thus, there were not significant changes of success rate during the winter semester 2019 and 2020. We can see that the distribution of marks was very similar, see Figure 7, and the mean value of marks only slightly increased.

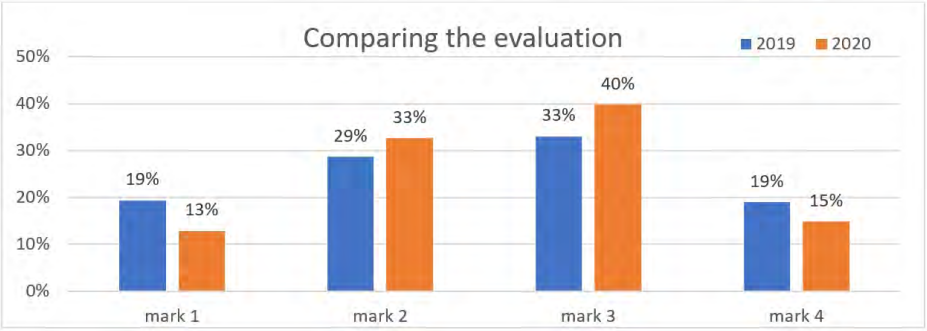

Figure 7: Comparing the evaluation in the winter semester 2019 and 2020

Discussion

Increase of online teaching has led to discussion the efficiency of online and FTF learning. We can see advantages of the online learning in recording lectures and the freedom of students to watch it repeatedly or whenever they wanted. The disadvantages can be the lack of the relationship, FTF meetings and cheating during tests.

To compare our results, we emphasize the following articles. The similar conclusion as in our article was found by Mathieson (2010). They discussed the results of online and FTF teaching statistics courses in 13 studies in different countries. Most of the studies comparing statistics courses taught online to those taught FTF found student achievement to be comparable between modes. Another interesting study was made by Arias et al. (2018) on students in a Principles of Macroeconomic class. Students were randomly assigned to either an online or FTF section of the same class. There were two broad measures of student performance: the exam average for the entire course and the improvement on a post-test relative to a pre-test. The FTF class performed significantly better than the online class in terms of the exam average. But there was no statistical evidence for a difference in improvement in total post-test questions.

We find the topic of FTF and online teaching and learning very important. We expect the higher interest of other researchers in testing the hypothesis if the online environment is interchangeable to the FTF environment or if the type of learning has an impact on students´ results.

Conclusions

At the beginning of the winter semester 2020, we were scared if the online learning would be suitable for students. From above implies that despite the concern, students´ success rate did not change. We confirmed that during the online teaching period students were more successful in the first test, where the mean value went up from 11 to 13 points. In the final exams there were not statistically significant differences. The biggest difference was between numbers of students who did not come to try to pass the exam. It decreased from 29% to 15% of all enrolled students. We think that it was thanks to online learning. We assume that there were more encouraged students who tried to pass the exam. These research results are useful for teachers to assure that there were not any big problems with online learning.

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STUDY MATERIALS FROM THE PERSPECTIVE OF EYE TRACKING AND PERSONALITY TYPE

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Abstract

The current period of distance education places much higher demands on the quality of study texts and materials. At the same time, various digital tools, applications, social networks can negatively affect the performance of human cognitive processes, which can be reflected in the processing of study materials. Presented research study focuses on the analysis of visual perception of selected study texts and their illustrations, in relation to the type of personality of students, specifically to Eysenck's typology of personality. The aim is to find out whether the type of personality of the student influences the way of visual processing of the submitted study texts. The survey carried out so far shows that unstable introverts, compared to other personality types, need the most time to remember individual. On the contrary unstable extroverts requires the least time of vision fixation to remember information.

Keywords

Eye tracking, Eysenck's typology, learning process, study materials

Introduction

Currently, especially distance education places greater demands on the quality of study materials and texts intended for students. The effectiveness that individual students process, understand and memorize study materials varies. In today's digital environment, human cognitive processes are negatively affected by so-called banner blindness, due to which people ignore a certain type of monitored content (Palcu et al, 2017). The overuse of various digital technologies and social networks is increasingly leading to so-called internet addiction (Milková and Ambrožová, 2018; Suchá et al, 2019; El-Khoury et al, 2021). It can be an overuse of mobile phones, tablets or various applications, which can significantly facilitate many activities, but can ultimately contribute to digital dementia (Spitzer, 2014), which reduces the performance of working memory, logical thinking or has a negative influence on the social skills of individuals. Goleman (2014, p. 25) states that "in 20 to 40 % of the time devoted to reading a text, the reader's mind ceases to focus on that text" due to a lack of attention. Koukolík (2002) even states that when playing computer games, the hormone dopamine is released in the brain, while the brain can behave in the same way as a brain addicted to drugs or alcohol when addicted to computer games. Based on these negative phenomena, there may be a change in strategies, forms and quality by which the reader processes information from study texts. All the above negative phenomena can affect how and with what quality students process study texts.

In addition to the mentioned determinations, internal factors, such as personality type, can also influence the process of processing study texts. The form of textual information processing can also be influenced by the personality traits, like an introversion / extroversion and emotional stability / lability (Nakonečný, 1997). For example, according to the authors (Ellingsen et al, 2019), personality traits can be a significant factor influencing visual attention. And according to the authors (Zafar et al, 2017), extroverts may have an advantage over introverts in reading skills.

This is followed by the presented research focusing on the analysis of visual perception of selected study materials and their illustrations, in relation to the type of personality of students. It was established null hypothesis for the presented survey: the type of personality does not affect the form of visual processing of study texts. The goal of this study is to find out if the type of student's personality affects the form of visual processing of the presented study texts and their memorization. The following part of this text deals with the methods used and data collection. The results section describes the identified research outputs, which are more set in context in the discussion chapter.

Materials and Methods

The research focuses on the analysis of visual perception of selected study texts and their illustrations, in relation to the type of personality of students – for this purpose, Eysenck's typology of personality was used, on the basis of which the respondents were divided. To ensure a relatively identical velocity learning ability was used WAIS-R test. To capture eye movements, the eye tracking method was used, supplemented by an individual interview.

Eysenck's typology of personality

Eysenck's personality typology is based on biological foundations (Nakonečný, 1997; Soliemanifar et al, 2018). A standardized Eysenck's Personality Inventory (EPI) consisting of 57 questions was chosen to determine personality type (cf. Roslan et al, 2019).

WAIS-R test

The WAIS-R test is the Wechsler Adult Intelligence Scale. This research used only 10th subtest, named as "symbols", that determines the ability to create new associations in the brain (Svoboda, 2010) and thus to determine the speed of learning.

Eye tracking method

The essence of this method is the tracking of the visual path, based on which the researcher is able to determine where, how and when the subject looked at the time of monitoring his visual trajectory, and includes an accurate record of the visual trajectory (Jesenský, 2018), which is non-invasive method measuring the movement of the eyes in relation to the head and the visual stimulus (Bruckmaier et al 2019). Unconscious eye movements can also be detected using this, which provides the researcher with objective information that would not be possible to find out, for example through an interview, and is therefore a useful method for analyzing behaviour and the cognitive process (Zurawicki, 2010).

Research question and goal

The following research question was set for the presented survey: is there a relation between personality type and form of visual information processing? The goal is to find out if student's personality type affects the form of visual processing of presented study texts and their remembering.

Research sample

The research sample of participants are students of University of Finance and Administration, specifically the field of marketing communications. The criterion for selecting students for the research sample of respondents was the type of personality of the respondent according to Eysenck's typology and also the ability to learn according to the WAIS-R test. A total of 130 students participated in the EPI and WAIS-R questionnaires. For the purposes of the research

survey, 28 participants were selected from them (7 unstable extroverts, 7 unstable introverts, 7 stable introverts and 7 stable extroverts). They were selected based on the results of the Eysenck's personality test and the 10th subtest (named as symbols) of WAIS-R test. The characteristics of the respondents according to Eysenck's typology are given in Table 1.

	Extroversion			Neuroticism		
	Average	Median	S.O.	Average	Median	S.O.
stable introvert	8.7	9.0	2.4	6.9	7.0	3.2
stable extrovert	16.7	16.0	2.9	8.0	8.5	2.4
unstable introvert	8.6	9.0	2.0	17.1	17.0	2.8
unstable extrovert	15.5	15.0	1.7	17.2	17.0	3.3

Table 1: Selection of respondents according to Eysenck's typology (source: own research)

Table 1 shows the average, median, and standard deviation for the extroversion dimension and dimension neuroticism. Only respondents who met the median values in the range of the standard deviation values with their achieved values were selected for the next phase of the research (a total of 56 persons out of 130 in total). From 56 people who met these criteria, 28 respondents were randomly selected to participate in the main phase of the research.
At the same time, respondents were selected who had a relatively identical result of the WAIS-R test, while the achieved values in the test could deviate by a maximum of 15% from the median determined from the data of all respondents.

Selection of study materials for eye tracking testing

The next step in the methodology of the own survey was to select suitable study texts, which were submitted to 28 respondents, whose characteristics were given above. Several criteria were set for the selection of study texts - the topic of the study text, its length and the type of illustrative image in the text. The first selection criterion was a suitable topic - educational leisure topics of articles were chosen, especially from the magazines People and Earth, Gardener etc. The selection was influenced by the fact that the target group of respondents were students of the humanities study field. The aim was to select and then submit 6 texts to the participants. The second criterion for texts selecting was a suitable illustration image – each text contained 1 illustration element, namely a diagram, a table with numerical data, an illustration image in shades of grey, a colour illustration image and a colour image with an integrated description of its parts. The sixth text was a control and did not contain any illustrations. The third aspect for the final editing of texts was their length – the average number of words for all selected texts was 262 words, which is slightly shorter (Chang and Choi, 2014; Or-Kan, 2017), but the length was chosen due to the number of selected texts (the aim was to select 6 texts). This length of text was also suitable so that the text could be displayed legibly on a computer monitor without the need to scroll the mouse.
The final selection of the texts was based on a pre-survey questionnaire, which was attended by other participants than those who participated in the selection using EPI and WAIS-R. Respondents in this preliminary survey were presented with a total of 10 texts, which they gradually evaluated on a 10-point scale according to various criteria. These criteria were: emotional interest in the text, difficulty of understanding or comprehension (Tsai et al, 2019), suitability of the visual element and the amount of new information in the text (Jian, 2018). The purpose of this preliminary research was to select 6 texts with the most neutral evaluation possible, so that the texts for the respondents were not too difficult, but also not too trivial without informational value. Based on the results of the preliminary research, a text focused on the protection of coins and banknotes against counterfeiting, a text on historical figures, a text on chronotypes (day and night type), a text on watering vines during vegetation, a travel text on Erfoud and a text on Danish city associated with the lego. These

6 texts were subsequently submitted to 28 respondents (selected according to EPI and WAIS-R), while during the reading of these texts the respondents were monitored by eye tracking behaviour and subsequently the evaluation of texts and the amount of information provided were ascertained by individual interview. The course of this main phase of the investigation is described below.

Eye tracking data collection

For this phase of data collection, eye tracking was chosen as the main method, which was used to monitor the visual behaviour of the respondents during the reading of the submitted 6 texts. A Gazepoint GP3 static eye camera was used to collect data, which was mounted on a 22-inch Full HD monitor from Philips. Data collection took place in a quiet, undisturbed room of the University of Finance and Administration. Respondents were invited to collect data individually, for a specific time, in order to avoid passing on impressions and information from data collection, and at the same time, as a result, respondents did not have to wait too long (Rosenlacher et al, 2020). The eye camera administrator was placed behind the respondent, not next to him, so as not to disturb him with his work (Tichý et al, 2017).

After reading all the texts, an individual interview with the respondent was followed, by which the amount of information provided from individual texts was ascertained (Chang and Choi, 2014; Rosenlacher et al, 2016) and emotional interest in the text was determined using a 5-point scale (Tsai et al, 2019) and the respondent's self - evaluation of how well he memorized the information from individual texts (Jian, 2018).

Results

Data obtained from the main phase of data collection were evaluated using analytical software SPSS. To obtain a basic overview of the viewership of illustrative images and texts from the point of view of individual personality types, Table No. 2 was prepared.

		Illustrations			Texts		
		Correctly recalled details	Tracking time (sec.)	Number of vision fixations	Correctly recalled details	Tracking time (sec.)	Number of vision fixations
Stable introvert (S-I)	Ave.	1.34	5.93	17.29	4.09	60.1	191.6
	Median	1.0	1.8	6.0	3.0	61.2	197.0
	S.D.	0.6	3.71	7.61	1.1	2.3	8.5
Unstable extrovert (U-E)	Ave.	1.11	5.61	19.10	4.11	47.2	167.0
	Median	1.0	5.7	20.0	4.0	47.0	192.0
	S.D.	0.3	2.94	8.96	0.7	1.3	5.8
Unstable introvert (U-I)	Ave.	1.31	9.42	29.57	4.09	63.6	207.2
	Median	1.0	9.1	32.0	3.0	62.0	201.0
	S.D.	0.34	4.7	9.97	0.8	3.7	8.1
Stable extrovert (S-E)	Ave.	1.14	6.50	22.71	4.06	49.5	181.8
	Median	1.0	3.4	15.0	3.0	47.7	191.0
	S.D.	0.53	2.29	9.45	0.8	2.5	9.0
Total	Ave.	1.23	6.91	22.28	4.09	55.1	186.9
	Median	1.0	4.4	16.0	3.0	59.4	191.5
	S.D.	0.31	2.96	6.97	0.7	1.0	4.1

Table 2: Basic statistics on monitoring texts and their illustrative elements, 2020 (source: own research)

Table no. 2 shows the summary data (average, median and standard deviation) on the visual behaviour of respondents to the reading of texts submitted 6 (the aggregate data). The "correctly

recalled details" column lists the amount of properly recalled information from the content of images or texts, which was ascertained through an interview. The "Tracking time (sec.)" column describes the number of seconds that respondents focused their eyes on illustrations or texts. The "number of vision fixations" column indicates the number of visual suspensions while viewing an image or text, and each visual suspension can have the potential to memorize the information being read. The values of the table show that unstable introverts watched the illustration for the longest time (average 9.42 seconds), which is accompanied by a greater number of visual fixations in the pictures (average 29.57 fixations), but the number of information provided from the pictures is comparable to other types personalities.When evaluating data related to texts, not illustrative images, unstable introverts again show the highest number of visual fixations (207.2), the longest time of following texts (63.6 seconds), but again the amount of information provided from texts is comparable to other personality types. This could indicate differences in visual perception of unstable introverts, it will be possible to evaluate after deeper analysis.

	Illustrations				Texts			
	Average		Median		Average		Median	
	Illustration tracking (sec.) / correctly recalled information	Nr. of vision fixations / correctly recalled information (F-I)	Illustration tracking (sec.) / correctly recalled information	Nr. of vision fixations / correctly recalled information (F-I)	Text tracking (sec.) / correctly recalled information	Nr. of vision fixations / correctly recalled information (F-I)	Text tracking (sec.)/ correctly recalled information	Nr. of vision fixations / correctly recalled information (F-I)
S-I	4.41	12.87	1.84	6.00	14.72	46.90	20.39	65.67
U-E	5.04	17.14	5.66	20.00	11.48	40.58	11.75	48.00
U-I	7.17	19.88	9.10	32.00	12.19	44.81	20.67	67.00
S-E	5.62	18.14	3.35	16.00	13.49	45.74	19.80	63.67
Total	5.56	17.01	4.51	18.00	12.97	44.51	20.09	64.67

Table 3: Recall of information according to participant's vision behaviour, 2020 (source: own research)

Table 3 shows the conversion of images and text viewing seconds to the number of correctly recalled information. At the same time, the table shows the conversion of the number of vision fixations to the number of correctly recalled information (hereinafter "F-I"), which relates to images or texts. The table shows that unstable introverts needed the most fixations on one correctly equipped information related to the illustrative image (average 19.88 fixations, median 32). This data also confirms the evaluation of the image tracking time required to correctly recall details and information unstable introverts needed the most time (on average 7.17 seconds). Less clear are the results from following texts, where unstable introverts show the largest number of F-I in the text (median 67 fixations), but the results differ minimally from other personality types and there are differences between average values and median values. The resulting trend confirms the median number of seconds to follow the text needed to process one piece of information, where unstable introverts needed the most seconds (20.67). In contrast, the unstable extroverts type the text needed to monitor the smallest number of seconds per memorizing and recalling information from the submitted texts (average 11.48), which is confirmed by data average and

median values. The same trend is evident from the data in Table 2. In relation to these results, it will be appropriate to perform an analysis in the further processing of data indicating the order of the monitored parts of the texts and thus find a closer look at the way of visual perception of texts by respondents.

Summary:

- Unstable extroverts showed the least of F-I per recalled information from submitted texts,
- Unstable introverts showed the most F-I in the submitted texts,
- Unstable introverts focused their eyes on texts for the longest time

The established null hypothesis (the type of personality does not affect the form of visual processing of study texts) was verified using the ANOVA tool. This hypothesis was confirmed because p-value = 0.26 > 0.05. The aim of the survey, i.e., finding out whether the student's personality type influences the way of visual processing of the submitted study materials, was fulfilled.

Discussion

According to research studies (Ağıl and Güdükbay, 2018; Ellingsen et al, 2019) the survey shows that there are obvious differences between introverted and extroverted personality types: unstable introverted when reading the study text, they show the need of more time and fixations of sight to memorize one piece of information. In contrast, unstable extroverts requires the least amount of time and fixation. Extroverted personality types show better results and performance in reading skills than introverts (Zafar et al, 2017), which may be one of the factors that unstable introverts processed the text with their eyes longer and less efficiently compared to unstable extroverts. Eysenck's personality typology is used to measure the level of extroversion we observed, but also the degree of neuroticism (Yin et al, 2019), while the degree of neuroticism will be the focus of further analysis of the data obtained.

The topics of the tested texts can also be discussed, while the subject of other research were texts dealing with the basic principles of physics, chemistry and biology (Lindner et al, 2017), botany – specifically the construction of plant flowers (Jian, 2018). The texts were also focused on the humanities, specifically on the field of psychology, sociology (Malčík and Miklošíková, 2017) or medicine, specifically the human circulatory system (Scheiter and Eitel, 2015). This study is a follow-up to studies using leisure-time texts, such as temperature records and drought (Rosenlacher et al, 2016) or articles from the journal National Geographic (Or-Kan, 2017). From the point of view of illustrative elements, the presented survey follows studies in which a diagram was used as an illustrative element (Susac et al, 2019), a table with numerical data (Rosenlacher et al, 2016), an illustrative image in shades of gray (Lindner et al, 2017), colour illustration image (Rop et al, 2018), color image with integrated description of its parts (Désiron et al, 2018).

Conclusion

From Tables 2 and 3 it was evident that unstable introverts needed the most fixation of vision compared to other personality types in order to recall (or remember) one piece of information from the submitted texts. On the contrary, unstable extroverts were more efficient in processing the text and needed the least time of fixation of vision to remember one piece of information from the text. It is possible to discuss to what extent this was influenced by the individual strategy of their visual perception and their individual abilities, which, however, should be verified in a follow-up investigation. This survey also examined how eye tracking technology can be used in conjunction with standardized psychological tests to examine how study texts are processed from

the perspective of personality type. The eye tracking method can be assessed as very useful for this purpose of research, although the conditions in the laboratory survey are not entirely realistic (Kohútek and Turčáni, 2020) in comparison with reading texts in the home environment.
It would be appropriate to expand the possibilities of data processing with a qualitative analysis of the visual behaviour of individual respondents or a correlation analysis. At the same time, however, in a follow-up survey, other variables could be examined, such as the ability to read, the ability to hold attention. The significance of this research is not only in the search for possible differences in the visual behaviour of individual personality types, but in finding the intersection in the visual behaviour of all mentioned personality types, which would be practically usable in the design of study materials.

Acknowledgement

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UNIVERSITY STUDENTS CREATING A DIGITAL IDENTITY FOR CARRER PATHS USING LINKEDIN

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Abstract

Professional digital identity is currently one of the main elements for a prosperous employment rate. Professional identity must be built gradually during the studies occuring at university. For a succsesful creation of a professional digital identity, social and professional networks are a essential key since they are a useful tool. One of the most used professional social networks in the world is LinkedIn. The aim of the article is to potray the extent to which students of FEM CZU in Prague work with professional social networks. Based on the results of the survey, it can be determined that university students who work with professional networks, establish the best results of securing professional contacts as well as the possibility of obtaining employment through a profile on a social network.

Keywords

Labor market, LinkedIn, networking, professional identity, social networks, students

Introduction

The identity of individuals can be formed not only in the offline environment, but now the online identity is becoming increasingly important. The internet has become a standard part of most people‘s lives (Bonebrake, 2002: 551). The internet has a major impact on the way people interact, and social networks in particular play an important role in changing or strengthening the way we connect with others (Jordan and Weller, 2018). The phenomenon of social networks as a tool for communication without restrictions between the borders of states and continents is closely linked to globalization (Hameed and Rehman, 2017: 143, Baker et al., 2013: 22). Today‘s society is characterized by the growing impact of online communication tools (Rosales, Guajardo and Medrano, 2021). The changing way of sharing information between people in the context of online social networks is also confirmed by the study Drlik (2017: 48). The development of social media has completely changed the way we access information (O‘Regan, Smithson, and Spain, 2018: 112). Social networks in various forms have become an integral part of life as well as a popular communication and interaction environment (Bozkurt and Tu, 2016: 153). Thanks to the possibility of online participation, immediate feedback, sharing opinions or photos, online social networks are very popular (Drlik and Beranek, 2015: 81). However, it is necessary to distinguish between personal identity and professional identity, which may differ from each other. The importance of professional social networks has grown significantly in recent years, especially in creating an individuals professional identity. For this reason, the article is therefore focused on the field of professional identity in the sense of professional social networks. In this context, we can talk about the so-called digital professional identity, which is formed through online social networks. Digital professional identity can be defined as „a professional identity that develops through online social interactions using online platforms and communication tools“

(Jawed, Mahboob and Yasmeen, 2019: 33). A social network can be defined as a set of human beings or rather their digital representations that refer to registered users. These users are covered by relationships obtained from data about their activities, joint communication or direct links collected on internet systems (Musial and Kazienko, 2013: 31). Social networks can be divided into personal social networks (eg Facebook, Instagram, Twitter and others) and professional social networks (Linkedin, Xing). LinkedIn is one of the most widely used professional social networks worldwide. Personal social networks focus mainly on facilitating personal self-presentation, while professional social networks mainly satisfy the need for professional self-promotion (van Dijck, 2013: 199). A social network can be defined as a set of human beings or rather their digital representations that refer to registered users and are covered by relationships obtained from data about their activities, joint communication or direct links collected in internet systems (Musial and Kazienko, 2013: 31).

It is a well-recognized fact that the success of graduates depends significantly on their opportunities to develop academic and professional identity during their studies (Jensen and Jetten, 2015). The goal of education is, in the broadest sense, to transform itself into new ways of thinking and relationships. For successful application in the professional field, it is necessary to build a professional identity from the beginning and even better in advance during the study, ie ways of working and building relationships in professional contexts (Goldie, 2012: 641). Empirical evidence has suggested that academics are interested in using social media to enhance their professional identity and reputation (Heidari, Salimi and Mehrvarz, 2020).

The aim of the article is to convey the extent to which students of FEM CZU in Prague work with professional social networks, whether they are aware of the importance of this method of communication and presentation for their professional life during their studies at university as an important tool for creating a digital professional identity.

The research questions are as follows: The first research question focused on whether FEM students, who are in some form concurrently employed during their studies, work in the intended field of employment after graduating from university and what is the reason for their employment. The second research question asked how FEM students are generally aware of professional social networks and whether students who have a profile based on a professional network actively use this network. The third research question dealt with whether students perceive the benefits of professional social networks in terms of creating digital professional identity.

Materials and Methods

The theoretical background of this paper has been based on an analysis of secondary sources gained from scholarly papers, specialized literature and official web portals. Primary data have been obtained through an own conducted survey.

The objectives of the analysis were as follows:

- mapping the employment rate of FEM students during their studies and, in this context, also the employment rate in the intended field of employment after graduation,
- mapping the use of social networks in general and, in this context, explicitly professional social networks,
- mapping the awareness of FEM students about the existence and possibilities of professional social networks, and in the context of the extent to which they actively use, namely, professional social networks,
- mapping the perception of the benefits of professional social networks in the context of digital professional identity.

Data collection for research took place from February 2018 to December 2020. Students of the 3rd year of bachelor‘s programs and the 2nd year of master‘s programs in Operations and

Economics and Business and Administration at the Faculty of Economics and Management of the Czech University of Life were asked to participate in the survey. These were students of the ending years, for whom it was assumed that they should already consider their future employment and should therefore also have a closer relationship with establishing professional contacts. The sample was intentional (each student filled the questionnaire only once). A total of 1963 students took part in the research in the period under review. According to the student structure on the faculty, 575 men and 1387 women were asked to fill in an online questionnaire (table 1). The most frequent age group (83 %), in agreement with the structure of FEM students, was the 21-25 age group (1624 respondents). Most of the interviewed students were in full-time study (79,73 %), part in the combined form of study (20.28%).

Gender	2017/18	2018/19 ws	2018/19 ss	2019/20 ws	2019/20 ss	2020/21 ws	Total
Male	150	97	84	47	93	104	575
Female	432	275	147	150	178	205	1387
Total	582	372	231	197	271	309	1962

Table 1: Demographic structure of students addressed in the research (ss – summer semester, ws – winter semester) (source: own calculation)

The questionnaire consisted of a total of 25 questions with a predominance of closed questions (23 closed, 2 open). The first part of the questionnaire focused on the demographic characteristics of the respondents (gender, age, study program and form of study). In the next part of the questionnaire, questions related to current employment during the study, the form of employment and reasons for employment during the study were identified. Furthermore, the knowledge of social networks in general was assessed. For professional social networks, the extent and reasons for their use and the possible link to current or future employment were determined. Students were interviewed electronically at the beginning of the summer semester between February and March and at the beginning of the winter semester between October and December. The return rate of questionnaires was 82.3 % in 2017/18 ss, 75.4 % in 2018/19 ws, 78.9 % in 2018/19 ss, 81.2 % in 2019/20 ws, 79.5 % in 2019/20 ss and 76.8 % in 2020/21ws.The data was processed and subsequently evaluated using the Microsoft Excel spreadsheet program.

To determine the dependence of the selected variables, five hypotheses were tested. The data were tested using the method of discriminatory analysis (what assumptions would be the one who gets a job through a professional network – eg gender, type of study, also the way of using a professional network) and nothing was statistically significant with this method. The ANOVA method was also used (eg. whether the frequency of network use depends on the type of study or on age) nothing significant was proven here either.

Results

Based on the results of the survey, it can be determined that the vast majority of FEM students are employed in some form while studying at university. This is a total of 1760 students from the monitored sample (89.7 %). The share of employed students was very high in the observed period (Figure 1). In this case, the value is stable between 85-92 %. This can be considered positive in terms of gaining work experience for later better employment. In 2020, the labor market was affected by the Covid pandemic, which was reflected in a slight decline in the number of employed students.

A positive finding is also that more than half of the students from the addressed sample (57.2 %) were employed in the field in which it is expected to continue and apply after graduation from university (Figure 2). In the structure of a specific form of employment a regular or occasional job predominates (51 %). The number of part-time and full-time students is also relatively high

(27 % and 22 %). It is obvious that students are aware of the importance of gaining professional knowledge, both in theory and in terms of practical experience. At present, work experience and practice are, in fact, already a basic precondition for the future successful employment of university graduates in the labor market.

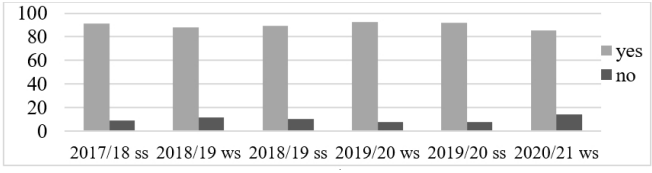

Figure 1: Share employed FEM students during their studies % (ss – summer semester, ws – winter semester) (source: own calculation)

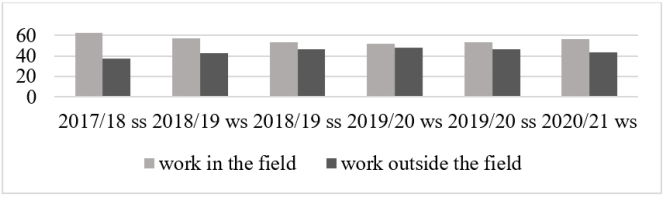

Figure 2: Share of FEM students employed during their studies in a later intended field of employment % (ss – summer semester, ws – winter semester) (source: own calculation)

Around 90 % of students state (89.2 in 2018 and 90.8 in 2020) that the predominant reason for employment is the economic aspect. Work activities are a common source of income and this also applies to students. It is very important that students also perceive the importance of employment as a space where they can gain valuable work experience that will help them in their further professional employment (2020 69.9 %). An interesting finding is the large increase in the perception of employment in the context of establishing working contacts. This aspect increased significantly in 2020 to 84 % from 28 % in 2018. The gradual creation of a network of contacts is very crucial for professional life. Professional social networks can in this case play a major role. In terms of the gradual creation of a professional digital identity, social networks can generally be a very useful tool. This is especially evident for professional social networks. As Graph 3 shows, awareness of professional social networks (their existence) grew in importance in 2020. In the observed period, the level of perception of the benefits of this professional type of social networks is growing. It is thus confirmed that students are increasingly aware of the importance of professional networks and the possibilities of their contribution to the further development of later professional employment. This is despite the fact that the active usage and intensity of addressing network participants with a specific job offer decreased slightly in the last monitored year. It is all caused by non-standard influences in the context of a pandemic in the whole economic environment and society.

Students who work with professional networks cite the establishment of professional contacts as the most common reason (2020 61 %) (Figure 4). The possibility of contacting a human resources manager and gaining a job through a profile on a social network (2020 56 %) is closely linked. This is a very common and widespread way of making use of a professional social network. A very important role in the utilization of networks is also played by one‘s own personal presentation in terms of professional knowledge and work experience (2020 48 %). This shows great potential in the context of professional digital identity. The biggest shift in the period under review is the acquisition of professional information, where this share increased from 31 % in 2018 to 45 % in 2020. Ways

and possibilities of draw on professional networks are gradually evolving in this context towards the creation of space and sharing of professional articles, seminars and new trends.

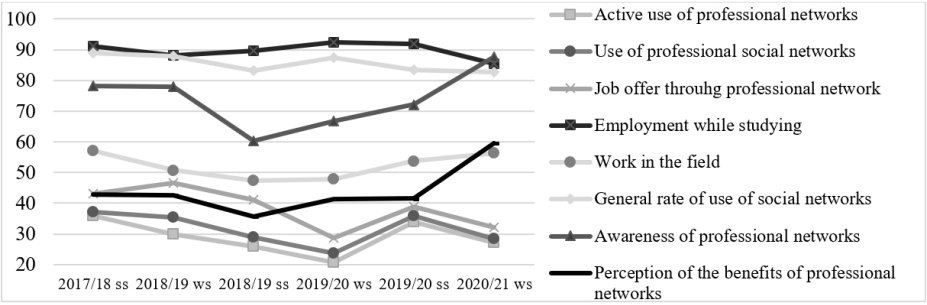

Figure 3: Characteristics of employment and use of social networks by FEM students % (PS professions networks, SS social networks) (source: own calculation)

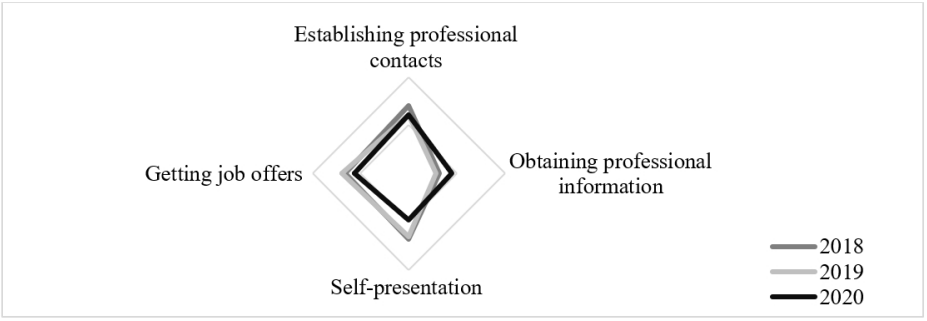

Figure 4: Reasons for using professional social networks by students (source: own calculation)

The most common reason for students who do not utilize professional social networks while studying at university is that they intend to start using them later. The share of this group of students reached the value of 51 % in 2020 of all persons who do not currently work with professional social networks. A common reason is the general ignorance of professional networks as such (22 % in 2020), which can be explained by the fact that in the Czech Republic is mostly used only one professional social network LinkedIn. Some students (20 % in 2020) know this type of network, but cannot work with it. On average, only 13 % of students do not consider professional networks important.

Discussion

In general, social networks are currently a very powerful tool of the so-called digital identity. This is confirmed by a study by Smith and Kidder (2010: 491). The most widespread professional social network LinedIn which can be a useful tool for the exchange of information between companies, professionals and potential future employees (Castillo-de Mesa and Gomez-Jacinto, 2020: 103). According to the research, the addressed students largely work with social networks (on average 86 %). It is possible to state that not only professional social networks, but also personal networks are used by HR professionals and potential employers to find out the information and profile of the person. With regard to digital identity and its scope, few users are aware of this, as confirmed by Miller, Parsons and Lifer (2010: 377). Publicly available information on social networks can be applied to profile any user using these services (Malhotra et al., 2012: 1065). The same issue

was addressed in the study Peluchette and Karl (2008: 95), which also confirmed that users of personal social networks are often not even aware of their possible use to complete the profile of a job seeker. The utilization of social networks by human resources professionals is becoming increasingly important, as stated by Skeels and Grudin (2009: 95). Thus, self-presentation and digital identity creation on personal and professional social networks should not be in great conflict, despite the fact that internet users usually work with several different social networks simultaneously (Villanti et al., 2017). Students who already actively work with professional social networks during theoretical training at the university state that their greatest contribution is to establish professional contacts and create a network of professional ties. Walczowski and Green's research (2013: 4885) found that professional social networks provide university students with the opportunity to present their skills and experience while expanding their online identity with a professional digital portfolio. This is one of the reasons why students should work with professional social networks such as LinkedIn during their studies. The study (Donelan, 2016: 706) found that lack of time and skills is a major barrier to working with networks and that with increasing levels of activity, the number of motivations to use social media increases, including contributions to career advancement.

Conclusion

Social networks, both personal and professional, make a significant contribution to the formation of a individuals digital identity. Namely, professional social networks have become an important part of shaping the professional profile and professional ties, including communication between network participants. A person's online identity allows to develop professional contacts and relationships. In the case of university students, professional social networks provide an opportunity to advertise their skills and experience. As social networks become more important in creating a personal professional profile, it is important that this digital professional identity is created during university studies. Which allows graduates a better position in the current labor market. At the same time, it is also important to emphasize that the digital identity should be consistent for all social networks. This should provide a single, inconsistent view of the person in terms of personal and a professional personality.

The subject of further research could be a more detailed monitoring of the elements influencing the creation of a professional digital identity, which is very important for students' future professional careers.

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STUDENTS' ATTITUDE TOWARDS THE NEW PRIVACY POLICY OF WHATSAPP

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Abstract

The popular messaging service WhatsApp decided to change its terms of use and privacy policy from the May 2021. We investigated how students of the University of Economics are aware of the new policy and how they react to it. The general problem with privacy policy and terms of use of internet services is that users don't read them. We confirmed this result in our research. We also found out that students use WhatsApp a lot even though they have worries about their privacy. Their decision to stop using WhatsApp is influenced by other people, privacy concerns, and contentment with the application. We conclude that apart from supporting users' information literacy the online environment as such should be more trustful.

Keywords

Internet messaging service, online privacy, privacy disclosure, privacy policy statement, trust

Introduction

Social media such as WhatsApp is used for instant messaging. Using these media, people can communicate over the Internet at any distance and in real time. Such communication can have a significant effect on all operations that need to be communicated immediately, and educational problematics can be one of them. Bouhnik and Deshen (2014) found the power of the application WhatsApp in teaching and in the bettering relationship between teachers and students. Their study of group chat concludes that instant messaging has a positive effect on education. Cetinkaya (2017) also comes to the same conclusions. In his study, he evaluates the combination of images and text in instant messaging and there is a significant quantitative and qualitative improvement in students' results.

Privacy remains a salient factor for users (Janssen and van den Hoven, 2015; Janssen and Kuk, 2016; Morey, Forbath and Schoop, 2015). To increase user's trust, web service providers can employ a lot of mechanisms that ensure the personal information will remain secure. Examples include approval of third-party certifications, quality of the web site design, ratings, references, financial compensations for privacy breach or privacy policy statements. These statements codify how the personal information will be used. They are relatively simple and cheap and help especially in cases where the service provider doesn't have a high reputation yet. The privacy policy statements vary in length, ease of understanding, placement and level of protection (Liu and Arnett, 2002).

The biggest problem with the privacy policy statements is that users don't read them. A recent study (Obar and Oeldorf-Hirsch, 2020) has shown that 74% of respondents skipped the privacy policy statements or terms of service statements. Most respondents agreed to the policies (97% to privacy policy, 93% to terms of service). The negative predictor of reading was the information overload. Most users consider the policies a nuisance and ignore them. Despite that, various strategies for the improvement of privacy policy statements are considered important to face

the users concerns regarding privacy (FTC, 2012; Bakos, Marotta-Wurgler and Trossen, 2014). Considering users' concerns about online privacy and the attempts of companies to increase users' trust we decided to investigate how students react to the current issues of WhatsApp's change in privacy policy.

New privacy policy of WhatsApp

We are interested in privacy for a long period and investigate students' approach and opinions on it. The change of WhatsApp privacy policy has been discussed in media and we talked about it with students in our seminars as well. Because many students use messaging services we were interested in how they react to the change of privacy terms. Two influences intersect in this topic. The first one is student's awareness and attention paid to the privacy policy and the second one is students' sensitivity to privacy.

WhatsApp was acquired by Facebook in 2014. It decided to change its terms and privacy policy from 15th May 2021: it will share personal information and data of users with Facebook to improve the revenue from advertising. If a user wants to use WhatsApp he has to agree to the new terms by this date. It has negative consequences for enterprises that use WhatsApp for business purposes and above all it was refused by many of the ordinary users. The new privacy policy is in conflict with privacy and on top of that it is a long document written in the legal jargon and is not clear to the normal user.

New WhatsApp terms stipulate that WhatsApp is allowed to share all data of a user with Facebook and its subsidiaries (e.g., Instagram). The option for the user to opt out of data sharing with Facebook will not be available anymore.

Sharing of phone number and user's personal information with Facebook will be used to show more relevant advertisement and probably to simplify the tracking of users. WhatsApp is starting to allow businesses (banks, airlines) to communicate directly with their customers and it will be possible that WhatsApp will be sending marketing messages. The bill will be paid by the companies and the data will allow users' identification.

The address book will be shared with Facebook. Sharing of address book gives an overview of the user's family, friends, colleagues, partners or customers. The details of the communication like how often the user communicates with a contact, at what time etc. will be available to Facebook, too. Even if the content of the communication will be encrypted, WhatsApp has a good overview of users' behaviour, habits etc. The address book can be used on its own for various marketing purposes.

Sharing of media files with Facebook will be also obligatory. Under the new terms the user grants WhatsApp free access for all information and medial content sent, received or uploaded. WhatsApp will have the right to use the user's content anyway it wants. This free licence can be transferred to Facebook and its subsidies. Facebook will be also informed about chat groups the user is participating in, the status and payments made through the application.

Using WhatsApp for business or advertising purposes is not in compliance with the GDPR, especially the uploading of the address book without approval of the contacts can be fined. The storage of data outside Europe, no control over customers' data, no possibility to fulfil GDPR requirements like the right to be forgotten are also problematic. (Teamwire, 2021)

In any event, users are unhappy about the new privacy terms and switch to other messaging services like Signal, Telegram etc. WhatsApp had about 2 billion monthly active users in 2020. Over the three weeks of January, Signal has gained 7.5 million users and Telegram 25 million users. (Hern, 2021) It shows users are very sensitive regarding private information. The scandals related to Cambridge Analytica LLC, United States presidential elections, etc. have increased public awareness of these issues. That is why we prepared a survey on how students from the

University of Economics in Prague react to the change of WhatsApp privacy terms. We were inspired by the model of behaviour called theory of planned behaviour, which distinguishes 3 categories of influences on a person's intention to carry out a behaviour, attitude, norm and behavioural control.

Based on the information from the media and students' interest in new technologies (Novák and Pavlíček, 2019) we formulated the hypothesis (H1) that the average answer to the awareness of the new privacy terms would be 4 on the 6-point Likert scale. The second hypothesis (H2) states that the more informed about the new terms the students would be the less they would agree. We expect a significant Spearman correlation between the agreement and consent. We also expect that students would be distrustful towards WhatsApp concerning the use of private information (H3). We expect the average answer to this question 3 or lower. The fourth hypothesis (H4) concerns the influence of opinion makers on students. We expect their influence to be low, the average answer can be expected 3 or lower. The fifth hypothesis (H5) deals with the ability of students to use WhatsApp and not to disclose personal information to it. Here we expect the average answer to be 3 or lower. And the last hypothesis (H6) states that from the three categories of effects on the intention to stop using WhatsApp the attitude towards WhatsApp will be the strongest, followed by control over personal data personal data provided to WhatsApp and social norms.

First we will describe the sample used in our research and the statistical methods used in the analysis of the results. Then, we will present the results of the analysis and interpret them. In the conclusion the outcomes will be summarized.

Materials and Methods

We prepared an electronic questionnaire on Google forms and asked students from the Prague University of Economics and Business to fill it in during 22nd February - 6th March 2021. We collected 105 respondents, 43% males, 57% females between 19-26 years of age. We used 6-points Likert scale in the answers, 1 meaning definitely no and 6 meaning definitely yes. We used the methods of descriptive statistics (mean, standard deviation, correlation – the Spearman correlation coefficient) and cluster analysis. We used the software IBM SPSS software for calculations.

As we teach at the Prague University of Economics and Business, we know the students and can ask them to fill in our questionnaire. We also preliminary know their opinions and so the questionnaire can address issues that seem relevant to them. The statistical methods used in the analysis of the results are widely used to obtain results on the average answer, deviations from the average, correlations between various answers and clustering respondents with regard to their answers. A qualitative research would be an alternative, but the sample size of 105 respondents allows for quantitative analysis even though its validity is affected by the sample size.

Results

The vast majority of students uses or used WhatsApp. Their average answer was 5.47, SD 0.81. 67% of students answered "definitely yes" in this question. That shows WhatsApp is a very popular messaging service. Students are quite contented with it (M=4.1; SD=1.39), they consider it a suitable communication tool (4.33, SD=1.54) and quality program (M=4.56; SD=1.54).

As for the awareness about the new terms and conditions of WhatsApp, students are not much aware of them. The average response to the question, if they heard about them in the media was 1.86 (SD=1.58), to the question if the know about them from their friends and other people was 1.64, SD=1.26 and to the question if they read them was 1.51, SD=1.17.

The details of the answers can be found in the tables 1, 2 and 3.

Type of answer	Frequency	Percent	Cumulative Percent
1 (definitely no)	72	68.6	68.6
2 (no)	9	8.6	77.1
3 (rather no)	13	12.4	89.5
6 (definitely yes)	11	10.5	100.0
Total	105	100.0	

Table 1: Information received from the media (source: own calculation)

Type of answer	Frequency	Percent	Cumulative Percent
1 (definitely no)	73	69.5	69.5
2 (no)	18	17.1	86.7
3 (rather no)	3	2.9	89.5
4 (rather yes)	6	5.7	95.2
6 (definitely yes)	5	4.8	100.0
Total	105	100.0	

Table 2: Information received from other people I trust (source: own calculation)

Type of answer	Frequency	Percent	Cumulative Percent
1 (definitely no)	76	72.4	72.4
2 (no)	22	21.0	93.3
5 (yes)	3	2.9	96.2
6 (definitely yes)	4	3.8	100.0
Total	105	100.0	

Table 3: Information received from my own reading of the privacy policy (source: own calculation)

There is a quite a strong correlation between the answers to these questions.

		Inf. from other people	Inf.from own reading	Inf. from media
Inf. from other people	r_s	1.000	0.614	0.758
	P	.	0.000	0.000
Inf. from own reading	r_s	0.614	1.000	0.533
	P	0.000	.	0.000
Inf. from media	r_s	0.758	0.533	1.000
	P	0.000	0.000	.

Table 4: Correlations between information sources of WhatsApp's new privacy policy (source: own calculation)

We can further support the correlations with the cluster analysis. We can differentiate two clusters. The first one consists of students who are not interested in the new terms and aren't informed about them. This cluster is very large. The second cluster consists of students who read the new terms and heard about them. It is very probable that if the student heard about the new terms in the media, he also heard about them from his friends and read the terms as well. We used the K-means clustering method.

	Cluster 1	Cluster 2
Info from media	1.37	6.00
Info from own reading	1.27	3.64
Info from other people	1.30	4.55

Table 5: Final Cluster Centers (source: own calculation)

Cluster 1	94
Cluster 2	11

Table 6: Number of Cases in each Cluster (source: own calculation)

We also found out that the more people know about the new terms, the less they agree/would agree with them.

		Inf. from other people	Info from own reading	Info from media
Do you/would you agree with the new WhatsApp's privacy policy?	r_s	-0.457	-0.263	-0.0408
	P	0.000	0.007	0.000

Table 7: Correlations between agreement to new privacy policy and information source (source: own calculation)

The H1 was not confirmed.

The results are surprising because students have worries concerning their privacy in the online environment (M=5.03; SD=1.14). The disproportion can be explained by the complexity and intricacy of modern technologies and their privacy policies and information overload. It is impossible to monitor all the changes in the online environment. But students are generally mistrustful towards WhatsApp and think about quitting using it on the average (M=3.42; SD=1.66), but they are not so strongly decided to quit using it (M=2.49; SD=1.55).

		Info from other people	Info from own reading	Info from media	Agreement with the new privacy policy
Intention to stop using WhatsApp	r_s	0.386	0.405	0.286	-0.652
	P	0.000	0.000	0.003	0.000

Table 8: Correlations between the intention to stop using WhatsApp and information source about the new privacy policy (source: own calculation)

The second hypothesis H2 was confirmed.

The results concerning trust are a little worse. Users rather don't trust WhatsApp (M=3.3; SD=1.47), but the distrust is not very strong. Thus, the third hypothesis H3 was not confirmed.
Students are not much influenced in their behaviour towards WhatsApp by their opinion makers (M=2.67; SD=1.57). The fourth hypothesis (H4) was confirmed.
As for privacy, students are reluctant towards WhatsApp and would not disclose their private information to it (M=2.82; SD=1.2). It would be worth investigating if they know precisely what types of their personal data are already available to WhatsApp. They do not have a definite opinion concerning the question if it is easy to use WhatsApp and not to provide it with their personal information (M=3.53; SD=1.3). The fifth hypothesis (H5) was not confirmed.
From the three types of influences on quitting to use WhatsApp the influence of social norms seems to be the strongest, but the influence of other factors is lower only a little. In all three cases the correlation coefficients are not very strong. The sixth hypothesis H6 was not confirmed.

		Attitude towards WhatsApp influenced by other people	Using WhatsApp without private data disclosure	Contentment with WhatsApp
Intention to stop using WhatsApp	r_s	0.278	-0.221	-0.209
	P	0.004	0.023	0.032

Table 9: Correlations between the intention to stop using WhatsApp and social norm, control and contentment (source: own calculation)

Discussion

Even though the issue of new WhatsApp privacy terms became topical both worldwide and in the Czech Republic (articles dealing with it appeared on novinky.cz, idnes.cz, mobilmania.cz etc) our students are not much aware of them. It can be explained by the ignorance of privacy policies by the users. The privacy policy statements are long, vague and tricky (Obar and Oeldorf-Hirsch, 2020). There is only a smaller group of students who are aware of them and are informed by all three available information sources: their own reading, media and other people. The rest ignores them. However, students have worries about their online privacy, they know it is difficult not to disclose their private information to the online services and applications and don't trust the WhatsApp application. The influence of other people on students' online behaviour is in general terms not very strong, even though it influences their intention to stop using WhatsApp a little.

That shows that transparency that was intended to balance the asymmetry between users and technological companies doesn't work properly. We need to support users' information literacy. However, we can't rely on users' responsibility only (Nissenbaum, 2011). We need to support the legal regulation as well as it should keep up with the technological development.

It is surprising how little students know the new privacy policy of WhatsApp even though they are concerned about their online privacy. The more detailed analysis has shown there is a group of them which carefully observes the online environment and collects information from various sources. This group is very critical towards the new privacy policy of WhatsApp. The second and larger group is not so careful and attentive to the new information, they rather focus on the usefulness of the application. Our results suggest that if they knew about the new privacy policy they would be more critical.

The limitation of our research consists in the small sample of respondents, which consisted of students of the University of Economic and Business in Prague. The respondents belong into the Z-generation.

We analysed one concrete situation, but the results can be for our category of respondents generalized to other situations related to privacy policy statements. Our results can be used by both companies intending to improve their image and by the authorities in their effort to protect the citizens. It seems privacy policy is not an effective instrument for addressing users' privacy concerns. They should rather monitor users' preferences and adapt their activities accordingly.

Conclusion

The online environment is becoming very disorganized, a lot of people feel lost and express worries about their privacy. In our research, we found out that students don't know about the change in privacy policy of the very popular and praised massaging system WhatsApp even though they are concerned about their privacy. There is a small group of well-informed students, but the majority is uninformed. Their intention to stop using it is influenced a little by other people, service quality and impossibility not to provide the service with their private information, but these influences are quite weak. That is why the role of state regulation should be supported to ensure a more transparent environment. The way GDPR has started seems to be a promising beginning that should be followed by professional self-regulation. The users' pressure will definitely help.

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COVID-19'S IMPACT ON VIRTUAL EDUCATION: DIRECTIONS FOR FUTURE RESEARCH

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Abstract

The presented paper systematically explores the virtual education domain considering the ongoing Covid-19 pandemic. The major aim is to provide information about current key factors in virtual education and reveal gaps for future research. To define the conceptual structure of the virtual education domain, we used bibliometric analysis, together with multiple correspondence analysis and clustering of a bipartite network. The results showed key factors that are addressed in virtual education at the time of the Covid-19 pandemic. The analysis also showed three major clusters of key factors in the virtual education domain - virtual education factors, virtual education organisation and platform selection. It has also revealed gaps in current research, such as changes in curricula considering virtual education, the role of platform selection, verification of factors identified in this paper (e.g., a meta-analysis of factors that affect virtual education), teachers' perspectives on virtual education and focus on lower levels of education.

Keywords

Bibliometrix, covid-19, learning, pandemic, teaching, virtual education

Introduction

The information technology progress during the end of the 20th century had a considerable impact on many aspects of our lives (Popovic et al., 2018). Thus, it has brought changes in the educational environment (Rotellar and Cain, 2016) and allowed to design new teaching models and approaches (Zhang, Dang and Amer, 2016). Nevertheless, digitisation in education under normal circumstances would have taken years (Strielkowski, 2020). As Srivastava et al. (2020) mentioned, unpredictable pandemic Covid-19 situation has affected the lives of most people around the world. Almost all governments started regulations to stop the spread by strict lockdown, quarantine policies, and social as well as physical distancing (Gonzalez et al., 2020). Like any other sector, Covid-19 noticeably affected education (Abidah et al., 2020). Many countries suspended face-to-face education and examination. Traditional ways of education were overnight transferred to the virtual environment (Gonzalez et al., 2020; Srivastava et al., 2020) and it led to a digital revolution in education (Kapasia et al., 2020; Sutton and Jorge, 2020). Strielkowski (2020) point out that schools already had necessary tools for virtual education, however, they did not use them yet.

Generally, virtual education presents a novel educational approach (Mousavi Chelak and Kaviani, 2019). Regardless of time and place, the use of virtual education facilitates simple and economical access to educational resources and services through communication technologies, with the utilisation of electronic tools (Farrell and Commonwealth of Learning., 1999). Virtual education has certain pros and cons. Students favour flexibility and convenience (Pastore and Carr-Chellman, 2009; Ilgaz and Gulbahar, 2017; Antonova, Abramova and Popova, 2020).

Further, previous findings show that virtual education is as effective as traditional education and can improve learning effects (Piccoli, Ahmad and Ives, 2001). According to the literature, virtual education promotes vocational education, improve the transfer of learning, encourage entrepreneurial skills (Alonso-Díaz, Gutiérrez-Esteban and Yuste-Tosina, 2014), professional skills (Baranov, 2016) and has a positive impact on student learning (McLaughlin and Rhoney, 2015). In addition, in the present Covid-19 situation, virtual education offers certainty because of health and safety concerns (Trout, 2020). Piccoli et al. (2001) claim that electronic interaction could improve learning effects. The main cons relate to student's low self-discipline (Artino and Stephens, 2009; Antonova, Abramova and Popova, 2020), study distractions (Antonova, Abramova and Popova, 2020), and motivation (O'Neill and Sai, 2014; Trout, 2020). Jaggars (2014) found that students prefer taking easier classes in online formats and more tough classes in person (because of the student-teacher interaction). Unfortunately, face-to-face classes are impossible because of Covid-19. For this reason, the highest stressor affecting the students is uncertainty (Moawad, 2020).

The Covid-19 influence on virtual education in various fields is very topical. In the last year, there has been an increasing amount of literature on virtual education. However, none of the current researches have mapped the entire virtual education domain. So far, only Rodrigues, Franco and Silva (2020) concerned with mapping the scientific literature in education, management of business and similar areas, and how teaching institutions have adapted to Covid-19, but their bibliometric analysis is narrowly focused. To fill a research gap related to key factors addressed in virtual education, our major research question is: what are the key factors addressed in virtual education at the time of the Covid-19 pandemic? The paper systematically reviews the domain of virtual education, aiming to provide information about current key factors in virtual education and reveal gaps for future research. From this perspective, we are the first addressing this issue.

The present paper is divided into several sections. The introduction of this paper offers a brief theoretical background of the examined issue. The materials and methods section describes how bibliometric analysis of virtual education was made together with multiple correspondence analysis and clustering of a bipartite network. Section of results and discussion present and interpret obtained results. The last section of the paper, a conclusion, summarises the paper results together with recommendations for further research.

Materials and Methods

We used the bibliometric analysis to cover important factors in the virtual education during the current pandemic. This method is particularly useful in science or domain mapping, to show the underlying factors and connections between them (Aria and Cuccurullo, 2017). First, we got records from the Web of Science (WOS). We retrieved the data on February 23rd, 2021. To obtain references we used the following search query:

TS = (teaching OR learning OR studying OR education) AND TS = (virtual) AND TS = (covid 19 OR pandemic OR covid OR coronavirus) AND PY= (2019-2020)*

The initial search returned 1,151 references. We removed articles without abstract and non-English articles. To bibliometric analysis, we included records indexed only in selected categories. We chose these categories to better describe virtual education from the perspective of education research (to eliminate the impact of health, medicine, etc. publications). Selecting records is in the PRISMA diagram – Figure 1 (Moher et al., 2009).

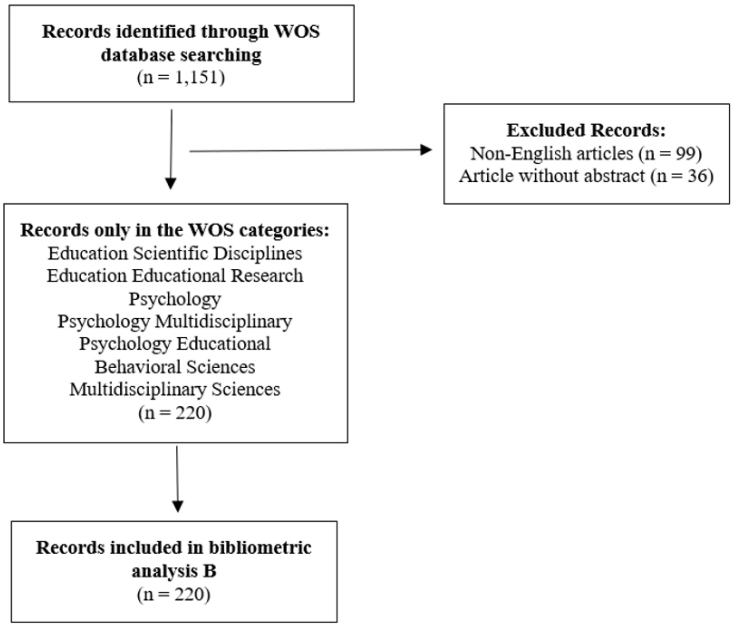

Figure 1: PRISMA diagram, based on Moher et *al., (2009)*

We conducted the bibliometric analysis in RStudio using the Bibliometrix package by Aria and Cuccurullo (2017). To begin this process, we load and convert tha data, created a bibliographic data frame, ran the bibliometric analysis, and extracted WOS keywords plus. To analyse conceptual structure, we used a multiple correspondence analysis and K-means clustering of a bipartite network of terms extracted from WOS keywords plus (Aria and Cuccurullo, 2017). The advantage of multiple correspondence analysis is that it can detect dependencies among a set of categorical variables that aim to identify new latent variables (Cuccurullo, Aria and Sarto, 2016). These latent variables are a combination of the original variables and they can explain information that is not directly observable (Greenacre and Blasius, 2006).

Results and Discussion

Multiple correspondence analysis and clustering generated three clusters of the virtual education domain (Figure 2). Clusters represent key factors addressed in the virtual education domain at the time of the Covid-19 pandemic. Heights reflect the distance between the keywords in clusters. Keywords that appear in publications near each other are closer to each other on the dendrogram, on the contrary, when they are distant from each other, only a small fraction of articles parse those keywords together (Cuccurullo, Aria and Sarto, 2016).

In the blue cluster, called *virtual education factors*, are the most popular factors in the virtual education domain. The red cluster show factors connected to *virtual education organisation*. Within that cluster, scientists dealt with factors related to curriculum, educational programs, organisation of classrooms and lectures, and the overall future of virtual education. Finally, the green cluster relates to *platform selection*. Scientists within that cluster paid attention to a platform selection for transferring knowledge to students.

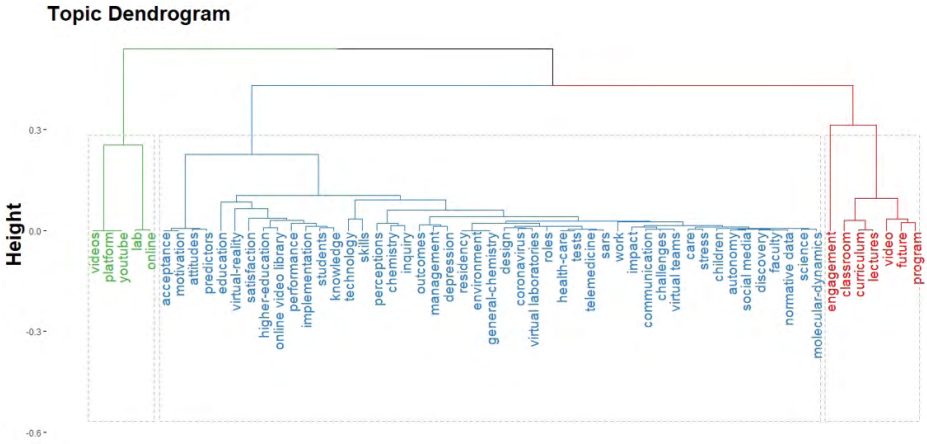

Figure 2: Topic dendrogram of virtual education domain (own calculation) – high quality picture can be found at https://doi.org/10.5281/zenodo.4675382

The findings of this paper broadly support the work of other studies in the virtual education area. Specifically, related to a necessary organisation change of education (for example curricula, programs etc.). Some authors, like Sabharwal, Ficke and LaPorte (2020), dealt with modifying programs and curricula into virtual forms. Other authors see Covid-19 as a challenge and opportunity to redesign curricula and programs to enhance curricula practice to better respond to students' learning needs beyond classical classrooms (Sutton and Jorge, 2020; Toquero, 2020). Cahapay (2020) states that is necessary to rethink curricula after the Covid-19 era and online or blended learning will become a common part of it.

Konstantinidis, Tsiatsos and Pomportsis (2009)which could be used in order to support collaborative e-learning scenarios. The main aim of this paper is to aid educational designers in selecting, designing and evaluating three dimensional collaborative virtual environments in order to gain the pedagogical benefits of Computer Supported Collaborative Learning. Therefore, this paper initially discusses the potential of three dimensional networked virtual environments for supporting collaborative learning. Furthermore, based on a two-step platform selection process this paper (a suggested that platform selection is important for virtual education, our research confirms this insight. We found YouTube is the most addressed virtual education platform. It is surprising because Ferhatoglu et al. (2019) point out the lack of links, data sources, and reliability in videos. Contrarily Kapasia (2020) found that Zoom, Google classroom and YouTube, are the most used virtual education platforms. Online lab notes are also coming to the fore in virtual education. Glassey and Magalhães (2020) claim that online lab notes can help students to understand concepts, relationships and other important factors of experiments within a shorter time. However, they also pointed out that online lab notes are unlikely to replace a student's physical interaction with equipment (Glassey and Magalhães, 2020).

The most popular factors which are affecting virtual education are in the blue cluster. The findings of this paper show importance and reciprocity of factors such as motivation, attitudes, acceptance, and predictors in virtual education. Prior studies also noted the importance of factors such as low self-discipline (Artino and Stephens, 2009; Antonova, Abramova and Popova, 2020; Kapasia *et al.*, 2020), study distractions (Antonova, Abramova and Popova, 2020), and motivation (O'Neill and Sai, 2014; Trout, 2020).

Looking closely at our results, we can also see that scientists are further addressing the link between satisfaction and virtual education implementation and the link between knowledge and performance. According to these results, we can infer that the correct implementation of virtual education affects student satisfaction. These results reflect those of Gonzalez et al. (2020) who found that Covid-19 has a positive effect on learning efficiency and performances if students adopt learning strategies. Scientists are addressing in connection with virtual education other factors such as autonomy, social media and their link to outcomes, management, quality, or impact on people (including depression). The influence of these factors monitors in conjunction with the skills of students and teachers.

Based on the Figure 2, follows that technology and experiences form an important bridge to other factors. Advances in information technology have enabled using new teaching methods (Sun *et al.*, 2008). Thanks to this progress we are now able, in the time of Covid-19, to face the sudden transformation into the virtual environment. Nevertheless, many students still have problems with technical equipment and poor internet connectivity (Antonova, Abramova and Popova, 2020; Kapasia *et al.*, 2020). According to our results, working in virtual teams and overall virtual communication is a challenge of virtual education. Alongside technology and experiences are also important factor of virtual education. Students without previous experience with online learning expected that online learning will be easier and require less time to manage, but Trout (2020) claimed, this presumption is wrong. It is possible, therefore, that previous experience of virtual education affects not only the outputs and results of students but also their well-being.

One unanticipated finding was that most of the research merely focused on the college environment. According to these results, we can infer that researchers have not yet paid attention to researches at lower levels of study, which opens possibilities for future research. Also, there is a lack of literature concerned with the teachers' perspective on virtual education. As mentioned in the literature review, Rodrigues, Franco and Silva (2020) mapped scientific literature at the beginning of the Covid-19 pandemic. The results showed that the major topics in virtual education were school closures, good educational practices, and the cancellation of international conferences. However, the findings of our paper do not support the findings of Rodrigues, Franco and Silva (2020).

Conclusion

The results of this paper showed the key factors that are addressed in virtual education at the time of the Covid-19 pandemic. We detected three major clusters in the virtual education domain in the last year - *virtual education factors*, *virtual education organisation* and *platform selection*.

Further researches should explore: (1) what changes are necessary in the organisation of virtual education (for example curricula change), (2) what role does platform selection play in virtual education, (3) find whether there is an effect between factors identified in this paper and determine whether the effect is negative or positive (e.g. a meta-analysis of factors that affect virtual education) (4) investigate factors identified in this paper to determine how they affect the acquisition of knowledge, performance and satisfaction of students and teachers, (5) study the effect of previous experiences in virtual education on outputs, results and well-being, (6) focus on the teachers' perspective on virtual education, (7) focus on lower levels of education.

The limitation of this paper is the bibliometric approach itself. We used only articles indexed in WOS for the bibliometric analysis and for multiple correspondence analysis and clustering used only keywords-plus. While considering these limitations, this paper lays the basis for future research in virtual education.

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TESTING OF PRE-SERVICE MATHEMATICS TEACHERS' SPATIAL ABILITIES

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Abstract

The article presents the results of testing the spatial abilities of pre-service teachers, with the aim of identifying geometric task difficulty, and providing them with adequate training in geometry classes. Pre-service mathematics secondary school teachers were given an online test with geometric tasks in the plane and in the three-dimensional space. Our aim was to measure their performance in spatial orientation and spatial visualization geometric tasks. The primary research questions were in which types of geometric tasks students were more successful and what their opinion was regarding the difficulty of the selected tasks. We found out that students' success rate in spatial orientation and spatial visualization tasks was similar. Furthermore, students were more successful in the spatial geometric tasks than in the planar tasks.

Keywords

Planar geometry, pre-service mathematics teacher education, spatial geometry, testing spatial abilities

Introduction

The aim of our research is to measure students' success rate in solving various geometric problems and, based on their results, provide them with an optimal training in our geometry courses.

Visual spatial ability covers the mental manipulation of both two-dimensional and three-dimensional figures, i.e., dealing with geometric tasks in the plane and in the three-dimensional space (Karaman and Toğrol, 2009). In compliance with literature, we uniformly use the term *spatial ability*.

The bases of our research are spatial ability and its factors. According to Lean and Clements (1981), spatial ability is the ability to formulate mental images and to manipulate these images in the mind. The extensive research on human spatial abilities has resulted in detailed categorizations of spatial abilities which vary by individual research findings (Carroll, 1993). In our research, we have limited ourselves to two major components of spatial ability – *spatial visualization* and *spatial orientation* (McGee, 1979). These two so-called factors (sub-factors) can be distinguished according to what is being moved when we solve a geometric task. Spatial visualization is the ability to imagine manipulating, moving, rotating, twisting, or inverting objects without reference to one's self. It means that the imagined object or its parts are moved or changed in our minds. On the contrary, spatial orientation is understood as the ability to imagine a mentally presented object from different perspectives. In other words, the imagined object remains still and we mentally move ourselves to different viewpoints.

Meaningful assessment involves examining not only students' spatial ability but also conceptual and procedural understanding. There are two basic principles in acquiring learning outcomes and solving problems which are applied in mathematics education including solving geometric

tasks: procedural knowledge and conceptual knowledge. The first one is usually defined as an action sequence needed for solving mathematical tasks, the second one as an understanding of the fundamental principles and connections of a particular mathematical domain (Hiebert and Lefevre, 1986; Star, 2005; Rittle-Johnson and Star, 2007). According to several research findings, pre-service teachers focus mainly on procedural knowledge in their geometry problem solving strategies, e.g., (Son, 2006). A possible reason may be that they themselves do not have sufficient conceptual knowledge. Therefore, among other things, this knowledge should be emphasized in the training of pre-service teachers (Hacısalihoğlu-Karadeniz, Kaya and Bozkuş, 2017; Thaqi, Giménez and Rosich, 2011).

The presented study is the first part of a long-term research project accompanied by teaching and learning interventions during pre-service mathematics teachers' training. In the first phase in autumn 2020 (i.e., in the first semester), we tested students before entering geometry classes. The aim was to identify their entry skills related to spatial ability, which is essential for their future teaching geometry in schools. Based on the results obtained, we intend to prepare interventions in compulsory geometric courses (dynamic models of geometry situation, applets, exercises,…) so that students have enough opportunities to develop their spatial abilities. We assume that we will test pre-service teachers repeatedly in the beginning and at the end of each geometric course so that we can respond to students' needs. The final testing will be realized at the end of their university studies. We would like to compare the input and output levels of students' visual abilities.

The rest of the paper is organized as follows. In the next section, we describe the design of the test for pre-service mathematics teachers and the methodology for the assessment of the research. Then the results of the study are presented and the discussion afterwards. A short summary, suggestions and ideas for future work are given lastly.

Materials and Methods

As has been already explained, our aim is to analyze students' success rate in geometric tasks, specifically in spatial visualization and spatial orientation tasks in the plane and in the three-dimensional space.

The students were given an online test with 22 geometric tasks on December 17th 2020. The standard time limit for the test was 40 minutes; the extended time limit for students with special needs was 60 minutes. The students who participated in the test were pre-service mathematics secondary school teachers in the first year of their university studies, i.e., newcomers to the faculty (Faculty of Mathematics and Physics, Charles University, the Czech Republic). We received 36 completed tests in total (33 were assigned in standard time limit, 3 in the extended time limit).

The test contains the introductory requiring questions such as name, age, and students' study specialization. These data show the basic characteristics of students who filled in the test. It is planned to be a long-term research, i.e., the same group of students will be tested in the future again; that is why the test is not anonymous.

The geometric problems in the test are designed so that one certain spatial ability is mainly tested by solving them. The test was aligned with the curricular requirements of secondary schools because it is more suitable than standardized tests for measuring spatial abilities. The test consists of 22 individual geometric tasks; of which 12 are spatial tasks (7 spatial orientation, 5 spatial visualization) and 10 are planar tasks (6 spatial orientation, 4 spatial visualization). All types of geometric tasks (planar, spatial, spatial orientation, and spatial visualization) are ordered alternately. Students were also asked what their opinion regarding the difficulty of individual tasks is. These comments were required in the test for several tasks which we considered as the most difficult ones; otherwise students wrote these comments voluntarily.

From the acquired data, the absolute and relative frequencies of students' answers were determined and certain dependencies were observed, described graphically or summarized in tables. Students' success rate in spatial visualization and orientation tasks and in planar and spatial tasks was interpreted using the Mann-Whitney test. To show dependencies between students' correct solutions and spatial visualization or spatial orientation tasks, the data were also processed into a contingency table of the absolute frequencies. Pearson's χ2-test of independence was used; the results were interpreted at the chosen level of significance. The significance level was chosen 0.05 in each test. In this article we deal with the following null hypotheses (the alternative hypotheses would be formulated in the negative sense) and research questions.

$H0_1$: The students' success rate in both types of geometric tasks (regarding visualization and orientation) is the same.

$H0_2$: The students' success rate in both types of geometric tasks (regarding planar and spatial tasks) is the same.

RQ1: Are students more successful in the spatial orientation or in the spatial visualization geometric tasks?

RQ2: Are students more successful in the planar or in the spatial geometric tasks?

Results

Hypothesis $H0_1$ was tested by the Mann-Whitney test. The first sample ($n_1 = 13$) consists of the numbers of students' correct answers for each spatial orientation task; the second sample ($n_2 = 9$) consists of the numbers of students' correct answers for each spatial visualization task. The critical value of U at $p < 0.05$ is 28 which is lower than the test criterion of 48. Therefore, the result is not significant at $p < 0.05$. Hypothesis $H0_1$ cannot be rejected. We cannot conclude that there is any dependency between the students' success rate in spatial orientation and spatial visualization tasks. Students' performance can be observed in Table 1. Spatial orientation tasks are denoted by O, spatial visualization tasks by V. The tasks are sorted according to the number of correct answers (N) and are assigned ranks (R). The distribution of different types of tasks is more or less the same. This was also confirmed by the Mann-Whitney test.

	V	O	O	V	V	O	O	V	O	V	O	O	V	O	O	V	O	O	V	O	V	O
N	17	19	20	20	21	23	23	23	24	26	30	30	31	32	32	32	34	34	34	35	35	36
R	1	2	3.5	3.5	5	7	7	7	9	10	11.5	11.5	13	15	15	15	18	18	18	20.5	20.5	22

Table 1: Tasks ranking regarding the numbers of students' correct answers, 2021 (source: own calculation)

In addition, we used the chi-square test of independence to verify the same hypothesis. For this purpose, we set the success limit for the 4th quartile, which means gaining 11–13 points in spatial orientation tasks and 8–9 points in spatial visualization tasks. We compiled a contingency table for the examined characters – success in both categories of tasks, see Table 2. Test criterion K (χ^2-test) was lower (2.786), than the critical value of 3.841 on the significance level of 0.05. Therefore, hypothesis $H0_1$ that the success rate in both groups of tasks does not depend on each other cannot be rejected. The dependence between the two examined features is not statistically significant.

		Spatial visualization	
		8–9	0–7
Spatial orientation	11–13	11	6
	0–10	7	12

Table 2: Contingency table for spatial orientation and visualization tasks, 2021 (source: own calculation)

Hypothesis $H0_2$ was also tested by Mann-Whitney test. The first sample ($n_1 = 10$) consists of the numbers of students' correct answers for each planar task; the second sample ($n_2 = 12$) consists of the numbers of students' correct answers for each spatial task. The critical value of U at $p < 0.05$ is 29, which is equal to the test criterion. Therefore, the result is significant at $p < 0.05$ and hypothesis $H0_2$ is rejected. There is a dependency between whether the student solves the planar or the spatial task. This dependency can be observed in Table 3. Planar tasks are denoted by P, spatial tasks by S. The tasks are sorted according to the number of correct answers (N) and are assigned ranks (R). Note that the lower ranks are assigned more likely to planar tasks while the higher ranks are assigned more likely to spatial tasks. This was also confirmed by the Mann-Whitney test.

	P	S	P	P	P	P	P	P	S	S	P	S	S	S	S	S	S	P	S	S	P	S
N	17	19	20	20	21	23	23	23	24	26	30	30	31	32	32	32	34	34	34	35	35	36
R	1	2	3.5	3.5	5	7	7	7	9	10	11.5	11.5	13	15	15	15	18	18	18	20.5	20.5	22

Table 3: Tasks ranking regarding the numbers of students' correct answers, 2021 (source: own calculation)

Furthermore, we analysed the students' performance in the individual tasks which were the most difficult for students. The students had a success rate of less than 70% in 9 tasks: 4 tasks on the rotation of a line segment in the plane (RO1–RO4), 3 tasks on the relative position of circles in the plane (C1–C3) and 2 tasks on determining the relative position of straight lines in the three-dimensional space (SL1, SL2).

In tasks RO1–RO4, the center of rotation, the pre-image and the image of the line segment were entered in the square grid. The students had to determine by which oriented angle the line segment is rotated. There was a choice of 6 options: +90°, -90°, +60°, -60°, +45°, -45°. In addition to the correct answers, we monitored how many students correctly determined at least the direction of rotation or the size of the angle, see Table 4. Only 15 students answered correctly in all 4 tasks, a total of 11 students chose the opposite direction of rotation in these tasks.

	RO1	RO2	RO3	RO4
correct answer	23	20	17	21
correct direction	23	23	24	24
correct angle	35	31	24	31

Table 4: Numbers of students' answers on rotation tasks, 2021 (source: own data)

	parallel	intersecting	skew	two options
SL1	0	**24**	12	0
SL2	11	5	**19**	1

Table 5: Numbers of students' answers on relative positions of straight lines tasks – the numbers of correct answers are in bold font, 2021 (source: own data)

In tasks C1–C3, the students were asked to determine the number of common points of two different circles, which were given by their radii and the distance of centers. The students had no pictures available, they only had to imagine the problems. The tasks were open. In addition to the expected incorrect answers, there were also completely meaningless answers as '3', '4' or 'infinity' of common points in eight cases.

In tasks SL1 and SL2, students had to determine the relative position of two straight lines entered using solids (SL1 – pyramid, SL2 – cube). There was a choice of options: parallel, intersecting, skew. The numbers of individual answers are summarized in Table 5.

Discussion

We will first consider the possible causes of errors in the least successful tasks. In the tasks on line segment rotation, the +-90° rotation was the easiest one (tasks RO1 and RO2). The same result was reached by Hollebrands (2004). On the other hand, the research (Halas et al., 2020) implies that students have problems even with +-90° rotation. While the failure to recognize the correct size of the angle in tasks RO1–RO4 is related to insufficient spatial abilities, we consider the change of the rotation direction to be conceptual ignorance. One third of students commented on the task that they were not sure which direction was positive and which one was negative. Also, according to several studies (Ada and Kurtulus, 2010; Turgut, Yenilmez and Anapa, 2014; Kambilombilo and Sakala, 2015; Mainali and Heck, 2017), pre-service teachers did not sufficiently accept the concept of rotation.

The biggest problem of tasks C1–C3 was to imagine the position of two circles, especially in a situation where the circles touch internally. Five students stated that they would need to sketch the circles, i.e., they would prefer a procedural approach to solving the problem (Son, 2006). Due to the absence of a picture, the tasks were atypical for the students, which may be one of the reasons for the high failure rate (Kambilombilo and Sakala, 2015). According to the students' comments, the problem was also with the use of mathematical symbols in the assignment. Answers '3', '4' or 'infinity' of common points are again related to conceptual ignorance, as these possibilities for two different circles can never occur. The answer '3' could be given by those students who believe that the center of the circle belongs to the circle (Hromadová et al., 2020).

In task SL1, the straight lines were given by points obviously lying in a plane; in task SL2, the straight lines lay in opposite faces of a cube. In both tasks, the straight lines were not parallel at first sight. Thus, the tasks were not difficult in terms of spatial abilities, but the students did not have sufficient conceptual knowledge of the relative positions of two straight lines in the three-dimensional space. One student admitted in the attached commentary that he could not distinguish intersecting and parallel lines. The connection between language and conceptual understanding is mentioned, e.g., by Kieffer et al. (2009) and Huerta et al. (2016). One comment pointed out that not enough problems with polyhedra other than the cube had been solved at upper secondary school.

Students' errors point to a lack of conceptual knowledge of pre-service teachers in the beginning of their university studies. Therefore, an emphasis should be placed on this knowledge in the training of pre-service teachers (Hacısalihoğlu-Karadeniz, Kaya and Bozkuş, 2017; Son, 2006; Thaqi, Giménez and Rosich, 2011).

The students' success rates in both spatial orientation and visualization tasks were similar in our test. Al-Balushi and Coll (2013) obtained a consistent result when they investigated, among other things, the differences in solving static (i.e., spatial orientation) and dynamic (i.e., spatial visualization) tasks in upper secondary school female students from their learning style point of view. On the other hand, spatial visualization test items were usually more difficult than spatial orientation items (McGee, 1979). Diezmann and Lowrie (2009) also found out that lower secondary school students perceived the spatial visualization tasks to be more complicated than the spatial orientation tasks. Students' perceptions of task difficulty mirrored their performance in tests. Our results may be related to the fact that our planar tasks were more difficult for students and some students had conceptual understanding problems in several tasks (see above reasons).

Finally, the testing revealed that students were significantly more successful in spatial tasks than in planar tasks. These results are not consistent with the findings, e.g., of Jolicoeur et al. (1985). The analysis of students' comments showed that the planar tasks were seen as the most difficult ones. We impute this to the acceptance of the required conceptual knowledge, not to the students' spatial abilities.

Conclusion

We have chosen to design the test to measure students' spatial abilities on the basis of several constructs – planar versus spatial tasks, spatial orientation versus spatial visualization tasks. The students' performance in the test was statistically measured and the results were discussed. We found out that students' success rate in spatial orientation and spatial visualization tasks was similar (RQ1). On the other hand, students were more successful in the spatial geometric tasks (RQ2).

Related to the results obtained, we plan to modify the test to meet the validity of the instrument for testing spatial abilities, i.e., to balance difficulty levels among tasks especially in planar tasks. A modified version of the test will be used as a research tool for pre-test measure of a new group of students and in our research studies next year.

For the purposes of this study, students were given an online test because of the current pandemic situation. In the future, we plan to measure students' spatial abilities using a paper test in the classroom. However, we do not expect that type of tests concerning online and traditional versions can have any significant influence on students' performance.

According to students' results, we can also modify the content of geometric courses which these tested students will be entering next semester, for our goal is to train students to be able to solve various geometric problems. We plan to measure students' visual abilities during their university studies; that is why the same group of students will be tested after finishing certain geometric courses and before graduating from the university.

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TEACHER MEDIOCRITY IN HIGHER EDUCATION: CAUSES, EFFECTS AND PERSPECTIVES

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Abstract

The goal of the research paper is to analyze and outline the reasons why quality in higher education has been decreasing within the last decade. The paper conducts a case study at a technical faculty from Romania through focus groups, quantitative and qualitative research data regarding the efficiency of the teaching process. Student enrollment and graduation statistics, questionnaires regarding the quality of the educational process and data on teachers' research activity are analyzed and discussed. Results provide insights on how important academic professionalism, grading objectivity and misconduct tolerance of university teachers is related with both their own and their students' performance as well as the outcomes generated for the higher education institution's reputation. Conclusions show that underperforming teachers neglect their academic duties in teaching and research, as well as their role in responsibility by enabling misconduct behavior, thus negatively affecting students' motivation and their learning outcomes.

Keywords

Academic professionalism, institutional management, quality of education, student feedback, teaching performance, teacher responsibility

Introduction

The stakeholders involved in Romania's higher education process (teachers, students, local companies) agree upon the decrease in the quality of the graduates universities provide, but fail to acknowledge their own shortcomings and responsibility and prefer to shift the blame elsewhere. Teachers from university tend to blame the weak background of freshman students for lowering their own standards instead of assuming an active role (Weiner, 2020). Students also provide their input upon the way they perceive their teachers' performance within class which may indeed help improve teacher's adaptive response to different groups of students and their specific learning behavior, improving learning efficiency (Arthur, 2009). Higher education institutions (HEI) need to also create an appropriate setting for a better overall educational process which is not by a rigid approach (Dehghan, 2020), as most expect, but rather within a framework where contributions are sourced from both directions to provide a productive environment (Chipaco and Branco, 2018). A famous saying within the Romanian academic environment states that "it is not the walls that build a school, but the spirit that reigns within them." This is a clear message for teachers to assume the responsibility they have within their institution, beginning by learning themselves how to be better in their profession (Tatto, 2018) and have the actual support to grow professionally within a proper higher education environment (Jiang, 2020). This mindset will enable a faster and more productive response to ongoing and future challenges and help them better adapt to the constant dynamic changes (Mailybayeva et al, 2020) that are shaping today's world. The work invested within this process will also strengthen one of their main roles and responsibilities they have as a teacher, which is to teach by example and promote strong ethical and moral values (Cheruvalath, 2018) that should be embraced by their students as a form of respect towards the effort teachers carry out on a daily basis for the society of tomorrow. The objective

of the paper is to provide a comprehensive overview upon the reasons which lead to mediocrity in higher education, the issues that will arise on short-term as well as the effects on medium-term for the involved stakeholders and provide insights to better understand the implications and consequences of tolerating such complacent behavior. The paper is divided into the following sections: Materials and Methods, Results, Discussion and Conclusion, References.

Materials and Methods

The paper presents a case study from a technical faculty in Romania using empirical, quantitative and qualitative data. Focus groups were used to source the most relevant data from the questionnaires applied to the faculty's students in 2010 (40 students), 2015 (57 students) and 2020 (82 students) and involved the faculty's students' union representatives, scholars and faculty management. The focus groups were managed by the educational department of the students' union, its board members and leading president after receiving proper briefing from the faculty's Vice Dean and Dean and were part of an internal assessment. Only the most relevant data was used in the conclusions of the report provided to the faculty's management. More than 90% of the subjects within the case study are faculty-related specialization subjects, the first 10 (Subject 1-Subject 10) being from the first two academic years, whilst the other group (Subject 11-Subject 20) being from the last two and account for more than a third of the faculty's curricula. Questionnaires were designed by the university's Quality Assurance (QA) department, are part of standard procedures and are regularly employed and applied by each faculty's associated quality commission and members. Three main indicators were extracted from the overall questionnaire: academic professionalism (perceived competence and teaching performance), grading objectivity (perceived transparence and righteousness of grading process) and misconduct tolerance (general prevention, upholding discipline during exams and attitude towards cheating attempts). These indicators were assessed by students (within the questionnaire) using a five-level Likert scale ranging from 0-4 as follows: excellent (4), very good (3), good and/or appropriate (2), weak and/or superficial (1) and very weak (0) with a value of 2 being considered acceptable by a slim margin (the internal target of the faculty was to reach at least 2.5 for each indicator). For the misconduct tolerance indicator (among others as well), the meaning of the provided ratings was inversed within the original questionnaire (0 being "excellent" and 4 "very weak"). The overall academic seriousness indicator sums up the positive performance of all three selected indicators, in this sense a multiple of 3 was used to assess overall average results. The arithmetic mean was used to average teacher's h-index metric within the selected databases (Havg), then divided by the full years of each their academic experience to filter overall research performance in all databases (Havg performance) as well as within the one where the teacher has the best rating (Hmax). Research performance (Havg or Hmax) is interpreted as "good" (if Havg has a value of 1), "great" (if Havg exceeds 2) or "remarkable" (if Havg is above 3). Data was collected from the grade registers, data and statistical reports of the faculty, online available data on each teacher's h-index ratings (as of February 2021) within the university's list of 3 relevant databases (Web of Science, Scopus and Google Scholar), focus group meetings, discussions (2020) and reports (2010 and 2015) and department and faculty council meetings. Due to the sensitive nature of the data and results, no direct linkage was made between teachers and their subjects within this paper.

Results

Over the past decade the number of allocated places to the faculty we will be analyzing throughout this paper has been reduced by almost 20% and is currently at 180 places (since 2016) after 2 consecutive 10% reductions (in 2012 from 200 places and in 2008 from 220 places). From these places around 85% are financed from the budget of the Ministry of Education (tuition free) and

only around 15% of them are with paid tuition, i.e. since 2016 from 180 places, 155 are tuition free (budgeted) and 25 are with paid tuition (tuition tax). In Romania, the number of allocated places to each faculty is in accordance with the number of graduates it provides at the end of each cycle, therefore its main source of financing depends on a high graduation rate of its enrolled students which most often is in a conflict of interest with the quality of the educational process. An overview of such data is shown in table 1. The faculty in question has no real problems to successfully occupy its allocated places, but around 12% of students withdraw soon after the beginning of the first academic year (administrative loss) without even attending any of the lectures, mainly due to poor reasoning upon their specialization choice. The dropout rate after the first year (only considering students who actually attended classes) varies depending upon average level of each class somewhere between 10-20%. Class of 2020 (enrolled in 2016) had a huge dropout rate of almost 40% at the beginning of the second academic year, but that was an unfortunate exception in recent years (the future class of 2021 had a dropout rate of 17.76% after the first year and the future class of 2022 of 26.06%). Grading in Romania is from 1 (worst) to 10 (best), with 5 being the minimum passing grade and an average of 6 being required for the successful completion of academic studies. Despite all teachers agreeing upon the fact that the level of students' knowledge and academic performance is constantly dropping, the figures related to average class grades do not confirm this opinion. Paradoxically, the class average grades have slightly increased (between 2-5%) within the last 5 years, mainly due to a larger proportion of students upgrading from a below average performance to an average level, thus contradicting the overall view of the teaching staff. The reason behind this situation is explained by grading bias, as most of the teachers have lowered their expectations and standards in response to the students' lack of background knowledge from secondary education, as well as from previous academic years (in case of subjects from upcoming semesters). This phenomenon thus hides some of the harsh realities of higher education and creates an altered image upon the quality of acquired knowledge and academic level of its students upon graduation and employment at a domain relevant job.

Graduation year (class of)	2016	2017	2018	2019	2020	Overall average (2016-2020)
Enrolled in 1st year (total)	185	175	162	184	176	176
Enrolled in 1st year (actual)	162	155	145	149	155	153
Administrative loss (1st year)	23	20	17	35	21	23
[%]	12.43	11.42	10.49	19.02	11.93	13.15
Enrolled in 2nd year (actual)	121	118	127	134	95	119
Dropout rate (after 1st year) [%]	25.30	23.87	12.41	10.06	38.70	22.32
Graduates	98	98	114	123	81	102
[%]	52.97	56.00	70.37	66.84	46.02	58.27
Overall multiannual average grade (class)	7.44	7.42	7.76	7.91	7.78	7.66
Above average multiannual grade (> 9.00)	11	5	14	11	11	10
[%]	11.22	5.10	12.28	8.94	13.58	10.15
Average multiannual grade (7.00 – 8.99)	52	54	73	90	55	64
[%]	53.06	55.10	64.03	73.17	67.90	62.68
Below average multiannual grade (< 6.99)	35	39	27	22	15	27
[%]	35.71	39.79	23.68	17.88	18.51	27.15

Table 1: Enrollment and graduation figures, 2016-2020 (source: own processing)

The shallow level of professionalism and skills is not only valid for the faculty's graduating students, but for its teaching staff as well. Another source contributing to this reality is driven by a similar and maybe even more surprising decrease in perceived academic professionalism, ranging from

research and teaching performance to an increased level of tolerating misconduct and cheating. Table 2 presents an overview of the research performance associated with the 24 members of the faculty's research center (not all faculty teachers are part of the research center). The main focus (and ranking) is around the performance of the average h-index from the university's 3 main and relevant databases, adjusted with the years of experience of each teacher. Less than a third (29%) of teachers manages to obtain a value of at least 1 (considered as "good") for either the Havg or the Hmax performance indicator and only 2 of them (8%) are close to a value of 2 (considered as "great"). Almost half (41%) do not even manage to obtain a quarter of the target value in either Havg or Hmax, which is a very poor result and quite dismaying considering the experience from the teacher profiles present in the lower part of the rankings provided.

Teacher ranking	H1	H2	H3	total	Havg	Academic level	Experience (years)	Havg performance	Hmax performance
#1	12	12	22	46	15.33	4	12	1.27	1.83
#2	9	5	12	26	8.66	3	7	1.23	1.71
#3	2	1	5	8	2.66	1	3	0.88	1.66
#4	4	2	5	11	3.66	2	5	0.73	1.00
#5	3	3	6	12	4.00	2	6	0.66	1.00
#6	5	3	5	13	4.33	2	7	0.61	0.71
#7	9	7	21	37	12.33	4	20	0.61	1.05
#8	5	3	6	14	4.66	2	14	0.33	0.42
#9	3	2	3	8	2.66	2	11	0.24	0.27
#10	4	3	7	14	4.66	4	23	0.20	0.30
#11	4	6	6	16	5.33	4	27	0.19	0.22
#12	6	2	9	17	5.66	4	30	0.18	0.30
#13	3	2	6	11	3.66	3	23	0.15	0.26
#14	1	1	4	6	2.00	2	13	0.15	0.30
#15	2	1	5	8	2.66	3	19	0.14	0.26
#16	5	4	10	19	6.33	4	48	0.13	0.20
#17	2	2	2	6	2.00	2	16	0.12	0.12
#18	3	3	5	11	3.66	3	31	0.11	0.16
#19	2	1	4	7	2.33	3	23	0.10	0.17
#20	2	3	4	9	3.00	3	31	0.09	0.12
#21	2	2	8	12	4.00	4	48	0.08	0.16
#22	1	3	5	9	3.00	3	38	0.07	0.13
#23	1	1	2	4	1.33	2	20	0.06	0.10
#24	1	1	2	4	1.33	2	25	0.05	0.08
Overall average	**3.79**	**3.04**	**6.83**	**13.66**	**4.55**	**2.83**	**20.83**	**0.35**	**0.52**

Table 2: Ranking of the faculty's research center members' performance (source: own processing)

22 of the 24 teachers from the research center (91%) are also involved in the student assessments provided in the following section, where some additional comments are made in order to complement data provided in the tables below. A total of 16 teachers obtain noteworthy performances (72%), either positive or negative which will be mentioned in short: 9 teachers provide positive examples (40%), 5 of which (22%) are present in the upper third and 7 in the first half (31%) of the research center's rankings. There are also 7 teachers (31%) sourcing negative examples, 4 of which (18%) are ranked in the lower third and 3 in the middle third (13%) of the research center's rankings. In terms of research performance it is surprising that some of the members ranked in the middle third receive merit bonuses, some experienced teachers have very

low and scarce English skills (some do not even speak at all) or some members (from the lower third) have not written a research article for more than 10 years. Additional comments will be provided in addition to the results presented and related to the data from the tables below.

crt	Professionalism (teaching)					Objectivity (grading)					Tolerance (cheating)				
year	2010	2015	2020	**avg**	+/-	2010	2015	2020	**avg**	+/-	2010	2015	2020	**avg**	+/-
#1	3.27	3.13	3.06	**3.15**	-0.21	3.42	3.28	3.18	**3.29**	-0.24	0.77	0.98	0.89	**0.88**	0.12
#2	3.50	3.88	3.81	**3.73**	0.31	3.55	3.78	3.72	**3.68**	0.17	0.92	0.13	0.11	**0.38**	-0.81
#3	2.17	2.23	2.42	**2.27**	0.25	3.77	3.83	3.91	**3.83**	0.14	1.85	1.78	1.89	**1.84**	0.04
#4	2.65	2.48	2.36	**2.49**	-0.29	2.87	2.23	2.18	**2.42**	-0.69	2.27	2.88	3.13	**2.76**	0.86
#5	1.12	0.65	0.71	**0.82**	-0.41	1.57	0.88	0.91	**1.12**	-0.66	3.95	3.90	3.96	**3.93**	0.01
#6	2.02	2.23	1.96	**2.07**	-0.06	2.65	2.78	2.39	**2.60**	-0.26	3.80	3.38	3.48	**3.55**	-0.32
#7	2.75	2.55	2.41	**2.57**	-0.34	3.22	2.93	2.87	**3.00**	-0.35	1.65	1.88	2.17	**1.90**	0.52
#8	3.17	3.35	3.59	**3.37**	0.42	3.72	3.71	3.61	**3.68**	-0.11	0.37	0.25	0.22	**0.28**	-0.15
#9	0.77	0.61	0.71	**0.69**	-0.06	1.22	1.11	1.34	**1.22**	0.12	4.00	4.00	3.96	**3.98**	-0.04
#10	3.87	3.85	3.61	**3.77**	-0.26	3.17	3.23	3.36	**3.25**	0.19	3.35	3.68	3.83	**3.62**	0.48
avg	**2.52**	**2.49**	**2.46**	**2.49**	**-0.06**	**2.91**	**2.77**	**2.74**	**2.81**	**-0.16**	**2.29**	**2.28**	**2.36**	**2.31**	**0.07**

Table 3: Students' perceptions upon teacher performance (first two), 2010-2020 (source: own processing)

Table 3 highlights the individual and overall results obtained for each of the 10 relevant selected subjects (Subjects 1-10 from 20) from the first two academic years in terms of academic professionalism, grading objectivity and misconduct tolerance. All three analyzed criteria follow a slightly negative dynamic: overall professionalism decreases by 0.06 points (a relative decrease of 2.57% over the 10 years), but the perceived average of 2.49 is between "good and/or appropriate" and "very good", therefore above average; overall grading objectivity decreases by 0.16 points (a relative decrease of 5.80% since 2010), but the perceived rating of 2.81 is again above average, being closer to "very good" than the previous analyzed criteria; misconduct tolerance increases by 0.07 points (a relative increase of 3.10% as of 2020) and the perceived rating of 2.31 is in this case above average, being the only criteria where performance does not exceed the average limit and falls behind the minimum imposed target value by more than 15%. Table 4 introduces the overall academic seriousness criteria, a sum of the positive performance of all 3 indicators for each subject, ranked in decreasing order from the best performing subject to the least best performing one.

criteria	Overall academic seriousness				
year	2010	2015	2020	**average**	dynamic
Subject 2	10.13	11.53	11.42	**11.02**	1.29
Subject 8	10.52	10.81	10.98	**10.77**	0.46
Subject 1	9.92	9.43	9.35	**9.56**	-0.57
Subject 3	8.09	8.28	8.44	**8.27**	0.35
Subject 7	8.32	7.60	7.11	**7.67**	-1.21
Subject 10	7.69	7.40	7.14	**7.41**	-0.55
Subject 4	7.25	5.83	5.41	**6.16**	-1.84
Subject 6	4.87	5.63	4.87	**5.12**	0.00
Subject 5	2.74	1.63	1.66	**2.01**	-1.08
Subject 9	1.99	1.72	2.09	**1.93**	0.10
average	**7.15**	**6.98**	**6.84**	**6.99**	**-0.30**

Table 4: Overall performance of selected criteria (first two), 2010-2020 (source: own processing)

The overall average of the 10 subjects has continuously decreased within the 10 year analyzed timespan by 0.30 points (a relative decrease of 4.26%) to a level of 6.84 as of 2020. Since 2015 the overall academic seriousness of the tenured teachers in these subjects has fallen to a level of just over 6, meaning it only rated as slightly above average is terms of academic standards. Within the selected subjects from the first two academic years 60% achieve ratings considered "good and/or appropriate" (3 of these subjects achieving even "very good" overall results), whilst 40% have a below average rating and a negative dynamic, as 2 subjects have been under the limit value of 6 since 2015 and 2 subjects obtain very bad ratings (under 2, thus in the category "very weak") within the analyzed timespan. Subject 2 is by far the best of the selected range, with an important increase since 2015 (a relative increase of 13.82%) when a new tenured teacher was appointed for that particular subject, the subject's dynamic in 2020 and its level of perceived overall academic seriousness being very close to "excellent" and the only one in the range to score higher than 11. Subject 8 has also an improved dynamic within the past 10 years, with similar reasoning, as a new tenured teacher was appointed since 2015, managing to uphold and improve the subject's ongoing good perception by 4.37% to a rating of almost 11 in 2020 and an average rating between "very good" and "excellent". Subject 3 was also subject to a new tenured teacher starting 2015 and despite marginal decline in all 3 categories and an overall decrease since 2010 of 0.57 points (a relative decrease of 3.62%), the subject's performance is still above the "very good" level, scoring above 9 in the overall academic seriousness criteria. Subject 5 has an overall negative dynamic of 1.08 points (a relative decrease of 39.41%) as of 2020 since the tenured teacher was changed in 2015, with a similar results being registered by Subject 9, where the new appointed teacher in 2020 has managed to only slightly increase the very weak perceived academic level of the subject (a relative decrease of 5.02% since 2010, but of 21.51% since 2015) as of the last evaluation. The biggest decrease however was registered by Subject 4 (a negative dynamic of no less than 1.84 points), a relative decrease of 25.37% since 2010, which was only slightly limited by appointing a new tenured teacher in 2020. All of these 3 subjects have something in common: a very high level of tolerance for cheating, as is perceived by students (Subjects 5 and 9 have a level of almost 4, which is by no means acceptable). This is also the case for Subjects 10 (rating of 3.62) and 6 (rating of 3.55), but these subjects are averaged out by a better perception in terms of the teaching process and grading objectivity, especially for Subject 10, where these criteria are even considered "very good" (average ratings of 3.77 for professionalism and 3.25 for objectivity). Table 5 outlines the individual and overall results obtained for a further 10 relevant selected subjects (Subjects 11-20 from 20) from the last two academic years in terms of academic professionalism, grading objectivity and misconduct tolerance. These subjects cover the specialization domain of the faculty better and are supposed to provide its graduates with more specific and applicable knowledge and skills for an improved insertion in the economic environment. In this sense, compared to the first 10 subjects and the results presented in the previous section, these perceptions are more important and more relevant for the aim of the paper, therefore some additional comments will be provided for a more thorough interpretation of the results and their implications. All three analyzed criteria have a better average performance than the subjects from the first 2 academic years: overall professionalism (2.83 compared to 2.49, a relative increase of 13.65%), grading objectivity (3.07 compared to 2.81, a relative increase of 9.25%) as well as misconduct tolerance (2.07 compared to 2.31, a relative decrease of 10.38%). Nonetheless, these results average out some critical issues, which will be presented below: overall professionalism is indeed above average (between "good and/or appropriate" and "very good") with a rating of 2.83, but the criteria decreases by 0.17 points, marking a relative decrease of 6.25% over the past 10 years. Overall grading objectivity is on average at a level considered "very good" (a rating of 3.07), but again the criteria decreases by 0.29 points (a relative decrease of 9.31%)

since 2010 and is in 2020 technically only in the upper section of the "good and/or appropriate" range of values. Misconduct tolerance has the worst evolution, as the average dynamic of this criteria shows a 0.45 points increase (a relative increase of 25%), a worrying figure by all means, making this indicator fall within the "weak and/or superficial" range of values since 2015. Table 6 introduces the overall academic seriousness criteria, a summary of the questionable evolution and performance of all 3 indicators for each subject, presented in order from the best performing subject to the least best performing one.

crt	Professionalism (teaching)					Objectivity (grading)					Tolerance (cheating)				
year	2010	2015	2020	**avg**	+/-	2010	2015	2020	**avg**	+/-	2010	2015	2020	**avg**	+/-
#11	3.67	4.00	3.87	**3.84**	0.20	3.75	3.55	3.66	**3.65**	-0.09	0.32	0.25	0.22	**0.26**	-0.10
#12	3.72	3.75	3.95	**3.80**	0.23	3.75	3.93	3.87	**3.85**	0.12	0.17	0.03	0.02	**0.07**	-0.15
#13	3.70	3.56	3.66	**3.64**	-0.04	3.25	2.68	2.95	**2.96**	-0.3	0.05	0.11	0.07	**0.07**	0.02
#14	2.72	3.85	3.90	**3.49**	1.18	3.52	3.25	3.66	**3.47**	0.14	2.50	2.38	2.27	**2.38**	-0.23
#15	2.35	2.93	2.65	**2.64**	0.30	3.45	3.51	3.71	**3.55**	0.26	3.25	3.35	3.22	**3.27**	-0.03
#16	2.47	2.16	1.55	**2.06**	-0.92	2.57	2.25	1.45	**2.09**	-1.12	3.47	3.75	3.93	**3.71**	0.46
#17	2.27	3.25	2.96	**2.82**	0.69	2.75	3.23	2.87	**2.95**	0.12	1.57	2.85	3.39	**2.60**	1.82
#18	1.97	1.71	1.41	**1.69**	-0.56	3.32	3.55	3.26	**3.37**	-0.06	2.67	2.98	3.23	**2.96**	0.56
#19	2.17	1.93	1.27	**1.79**	-0.90	2.65	2.11	1.31	**2.02**	-1.34	3.55	3.86	3.96	**3.79**	0.41
#20	3.77	2.01	1.87	**2.55**	-1.90	3.23	2.66	2.54	**2.81**	-0.69	0.45	2.13	2.28	**1.62**	1.83
avg	**2.88**	**2.91**	**2.70**	**2.83**	**-0.17**	**3.22**	**3.07**	**2.92**	**3.07**	**-0.29**	**1.80**	**2.16**	**2.25**	**2.07**	**0.45**

Table 5: Students' perceptions upon teacher performance (last two), 2010-2020 (source: own processing)

criteria	Overall academic seriousness				
year	2010	2015	2020	**average**	dynamic
Subject 12	11.30	11.65	11.80	**11.58**	0.50
Subject 11	11.10	11.30	11.31	**11.23**	0.21
Subject 13	10.90	10.13	10.54	**10.52**	-0.36
Subject 14	7.74	8.72	9.29	**8.58**	1.55
Subject 20	10.55	6.54	6.13	**7.74**	-4.42
Subject 17	7.45	7.63	6.44	**7.17**	-1.01
Subject 15	6.55	7.09	7.14	**6.92**	0.59
Subject 18	6.62	6.28	5.44	**6.11**	-1.18
Subject 16	5.57	4.66	3.07	**4.43**	-2.50
Subject 19	5.27	4.18	2.62	**4.02**	-2.65
average	**8.30**	**7.81**	**7.37**	**7.83**	**-0.92**

Table 6: Overall performance of selected criteria (last two), 2010-2020 (source: own processing)

The overall average of the 10 analyzed subjects has continuously decreased since 2010 by 0.92 points (a relative decrease of 11.16%) to a level of 7.37 as of 2020. The negative dynamic is outlined by the fact that half of the subjects have a consistent overall decrease in the last decade, which is somewhat altered by the exceptional performance of the top 3 subjects from this selection where performance is rated between "very good" and "excellent" (Subject 13) and close to "excellent" (Subjects 12 and 11). The huge gap in polarity is also shown by the fact that only 2 other subjects manage to achieve a positive dynamic (Subjects 14 and 15) within this timespan. Thus within the selected subjects from the last two academic years 60% achieve ratings considered above "good and/or appropriate", whilst 40% have either a below average rating or some major flaws, with 2 subjects being under the limit value of 6 even since 2010, decreasing ratings as well as a significant negative dynamic. Subject 12 is the best rated of

the selected range (as well as the best rated overall subject), with a constant positive dynamic (a relative increase of 4.42%) and an "excellent" level of perceived overall academic seriousness, being only one of three subjects rated above 11 in this analysis. Subject 11 follows a similar pattern (average rating above 11 and a positive dynamic), which is normal considering the tenured teacher is the same as in Subject 12. The difference is made at the misconduct tolerance criteria, where starting 2015 a new assistant teacher was appointed for Subject 12, who imposed a very strict policy regarding cheating and thus reduced the criteria by an impressive 88.23% to a record value of only 0.02, an exceptional level of academic strictness. Subject 13 has an overall rating of above 10.5, being therefore just above the boundary between "very good" and "excellent", the negative dynamic of 0.36 points for the subject (a relative decrease of 3.48%) being due to the reduced rating in grading objectivity (especially in 2015 when ratings dropped by 17.53%). Subject 13 has however the most constant academic strictness regarding misconduct (a minor increase was noted in 2015), the average of 0.07 being matched only by Subject 12. An important mention to be made is that these top 3 rated subjects were/are tenured by the former/current Dean of the faculty, in both cases their respective academic results and professionalism being an imposing factor per se. Subject 14 has the most important positive dynamic within this range, 1.55 points higher (a relative increase of 20.02%) since a new tenured teacher was appointed in 2015, who managed to outperform his outgoing colleague, especially in teaching (by 43.38%, reaching an "excellent" level of perceived professionalism, close to the maximum value of 4) and a slight improvement (9.20%) in academic strictness as well. Subject 15 also has a positive dynamic due to the perceived grading objectivity of the subject where the subject scores almost half of its overall rating (the exam is a multi-choice evaluation), despite having the worst average rating for professionalism (perceived as "weak and/or superficial), a negative dynamic for academic teaching (a perceived decrease of 28.42%) and an increasing tolerance for misconduct (a perceived increase of 20.97%) since a new tenured teacher was appointed in 2015, who is also the Head of the faculty's student internships' program. The most appalling drop in performance is noted for Subject 20, which is shocking as it is the subject best related to the faculty's specialization and tenured since 2015 by the faculty's Head of Department. The average rating of the subject has decreased by a record 4.42 points, with ratings getting much worse in all criteria (professionalism declined by 50.39% as of 2020, grading objectivity was reduced by 21.36% and tolerance for cheating increased more than 5 times since 2010 to a level of 2.28). Interestingly, another subject with a very high misconduct toleration perception (average rating of 3.26), Subject 15, is also tenured by the same Head of Department, but the very weak rating is averaged out by the exam type (multi-choice evaluation) and an above average perceived professionalism. Another high misconduct tolerance-rated subject is Subject 17, where since a new tenured teacher was appointed in 2015 students' perception increased by 1.82 points (a more than double relative increase of this criteria) and reached a value of 3.39, the third highest cheating tolerance of the selected range. This subject is tenured by the faculty's Head of Human Resources Development, who manages to average out her questionable academic rigorousness by an above average level of academic teaching and grading objectivity, despite both these indicators slightly decreasing in 2020 (by 8.92% and 11.14%, respectively) compared to 2015. The worst performing subjects from this range (Subjects 16 and 19) have the highest perceived level of cheating tolerance (both rated over 3.9 in 2020, completely unacceptable), as well as the lowest level of perceived academic professionalism (1.55 and 1.27) and a similar negative dynamic in terms of grading objectivity (a relative decrease of 43.57% and 50.56%), the close similarity being also linked to the fact that the tenured teacher is the same for both subjects, as well as the Head of the Quality Assurance commission within the faculty. The faculty's research center members' performance

is an indication of the efforts teachers invest in themselves by being up to date with their research and teaching topics, also enabling a more appropriate and adapted teaching content provided to their students. The average Hmax is thus a relevant indicator within our study (more than half of those obtaining above average ratings in professionalism are within the first third of the Havg research performance whilst 75% are within the first half) and indirectly mirrors on the teacher's level of professionalism. An interesting conclusion drawn from the analysis shows that in 94.73% of cases there is a very clear high positive correlation (around two thirds ranges within a direct proportional match) between a teacher's perceived academic professionalism and his overall upholding of ethical issues.

Discussion

Eastern European countries have a specific gap between the old-fashioned way of providing education and the shifts arising today bring out and even enlarge the major gap in principles between the younger and more experienced teachers' backgrounds (Potyrala et al, 2018). Quality Assurance in Higher Education is of great importance in the educational setting and should constantly be adapted to match a large range of specific needs, as a result of a thorough background review in order to source and provide sustainable curricula (Varouchas, Sicilia and Sánchez-Alonso, 2018). Cheating is a very sensible topic for universities in Romania (Turi, Mocan and Pujol, 2016) which has been avoided due to the growing nature of misconduct issues from both teachers (bribes for passing exams) and students (cheating during exams) within a general background of tolerating misconduct to a certain extent (Petri et al, 2020). Views such as: "When all others are tolerating misconduct, being honest is just ridiculous.", "We teachers should be able to teach any subject from this faculty at comparable level", "We have a colleague who wants a promotion, let us all help in every way we can to support him for the good of all, because it is his turn." lead to frustration and problems such as regular teacher absence from class, teaching while not being sober or even failing to keep most of one's classes during successive semesters and become regular occurrences (Baumert and Kunter, 2006). Publishing research nowadays for academics is becoming increasingly important, taking up time and generating pressure and in some cases a counterproductive competitiveness. Our evidence shows that some younger teachers have a better overall Havg performance than some of their more experienced colleagues, being a source of bias, as they have begun their research efforts earlier and within a different academic setting. Adaptation has several sides (Hovdenak and Wiese, 2016) and is seen very differently within the faculty's setting: teachers keeping the same lectures since more than 15 years, faculty secretaries graduating bachelor and/or master degrees within the same faculty they work in and having their spouses receive either scholarships while completing their studies or even being employed as teachers (within the same faculty) and pressuring certain teachers to pass some of their acquaintances' children or top scholarship receiving students being caught cheating by a younger teacher filing a complaint against the teacher to try and make him reconsider his decision of failing them, as they would lose their scholarships (Schwartz, 2017). Some of these issues will take time to be handled properly (Tirri, 2014) and maybe reach a less shameful degree within the years to come, but change must come from within the institution and the words of the Dean should give hope for improvement in the future: "I believe in the value of effort in every profession and not in luck, circumstances or miraculous secrets for getting there faster. The higher the level of professionalism is, the lower the chances are for misconduct and corruption to arise. It's not an easy road, there are going to be inconveniences, but they are an essential part of the process." Due to the sensitive nature of the chosen topic, the authors have decided to screen certain data and results, thus adding to the limitations of the obtained results and sourcing certain inconveniences for the reader and critics from the reviewers, which we aware of and accept as such.

Conclusion

The quality of graduates from higher education institutions in Romania has decreased in the past decade and the worth of the degrees awarded by universities is becoming shallower. Most universities blame high schools for the weak knowledge background of their freshman students and the increasing gap between the expected prerequisites and actual level of understanding. This imbalance enabled a general drop in academic standards from most teachers (degree of motivation, teaching content and evaluation level) and caused a rise of the misconduct phenomenon among students, as shown by the 25% increase in subjects from the last semesters. The questionable quality of graduates can also be associated with the decline in academic professionalism (more than 6% in decrease of perception over the last decade) as well as in research, where only 29% of teachers have a good performance and 41% have a level which is 5-10 times lower than the required minimum. Younger teachers have made an impressive positive impact (30% of subjects have above average and even "excellent" ratings in professionalism), are dynamic in research (55% are in the first third of overall rankings) and have improved the upholding of ethical standards (in some cases by more than 80%), despite conditions not always being favorable for change. Low performing teachers (either teaching or research, or both) are more prone to only scarcely contribute to students' knowledge, skills and motivation within the learning process and even tolerate different forms of misconduct and/or cheating (57% of teachers with negative perceptions are also ranked in the lower third of research performance). Such shallow experiences will decrease students' level of implication, as well as associated adaptive behavior (attendance, contributions during class, hard work and overall studying, exam preparation, proper exam conduct), adjusted downwards. With some of the faculty's key management positions also chaired by some of the more experienced teachers, but who have a much lower willingness to adapt to current academic dynamics and challenges (teaching, research, academic conduct, curricula updating), perspectives are not looking very good in the following years, unless the new wave of younger teachers can compensate the existing polarity between those ranked above and below average towards an improved academic level within the following years. Education is the mirror of society and a long-term investment in a better future, but it is up to the teachers to provide it to their students in such a way that it is based on professionalism, objectivity and proper conduct, those exact strong values they need to prove themselves, thus leading and inspiring by their own example.

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OBSERVING HOW FUTURE PRIMARY SCHOOL TEACHERS REASON ABOUT QUADRILATERALS

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Abstract

The contribution belongs to a long-term empirical qualitative study that focuses on various ways of employing an educational tool called Concept Cartoons in the professional preparation of future primary school teachers. In this particular case, we newly work in the field of geometry and use the tool for collecting written data and observing how future primary school teachers reason about conditional statements regarding quadrilaterals. Collected data enable us to connect the responses to various modes of reasoning that are compatible or incompatible with the process of proper argumentation and to various modes of classification of geometric objects. The qualitative categories that emerged from data analysis in this study are put in context with the categories obtained in the previous research that focused on the field of arithmetic.

Keywords

Argumentation, classification of geometric objects, conditional statements, Concept Cartoons, future primary school teachers, quadrilaterals

Introduction

Despite the fact that the geometry curriculum has changed in different ways throughout history, the current content of school geometry is still largely based on ancient mathematics and the well-known Euclid's work *Elements*. In the past decade, facing new technologies and the changes in the society outside of school, the question has arisen as to what really is the role of school geometry and which form of geometry literacy is significant to be developed now (Herbst et al, 2017). One of the arguments to justify teaching and learning geometry poses the aspect that the study of geometry provides certain exercises in deductive logic (Gonzáles and Herbst, 2006). In that sense, school geometry seems to be a natural field for investigating and developing argumentation skills.

In recent years, we have been analyzing an educational tool called Concept Cartoons and various ways of its eligible employment in the professional preparation of future teachers. Specifically, we have focused on future primary school teachers and their mathematical knowledge within the field of arithmetic. Among others, we have assessed their reasoning about calculation tasks (Samková and Tichá, 2016), about word problems solved by calculations (Samková, 2018) and also about general statements regarding properties of arithmetic operations (Samková, 2020). The latter study has shown that Concept Cartoons allow us to collect data that might be clearly connected to various modes of argumentation: to various proof schemes in the sense of Harel and Sowder (2007) and to various types of examples – counter-examples and generic examples in the sense of Balacheff (1988).

In this contribution, we follow the path of investigating future teachers' reasoning about mathematical statements and extend the issue to the field of geometry. We focus on quadrilaterals, especially on rectangles, since rectangles belong to the basic geometric shapes

that are taught already at the primary school level while quadrilaterals are taught at the secondary school level. Such an arrangement provides a stimulating way to investigating adult respondents' modes of argumentation through discussing basic properties of rectangles or of quadrilaterals in general. Our research question is "What kinds of reasoning about quadrilaterals can be observed in future primary school teachers when using Concept Cartoons as a diagnostic instrument?"

At previous ERIE conferences, an associated topic of understanding of geometric concepts and their properties has already been discussed, namely for the topics of an axial symmetry of shapes (Moravcová et al., 2019) and a rotation of a straight line (Halas et al., 2020).

The text of this contribution is organized as follows: at the beginning, it presents the background of reasoning and understanding in geometry. Then it describes the participants of the exploratory empirical qualitative study and the diagnostic instrument, the course of data collection and data analysis, the findings and their discussion. All the relevant findings are accompanied by illustrative data excerpts.

Understanding in geometry and classification of objects

When dealing with reasoning regarding the basic properties of rectangles, we get in touch with various ways of understanding the concept of the rectangle and various conceptions of the definition of the rectangle. From the perspective of the ways of understanding, we proceed from the work of de Villiers (1994) who studies features and functions of the concept of quadrilaterals and for this purpose distinguishes four types of understanding in mathematics: *instrumental*, *relational*, *logical* and *functional*. According to de Villiers, instrumental understanding (also *proficiency*) is interpreted as the "ability of an individual to correctly and efficiently manipulate mathematical content" while relational and logical understanding "refer to understanding the conceptual relationships between content and the underlying logic upon which these relationships are based"; functional understanding is interpreted as "understanding the role, function, or value of specific mathematical content or of a particular process" (ibid: 11). In that context, there are basically two approaches to comprehend the types of quadrilaterals. The first one considers each quadrilateral as a unique object. For instance, a square is not understood as a special case of rectangle and a rhombus is not understood as a special case of rhomboid, i.e., rectangles, as well as rhomboids, are considered as having different length of adjacent sides. De Villiers (1994) calls this approach a *partition classification*. Such an approach is typical for geometric concepts at the primary school level but is not suitable for higher levels of schooling since it makes it difficult to study common properties and relationships between various objects. And so, the secondary school curriculum employs a *hierarchical classification* (ibid) that understands more specific concepts as subsets of the more general ones. In that sense, squares are considered special cases of rectangles but also of rhombi, whereas rhombi, rhomboids and rectangles are considered special cases of parallelograms. Primary school teachers are in an unusual position regarding the partition vs hierarchical classifications issue since their students are deeply taught to distinct between squares and rectangles but the teachers themselves should be aware of the future geometrical content and thus of the possibility to consider squares as special cases of rectangles.

From the perspective of the form of the definition, we choose to focus on the *structural* definition, i.e. the definition that is presented by a common property of the concept (Zaslavsky and Shir, 2005). In our study, we employ various combinations of the properties "having opposite sides equal in length", "having all angles right", "having diagonals that bisect each other" and "having diagonals equal in length" taken into account in the context

of quadrilaterals. The structural definition of a rectangle then requires precise identification of the rectangle by assigning properties that are necessary and sufficient for determining the object. Within the framework of hierarchical classification of rectangles, such a definition may consist e.g. in the combination of properties "having opposite sides equal in length" and "having diagonals equal in length". Within the framework of partition classification, the two properties would be accompanied by the property "having different length of adjacent sides". According to educational research, students often face difficulties with the classification of quadrilaterals: they formulate statements with superfluous information, i.e. their definition is *uneconomical* (de Villiers, 1994), or forget to mention an important attribute due to being strongly influenced by their personal figural concepts (Fujita and Jones, 2007). Similar difficulties are observed also in future teachers (Erdogan and Dur, 2014), where the isolated way of considering geometric objects that connects with the use of partition classification may result in the impossibility to move between static and dynamic ways of talking about the geometric objects (Tuset, 2019).

Materials and Methods

Participants

In our study, we worked with 29 future primary school teachers. They were students of the second year of a five-year master degree program at the Faculty of Education. In the Czech Republic where the study took place, primary school teachers are usually responsible for the whole curriculum. Therefore, they mostly teach all school subjects to pupils of 6 to 11 years of age. Data were collected at a compulsory course that focused on mathematical content preparation of the future primary school teachers; all of the actual attendees of the course became the participants of the study. Each of the participants was randomly assigned a code number from 1 to 40.

Diagnostic instrument

As a tool for data collection, we used a written form of a Concept Cartoon. As posed above and indicated in our research enquiry, we consider Concept Cartoons an effective diagnostic instrument that provides opportunities to assess respondents' reasoning about mathematical statements (Samková, 2020). It is worthwhile mentioning that Concept Cartoons have been a significant tool for science education in a wide spectrum of instructional situations. They stimulate students' interest and their attention on the educational content or on the problem to be solved in the sense of constructivist approaches to learning (Keogh and Naylor, 1999). A typical Concept Cartoon consists of a picture of a situation related to a problem, with several children expressing their opinions on the problem in text bubbles. In our study, we got use of a Concept Cartoon that is related to the issue of recognizing a rectangle (see Fig. 1). In the picture, five children comment on various properties of rectangles. They explain how they identify this particular quadrilateral, what are the features of its sides, diagonals and angles that they consider important for recognizing the shape.

For the purpose of the study, we would concentrate on bubbles A, C and E. These three bubbles contain statements that can be all reformulated as implications:

(A) If a quadrilateral has opposite sides equal in length, then it is a rectangle.

(C) If a quadrilateral has diagonals that bisect each other, then it is a rectangle.

(E) If a quadrilateral has diagonals equal in length, then it is a rectangle.

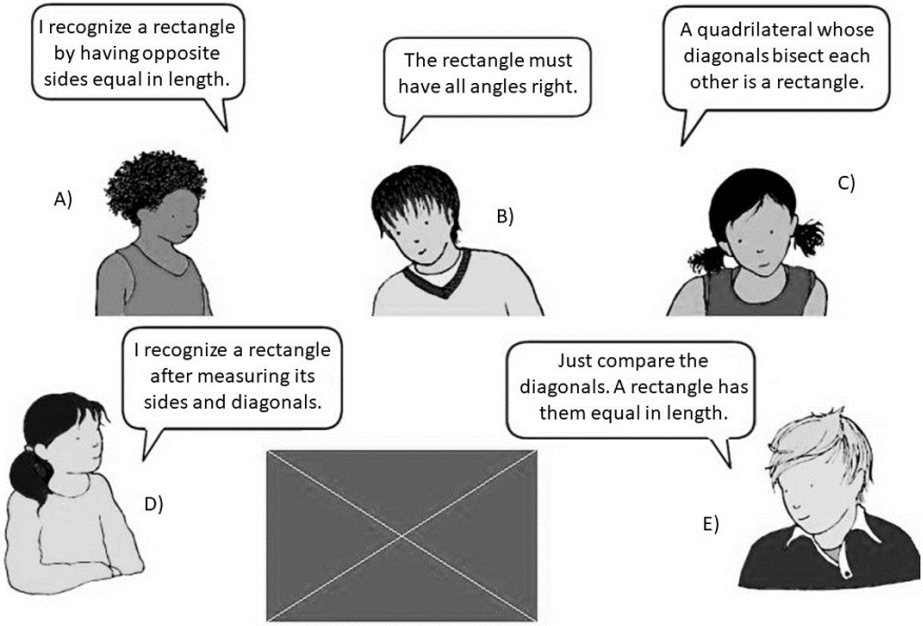

Figure 1: A Concept Cartoon on recognizing a rectangle; (source of the template of the children with bubbles: Dabell, Keogh and Naylor, 2008: 1.3; source of the texts in bubbles: Roubíček, 2014)

None of the above statements is true, since the assumptions do not contain enough information to unequivocally identify a rectangle, i.e. there exist counter-examples for which the statements are not valid: A, C and E are not valid for all parallelograms outside of rectangles (e.g. a rhomboid), E is not valid also for some quadrilaterals outside of parallelograms (e.g. a kite, an isosceles trapezoid). However, in all three cases, the counter-course of the implication is true, i.e., all the properties mentioned in the assumptions are actual properties of rectangles. Moreover, it is possible to add additional conditions to the assumptions that would make the statements true. Some of the additional conditions are even indicated in the other bubbles. Let us give an example: adding an additional condition from the bubble E to bubble A would create a statement "If a quadrilateral has opposite sides equal in length and diagonals equal in length, then it is a rectangle" which is true with respect to the hierarchical classification of quadrilaterals.

From the perspective of argumentation, such an arrangement of the content of bubbles can challenge respondents' skills in conditional reasoning, namely their ability to distinguish properly between assumptions and conclusions of a conditional statement that is informally worded. The informal type of conditional statements often appears in primary school classrooms (Hadar, 1977).

Data collection and data analysis

During data collection, the participants were asked to observe the Concept Cartoon from Fig. 1, mark which statements in bubbles they consider correct and explain their decision. They worked individually, given a time span of 20 minutes.

During data analysis, we used open coding and constant comparison (Miles, Huberman and Saldaña, 2014) to provide qualitative analysis of obtained data. At first, we noted which bubbles

were considered correct by individual participants. Then, we went through all of the participants' explanations and openly coded the statements while carefully analyzing the proclamations from the point of view of mathematical argumentation and logical reasoning. During the process of constant comparison, we assessed the codes from the overall perspective, from the perspective of individual participants across the three relevant bubbles and from the perspective of individual bubbles across all participants. Complementarily, we also monitored responses related to the issue of partition vs hierarchical classifications of quadrilaterals. Eventually, we identified eleven different code categories and assigned exactly one of them to each of the participants' responses given to each of the three bubbles. And so, $29 \cdot 3 = 87$ assignments were provided. In the paragraphs below, we present an overview of all relevant acronyms of code categories and their frequency in data, explain the meaning of all the code categories and illustrate them by selected data excerpts.

Results

As mentioned above, eleven relevant code categories were revealed in data. Each of them is abbreviated by an acronym. The list of all relevant acronyms and their frequency is shown in Tab. 1. While creating the acronyms, we distinguished between three-letter ones that were intended for code categories referring to responses that might be considered a constructive basis for further learning of proper argumentation, and two-letter ones that were intended for code categories referring to blank responses or responses that were incompatible with proper argumentation. The meaning of the individual acronyms is explained in the further text, in the same order as in Tab. 1.

acronyms	bubble A	bubble C	bubble E	altogether
GSX	6	10	11	27
GEX	0	1	0	1
GSD	0	1	1	2
AWX	0	4	5	9
AWC	3	0	0	3
COX	2	0	0	2
XR	4	7	8	19
AG	2	0	3	5
VR	1	0	0	1
EK	0	3	1	4
CI	11	3	0	14
altogether	29	29	29	87

Table 1: List of relevant acronyms for code categories and their frequency in data, *n*=29, 2014 (source: own calculation)

According to data analysis, 44 of the assignments of code categories belonged to three-letter acronyms. Among them, the most frequent mode of reasoning consisted of naming a set of counter-examples but not providing a particular counter-example nor justification (code category GSX):

S9 (E) No, it could be, for example, a trapezoid.

S24 (C) It doesn't have to be just a rectangle, the diagonals are bisected also in a square, a rhombus, a rhomboid.

Only one of the responses provided a name of a set of counter-examples accompanied by a particular counter-example that was in the form of an illustrative picture (code category GEX):

S9 (C) No, they can bisect in various quadrilaterals (for example in a square: *a picture of a square with diagonals*).

One of the participants provided the name of a set of counter-examples accompanied by an attempt of a deductive justification (code category GSD):

S31 (C) If we draw both diagonals, 4 isosceles triangles will be formed. But watch out: the diagonals bisect also in a square, a rhombus and a rhomboid.
(E) The diagonal divides the rectangle into 2 congruent triangles. But watch out: the diagonals are also the same in a square.

Altogether, 46 correct names of sets of counter-examples were provided by participants: a square (29 cases), a rhomboid (7 cases), a rhombus (5 cases), a parallelogram (3 cases) and a trapezoid (2 cases). The square in the sense of a name of a set of counter-examples was employed by 13 participants (including S24, S9 and S31 above), one of them used it as a universal counter-example for all three bubbles. Such an approach distinguishes between rectangles and squares, i.e., supports the partition classification of quadrilaterals.

Some of the participants were aware that the statements in bubbles might not be always true but did not provide any (sets of) counter-examples or additional conditions of validity (code category AWX):

S13 (C) Not only a rectangle.

S4 (C) Yes, they bisect, but it is not an identification character, it is also with other shapes.

Others, who were aware that the statements in bubbles might not be always true, provided additional conditions of validity but these conditions were not sufficient (code category AWC):

S6 (A) Yes, that is true. However, we must add that the adjacent sides should not be of the same length. Then it would be a square.

S34 (A) and are parallel.

Two of the participants provided sufficient additional conditions but without justification (code category COX):

S9 (A) No, the other condition is that it must have right angles. Otherwise, it could be a parallelogram.

S17 (A) The claim of boy A would not suffice on its own, it is important to supplement it with the claim of boy B.

The remaining 43 assignments of code categories belonged to two-letter acronyms, i.e., to code categories that refer to blank responses or responses that are incompatible with proper argumentation. 19 of them referred to cases when the participant did not provide any response to a bubble (code category XR), five to cases when the participant provided only incorrect agreement with a bubble without further comments (code category AG).

One assignment referred to a response that was too vague to be clear (code category VR):

S10 (A) Because a = a'; b = b'.

Some of the participants presented erroneous knowledge of geometric concepts and their properties (code category EK):

S15 (C) A rectangle is a regular quadrilateral – its diagonals do not bisect each other.

Twelve of the participants handled the implications counter-wise, i.e., confusing assumptions with conclusions (code category CI):

S22 (A) Yes. For each rectangle, it is true that two opposite sides are of the same length.

S25 (C) True, a rectangle has the diagonals of the same length, they bisect each other and mark the center of the rectangle.

Discussion

The results of this study complemented the results of the previous contribution that focused on reasoning about general statements in arithmetic (Samková, 2020). Having the current study situated to a different field (geometry) and using a different type of the statements of bubbles (implications that are not true but the counter-course implications are true), only

four code categories from the previous contribution reappeared here: XR (no response), VR (vague response), GE (renamed as GEX due to the three-letter rule, referring to generic examples without justification) and COX (conditions of validity indicated but without justification). The remaining code categories are new: GSX and GSD refer to the initial stages of GEX and GED where the respondent provides a name of a set of counterexamples but do not provide a particular sample – in arithmetic, the particular samples consist of particular numbers (e.g. numbers 2, 4 can be provided as samples of even numbers), in geometry, of particular figures (e.g. a quadrilateral with sides 2, 4, 2 and 4 can be provided as a sample of a rectangle); AWX refers to the initial stages of COX or GEX; AWC refers to the initial stages of COX; EK refers to erroneous responses similarly to OF but has a different source of the error (over-fixation to previous concepts in OF vs weak knowledge of new concepts in EK); CI refers to the new fact that the counter-course implications are true; AG is new, refers to incorrect agreements without further comments – such kind of responses did not appear in the previous study; AG might refer to the initial stages of VR, EK or CI.

From the point of view of de Villiers' (1994) types of understanding in mathematics, the code category GSX corresponds with the instrumental understanding described as the ability to work with mathematical content. The class GSD refers to relational and logical understanding, i.e. the interpreting the relationships within the content based on logical argumentation and the categories AWI and AWC coincide with the functional understanding explained as the ability to recognize mathematical content's role, function, or value.

From the perspective of the process of learning proper argumentation, approximately half of the responses in the current study (44 of 87) might be considered compatible with the process of learning of proper argumentation, i.e., might be used as a constructive basis for further learning. The responses that are not compatible are mostly caused by phenomena that are probably more connected to argumentation itself than to classification of quadrilaterals, especially by confusing assumptions with conclusions. Such a finding draws attention to the importance of exposing future primary school teachers to various informal wordings of mathematical statements and training the assessment in this setting; a possible conceptual basis for such an intervention might be found in (Hadar, 1977). The results of our study particularly correspond with the conclusion given by Miller (2019) who investigate teachers' strategies for generating the definitions of certain geometric objects. She found that learners students have difficulty formulating a definition of a geometric object if they have to choose from a group of attributes belonging to the shape only the necessary ones. The challenge for students is to understand the relationship between the properties of the object which implies from the hierarchical classification.

The responses that are compatible with the process of learning proper argumentation are often incomplete. However, it is not possible to distinguish from available data whether the incompleteness is due to participants being influenced by their personal figural concepts (as reported by Fujita and Jones, 2007) or due to other reasons. An uneconomical classification that would contain superfluous information about rectangles (as reported by de Villiers, 1994) has not appeared in our data.

Conclusion

In this contribution, we extended our previous research from the field of school arithmetic to the field of school geometry. In particular, we showed how the use of Concept Cartoons as a diagnostic instrument might trigger certain kinds of students' reasoning which can encourage the improvement of learning and teaching of quadrilaterals. Our findings indicate that Concept

Cartoons can be employed in the professional preparation of future primary school teachers irrespective of the mathematical topic but also that for different topics, the relevant qualitative code categories referring to reasoning might vary a lot. Some of the differences are just a natural consequence of working with two different Concept Cartoons within two different data collections, others are interconnected with the differences in logical wording of the statements presented in the two Concept Cartoons or with the conceptual differences between the discussed arithmetic and geometric topics.

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DECISIONS BASED ON INTUITION VERSUS DECISION THEORY: BENEFITS OF EDUCATION

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Abstract

Decision-making is a part of everyday life of each individual. Nowadays, various subjects/ methods at the university also deal with this issue, for example, multi-criteria decision-making methods (MCDM). MCDMs are challenging for students. Therefore, it is good to show them this object in practice and ensure that they use it. This is also related to the aim of this study - to analyse in more detail whether the methods of teaching MCDM are useful for students, and to show them the progress of their ideas. An experiment directly with students was used to fulfil the aim. Students had to solve a typical decision problem at different levels of MCDM knowledge. The results showed that the ability to solve the problem of decision-making in real life is strongly influenced by the theory of basic knowledge. Students could realize how much their knowledge/ experience had changed and how important is to study.

Keywords

Education, experiment, multi-criteria decision-making, weights

Introduction

Operations Research (OR) is an analytical method of problem solving and decision-making that is useful in managing organizations. This is also one of the main reasons why operations research methods (in some of their versions) are taught at all universities in the Czech Republic, which are focused on economics. The core of operations research is the development of approaches for efficient decision-making. And multi-criteria decision-making (MCDM) can be seen as a prominent class of such problems. A typical MCDM problem deals with the evaluation of a set of alternatives in terms of a set of decision criteria. It can be reasonably expected that the current students will have to take many important decisions at work in the future. Thus, it is important that they should be able to determine the structure of the problem and find the best suitable solution.

Despite online teaching is the current trend at all levels of education because of the pandemics, it can be expected that classical teaching will return to and not everything old is bad. It heavily depends on how the issue is viewed and how good methods are used. As McKeachie (1990) states in his publication, it is important to conduct pedagogical research that can contribute to pedagogical practice. For example, Vlachopoulos and Makri (2017) researched the impact of games and simulations with regard to achieving specific learning objectives. Their results indicate that games and/or simulations have a positive impact on learning goals. That is why different types of lectures have to be included during the semester.

Unfortunately, although MCDMs are widely used and taught at universities, there are not many publications that focus on their teaching. One of the exceptions is the study of Kowalski and Lasley (2008). The authors have created a three-part handbook, which is an important contribution to the educational literature in the field of MCDM. This is a unique summary of the most original study, which is still available at this time on how, when, and why the evidence should be used

for practical practice. It is a comprehensive interdisciplinary resource based on research and practice that all educators can turn to as a guide for data-based decision making. There are many examples in the publication for students who need to be in classrooms where "best practice" is the norm and not the exception. The second important and exceptional study in this area is the study of Schildkamp, Lai and Earl (2013). This book is unique in its view of decision-making based on data from different parts of the world. The authors focus on the situation where schools are more and more responsible for the education they provide, and data-based decision-making is becoming increasingly important. The authors connect scientists from several countries to explore data-based decisions. Data-based decision-making in this book refers to decision-making based on a wide range of evidence, such as student evaluation scores, classroom observations, etc. It is a suitable basis for MCDM lessons.

This study aims to analyse in more detail whether the methods of teaching MCDM are useful for students. Based on the results, there is a discussion about how to properly motivate students in the courses. The objective of this study is to show the influence of teaching by MCDM methods on final decisions. Namely, an emphasis is put on the impact of education in this field on the systematic approach of students to a given problem, the level of detail used when solving a decision-making problem, the methods selected for the problem and the final ranking.

The paper is organised as follows. After this introduction, there is a section focused on details about the presented survey. The results of the survey are provided in the section called Results. The greatest contribution should be found in Discussion where the results are discussed in detail and the lessons learned are concluded. As usually, the paper is ended with conclusions where the main contributions of this paper as well as its future possible extensions are pointed out.

Materials and Methods

The survey presented in this paper was applied to students from the VŠB - Technical University of Ostrava, Faculty of Economics, who had been passing the course called "Multi-criteria decision-making methods". This course of managerial decision-making has been taught at this institution for more than 30 years (under various names). Seven years ago, the course has been substantially modified under the new guarantee. The original course was focused more on a normative theoretical description of a decision-making process aiming mainly at the managerial soft skills. The new concept of the course is built on quantitative methods and data-driven decision-making. The suitability of this change was confirmed by the following objective measures:

- the number of students who chose this course as the optional one increased by more than 4 times and almost 5 times in 2020 and 2021, respectively, in comparison with 2014. In 2014 there had been only one class with 10 students. Nowadays there are at least two classes about 25-30 students each. Also, students are very satisfied with the subject, at least the comments on the survey at the end of the course says so. Plus, they are recommending to other students the course as we hear from the students at the beginning.
- students use more often the quantitative support of decision-making in their bachelor and diploma thesis.

Currently, the cornerstone of the course lies in the methods of multi-criteria decision-making (MCDM) and methods for weighting the decision criteria.

Many MCDM methods of different difficulty, assumptions, benefits, and weaknesses are provided to students, namely, Weighted Sum Approach (WSA, see Chourabi), TOPSIS (see Yoon), Analytic Hierarchy Process (AHP, see Forman), PROMETHEE (see Vincke and Brans) and Even-Swap method (ESM, see Hammond et al.). The motivation is to make the decisions done by the students less intuitive and more data-supported, and thus more reliable. This study explores the influence of the acquired knowledge on decision-making on a real example.

The specific example that was used for the experiment in this article was - Mobile phone selection problem. The idea of the experiment was to see if there was a shift in students' thinking during the course. In other words, students were given the same task three times during the semester (selecting a mobile device) and observed how the weight of decision-making changes during the teaching process.
The experiment was attended by all 57 students who attended the "Managerial decision-making" course during the 2020/2021 school year. This course is taught at VŠB-TUO in the summer semester for two groups of students:

1. as a compulsory course for 5 credits for students of the third year of study – degree: Informatics in Economics;
2. as a compulsory optional course for 4 credits for students of the second year of study – degree: Management, Finance, Business Economics and Accounting.

Note, although the evaluation of subjects is different. Students attend the same lectures and exercises. Only students of compulsory elective variants do not have an oral exam.
The questionnaire was given to students three times, namely:

- 1st lesson - students were without knowledge of MCDM theory. This decision can be described as a decision based on intuition
- 3rd lesson - students gained basic knowledge about the criteria and their evaluation (students were after 3 lectures and 3 exercises).
- 13th lesson - students have completed all lectures and exercises and have a deep knowledge of MCDM.

Each phase lasted 60 minutes and it should be noted that the lessons took place online and even if the students were absent from class, they had the opportunity to play everything and learn. For clarity, the completion of the questionnaire is now referred to as the first, second, and third phase, respectively.

Results

The following chapter provides the exact results of all phases of experiment. To make the results clearer, the specific task for each phase is presented here, along with the description of the proper results.

1st phase: *Your task is to choose the most suitable mobile phone for you (imagine that your current phone is broken and you have to buy a new one tomorrow). Respect all constraints as you are really going to buy it. Write down the criteria, which you consider.*

Number of criteria	Number of students
3	6
4	21
5	15
6	9
7	5
8	0
9	1
AVG: 4.82	SUM: 57

Table 1: The results of the first phase, 2021 (source: own calculation)

Table 1 shows that the average number of criteria is about 4.8.

2nd phase: *Your task is to choose the most suitable mobile phone for you again, as you did at the first lecture. However, now, you should consider the knowledge from the previous sessions regarding the criteria and their assessment.*

Number of criteria	Number of students
5	2
6	9
7	12
8	11
9	12
10	4
11	2
12	3
13	1
14	0
15	1
AVG: 8.24	SUM: 57

Table 2: The results of the second phase, 2021 (source: own calculation)

Table 2 shows that despite the number of criteria is almost twice greater on average in comparison with the original (first-stage) results. On the other hand, 52 students (i.e., 91.2%) selected exactly the same alternative as the best one.

3rd phase: *Now, for the very last time you are asked to choose the best mobile for you. Try to use the knowledge you acquired during the semester. You can choose any MCDM method which you find suitable for this type of problem. Please, work out this problem independently of the previous attempts from the beginning of the semester.*

Number of criteria	Number of students
5	3
6	13
7	24
8	12
10	1
11	3
13	1
AVG: 7.24	SUM: 57

Table 3: The results of the third phase, 2021 (source: own calculation)

Table 3 shows that the number of criteria is now in the middle – not too much as in the second phase, but more than in the first phase.

The students are at this point familiar with the following MCDM methods: Weighted sum approach (WSA), TOPSIS method, AHP method, PROMETHEE method, and Even-swap method (ESM). 11 students (about 20%) applied 2 methods to validate the results (Note. The students are familiar with the decision-making paradox, thus they wanted to make the results more reliable). The structure of the selected methods was as it is seen in Table 4.

MCDM method	Number of students	The main motivation
WSA	22	Easy and fast, application in MS Excel
TOPSIS	6	Fast, application in MS Excel
AHP	10	Hierarchical structure, many criteria
PROMETHEE	28	Graphical results, SW available*
ESM	2	No need to calculate the weights
	SUM: 68 (11 students used two methods)	

**the only one method for which the students used the special software product (Visual PROMETHEE available for free for academic purposes)*

Table 4: The structure of used methods, 2021 (source: own calculation)

Of course, the particular brands and models that were the winners among the students do not matter at all. On the other hand, let us focus on the differences in final ranking among the phases. Tab. 5 provides the accordance in rankings. It can be seen that the results under the deep knowledge of decision-making methods are substantially different than the results of the previous phases. The differences are explored more in detail in the next section.

The same P3 winner as in P1	The same P3 winner as in P2	P1 Winner ranked as 1st, 2nd, or 3rd in P3	P1 winner ranked as 4th and worse in P3
18	23	47	10

Table 5: Comparison of the results in particular phases, 2021 (source: own calculation)

Discussion

Several interesting facts can be viewed in the results. Undoubtedly, the lectures play an important role in students' approach to the given decision-making problem. In line with Kahneman (2011), even the results of the first phase are more relevant than the purely intuition-driven conclusions because the problem structuring using a coherent set of criteria can help to avoid the distorting effect of cognitive biases caused by lack of information, non-systemic approach, convenience and many other factors. On the other hand, the knowledge of basic algorithms forces students to think about the problem more thoroughly.

As for the size of the problem, students tend to use more criteria after the lectures than without the corresponding knowledge. This is an evidence of a deeper analysis of the problem. Forgetting some important criteria is a common mistake in decision-making. However, it is surprising that the average number of criteria dropped by one when comparing the results of the second and third phase. This can be potentially caused by several factors. (i) The students could feel some sort of enthusiasm from the lecture devoted to the criteria and their evaluation, and they simply wanted to capture all, even marginally important factors. (ii) the students could be affected by the knowledge of the Rule of 7 (Miller, 1956), implying that more than seven criteria are more difficult to evaluate directly at once due to the limited capacity of human short-term memory (the average number of criteria decreased from 8.24 to 7.24). (iii) The students could be aware of some strong dependencies between the criteria identified within the second phase (the correlation between criteria can distort the real importance of these criteria and impact the final ranking, see Ishizaka and Nemery (2013)).

The choice of the methods was driven by two main factors: graphical outputs and simplicity to use. Both factors are reasonable, and a similar behaviour can also be expected for practitioners in business. The most frequently used methods were PROMETHEE (with many possible graphical outputs and available free software) and Weighted Sum Approach, whose algorithm is easy and perfectly traceable. Both mentioned algorithms are also computationally efficient. Moreover, students are aware of the flexibility of the POMETHEE family, which can be used to solve

not only the ranking problems (this is the most usual case), but also sorting (Brans), efficiency evaluation (Zapletal, 2020), or portfolio selection (Pohl).
The analysis of the results showed that only about 32% and 40% of students obtained the same winner in the third phase as in the first and the second phase, respectively (see Tab. 5). For approximately one student out of five, the winner alternative in the first phase was not even among first three places in the third phase. This fact gives rise to the conclusion that the course is beneficial for students and helps them to improve both, analysis of a problem and decision support.

Conclusion

The objective of the study was to analyse to what extent the methods of teaching MCDM are useful for students. Students had to solve an easy example in the field - they had to decide which mobile device to buy. They were asked to solve this problem repeatedly during the semester. It was shown that their preferences changed with increasing knowledge.
The results of the study showed that the ability to solve a real-life decision-making problem is highly influenced by the knowledge of the background theory. The students tended to solve the problem more systematically, captured more details of the considered problems, and were also more consistent with their analysis and results after acquiring the basic knowledge of decision-making at the lectures. From this point of view, the results are very encouraging for the teachers of the course and make the promotion of the course to students easier.
The experiment was also useful for the students. They were acquainted with the overall results at the end of the semester. In this way, they could realize how much their knowledge / experience had changed. Most of the students admitted that they were impressed and surprised by the results.
One must be also aware of the limitations of the presented study. The analysis should be done for more students and repeated in the next years to confirm the validity of the conclusions. Above that, the presented research can be taken as a pilot study for the research in this area. The conclusions would be sounder, if more problems of different complexity and from different fields were considered. Therefore, in the future, we would like to do this experiment several times during the next semesters and use different decision-making problems.

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ICT IN PUBLIC EDUCATION: E-TAX-LEARNING FOR GENERATION Y AND GENERATION Z

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Abstract

The paper discusses the design of teaching methods and technologies of non-invasive tax e-learning support as applied in the environment of the Czech e-government. The results of worldwide studies point to the fact that taxpayer education is closely linked to the heightened moral value and responsibility of taxpayers. Understanding of the tax system leads to an awareness of why taxes are paid and at the same time reduces the acceptability of tax evasion. Increasing the education of citizens through e-government information technologies could solve the problem of circumventing tax laws and remedy citizens' often hostile attitude to obligations imposed by the state. The aim of the paper is to design effective elements of an adaptable e-learning system for taxes, which would focus on users from Generation Z and the younger cohorts of Generation Y.

Keywords

E-learning, tax knowledge, information technologies, lifelong education, e-government

Introduction

The online environment offers a wide range of possibilities for the use of ICT for educational purposes. While the development of successful e-government has long been the topic of studies by researchers in many countries, insufficient attention is given to the incorporation of a comprehensive system of educational elements for their users. And yet, a well-designed e-learning support structure offers multiple benefits for both citizens and the state. The paper therefore aims to answer the question: What educational elements should be contained in tax e-learning support for Millennials and Generation Z? In order to design an adaptive user-centred learning environment, it is important to recognize individual learner preferences. Therefore, a Mann-Whitney U test was applied to investigate the existence of possibly significant differences in perception with regard to individual e-tax-learning educational tools. The populations compared were A. women and men, B. Generation Z and Generation Y. Both tests with a null hypothesis H_0, that there are no significant differences between the results of both groups, and an alternative hypothesis H_1, that there are significant differences between the results of both groups. The paper's further contribution lies in its findings regarding the perception of tax education support and its implementation into e-government.

Enhancing tax knowledge helps to raise awareness of the tax system and laws. Several studies explore how tax knowledge influences tax evasion. They validate the strong connection between tax education and taxpayers' tax morale. Research confirms that a greater understanding of taxes leads to the higher moral value of individual taxpayers, who consequently have a greater tendency to refrain from tax evasion (Palil and Mustapha, 2011). Taxpayers' efforts to understand the tax system increases their level of trust and responsibility towards the system. Tax knowledge emphasizes the responsibility of taxpayers to meet their tax obligations (Mohamad et al, 2013).

The development of an educational user interface requires a comprehensive and in-depth analysis of the target group. This target group is very broad in the case of e-government or Financial

e-Administration. The same applies to e-learning support, which should include a wide range of elements and tools adapted to the knowledge and experience of individual types of users. In order to provide a greater accuracy of the results, the paper deals with the design of an e-learning support system primarily for users from Generations Y and Z. These age cohorts grew up in the world of information technology and thus have greater expectations with regard to the quality of the educational user interface compared to previous generations. At the same time, these users are or will become novice taxpayers in the future and will need a higher level of tax education than existing entrepreneurs.

When designing e-learning support, the author assumes that each user in the system would have their own personalized interface. Besides the automatically generated educational elements, they would be able to add other optional extensions according to their own preferences. Van Oordt and Mulder (2016) emphasize the need for an online learning environment that adapts to users on a student-centred basis and provides different ways and means of involving students in the learning process. Personalized learning helps to understand students' needs and style. When properly applied, it makes teaching technologies more efficient and improves the quality of teaching (Turčáni, Burianová and Balogh, 2017). Although tax knowledge is important, its incorporation into elements of educational support within the national e-government has not been thoroughly researched. Many previous studies deal with the characteristics of tax courses, including the use of appropriate tax teaching methods, but do not address innovative approaches to implementing a tax e-learning course in e-government. Tax information should be communicated using the internet to create an effective learning environment (Lee and Hung, 2015). At the same time, this offers clear advantages by facilitating updates to reflect frequent amendments to the law in comparison with printed educational materials and by providing constant availability. Lee and Hung (2015) focused on the implementation of an e-learning web system on the subject of income tax in order to provide a diverse learning environment with a high level of learning motivation. They created a platform that contained – besides information on tax law – an online quiz, a game, a communication channel and additional links.

The paper is divided into four sections. In the Materials and Methods section, the author describes quantitative methods for finding results to answer the research questions and related areas. The Results are then plotted and described using one figure and two tables. The current state of the issue and the paper's findings are analysed from multiple perspectives in the Discussion. The most important findings are summarized in the Conclusion.

Materials and Methods

Information from related studies, long-term observation of phenomena during online lessons and the author's practice in the field of online teaching were put together and analysed through the mind mapping in order to design an e-learning system in the field of taxation. The author performed categorization into thought and logical contexts based on the selected characteristics of the first two phases of the ADDIE Model of Instructional Design theoretical framework: 1. Analysis of the current situation to understand the gaps that needs to be filled, 2. Design the best possible learning experience (Drljača et al, 2017). An adaptation of the Cone of learning (Dale 1969) for an e-tax-learning platform was designed as a result.

The second part of the methodological procedure consisted of obtaining the data from an online questionnaire survey to find out answers to the paper research questions. Respondents were part of a deliberate selection using the snowball method. The questionnaire survey was conducted anonymously on a voluntary basis and the forms were distributed on social networks and directly to specific persons in the 18-35 age group (born between 1986-2003). The data collection included purely closed questions, namely the Likert rating scales and ranking format. Odd rating scales

were chosen so that respondents were not pressured to any of the extreme sides of the decision. Mean values were part of the rating scale (e.g., yes-partly-no).

The perception of the effectiveness of the proposed e-tax-learning methods and technologies was examined in two different forms of questions. Firstly, in terms of evaluation on the five-point scale of the Likert scale, and secondly, according to the order of items within the rank question. The five-point verbal assessment on the Likert scale was subsequently replaced by a numerical one (no-1, rather not-2, partly-3, rather yes-4, yes-5) in order to determine the level of satisfaction for the respondent group. The supplementary question was focused on the comparison of 9 tools (Instructional Video, Educational Game, Discussion Forum, Article & Book, Infographics, Podcast, PPT Presentation, Practicing Cases, Online Consultation) in the range from the most effective to the least effective. Thanks to this, it was possible to determine the weight of the efficiency attributed to these tools and create an overall ranking. The total weight for each instrument was calculated as a sum of multiples of the number of responses and individual weights. Respondents could decide according to their previous experience with e-learning in various areas similar to taxes (e.g., mathematics and logic) and according to the examples of tax educational materials of the FreelanCZer tax instructional project: videos, infographics and articles attached to the questionnaire.

To find out possible median differences in the distribution of perceived effectiveness by gender and by age group, the Mann-Whitney U tests with effect size using the rank biserial correlation were applied. Both tests analysed the results from the five-point Likert scale regarding effectiveness evaluation of the educational tools. A chi-squared test of independency was performed on an important factor of the tax knowledge of the respondents to determine its dependency on the gender or on the age groups of respondents on significance level of 0.05. The questionnaire survey received 71 responses. During the data cleaning, five cases were identified as erroneous and were therefore excluded. Consequently, 66 responses ($n = 66$) from age group Z and younger from Generation Y were marked as representative. Nationally, 82% are domestic respondents, 14% Slovak and 5% others, but most of the foreign respondents have lived in the Czech Republic for a long time. Most responses came from women (79%), with men answering in almost a quarter of the cases (21%). In terms of the highest level of education attained by the respondents, university graduates had the highest share of 53%, followed by 39% of those with a high school diploma. 70% of respondents stated that they have experience with e-learning. A half of the respondents (52%) have at least some knowledge in the field of taxation and 15% consider themselves to be tax experienced.

Results

E-Tax-Learning Model Design

Designing an effective tax-based learning environment using the internet should combine both a diverse learning environment and motivation to learn. Its main purpose is to provide non-invasive educational elements and tools within the tax interface during the performance of duties towards the state in order to continuously increase the knowledge base and understanding of taxes (tax system and laws). As a consequence, tax morale, willingness, and cooperation will increase. The interface should be created according to the preferences and habits of the Czech users from Generation Z and younger from Generation Y and according to the effectiveness of tools. Users come from different environments and have different degrees of education and tax knowledge, but they are united by their lifestyle habits in the use of technology and social networks. They appreciate the flexible way of learning, the availability of learning materials anywhere, anytime and on different types of devices (computers / laptops, tablets, mobile phones), as well as the interactive design, which they can adapt to their own needs and ideas.

Figure 1 contains a proposed combination of online educational methods and technologies (e-learning mapping) classified into the levels of learning according to the degree of consolidation of knowledge. The more actively the user participates, the greater the level of memorization and understanding. Thus, the tax portal should offer more user activities to do than those to read. Thanks to the passive activities such as watching videos, infographics or listening to podcasts, e-learning is becoming a more tangible, flexible, and natural environment for the new generation. An environment which they are familiar with from the social networks. The same function can be further reinforced by the interactions with other users in discussion forums, where they will be able to find solutions to their situation together.

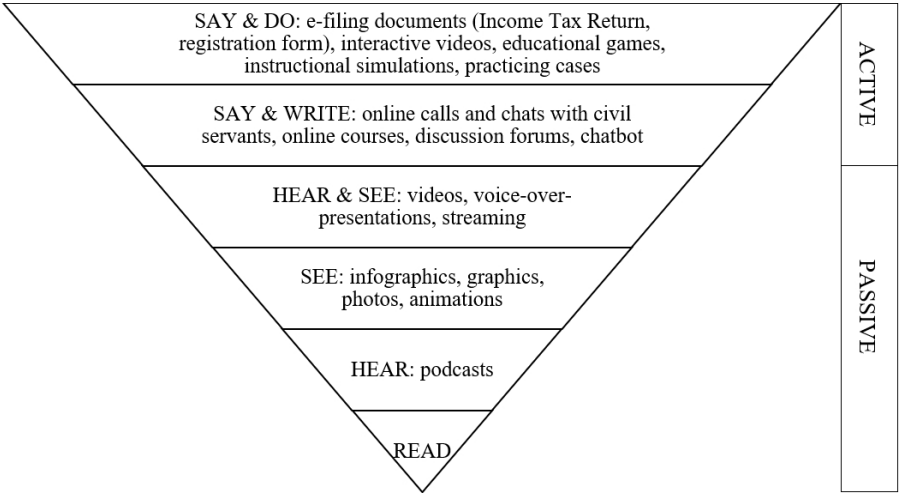

Figure 1. Cone of Learning (source: Dale 1969): E-Tax-Learning Methods and Technologies (author)

E-Tax-Learning Educational Tools Perception

Results of the χ^2 test regarding the relation between gender and tax experience (χ^2 0.89, *df* 2) show that there is no significant association between the gender and experience (*p*-value 0.640). Therefore, it cannot be said that one gender should have more experience. The Chi-square test examining the relationship between age and tax experience (χ^2 1.11, *df* 2) brought the same conclusion on the independence between these two characteristics. There is no relationship between age and experience (*p*-value 0.574). Therefore, it cannot be said that one age group has more experience. Considering these facts, the results of both age groups and genders can be interpreted together.

Regarding the meaningfulness of e-tax-learning, the answers to the following questions brought positive results: 1. Do you think people should understand why taxes are paid? (98% of respondents said yes), 2. Would you like to understand the meaning of taxes? (88% of respondents said yes and 11% partly), 3. Does e-learning tax educational support make sense within e-government? (70% of respondents said yes and 21% partly). These results mean that the target group sees tax education and e-tax-learning support within the Czech e-government as meaningful and useful.

The results of the question about the effectiveness of e-learning tools for understanding tax issues proved as the most effective instructional video tool, in which the mode and median reached the highest value of 5 (answer yes), followed by practicing examples and online consultations. The respondents consider online discussion forums to be the least effective. The results of the

ranking comparison of the effectiveness of e-learning tools confirmed previous conclusions about the highest effectiveness of instructional video for understanding and remembering the tax issues. Respondents see the educational game as the second most effective method. The use of infographics can also be considered important. On the contrary, the results show a scale of the lowest perceived effectiveness in practicing cases and podcasts, which is interesting compared to the previous results.

		Statistic	*p*		Effect Size
Instructional Video	Mann-Whitney U	326.00	0.516	Rank biserial correlation	0.10
Educational Game	Mann-Whitney U	362.50	0.987	Rank biserial correlation	0.00
Discussion Forum	Mann-Whitney U	320.50	0.487	Rank biserial correlation	0.12
Articles	Mann-Whitney U	336.50	0.654	Rank biserial correlation	0.08
Infographics	Mann-Whitney U	350.50	0.828	Rank biserial correlation	0.04
Podcasts	Mann-Whitney U	244.00	0.054	Rank biserial correlation	0.33
PPT Presentation	Mann-Whitney U	259.00	0.091	Rank biserial correlation	0.29
Practising Cases	Mann-Whitney U	186.50	0.004	Rank biserial correlation	0.49
Books	Mann-Whitney U	303.00	0.329	Rank biserial correlation	0.17
Online Consultation	Mann-Whitney U	354.50	0.883	Rank biserial correlation	0.03

Table 1: Mann-Whitney U test I for comparing the effectiveness evaluation of e-tax-learning educational tools depending on gender (author)

Mann-Whitney tests I with effect size using rank biserial correlation (Table 1) shows the only statistically significant difference between the gender in the practicing cases (*p*-value 0.004, H_0 rejected). The effect size points to an interesting difference. Women have demonstrably higher values for this item.

The results of the Mann-Whitney Test II (Table 2) show that no difference between age categories and the effectiveness evaluation of educational tools can be demonstrated. Basically, this means that the evaluation does not change with age group (18-25 / 26-35, H_0 not rejected).

		Statistic	*p*		Effect Size
Instructional Video	Mann-Whitney U	441.50	0.782	Rank biserial correlation	0.04
Educational Game	Mann-Whitney U	394.50	0.346	Rank biserial correlation	0.14
Discussion Forum	Mann-Whitney U	307.00	0.028	Rank biserial correlation	0.33
Articles	Mann-Whitney U	450.50	0.894	Rank biserial correlation	0.02
Infographics	Mann-Whitney U	396.00	0.346	Rank biserial correlation	0.14
Podcasts	Mann-Whitney U	447.00	0.858	Rank biserial correlation	0.03
PPT Presentation	Mann-Whitney U	439.00	0.768	Rank biserial correlation	0.05
Practising Cases	Mann-Whitney U	410.00	0.468	Rank biserial correlation	0.11
Books	Mann-Whitney U	369.50	0.197	Rank biserial correlation	0.20
Online Consultation	Mann-Whitney U	338.00	0.076	Rank biserial correlation	0.27

Table 2: Mann-Whitney U test II for comparing the effectiveness evaluation of e-tax-learning educational tools depending on age group (author)

Discussion

The discussion follows the goals of the paper and deals with the selected results of the paper. Firstly, the importance of the tax education for citizens and e-tax-learning integrated into e-government is explained. Secondly, the perspective of Millennials and Z generation on learning environments is presented, followed by the theoretical learning concepts leading to the results discussion.

The following analysis of the literature answers the question of why tax education is important. Almost all the respondents of the study consider it important to understand why taxes are paid

and 88% of respondents would like to understand the meaning of taxes. In this paper, e-learning incorporated into e-government is considered to be an educational process in which the state stands in the role of a teacher and learners are citizens - users of the system. The paper does not address the related technical training needs of users and staff of online law enforcement offices, which should also be part of the e-learning. The topic is covered by research from previous studies (Panda and Swain, 2009; Veljković and Stoimenov, 2011). Yee, Moorthy and Choo (2017) demonstrated, based on the sample of 400 respondents, that there is a significant link between tax knowledge and taxpayers' attitudes toward tax morale. In addition, these attitudes are important for the perception of tax evasion. The higher the level of education and knowledge taxpayers have, the greater their honesty, willingness, and cooperation will be (Yee, Moorthy and Choo, 2017). The hypothesis that there is a positive relationship and a significant effect of tax understanding on taxpayers' compliance was confirmed in the sample of 200 respondents in the study of Nurkhin et al (2018). The same conclusions were reached by Yee, Moorthy and Choo (2017), who state that the understanding of taxes is a crucial factor that can influence taxpayers' compliance with law. Indriyarti and Christian (2020) emphasize the need for taxpayers to be educated to increase the likelihood of compliance, especially in tax payment, which works more effectively than imposing tougher sanctions. The importance of tax understanding and awareness-raising compared to fines has also been verified in the latest Triandani and Apollo research (2020). Taxpayers with a high awareness of taxes will pay taxes more willingly and thus increase tax revenue of the state budget (Triandani and Apollo, 2020). The implementation of a policy of fiscal transparency, i.e., raising citizens' awareness of government accounts and financial transactions to strengthen tax morale, is also discussed in the study Fiscal transparency and tax ethics: does better information lead to greater compliance? (Capasso et al, 2020). Some studies have come to different conclusions, but their frequency is significantly lower. For example, Andinata (2015) identifies different views, according to which understanding tax rules does not have a significant effect on tax compliance.

The subsequent part of the discussion deals with emphasizing the importance of incorporating e-learning support into e-government. The e-learning tax educational support makes sense within the e-government according to more than two thirds of the respondents of this study. Incorporating a successful e-government system brings the positives of possible lifelong learning. Advanced e-learning can provide citizens with constant access to sophisticated personalized online educational tools. For effectively functioning e-learning support it is necessary to ensure the reorganization and training of relevant public administration employees (Panda and Swain, 2009). The close connection between e-learning and e-governance is also pointed out by Patarakin, Burov and Parfenov (2014), who call this concept a mixed e-gov-e-learning project. The European Union has emphasized the need to build a common interface for e-services based on the e-Learning, e-Health, e-Government, and e-Business components more than 15 years ago (eEurope2005 initiative). A proactive electronic system should be based on people-oriented principles (Romansky and Noninska, 2008).

In the final part of the discussion e-learning and its tools are analysed in the context of researched generations and theoretical concepts. Millennials and representatives of the Z generation have different levels of habit and experience in using information and building knowledge, which needs to be considered when designing a new education system (Spector et al, 2014). Z-era students feel comfortable using technology, enjoy multitasking, appreciate simplicity and interactive design, and communicate through social networks. These facts indirectly influence their thinking and decision-making process (Hariadi, Sunarto and Sudarmaningtyas, 2016). Although the results of some studies conclude that e-learning tools do not significantly increase student performance, they agree that the e-learning environment offers diverse ways of involving students, diverse opportunities and greater flexibility of student-centred learning

(Van Oordt and Mulder, 2016). As a result, students perceive an improvement in the learning environment and their involvement. They could take control of the learning process which can also increase their learning performance (U.S. Department of Education, 2010). Next-generation students are accustomed to personalizing online spaces around them for their needs and expressing themselves in various forms utilizing user-generated content. It will therefore be necessary to design customized and personalized learning spaces for knowledge generation to support their lifelong, engaged, and independent study (Keppell, 2014).

According to Dam's (2004) diagram – based on the implication of ways how people remember (Dale, 1969) – an interactive and media-rich learning environment enhances the learning experience. Many modern constructivist teaching paradigms are based on Dale's assumptions that people are more likely to retain knowledge provided in a multisensory way, especially when applied to a real-world context. As confirmed in this study by highly rated video and educational game efficiency, most people remember what they do (simulation and game teaching), a little less what they say or write (interactive live e-class teaching, e-mentoring and e-coaching), a little less what they hear, or they see (teaching online eCourses with audio and video, e-learning recorded sessions), a little less what they only see (online self-study guides, online PowePoint presentations) and the least what they read (e-mail, eDocuments). An interesting paper finding in confrontation with Dale's assumptions is the high efficiency assessment of infographics as a passive educational tool. Evaluation of the educational tools' effectiveness specifically for the e-tax-learning concept is not broadly researched. But there are studies dealing with effectiveness of educational technologies in general as well as studies comparing the learning process of different gender and age groups. Effectiveness and meaningfulness of the technology-based learning including educational videos, simulations and games has been confirmed by several studies (Finger and Trinidad, 2002; Fitriansyah, 2020; Wong, 2020). Instructional design increases from basic e-reading to a richer e-learning environment (Dam, 2004; Rawal and Pandey, 2013). Study of the Arenas-Gaitán et al (2010) did not find statistically significant differences for university students' behavioural acceptance of e-learning technology usage when comparing both male and female. Even if the expectations of members of generations Y and Z on how the educational process should look like are diametrically different from the expectations of the previous generations, the influence of age on the use of e-learning has not been proven by research (Postolov et al, 2017; Rouhani and Gholizdadeh, 2018; Šnýdrová and Ježková Petrů, 2020).

Conclusion

The state in the role of taxation educator should use the potential of information and communication technologies within the Financial e-Administration. This would simplify the learning process and enable flexible knowledge transfer and the lifelong citizen-student-centred development of human capital. The results of the study brought positive findings with regard to accepting the meaning of e-tax-learning support. Overall, 70% of respondents found educational tax support useful, and almost all respondents said it is important to understand why taxes exist and why they are paid. For the development of e-tax educational support, the most effective methods and technologies were those that required user activity, namely, interactive videos and educational games. When comparing the cone of learning with the results according to rating scales and ranking, it is also worth mentioning the high efficiency of infographics in the education process. The Mann-Whitney U test showed that women have demonstrably higher values for practicing cases than men. Other categories did not display any difference in the effectiveness of educational tools with regard to the gender. Likewise, no significant difference was found in e-learning tools effectiveness when comparing Generation Y and Z.

The paper's contribution lies not only in the aforementioned results regarding the suitability of specific educational tools for an unconventional e-tax-learning platform, but also in the presentation and discussion of this specific concept, which has been previously largely overlooked in the Czech Republic. The paper can bring new stimuli to representatives and commissioners of the Digital Czech Republic project and other related staff and officials involved in the creation of e-government. Linking e-government with a non-invasive form of personalized e-learning to increase the knowledge base of users is a procedure that could also be applied in other countries that use electronic government systems. A partial introduction of this educational system should be followed up by testing to assess whether the knowledge base of a specific population of users has changed according to the expected assumptions. Further investigation would then determine whether this change is also related to citizens' increased responsibility and understanding of their obligations to the state.

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