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EDUCATION REQUIREMENTS FOR WORKERS' PROMOTION: AN APPROACH TO THE MEXICAN LABOR MARKET

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Abstract

When companies decide to promote their workers, one of the options for the latter is training. Based on game theory concepts, this paper derives a threshold that determines the conditions under which a firm can promote an employee; threshold identified after the worker sends a signal that he has finished his college studies. Once the threshold is deducted and from the reports on training and characteristics of the workers such as education, the result shows that companies are willing to promote the worker, as long as the additional benefits for the promotion of the worker are twice as high as the investment made. Although this paper shows a cost-benefit requirement, which could be useful for companies to identify whom to promote, the application is limited as it only considers approximate values rather than data from institutions.

Keywords

Education, labor market, signals, training

Introduction

Worker training, regardless of cost and who pays for it, is always helpful; either for the worker to update himself or the opportunity of a promotion. Companies usually spend part of their budget on training their workers, where the most important objectives of such training are a salary increase and promotion. In addition, companies expect a significant increase in profits as a return on investment. When companies are responsible for the cost of training, it is logical to question whether the workers took advantage of it. In this way, the uncertainty faced by the company due to this situation is crucial to decide if the training is sufficient to promote the worker.

The objective of this article is to analyze the situation of a company that decides to promote its workers, who were trained for it. Based on game theory concepts, we deduce a threshold that defines the conditions for the company to promote the worker, involving uncertainty and the characteristics of the worker's education. The paper is structured as follows: in addition to the introduction, the first section shows the relevant literature on the subject. The second part corresponds to the methodology, followed by the analysis, results and applications in the third section. Finally, the conclusion, scope and limitations of the article are shown.

Literature review

Our work begins with a training of the worker with the objective or not, of opting for a job promotion. Where, completed studies are considered signs that the training was used. The foregoing, regardless of whether the opportunity is granted to all workers. In this sense, Gama and Willemse (2015) comment on the conditions of non-whites in South Africa and their restrictions on education. This means that these workers are not considered for qualified jobs, resulting in precarious wages and working conditions.

Regarding the costs of training, sometimes there is no way to invest in this training, either due to internal or external crises. For example, Bellmanna et al. (2014), based on a panel data analysis

applied to 16,000 German establishments, comment that the companies that were most affected by the crisis trained their staff to a lesser extent, and that the less affected companies only reduced training of experienced staff.

Regarding the opportunity to train all workers, our model assumes a choice without discrimination, in addition to considering benefits for all those involved. In this regard, Gürtler and Gürtler (2019) based on a signaling model to the Norwegian labor market, comment that promotions can be used as signals of the worker's ability and thus conclude that discrimination could be positive for both parties. The objective of training for the worker in this model is to increase his salary, thinking that the economic scenario has the conditions to do so. On this point, Kaufman (2010a) suggests, among other things, establishing a wage floor to compensate for imperfect competition and inequality in workers' bargaining.

The model incorporates the company's uncertainty, since it cannot identify whether or not the worker took advantage of the training. To return this uncertainty objectively, the company uses the completed studies of the workers as a signal. For example, MacLeod et al. (2017), based on an analysis of graduate students and their incorporation into the labor market in Colombia, conclude that the university reputation of graduates is a good sign that employers consider when setting salaries.

Although this work is not focused on the issue of labor discrimination, the fact that the company considers a sign not to make a mistake who promotes, retakes such discrimination. The foregoing means that discrimination is not necessarily inevitable, as pointed out by Rivera and Tilcsik (2016), who, based on an analysis of the labor market of large law firms in the United States, comment that the advantages of social class characterized by Formal schooling is a red flag when it comes to determining whom to give a job to. In particular, the authors find that firms in this elite labor market were more biased towards upper-class male applicants.

Our work addresses a relationship between education and the labor market, considering concepts of asymmetric information and signalization, based on the classic model of Spence (1973). Similar applications can be seen in Hopkins (2012), which shows a matching model between workers, who have private information regarding their ability, and which serves as a signal so that the most qualified workers can be chosen by the best companies. Furthermore, Coles et al. (2013) model a situation where workers send signals that are of interest to employers, making job search and occupation matches easier.

METHODOLOGY

In this section, basic concepts of game theory are defined, in principle,

Definition 1 (Kreps, 1990). – A game is a strategic interaction between two or more economic agents, called players, represented as follows:

$$\tilde{A} = \left\{ N, \, A_i X A_j, U_i \left(a_i, a_j \right) \right\}$$

where N denotes the number of players, A_i denotes the set of strategies of player i, $a_i \in A_i$, denotes the possible strategy of player i and $U_i \left(a_i, a_j \right)$ the payoff function of player i. Given the different decisions to be made by the player j, player i should have a best response, i.e.:

Definition 2 (Kreps, 1990). – Let $\tilde{A} = \left\{ N, \, A_i X A_j, U_i \left(a_i, a_j \right) \right\}$ a simultaneous game, a strategy a_i is the best response of player i to any strategy a_j of player j, denoted as $a_i = BR_i \left(a_j \right)$, if

$$U_i \left(a_i, a_j \right) \geq U_i \left(a_i', a_j \right), \; \forall a_i' \in A_i \tag{1}$$

On the other hand, suppose a 2-player game with strategy sets $A_1 = \{a, b\}$ y $A_2 = \{c, d\}$, respectively. Where, player 1 values his utility differently under the strategy (a, c), that is:

$$U_1(a,c) = t \text{ , where } t = \begin{cases} 3 \text{ if } P1 \text{ is type} 1 \\ 0 \text{ if } P1 \text{ is type} 2 \end{cases}$$

Thus, when player 1 values with $t = 3$, he is said to be type 1, and when he values with $t = 0$, he is said to be type 2. The values of t are known for both players, what player 2 does not know is when P1 will act as type 1 or type 2. Hence, it is said that there is information asymmetry from P2 towards the types of P1.

For P2 to figure out when he faces player 1 as type 1 or when he faces player 1 as type 2, he relies on experience and assigns subjective beliefs regarding the type of player he faces. These beliefs are defined as probabilities regarding the types of P1 that player 2 faces:

$$P_2(P1 \text{ is type} 1) = p \text{ and } P_2(P1 \text{ is type} 2) = 1 - p \tag{2}$$

The above analysis is a game theory problem with asymmetric (incomplete) information, defined as follows:

Definition 3 (Riascos, 2016). – A game with incomplete information (asymmetric), is a strategic game under uncertainty, represented by:

$$\Gamma = \left\{ N, A_i, T_i, P_j(t_i), U_i(a_i, a_j, t_i) \right\} \tag{*}$$

where T_i denotes the set of types of each player, $P_j(t_i)$ is the belief assigned by player $j \neq i$ to the person type $t_i \in T_i$ for each player i, which he does not know. Finally, $U_i(a_i, a_j, t_i)$ is the payoff of player i for each of its types t_i, for $i = 1, 2, \ldots, N$.

The beliefs or probabilities shown in (2) are subjective and are assigned by the player who has asymmetric information; in case of Table 1, P2. In order to make these beliefs more "reliable", player 1 sends signals (Spence, 1973; Harsanyi, 1967) to P2, so that the latter includes them and thereby updates these beliefs. His approach is through Bayes' rule, ultimately deducing objective beliefs, i.e.:

$$P_2(T1|signal) = q \text{ and } P_2(T2|signal) = 1 - q \tag{3}$$

The Model

When the company decides to make a promotion and the key is to train the workers, the problem is not to train all of them, the dilemma is that the company cannot accurately recognize the worker who took or did not take advantage of such training. Therefore, it is recommended that the company differentiates workers through an "attribute" or characteristic. Failure to do so could result in loss and low credibility with the unions for failing to grant or deny the promotion. In this work, it is proposed to catalog the workers who take advantage of the training and those who do not take advantage of it. Although the company knows that these two types of workers exist, it cannot accurately detect their type, so the analysis lies in a problem of asymmetric information on the side of the company. Formally, we define the types of workers as follows:

Type 1) Worker who takes advantage of training (Adv),

Type 2) Worker who does not take advantage of training $(NAdv)$.

and the firm's strategies are, promote (P) and Do Not Promote (NP).

In order to include the uncertainty factor, the firm assigns subjective beliefs, $P(Adv)$ and $P(NAdv)$, to the fact of facing the different types of workers and the expected payoff of the firm is defined as U_{Firm}. Thus, the firm's payoffs under its strategies are respectively:

$$U_{Firm}(P) = P(Adv)U_{Firm}(P) + P(NAdv)U_{Firm}(P) \tag{4}$$

$$U_{Firm}(NP) = P(Adv)U_{Firm}(NP) + P(NAdv)U_{Firm}(NP) \tag{5}$$

Since the beliefs of the company are subjective, it could lead to not promoting a worker who took advantage of the training (Adv), believing it was a worker who did not take advantage of the training $(NAdv)$. To avoid making a mistake, the firm will need signals from the workers and thus turn its subjective beliefs into objective ones. The signal to be adopted is whether the worker finished his college studies or not (FS).

Figure 1 details the extensive form of the model, at first the worker knows whether he is type 1 or type 2; then, the firm observes only whether the worker finished his studies (FS) or relies on experience (Exp), a signal used by the firm to modify its beliefs regarding the type of worker it faces. After the signal is received, the firm decides with incomplete information, hence the nodes, whether to promote or decline to promote. If the company receives the signal that the worker finished his studies (FE), then the expected benefit for the company when he promotes or does not promote are respectively:

$$U_{Firm}(P) = P(Adv|FS)U_{Firm}(P, Adv) + P(NAdv|FS)U_{Firm}(P, NAdv) \tag{6}$$

$$U_{Firm}(NP) = P(Adv|FS)U_{Firm}(NP, Adv) + P(NAdv|FS)U_{Firm}(NP, NAdv) \tag{7}$$
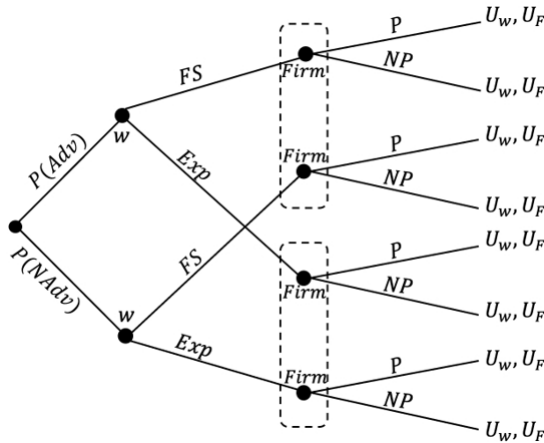
Figure 1: Game with asymmetric information for a promotion, under the signal of finishing studies (source: own elaboration)

When the firm promotes and improves wages, it expects a marginal productivity higher than this support. Let w denote the current wage of the employee and rw denote the wage increase of the promoted employee, where $0 < r < 1$. If the promotion is granted to the worker who took advantage of the training, which generates Π_{T1}, he will be committed to pay back the amount invested; so, the payoff of the firm when promoting type 1 is,

$$U_{Firm}(P, Adv) = \Pi_{T1} - w - rw \tag{8}$$

However, if the company promotes the worker who does not take advantage of the training, type 2 does not generate any additional benefit and the company makes a profit Π_{T2}, but pays an increase in wages,

$$U_{Firm}(P, NAdv) = \Pi_{T2} - w - rw - K \tag{9}$$

In addition, the employee who does not take advantage of the training will not pay back the training payment K. If the firm does not promote, its expected payoff is,

$$U_{Firm}(NP, Adv) = \Pi_{T2} - w - K = U_{Firm}(NP, NAdv) \tag{10}$$

That is, when it is not promoted, it does not matter what type of worker it is.

RESULTS

It is intended to derive an optimal mechanism to determine when and when not to promote:
$$U_{Firm}(P) > U_{Firm}(NP)$$
From the expressions (6) and (7) and adding (8), (9) and (10), it follows:

$$P(Adv|FS)(\Pi_{T1} - w - rw) + P(NAdv|FS)(\Pi_{T2} - w - rw - K) >$$
$$P(Adv|FS)(\Pi_{T2} - w - K) + P(NAdv|FS)(\Pi_{T2} - w - K) = \Pi_{T2} - w - K$$

Where the last equality follows from the fact that $P(Adv|FS) + P(NAdv|FS) = 1$. Likewise, making this sum of conditional probabilities in the first term,

$$P(Adv|FS)\Pi_{T1} + P(NAdv|FS)\Pi_{T2} - P(NAdv|FS)K > \Pi_{T2} - K + rw \tag{11}$$

From this expression, more specific requirements for detecting when it is best to promote, rather than not to, can be deduced. In particular, the following result is obtained:

Result 1. – Suppose that the firm knows that the employee finished college, also under optimal conditions: the payoff for promoting an employee who took advantage of the training, after discounting the cost of training and the additional pay for the promotion, is equal to the payoff before the promotion, i.e.,

$$\Pi_{T1} - K - rw = \Pi_{T2} \tag{*}$$

then, the difference between both payoffs satisfies,

$$\Pi_{T1} - \Pi_{T2} > \frac{rw(1 + P(Adv|FS))}{2P(Adv|FS)} \tag{12}$$

Proof. – replacing $P(NAdv|FS) = 1 - P(Adv|FS)$ in (11) and multiplying, it follows
$$P(Adv|FS)\Pi_{T1} + \Pi_{T2} - P(Adv|FS)\Pi_{T2} - K + P(Adv|FS)K > \Pi_{T2} - K + rw$$
reducing terms and factoring,
$$P(Adv|FS)(\Pi_{T1} - \Pi_{T2} + K) > rw$$
according to (*), it follows, $K = \Pi_{T1} - \Pi_{T2} - rw$, therefore, the above expression becomes,

$$P\left(Adv|FS\right)\left(\Pi_{T1} - \Pi_{T2} + \Pi_{T1} - \Pi_{T2} - rw\right) > rw,$$

reducing terms and isolating,

$2P\left(Adv|FS\right)\left(\Pi_{T1} - \Pi_{T2}\right) > rw\left(1 + P\left(Adv|FS\right)\right)$, finally,

$$\Pi_{T1} - \Pi_{T2} > \frac{rw\left(1 + P\left(Adv|FS\right)\right)}{2P\left(Adv|FS\right)}.$$

The following are approximations to numerically derive the above expression, i.e.,

1. According to Forbes (2020), only 11% of the employees who have taken advantage of their training, finished college. This implies that, $P\left(FS|Adv\right) = 0.11$;
2. also, El Economista (2019) reports that 71% of workers have taken advantage of the training course. Which infers the fact that, $P\left(Adv\right) = 0.71$;
3. at last, it is known that in 2021, 26.4% of the employees have finished college (Mi bolsillo, 2021), as opposed to 38% in 2020. This implies that, $P\left(FS\right) = 0.264$ for 2021.

The above results are useful to deduce, $P\left(Adv|FS\right) = \dfrac{P\left(FS|Adv\right)P\left(Adv\right)}{P\left(FS\right)} = \dfrac{0.11 * 0.71}{0.264} = 0.2958$,

Therefore, replacing this probability in (12),

$\Pi_{T1} - \Pi_{T2} > \dfrac{1.2958rw}{0.59166} = 2.19rw$, or alternatively, $\Pi_{T1} > \Pi_{T2} + 2.19rw$

which shows that the firm invests in training, as long as it obtains at least twice the wage increase in additional benefits. These benefits, once the company knows that the employee has finished college.

DISCUSSION

Our model assumes worker training as a tool for promotion, and also recommends training in general, which is necessary for the work environment. In this sense, Kaufman (2010b) comments that any labor protectionism promotes economic efficiency, loyalty to the company and, of course, human well-being. Once the company trains, it decides whom to promote; the dilemma is that it cannot recognize which worker did or did not take advantage of such training. This may be due to different circumstances of workers, talent, education, discipline, among others. In this regard, Ruesga et al. (2014), in an analysis of the labor market for Brazil, mention that the promotions of workers are not egalitarian and that informal labor is one of its causes. This is, despite the fact that training is mandatory, Ruesga et al. (2014) comment that it is not certain that the company will evaluate whether or not the worker seized the opportunity given.

In our article, it is recommended that workers send signals to better perceive who took advantage of such training; in this case, the signal was based on who finished their university studies.In relation to this, Moreno, Friesen and Bialystok (2011), analyze the behavior after musical training in two groups of children; the authors observe an equivalent improvement after training for both groups, however, children with musical training improved significantly more than children trained in visual-auditory learning.

CONCLUSION

An analysis between education and labor market was conducted, whose objective was to deduce an optimal mechanism of when a company promotes or not the worker, in which there is an initiative from the firm to train the employee. Since the company ignores whether the worker has taken advantage of the training, uncertainty is created by this asymmetric information from the firm, which is adjusted

based on a signal, the fact that the worker has finished college. In this way, a threshold that allows the firm to decide in a more optimal way whether to promote the worker or not, was deduced.

The analysis is useful in the sense that it involves random aspects, which can escape when the company makes key decisions. If there were no uncertainty, the strategies of the company could be dominant or have more feasible decisions, which happens with the classics such as the prisoner's dilemma, the battle of the sexes or the classic hawk and dove.

Although an application of the model is shown, this application is based on data reported in magazines, newspapers, electronic media, etc. Primary data from institutions such as INEGI, CONEVAL, OECD, among others, could have been considered, an analysis that is left for future work.

Acknowledgement

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ON PREDICTING THE OUTCOME OF THE STUDY OF BACHELOR STUDENTS

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Abstract

The fact that about one-half of students who enrolled for the bachelor study leave the university before obtaining the degree can be observed at universities worldwide. Factors of students' dropout can be studied either by surveys among students or by analyzing data the university collects. In the work reported in the paper, we analyzed data about students who enrolled for the bachelor study in the academic year 2013/14. We created several decision trees with the aim to predict who will finish the study successfully and who will not. Using data collected on a semester basis, we found out that the most important variable is the percentage of lost credits in the most recent semester.

Keywords

Bachelor study, decision trees, logistic regression, dropout

Introduction

Not completing the study by a large portion of students is a serious problem at universities worldwide. Regardless of the countries, the numbers are very similar: about one-half of students who enrolled for the bachelor study leave the university before obtaining the degree.

There are basically two approaches on how to analyze students' dropout. One possibility is to make an in-depth survey among students; examples of this approach can be found e.g. in (Sagenmuller, 2018; Norton and Cherastidtham, 2018; Vossensteyn et al., 2015; Fischer et.al, 2016). Another possibility is to analyze data the university collects about its students. These data can then be used to create models to predict students' unsuccessfulness or to look for important characteristics related to students' dropout. For examples of this approach see e.g. (Dekker et al., 2009; Kotsiantis et. al., 2003; Lykourentzou et. al., 2009). Our research fits into the second approach. In our previous work, we focused on data known about the students at the time of their admission (Berka et al., 2019). In the work reported in the paper, we analyze also the data about the students' study achievements collected on the semester basis. We used decision trees and logistic regression to be able to predict who will finish the study successfully and who will not. We analyzed the data on the university-level not going into details like faculties or study programs. In the rest of the paper, we describe the analyzed data, the settings for creating decision trees and regression models, show how these data were used to create decision trees and logistic regression models to differentiate between students completing the study and students being dismissed, discuss the results and show future research directions.

Materials and Methods

We used data about the same students as in our previous work (Berka et al., 2019), i.e.

about bachelor students who enrolled for their study at the University of Economics, Prague in the academic year 2013/2014. We removed students who didn't study in Czech study programs and/or who are still in the bachelor program (e.g. due to interruption of study). The dataset contains data about 3339 students after this filtering.

The available data can be categorized into three groups. First group are data known about the student at the admission time: socio-demographic characteristics (e.g. age, sex, citizenship), data about secondary education (type of secondary school, year of graduation) and data about admission to VSE (admission date, admission form, faculty, study program), Second group are data about the study progress in a particular semester (e.g. registered credits, lost credits, average study grade). The last group contains the information about finishing the study (date of defense, date of dismission). While in our previous work we focused on data from the first and second groups, now we are considering also the data from the second group.

Fig. 1 visualizes the pathway of the 3339 students through first three years of study in terms of average grade achieved in a particular academic year. Nodes refer to grade category within a year; A stands for average grade 1 – 1.5, B stands for average grade 1.5 – 2, C stands for average grade 2 - 2.5, D stands for average grade 2.5 – 3, E stands for average grade 3 – 3.5 and F stands for average grade 3.5 – 4. Edges show the proportion of students achieving the grade assigned to the parent node, who achieve the grade assigned to the child node (e.g. grade in the next academic year). The proportion is indicated by the shape of the edge: dotted edge denotes the proportion 1 – 9%, dashed edge denotes the proportion 10-19%, solid edge denotes the proportion 20 – 39% and bold edge denotes the proportion ≥ 40%.
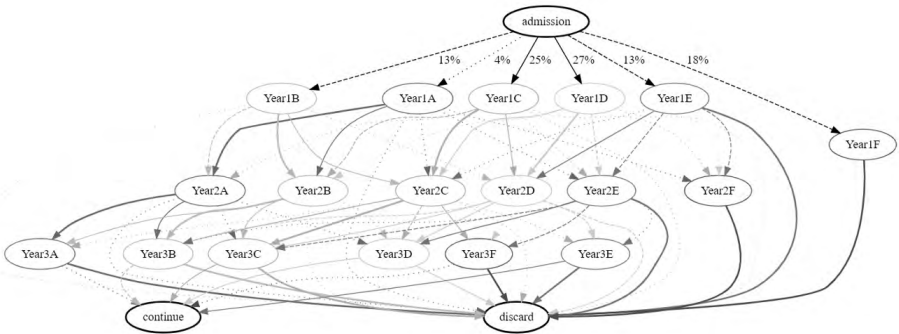
Figure 1: Pathway through the study (source: own calculation)

A student can finish the study at the university (and be discarded) in three ways: by defending the thesis, by being dismissed or by deciding to leave the University during the study. We used this information as the dependent variable in our analyses, while the variables known at the time of admission as well as the variables related to the study achievements in the first and second academic year enter the analyzes as independent ones. So we want to create classification models that will predict the final study result based on data known in the early phases of the study. The list of used variables is shown in Table 1. As we decided to distinguish only between students who defended and who were dismissed, we further reduced our dataset by removing students who left on their own. So we finally worked with the data about 2808 students; out of them, 69% successfully defended while 31% were dismissed.

There is a number of methods and algorithms that can be used to create a classification model. As we are interested in interpretable models, we used decision trees as the main method, but we also used logistic regression to check whether our focus on decision trees will not give biased results. Moreover, again to increase the interpretability of the decision trees, we turned numeric variables into categorical by discretization. AdmissAge was discretized into 2year intervals, YearSSVSE was discretized by considering each value as one category, CRLostSx was discretized into following intervals: 0%, 1-19%, 20-29%, 30-49%, 50-69%, 70-100%.

code	explanation	origin
Citizenship	Citizenship	available in the original data
AdmissAge	Age at the time of admission to VSE	computed from the date of birth and date of admission
Sex	Sex	available in the original data
YearSSVSE	Years between secondary school and VSE	computed from the year of graduating at secondary school and date of admission to VSE
SSType	Type of secondary school	derived from the code of secondary education
AdmissForm	Form of admission	available in the original data
StudyForm	Form of study	available in the original data
CRLostSx	Percentage of lost credits in semester x	computed from the number of registered and number of lost credits in semester x
CGrade2Sx	Cumulative average grade from the beginning of study till semester x	available in the original data
GradeYx	The average grade in academic year x	available in the original data
Target	Form of ending study at VSE (defended, dismissed, left)	available in the original data

Table 1: Used input variables (source: own calculation)

Decision trees belong to the most popular models for solving classification tasks but, due to their interpretability, can also be used for concept description. Algorithms for building decision trees recursively partition the attribute space in a top-down manner (therefore the general name for these algorithms is TDIDT – top-down induction of decision trees) into regions homogeneous with respect to the target (Quinlan, 1986). This method, also known as "divide and conquer" has been implemented in various algorithms. We used RapidMiner Studio, an integrated visual environment for data mining in our experiments (https://rapidminer.com). The tree learning algorithm implemented in RapidMiner generates a general tree creating a child node for each value of the splitting variable that appears in the parent node. The information gain ratio is used to select the splitting variable and the tree growing process stops if the number of examples within a node drops below a given threshold.

We start our experiments by assessing the relevance of the independent variables for the classification task. To do this, we computed the values of χ^2 according to the formula (1). Here Here o_{ij} is the observed number of examples that have the i-th value of the input variable X and the j-th value of the Target variable, and e_{ij} is the expected number of such examples. As intuitively expected, best (highest) values are obtained for variables related to the late stages of the study (see Table 2).

$$\chi^2(A) = \sum_{i=1}^{R} \sum_{j=1}^{S} \frac{\left(o_{ij} - e_{ij}\right)^2}{e_{ij}} \tag{1}$$

rank	variable	χ^2	rank	variable	χ^2
1	Grade for 2nd year	2231.47	10	CGrade till 1st semester	1461.10
2	RLost credits in 4th semester	2201.81	11	Age when entering VSE	220.65
3	CGrade till 4th semester	2095.44	12	Years between secondary school and university	211.00
4	RLost credits in 3rd semester	2057.78	13	Sex	80.74
5	CGrade till 3rd semester	1985.13	14	Citizenship	51.29
6	RLost credits in 2nd semester	1785.85	15	Admission form	48.60
7	Grade for 1st year	1739.52	16	Type of secondary school	24.67
8	CGrade till 2nd semester	1697.14	17	Study form	22.92
9	RLost credits in 1st semester	1543.57			

Table 2: Relevance of input variables (source: own calculation)

The setting for our data mining experiments was as follows. Using both decision tree learning algorithm and logistic regression, we created:

- A single model based only on personal data known about the students at the admission time (we denote this model as STUDENT)
- Set of models where we extend the personal data by data about the study achievements added on a semester basis; i.e. there will be separate models for up to semester 1, semester 2, semester 3 and semester 4 data (we denote these models as STUDENT+STUDY)
- Set of models based only on data about the study achievements; again, there will be separate models for up to semester 1, semester 2, semester 3 and semester 4 data (we denote these models as STUDY)

We used 10fold cross-validation to train and test all the models.

Results

We assess the quality of our models using three characteristics

1. Overall accuracy: computed as the percentage of correctly classified examples
2. Accuracy dismissed: computed as the percentage of correct classification for examples classified as dismissed
3. Accuracy defended: computed as the percentage of correct classification for examples classified as defended
4. Not relying only on overall accuracy allows us to detect possible overfitting in favor of one class. Tables 3-5 show the quality of all created models. Figures 2-4 show as examples the trees STUDENT, STUDENT+STUDY (for the first semester only) and STUDY (again for the first semester only) respectively.
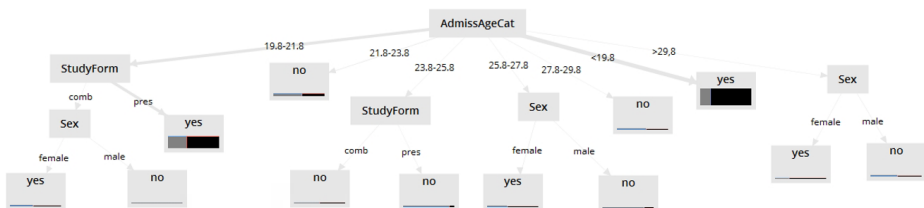
Figure 2: Decision tree STUDENT (source: own calculation)
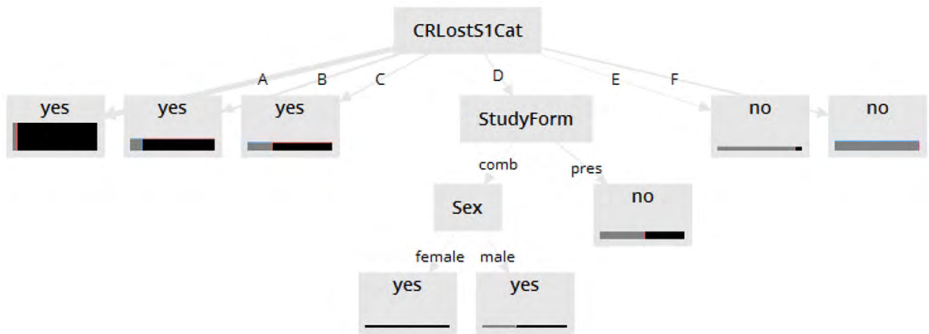
Figure 3: Decision tree STUDENT+STUDY1 (source: own calculation)
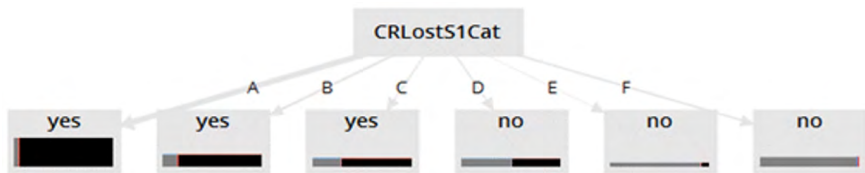
Figure 4: Decision tree STUDY1 (source: own calculation)

	Overall accuracy	Accuracy dismissed	Accuracy defended
Decision tree	71.11%	59.25%	72.34%
Logistic regression	72.50%	60.73%	74.50%

Table 3: Quality of models STUDENT (source: own calculation)

Sem.	Overall accuracy		Accuracy dismissed		Accuracy defended	
	tree	log.reg.	tree	log. reg.	tree	log. reg.
1	86.53%	87.10%	80.38%	85.69%	88.95%	87.57%
2	89.55%	90.83%	93.29%	89.74%	88.42%	91.24%
3	92.96%	93.00%	97.43%	91.82%	91.49%	93.46%
4	94.21%	95.27%	93.31%	94.94%	94.57%	95.41%

Table 4: Quality of models STUDENT+STUDY (source: own calculation)

Sem.	Overall accuracy		Accuracy dismissed		Accuracy defended	
	tree	log.reg.	tree	log. reg.	tree	log. reg.
1	85.39%	86.78%	81.63%	88.04%	86.67%	86.41%
2	89.59%	90.90%	93.17%	90.51%	88.49%	91.05%
3	93.07%	93.07%	97.44%	92.70%	91.62%	93.21%
4	94.31%	95.31%	93.66%	95.06%	94.58%	95.41%

Table 5: Quality of models STUDY (source: own calculation)

DISCUSSION

The results of the experiments can be summarized as follows:

- There is no significant difference between corresponding decision trees and regression models.
- As can be seen from Tables 3-5, using only the information available at the time of admission we obtain models (models STUDENT) that only slightly outperform the baseline classifiers that will assign all examples to the majority class Target=defended (Figure 3, right).

- When adding the information about the study achievements, the quality of the models (i.e. models STUDENT+STUDY) significantly improves. Even the information from the first semester helps to increase the overall accuracy from 71% to 87% (for decision trees).
- When using only data about study achievements (STUDY models) we again get better models than the models STUDENT.
- When adding more and more data about the study achievements, the quality of the models slightly improves. The importance of the information available at the time of admission decreases in this case; variables from the model STUDENT are not used to build the tree when going beyond the second semester.

Conclusion and future research

We report some initial analysis of the data about students who enrolled for their study in the academic year 2013/2014. Our results show, that to distinguish between successful and unsuccessful students, the key variables are related to the study progress. The variables known about the students when they enter university are less important. Even when considering the study achievements from the first semester, we obtained classification models with reasonably high accuracy. As the tree-based models are interpretable, we can easily identify "risky" students that tend not to successfully finish their study.

We will extend our work in several directions. We plan to repeat our analyses on time-shifted data, i.e. on the data about students who enrolled for their study in the years following 2013/2014 to check the stability of the found models. We also plan to perform similar analyses on the faculty level.

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COMPARISON OF STRESS VULNERABILITY AT STUDENTS AND PERCEIVED MENTAL LOAD AT COVID PANDEMIC ONLINE TUITION AT TWO DIFFERENT STUDY MODEST

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Abstract

The effect of stress vulnerability on the perceived mental load of two different groups of university students (n = 117) was explored – full-time bachelor students were compared to their lifelong learning fellow students during covid pandemic restrictions. The age characteristic of the respondents was considered as well. The data were collected with the use of psychological questionnaires – the Meister questionnaire for the assessment of neuropsychic load and the Stress Vulnerability Scale. The results show that even though there is an association between stress vulnerability and mental load and the age of students, the comparison of the student from the two different study modes is not so linear. The analysis yields interesting findings of higher vulnerability to stress together with surprisingly lower mental load reported by lifelong learning students compared to their full-time peers. In correspondence with these findings, adequate measures for the tuition and counselling of the two groups should be taken.

Keywords

Age, covid pandemic restriction, full-time study, mental load, lifelong learning, stress vulnerability, university students

Introduction

Covid restrictions in 2020 changed the educational environment, rules and habits worldwide, affecting all levels and modes of study, the university students being no exception. According to UNESCO (2020), tertiary education was the most affected one, with the highest risk of students dropping off education.

The abrupt turn to online education is related to the higher demands on the technical part and the psychological side. The perceived mental load of the online classes compared to the classical way of tuition was described by Chýlová and Krejčová (2021) The results pointed at higher psychological demands of the online settings, especially the high psychic monotony was identified as a setback to attention and the learning process in general.

The late adolescents were identified by Amicucci et al (2021) as a vulnerable population during the lockdown period and more pervasive repercussions on sleep and their mental health in connection with it were reported, together with encouragement to implement supportive strategies for this vulnerable population group. Aristovnik et al (2020) reported findings on covid pandemic restrictions' effect on university students. It indicates that students with certain socio-demographic characteristics (male, part-time) were significantly less satisfied with their academic work/life during the crisis, whereas female, full-time students were generally affected more by the pandemic in terms of their emotional life and personal circumstances.

Van Der Feltz-Cornelis et al (2020) explored how the COVID-19 outbreak and arrangements

such as remote working affect work and study stress levels and functioning in staff and students at university. High psychological distress was reported more often by students, amongst other characteristics female gender, having children, and having to self-isolate substantially contributed to vulnerability to stress. Stress vulnerability is usually described as the sensitivity to stressors, which influences individual differences in stress response (Handra et al, 2018).

That is one of the reasons why we find it important to pay attention to certain demographic characteristics in our study of stress vulnerability, we have concentrated especially on the mode of study and the age of students. Research conducted by Bonnefond et al (2003) indicated that age influences the more complex tasks demanding attentional resources and memory load. That seems to be a very accurate description of the study demands on lifelong learning students, who usually enroll at an older age, having their profession and family to take care of in addition to the university duties. The previous research (Chýlová and Krejčová, 2021) revealed a high level of mental load among full-time studying students, thus the current one shifted the focus on the lifelong learning students to establish their level of mental load during forced online tuition, considering the difference in the average age of the students in these groups, in comparison to their younger counterparts.

And so, we have decided to compare the groups of full-time and lifelong learning (part-time) students, to describe and better understand their specifics connected to online learning, to be able to find a way to offer them a purposeful approach.

The objective of the paper is to evaluate the vulnerability to stress and perceived mental load of students at FEM CULS also in a different mode of study – lifelong learning students. The different level of vulnerability to stress and mental load induced by the online tuition was expected, especially in connection with the higher average age of this group of students and with the level of stress vulnerability arising from a combination of several responsibilities (Van Der Feltz-Cornelis et al (2020), Aristovnik et al, 2020).

To reach this goal, the following hypotheses will be tested:

H_{01}: The stress vulnerability of full time and lifelong students is equal.

H_{02}: The mental load of full time and lifelong students is perceived as equal.

H_{03}: Students' stress vulnerability and perceived mental load are not mutually dependent.

H_{04}: The stress vulnerability and perceived mental load are not influenced by the age of students.

The present paper is structured into the following sections: The first part offers a brief description of the current state of the art; The second part describes the group of respondents and methods for data collection and used statistical analysis; The third part is dedicated to the most important findings arising from the statistical analysis of the data; The fourth section discusses results with other relevant researches; The fifth part concludes the paper and also provides for the use of the outcomes in an academic environment.

Materials and Methods

The presented research study was conducted on a convenience sample of 117 students in bachelor's study programs at the Czech University of Life Sciences during the calendar year 2020.

The research sample consisted of full-time students ($n = 55$) from the Faculty of Economics and Management (FEM), and from the Faculty of Agrobiology, Food and Natural Resources (FAFNR) and lifelong learning students at FEM ($n = 62$). Full-time, as well as lifelong learning students from FEM, are students in the study program Public Administration and Regional Development, students from the FAFNR study Zoorehabilitation program, all the students have a common subject – psychology, in the fundamental curriculum as it is crucial for them to learn how to communicate and cooperate with other people. There were 25 (22%) males, and 92 (78%) females in the group. The mean age of the whole group was 30.5 years (with a median of 26 years,

ranging from 20 to 50 years), the mean age of the full-time students was 22 years, and the mean age of the lifelong students was 38 years.

All the students cooperated voluntarily, with no financial reward for it. All participants were given a piece of feedback information about their individual levels of observed psychological characteristics as an integrated part of their psychological seminar.

To assess the vulnerability to stress we have used the Czech version of the psychological questionnaire the Stress vulnerability scale (Miller and Smith, 1985). The questionnaire consists of 20 items exploring healthy habits (sleep hygiene, smoking etc.) as well as psychosocial related items (assertiveness, social support etc.) - e.g. I eat at least one balanced meal a day., with a Likert scale rating from 1 (Always) to 5 (Never).

The method used to explore the perceived mental load of students was the Czech version of the Meister questionnaire for the assessment of neuropsychic load (Meister, 1975). The questionnaire is a universal method, in which psychometric qualities were repeatedly evaluated, and the critical value of the excessive psychic load has been stated (Židková, 2002). The questionnaire consists of 10 items (focusing on time pressure, low joy from work, tiredness), such as: 'I experience difficulties concentrating 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 data were processed with the use of software IBM SPSS Statistics, version 27.

The descriptive statistics and frequencies were run, to characterize the groups of respondents and outcomes from each questionnaire by the two groups of respondents.

The normality of the distribution was tested by the Kolmogorov-Smirnov test of normality, which is appropriate for sample sizes over 50 respondents (Norušis, 2011). The strength of association between the observed variables was tested by parametric measures – Pearson correlation coefficient. To compare the means of the questionnaire outputs in the two independent groups of students from different study modes and to determine whether there is statistical evidence that the associated population means are significantly different the t-test for equality of means was executed. To decide on which part of the output in SPSS to use Levene's test for equality of variances was computed (De Vaus, 2014). All the results are to be found in the respective section.

RESULTS

The average mental load for each study mode was calculated. The full-time students showed a higher level than the lifelong students from regional educational centres (mean value in Meister questionnaire 24.44 versus 20.68). On the other hand, vulnerability to stress was higher in the group of lifelong students than in full-time students (mean value of Stress Vulnerability Scale 47.10 versus 39.47), as can be seen in Table 1.

| Method | Kolmogorov – Smirnov test of normality | | Study mode | Mean | Std. Deviation | Std. Error Mean |
	Statistic	Significance				
Meister	.05	.200	Full-Time	24.44	5.85	1.79
			Life-Long	20.68	5.86	1.76
Stress Vulnerability Scale	.07	.162	Full-Time	39.47	7.47	1.01
			Life-Long	47.10	10.04	1.30

Table 1: Group Statistics, 2022 (source: own calculation)

Kolmogorov-Smirnov tests of normality proved that the data are normally distributed (Meister significance 0.200 and Stress Vulnerability Scale significance 0.162). We, therefore, proceeded to test the association of these characteristics with the use of the Pearson correlation test (details can be seen in Table 2).

		Age	Meister	Stress Vulnerability Scale
Age	Pearson Correlation	1	-.267**	.338**
	Sig. (2-tailed)		**.004**	**< .001**
	N	117	115	115
Meister	Pearson Correlation	-.267**	1	.242**
	Sig. (2-tailed)	**.004**		**.009**
	N	115	115	115
Stress Vulnerability Scale	Pearson Correlation	.338**	.242**	1
	Sig. (2-tailed)	**< .001**	**.009**	
	N	115	115	115

Table 2: Pearson Correlations, 2022 (source: own calculation)

The results yielded from the analysis of the Pearson correlation coefficient show significant associations between the perceived mental load and stress vulnerability ($r = 0.242$), therefore we can reject H_{03}. Also, the stress vulnerability and the age of students are significantly associated as well ($r = 0.338$), however, mental load itself correlate negatively with the age ($r = -0.267$), so we reject H_{04} too.

Stress vulnerability association to the perceived mental load is according to de Vaus (2014) low to moderate, whereas vulnerability to stress and age correlates moderately to substantially, mental load association with age is also low to moderate.

That is to say, the older the students are, the higher their vulnerability to stress is, though quite surprisingly the mental load they experience is perceived to be lower than the one experienced by their younger colleagues. And at the same time, their stress vulnerability is interconnected with the perceived mental load during the online classes.

The question, of whether this assertion could be applied also to the groups of students from different study modes – full-time and lifelong learning students, where the average age is considerably different (average age of 22 years versus 38 years) is answered by the t-test for equality of means (results displayed in Table 3).

Test	Levene		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-sided)	Mean Difference	Std. Error Difference	Lower	Upper
Meister	0.09	.76	3.43	113	**< .001**	3.75	1.09	1.59	5.92
Stress vulnerability Scale	3.88	.05*	-4.65	108.55	**< .001**	-7.63	1.64	-10.88	-4.37

Equal variances not assumed

Table 3: Independent Samples Test, 2022 (source: own calculation)

Levene's test for equality of variances was computed to reveal that results from the Meister questionnaire from both groups are of equal variances (sig. 0.76), but the Stress vulnerability scale results of the two groups do not show equal variances (significance 0.05, in Table 3 tagged by an asterisk) and therefore the appropriate line of the t-test outcome was selected.

The results point to the significant differences between the studied two groups. Full-time students report significantly higher (sig. < .001) perceived mental load than their colleagues studying part-time (H_{02} is rejected). On the other hand, they report significantly lower (sig. < .001) stress vulnerability than their life-long learning colleagues (H_{01} is rejected). The possible causes and implications of these findings are to be discussed in the respective section.

Discussion

Lifelong learning's importance for personal growth and development is indisputable. The onset of the COVID-19 pandemic has resulted in a massive shift in the higher education environment and posed questions on whether students can cope with the sudden transition of learning online. Our results have shown that lifelong learning students reported quite surprisingly that their perceived mental load during the pandemic online lessons was lower than the full-time students did. One of the potential causes might be that life-long learning students are generally older and next to the school activities usually have also their profession and family life might, so there is more to care about than solely the studying and therefore it may not be seen as important as is by the younger students, so maybe the mental load of the online tuition is than perceived as less important, hence lower.

A survey by Fejfar, Jadrná and Fejfarová (2021) showed that the mode of study and the age of the students affect the overall evaluation of distance learning at FEM. However, the respondent's gender and occupation next to the studies did not show any significant effect on the overall evaluation of distance learning. On the other hand, Yu (2021) revealed the effect of gender on online learning outcomes during the COVID-19 pandemic in his sample. Due to the significant gender imbalance of our sample, a similar comparison remains for future research.

Mishra, Gupta and Shree (2020) have reported a lack of interest and attention during the online classes during the lockdown of the Covid-19 pandemic showing that students were not accustomed to learning with smartphones and computers, which turned into a major setback for them, which could have been expected to be even more so at the older age category of students. A similar line of research was addressed in a study by Bravo-Agapito, Romero and Pamplona (2021) where the age of students was revealed to be an important negative predictor of academic performance in completely online learning.

At the same time as they perceive the lower mental load, lifelong students feel that they are more vulnerable to stress than the full-time ones. Stress vulnerability is a complex of psychosocial factors and healthy habits so therefore keeping all that in satisfactory balance could be more challenging with the increase of other responsibilities, next to the university ones (job, own family, age-related health problems). On the other hand, full-time students often report health issues related to psychological distress during studies, where one of the major causes, next from academic demands, was their financial situation (Recabarren et al, 2019; Deasy et al, 2015). Stress vulnerability has been traditionally understood as the opposite of resilience (Martin-Soelch and Schnyder, 2019), however, the intensity of the stressor may be perceived as a signpost directing either to the vulnerability or the resilience later (Bebbington et al, 1993). In research done by Van Der Feltz-Cornelis (2020) on psychological distress and resilience of students and staff during a pandemic, it occurred that students are much more resilient than staff, although psychological distress was much higher in the group of students too. This suggests that predictors of resilience may differ from psychological distress per se.

This may be in accord with the findings of Handra et al (2018), who reported that the vulnerability to stress was quite unexpectedly detected higher in students of political science and public administration than in the group of medical students, which is traditionally the leader group of the psychological distress and diseases induced by studies (e.g., Heinen et al, 2017). Determining the degree of vulnerability to stress is therefore considered by them an important instrument to improve resilience.

Conclusion

The research has shown some pieces of interesting and unexpected findings in the group of lifelong learning students, where the average age of the students is higher than in the group of

full-time students – the higher vulnerability to stress in this group goes with a lower perceived mental load reported by lifelong learning students during covid pandemic restricted online learning. In correspondence with these findings, adequate measures for the tuition and counselling of the two groups should be taken. Interventions to improve resilience should not only address psychological distress but may also address other factors. The close association between age and stress vulnerability is a factor worth considering especially for part-time students and lifelong students at consultation centres in regions.

The unexpected findings signal the need for additional studies to understand more about stress vulnerability and perceived mental load in students in all modes of study.

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THE USE OF ICT IN THE EDUCATION OF STUDENTS DURING THE COVID 19 PANDEMIC

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Abstract

This article focuses on online learning during the first wave of the COVID-19 pandemic at the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra. The main objective of this article is to evaluate the attitude of students toward the use of information and communication technologies (ICT) in the educational process and the quality of online education. A questionnaire survey ($n = 443$) was used to collect primary data. The survey showed the positive attitude of students toward the use of technology in teaching. The quality of online education was assessed by students at the same level as the full-time form, although the same percentage of students tended to be of lower quality. Part of the questionnaire survey was to determine the overall impact of COVID-19 on the digitization of education. Respondents rated this impact as positive.

Keywords

Information and communication technologies, education, digitization, online learning

Introduction

The COVID-19 pandemic has affected people in all areas. Education, which had to switch from full-time to distance learning, was no exception. Since 2020, 98% of universities have moved classes online (ThinkImpact, 2021). Information and communication technologies (ICT) have played an important role in this change in education. The importance of ICT in the educational process has been evident in the past but has become even more important during a pandemic. The 2020 academic cycle, at its various levels, as well as the educational systems in the world, suffered an untimely irruption with respect to the face-to-face modality. Therefore, students and teachers were forced to relearn new ways of accessing, transmitting, and interacting in cyberspace (Manco-Chavez et al., 2020). Using information and communication technologies in the educational process has so far been perceived as one way to increase learning motivation. Information and communication technologies have aided in the development of creative personalities in both students and lecturers. The introduction of information and communication technologies into the educational process was intended to enhance the effectiveness of lessons, free lecturers from routine work, enhance the attractiveness of the material, carry out task species differentiation, as well as diversify the forms of feedback (Abdullayev, 2020). According to Zolochevskaya et al. (2021), ICT has a substantial positive effect on the total success of students in universities.

Online or digital communications were available even before, but when the COVID-19 pandemic continued to make its presence known worldwide, many understood the importance

of such an online or virtual communication mode. Online degrees have been known for quite some time and often looked down upon, but during the pandemic, even established, high-ranked educational institutions were forced to adopt the online mode (Pathan, 2022). However, this transition to more intensive use of ICT has taken place at different rates, very individually, according to the capabilities and abilities of users (whether students or teachers), until the onset of the pandemic forced a forced transition from full-time to distance learning. This has resulted in a sharp shift in education to the online space and significant pressure on the use of ICT.

The main objective of this article is to evaluate the attitude of students towards the use of information technology in the educational process and the quality of online education at the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra during the first wave of the COVID-19 pandemic.

Materials and Methods

Primary data was obtained through a questionnaire survey, to which a total of 443 students responded. Participants in the survey were students in the Faculty of Economics and Management from all study years. The survey, focusing on all aspects of distance learning during the coronavirus situation, was conducted in the period from 10/2019 to 02/2020. The questionnaire contained 38 questions in total. For the purposes of this article, only parts of the questions were selected. Multiple choice, single answer, multiple choice questions, Likert scale questions, and open questions were included. Each respondent was described by their gender, age, and study level. The structure of the respondents is shown in Table 1.

Gender	Male		Female	Total
	89		354	443
	20%		80%	100%
Age category	18-29 years	20-24 years	Over 25 years	Total
	36	394	13	443
	8.1%	89%	2.9%	100%
Study level	Bachelor's degree		Master's degree	Total
	324		119	443
	73%		27%	100%

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

After clarification of dependent and independent variables, we formulated 3 null hypotheses that assume no relationship between the overall evaluation of online learning and basic identification variables. For the survey evaluation, the authors used contingency tables, stacked bar charts, and chi-squared tests of independence concerning the categorical type of obtained data. Furthermore, the authors presented the descriptive statistics in the form of frequency tables. For statistical calculations and analysis, the authors used the SAS software and MS Excel.

Results

The important questions of the survey were to find out the attitude of students towards the use of information and communication technologies in general and especially in relation to online learning. The attitude of the respondents was expressed through a typical five-level Likert scale: very negative, somewhat negative, neutral, somewhat positive, and very positive. More than 91% of respondents expressed a positive attitude towards ICT. In the case of the use of technology in teaching, respondents also expressed a positive attitude, namely 75% of respondents. Figure 1 shows a complete evaluation of the questions.
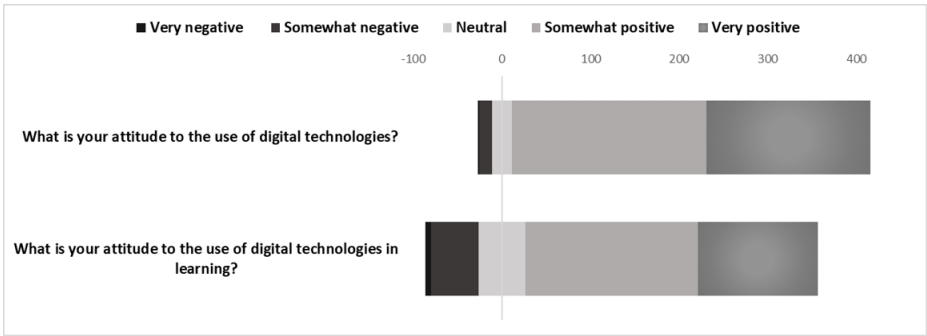
Figure 1: Respondents attitude to the use of technologies, 2020 (source: own survey)

The results of the survey also showed that students use search engines (84%), websites (79%), video servers (54%), data storage (53%) and social networks (44%) the most when studying online. Students most often used e-mail, video calls (MS Teams), and LMS Moodle to communicate with teachers and colleagues.

The COVID-19 pandemic made the transition from full-time to distance learning very rapid. Both teachers and students began to use technologies they had not used before or only very sporadically. As a result of these rapid changes, there have been discussions about the quality of online education. Approximately 35% of students think that online education is as good as full-time education. At the same time, however, the same number of respondents think that the quality of education is rather lower. However, a relatively high percentage of respondents (16%) think that education is certainly of lower quality. Figure 2 shows the evaluation of the quality of education.
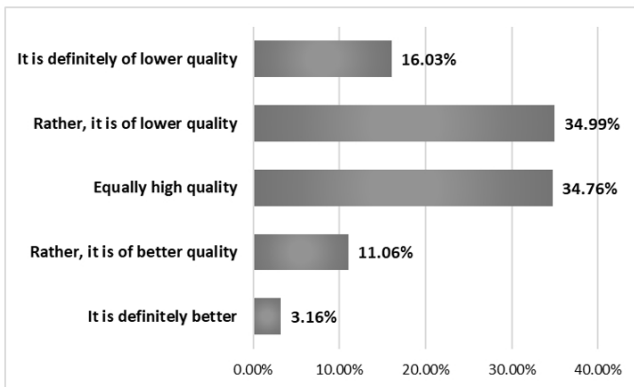
Figure 2: Respondents attitude to the quality of education, 2020 (source: own survey)

Computed Chi-square test showed that there is a relationship between the overall evaluation of online learning, and the age and study level. Also, it was found that the variable of the respondent's gender does not affect the overall evaluation of online learning. Based on the above, H_{01} was not rejected on the level of significance threshold $\alpha = 0.05$. Hypotheses H_{02} and H_{03} were rejected. But as they are part of another research, they will be tested further. Results of the Chi-square test showed Table 2.

Category	Statistic	*p*-value
Gender	3.2	0.525
Age category	6.383	0.006044
Study level	6.865	0.01432

Table 2: Chi-square statistics, 2020 (source: own calculation)

One of the final questions of the survey was the evaluation of the overall impact of COVID 19 on the digitization of education. More than 70% of respondents rated this impact as positive for the digitization of education (Figure 3).
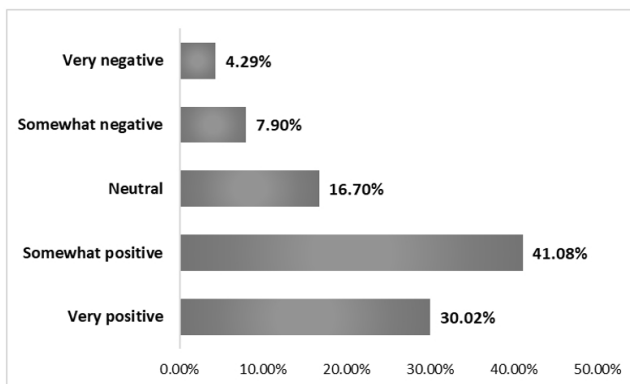
Figure 3: Impact of the COVID-19 on digitization, 2020 (source: own survey)

DISCUSSION

The COVID-19 pandemic has had an unprecedented impact on higher education worldwide in virtually all aspects of its functioning. In the academic year 2019/2020, the pandemic transformed the way teaching took place, accelerating a transformation that was already taking place in the form of online learning and teaching (Farnell, Matijevic, and Schmidt, 2021). According to Cicha et al. (2021), students' experience in the process of distance learning makes them believe that they will learn more remotely than during classroom activities. Their high computer skills mean that they do not worry that distance learning can cause them technical difficulties (related to the use of tools). Batez (2021) showed that the highest percentage of students (57.2%) stated that they use ICT daily outside of faculty for other purposes. According to our survey, more than three-quarters of students expressed a positive attitude towards digital technologies as well.

The rapid transition to online education has provoked much debate about the quality of this education. According to Coman et al. (2020) universities, teachers, and students were not prepared for the sudden shift to exclusively online learning and teaching, but they tried to find strategies to adapt and meet the new challenges. Universities did not have the technical capacity to provide optimal conditions for online learning, 69.4% of the respondents complained that they frequently and very frequently encountered technical problems with the platforms provided by the universities. Another study of Hvorecký et al. (2021) claims that educators have generally not been prepared for online teaching. In total, more than half of them (51.8%) had no previous experience of teaching remotely. Only 23.8% of them teach remotely regularly and another 24.4% occasionally. The results of our survey also confirm that students tend to be inclined to the same or worse quality of education. According to the Popa et al. (2020) online learning increases the probability that the student learns better, at his own pace of learning. This form of education

combines formal with informal learning, stimulating collaboration with colleagues and specialists, creating virtual communities. Another author's asked students 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 57.9%, 25.3% of students felt that it was half-and-half, and it did not suit 16.8% of students (Fejfar, Jadrná, Fejfarová, 2021).

In our study, more than 70% of respondents rated the impact of digitization in education as positive. Magomedov, Khaliev and Khubolov (2020) stated that the positive influence of the pandemic on education is the introduction or integration of new technologies into the system. According to the Aguilar et al. (2020) to the advantages belongs the availability on information and collaborative learning. However, integration of new technology into education does not mean that it will improve interaction between teacher and student, (meaning that the teacher will deliver material better and the student will receive it and fully understand it). New technology opens new opportunities for both teachers and students, but only when used correctly. According to Yaseen and Joshi (2021) students adopted many new techniques, and they realized the importance of ICT. On the other hand, we must not forget the negative consequences, such as the loss of social contacts or direct contact with teachers. Results of the study of Sahoo, Gulati and Haq (2021) show that most of the students are not much satisfied with the online learning method.

CONCLUSION

The coronavirus pandemic has fundamentally changed our way of life. It manifested itself in all areas of life, not excluding education. In particular, the first wave of the pandemic has hit teachers as well as students unprepared for online learning. For this reason, we conducted a survey at the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra focused on all aspects of online teaching. The questionnaire contained 38 questions in total, but for this article we chose four questions only. The increased use of information and communication technologies has led us to ask questions about students' attitudes towards these technologies. More than 91% of respondents expressed a positive attitude towards ICT, and about 75% expressed a positive attitude towards these technologies in teaching.

Because of the rapid change in the way they taught, both teachers and students were forced to begin using technologies that they had previously used sparingly. This has led to increased concerns about the quality of education. Around 35% of students in our survey stated that online education is as good as full-time education. But 16% of respondents think that education has lower quality. To improve the quality of education, universities have begun preparing various manuals for their staff and students, which have led to increased ICT skills.

An important question of the survey was the evaluation of the overall impact of COVID-19 on the digitization of evaluation. More than 70% of respondents rated this impact as positive. Thanks to online teaching, many electronic materials, video manuals, and online courses have been created that would probably not have been created under other circumstances. At the same time, the computer skills of both teachers and students have improved. Our research has some limitations also. We made questionary survey for students of the Faculty of Economics and Management, but we should try questionary for students of all faculties of Slovak University of Agriculture in Nitra and compare it. Next limitation is gender limitation. More women than men took part in the survey, but this also follows from the structure of students at the faculty.

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TOWARDS THE AUTOMATED INVIGILATED ASSESSMENT: A CASE OF AN OPEN-BOOK IN-CLASS EXAM IN THE INTRODUCTORY PROGRAMMING COURSE

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Abstract

Programming courses are characteristic with their difficulty, which inherently creates ground for cheating and other forms of academic dishonesty. High enrollment rates, pressures to retain students, and stretched computing resources demand to look for new innovative ways of test supervision. We developed and tested an application for automated invigilation of exams in an introductory programming course. In a sample of 1547 bachelor students who took a supervised exam in an introductory programming course between 2017-2019, we recorded the highest frequency of cheating attempts in the first and last ten minutes (18%) of the tests. We argue that an open-book, open-web exam in introductory programming supervised with the aid of the software can help the instructors to better identify students' weaknesses in comprehending and mastering the subject.

Keywords

Computer access control, examination, cheating, secure browser

Introduction

Introducing students to the concepts of programming remains one of the challenges in teaching computer science and informatics (Bennedsen and Caspersen, 2007, 2019). Computer programming is difficult to learn and requires a lot of practice (Scott et al., 2015; Malik, 2017). The evidence shows that programming courses have failure rates between 28 and 33 percent (Bennedsen and Caspersen, 2007, 2019), and they are in a similar rank of pass rates in other introductory STEM courses (Simon et al., 2019).

Instructors put enormous effort into enhancing understanding and delivery of introductory programming (Simon et al., 2019; Razakhovich and Razakhovna, 2020). Yet, the difficulty that students meet during learning programming comes hand in hand with cheating and other forms of academic dishonesty.

In-class exams

According to the methods used, written examination in the classroom can be divided into several categories. It is an examination of knowledge only based on memory recall or on the possibility of working with offline resources, or the student may also have resources available online - web. Some authors (Spiegel and Nivette, 2021) approach the division of categories by categorizing examinations into in-class (closed-book) examination (ICE) and take-home (open-book) examination (THE). Others (Williams and Wong, 2007) use the term 'open book, open web' (OBOW) for the examinations in which students can access any source, including the Internet. There are arguments against this method that emphasize that invigilated (supervised)

exams can also lead to cheating. Despite that, the OBOW method comes from the modern learning theory - constructivist learning. Concerns about cheating during open book exams remain (Green, Ferrante and Heppard, 2016); therefore, it is practical to include some form of monitoring into this type of examination.

Faucher and Caves (2009) define three primary domains in cheating techniques: (i) taking, giving, or receiving information from others; (ii) use of forbidden materials or information; (iii) circumventing the process of assessment. Wollack and Fremer (2013) described seven different types of test theft during the open web exams: (i) obtaining test materials from an insider, (ii) memorizing questions to be recalled later, (iii) violating retake rules to gain additional access to questions, (iv) stealing test questions through digital stills or video, (v) stealing questions by automatically recording test questions, (vi) transcribing questions verbally, and (vii) retrieving actual test files.

Factors leading to cheating in exams

Cizek and Wollack (2016: 4) have defined cheating as 'any action taken before, during, or after the administration of a test or assignment, that is intended to gain an unfair advantage or produce inaccurate results,' while Adzima (2021: 478) puts it simply that 'cheating occurs when students engage in dishonest behavior.' Orosz, Farkas, and Roland-Lévy (2013) conclude that competition leads to several negative outcomes within and beyond the classroom, and competition is regarded as a factor that facilitates academic dishonesty.

Yu et al. (2017) divide the factors which lead students to cheat in exams into three different groups: (i) students' beliefs or character, (ii) cocurricular factors, e.g., sports, (iii) students' perceptions and attitudes. Although the level of academic misconduct was derived from respondents' self-reports, Yu et al. (2017: 18) come with findings that 'college-age students who have a strong self-oriented purpose in life are also more likely to engage in academic misconduct incidents.' However, those who have a stronger level of beyond-the-self-focused purpose in life are less likely to be engaged in academic misconduct. Adzima (2021: 479) defines factors 'that may contribute to cheating behaviors' in the classroom environment as age, gender, intellectual ability, ethnicity, college major, extracurricular participation, employment status, level of schooling, and self-esteem.

Rios and Liu (2017) in Butler-Henderson and Crawford (2020) compared proctored and non-proctored online examinations across several aspects, including test-taking behavior. They conclude there is no difference in the behavior of students during tests regardless of the environment. They have not found any significant difference between omitted items and not-reached items.

Hylton, Levy, and Dringus (2016) found other factors contributing to misconduct - competition for better grades, insufficient organizational skills, the thrill of taking risks, as well as the financial and time setbacks associated with failure.

Issues of online exams

A systematic review of online examinations (Butler-Henderson and Crawford, 2020) has identified cheating as the most general area among all the themes. Problems identified by students are in test subject identification, prevention of examination theft, unauthorized use of textbooks or notes, preparation of settings for online examination, unauthorized access of students to the test bank, prevention of device use (e.g., telephone, Bluetooth, and calculators), restriction of access for other persons during the examination, fair access to equipment, computer crash identification, inconsistency of proctoring method. (Butler-Henderson and Crawford, 2020)

Invigilated assessment

Results of different studies, such as Harmon and Lambrinos (2008), Clark et al. (2020), or Young (2013) suggest that online exams administered in a proctored environment might equalize the incidence of cheating in supervised and unsupervised exams. Even from the students' perspective, cheating is easier and more prevalent in online courses, and students report unproctored remote exams to include more cheating behaviors than usual (Clark et al., 2020). Dendir and Maxwell (2020: 8) suggest that 'some form of direct proctoring is perhaps the most effective way of mitigating cheating during high-stakes online assessments.' As a special note, Adzima (2021) declares that it should be noted that proctoring software was still in its infancy and many online instructors were still conducting unproctored assessments.

Given the issues of unproctored and online exams compounded with growing numbers of students enrolled in the introductory programming courses, more researchers and instructors seek automation and innovation in administering invigilated exams. Mubin et al. (2020) came up with a study where a robot invigilates test writing and prevents cheating during it. This study brings a new approach to exams supervision. Still, the authors have mentioned the undisciplined and talkative behavior of students participating in the experiment, which probably comes from a humanoid robot used.

As a new approach in exam proctoring, there are some attempts to use artificial intelligence and blockchain-based self-identification. Kim and Huh (2020) came up with a very effective proposal of a system including these technologies accenting the situation coming up from COVID-19 pandemics.

Another approach to detect cheating in exams especially focused on information technology is the detection of source code plagiarism. Aniceto et al. (2021: 4) have analyzed different papers regarding source code plagiarism and they found 'most of them are based only on the static analysis of the source code, that is, the analysis is done only once after the students finished their assignments.' That analysis can be useful for the comparison of results among students' tasks and we suggest using it as a supportive tool.

A study that emphasizes concerns about students cheating in informatics from Teague, Fidge, and Xu (2016: 1) says, 'many students were able to achieve a much higher grade on the take-home assignments than the invigilated tests.' Their experiment oriented to solve those concerns is to develop a system of paired assessments, and they conclude that 'discounting any negative effect of exam stress and time constraints, invigilated tests seem to be a more accurate method of ongoing assessment of novice programmers' abilities.'

The paper objectives draw from the literature review and the authors' long-term experience with teaching an introductory programming course.

Materials and Methods

The authors of the study developed CZU WebBrowser, an application for automated invigilation (supervision) during the in-class open book exam in the introductory programming course taught at the Faculty of Economics and Management CZU Prague. The main requirements for the system were set as follows:

- the possibility of student communication with the teacher,
- report on the student's activities during the exam (open windows/running applications, visited pages),
- the possibility of recording the consultations provided,
- history of individual tests.

The system was designed in the form of a multi-tier architecture. The data layer consists of MySQL databases, while the API layer provides the application logic of the entire system. Two

applications on the Windows platform (Win32 and Win64) were created for the end stations. This architecture allows the system to be extended to other platforms using a single API.

Data collection

Data were collected between 2017-2019 during the exams in the subject Programming taught to the first-year students in the bachelor program Informatics at FEM CZU Prague. However, the data collection was limited due to measures against the spread of Covid19 during the academic year 2020/2021.

The data included the number of students participating in the test and information about users' activity during the test-taking, i.e., open applications, visited URLs, user and computer identification, and timestamps of the events. All exam tests were organized as in-class and invigilated, i.e., supervised by at least one instructor. At the beginning of the exam, the student launches the CZU Webbrowser and registers for the current open exam date. Through this application, he/she can ask for help from the teacher during the exam. The teacher can answer the question from his / her place without losing supervision of the classroom.

Year	No. of exams	No. of students	No. of events	Cheating ratio [%]
2017	58	733	30114	2.36
2018	36	416	16888	11.65
2019	31	398	16146	3.95
Total	125	1547	63148	2.97

Table 1: Overview of conducted exams over the three years

Analysis

The conducted analysis was three-fold. First, we analyzed the overall frequency of events during the tests in contrast to the relative frequency of cheating. The data were analyzed in summary for the exams in 2017-2019. Given the different possible lengths of the exams, the data were divided into intervals as a percentage of the total exam time. The total number of events was determined for each interval. An event is an activity done by one student, e.g., launching an application or opening a website. In addition, several cheating attempts were identified. Access to communication tools such as e-mail and chat applications have been identified and flagged as fraudulent activities. The resulting graph includes the number of events (black curve) and the ratio of fraudulent events to the total number of events in percent (grey curve).

	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%
Events	6665	9376	6610	5439	4877	3753	3549	2578	1373	751
Cheating ratio [%]	8,28	4,85	2,12	1,53	1,25	1,44	1,8	2,06	3,13	10,12

Exam time period
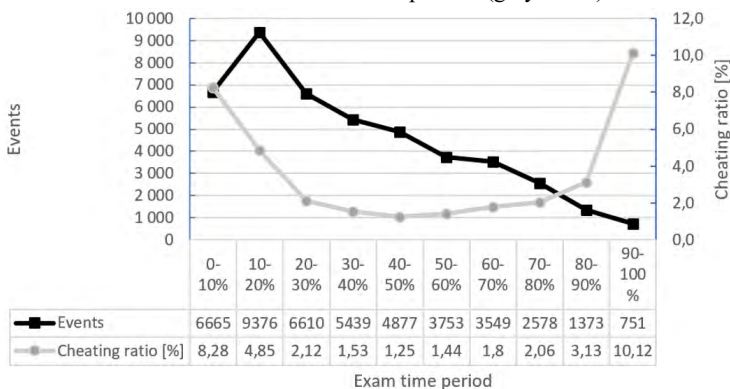
Figure 1: Event count vs. cheating ratio

The second analysis examined the proportion of fraudulent attempts for absolute time intervals. Given the significant proportion of fraud attempts in the initial and final parts of the test, the intervals of the first ten and last ten minutes were analyzed. In addition, the table also contains values for the remaining time intervals.

Period	Total events	Cheating attempts	Cheating ratio
First ten minutes	10127	710	7.01
Last ten minutes	336	38	11.31
Others	34508	833	2.42

Table 2: Analysis of first and last ten minutes of exam in absolute values

Finally, the differences in the distribution of events across the duration of the test in individual years can be seen in Table 3.

Period	2017	2018	2019
0-10%	3769	1405	1491
10-20%	4183	2200	2993
20-30%	2981	1737	1892
30-40%	2161	1499	1779
40-50%	2067	1449	1361
50-60%	1703	1050	1000
60-70%	1311	1320	918
70-80%	1100	704	774
80-90%	898	282	193
90-100%	595	110	46

Table 3: Events distribution during the test

RESULTS

The black curve on Fig. 1 shows a decrease in the total number of events during the exam. With the progress of the test time, students had already found the necessary information or completed the exam before the time limit expired. Therefore, there was a decline in the active retrieval of information during the test. In programming, students usually struggle with finding syntactic errors that can be remedied by searching help on the Internet, which can contribute to the high frequency of events in the early stages of the exam.

The aim of the study was not primarily to test the hypothesis. The main goal was to analyze the behavior of students during the examination and to identify critical moments during the examination. It will certainly be possible to establish hypotheses for further investigation – e.g., "Testing under stricter supervision has an effect on the exam result". Unfortunately, due to the need to maintain the same examination conditions for all students of the subject, it would be difficult to obtain the necessary data. In the future, we would like to focus on eliminating the "last minute" effect and assessing the success of the proposed measures.

The cheating ratio (the grey curve on Fig. 1) has a declining trend at first. In the introductory part, students often probe the measures and are instructed by the teacher not to use prohibited tools. At the end of the exam, the growth of this curve is remarkably high as the test takers resort to whatever means to get the right solution. This increase is particularly evident in the percentage of cheating events (Fig. 1) rather than in the absolute values of cheating attempts (Table 2). Hence, the instructor should pay the most attention at the end of the exam.

DISCUSSION

From the perspective of strategies to reduce cheating during an in-class supervised exam, the proposed software achieved to discourage cheating by observing students working and

making their work visible through monitoring of their activities during the test, which adheres to the observations made by Sheard et al (2017). At the same time, the instructor could directly communicate with the students during the chat without interrupting the supervision of the whole class. The purpose of the software was primarily to allow the teacher to control the students' activities during the examination. The results show that despite the students' knowledge and awareness that the inspection is being carried out, there are still attempts to cheat. We expect further analysis now after the resumption of teaching with the presence of students.

Due to the methodology of measurement and data collection, it is not possible to compare the situation before the introduction of control software. The software made it possible to record and assess students' activities during examinations that could not be analyzed until then. Apart from software fraud, only one other method of fraud has been detected.

Some students used a cell phone for uncontrolled communication. For this reason, physical examination by the examiner is of course necessary. The advantage of the software is that the examiner does not lose control over the class during the exam.

Hylton, Levy, and Dringus (2016) have compared several studies regarding cheating and how it depends on the factor of time. Their findings indicate a conflict in the literature about the issue of using time as a factor to measure potential misconduct in online exams. However, our findings point to a higher percentage of cheating students as the time is running out in the exam. Especially the last decile of the exam seems to be a problematic period as the cheating ratio rises above 10 %, which is the highest value of all deciles.

Conclusion

Based on the conducted experiment over 2017-2019, the application for automated invigilation of exams in an introductory programming course proved to be an effective tool both for cheating detection and prevention. In an in-class setting of the introductory programming course exam, the software-aided supervision reduces the frequency of cheating attempts and requires less attention of the instructors. For further research, the possibility of machine learning to identify suspicious activities will be analyzed.

Acknowledgement

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COVID-19 DISTANCE LEARNING: A REASON FOR DROPPING OUT?

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Abstract

The COVID-19 pandemic has impacted the form of teaching and learning because the higher education institutions had to switch to the distance form. However, students could not choose this form voluntarily. Therefore, the article focuses on the students' evaluation of distance learning at the selected university during the first wave of the pandemic. The results confirmed that it is possible to pursue distance learning long-term with the same effectiveness as contact learning. Furthermore, distance learning does not place a greater burden on students' personal lives than did contact learning in the period before the pandemic. Simultaneously students did not tend to drop out and most of them plan to complete their studies by the planned date. The survey also showed that there is a relationship between the overall evaluation of distance learning and its difficulty, the burden on the personal life, the form of assignments, and their quantity and structure.

Keywords

Assignments, COVID-19, distance learning, education, students, teachers

Introduction

The COVID-19 pandemic affected every country around the world, and hence it was necessary to introduce strict nationwide measures, which had an impact on all spheres of people's lives including education. The situation has challenged education systems throughout the world and forced teachers to switch from contact to online distance learning (Saidi, Sharip and Rahim, 2021). The speed of these changes and the sudden global transition to distance learning form have provided very little time to analyse or reflect on the potential risks and opportunities (Martiník, 2021). Education institutions have reacted impulsively to the pandemic situation, and to save the academic year, they have adopted distance learning platforms using online resources (Qazi et al., 2021). The pandemic challenged the current organisation of physical learning ecosystems, which date back several centuries, making it necessary to rethink their organisation and functionality (Giovannella, 2020). The forced transition to distance learning at universities in March 2020 thus raised complex issues involved in organising lifelong learning for students, conducting academic assessments, and maintaining the stability of education institutions in general, for education systems in every country (Aleshkovskiy, Gasparishvili and Krukhmaleva, 2020). Thanks to this, we are entering an era of large-scale online learning, where education is delivered remotely through various digital platforms. This move presented many challenges to students, teachers, families, administrators, and government regulations (Al-Karaki, Ababneh and Hamid, 2021). Antonova, Abramova and Popova (2021) emphasize that students' satisfaction with online education during the COVID-19 pandemic has decreased, which has led to a decrease in the overall satisfaction with life.

The pandemic COVID-19 has brought exceptional circumstances to teaching that require

questioning the teaching methodologies used (Gonçalves, Sousa and Pereira, 2020). During the COVID-19 pandemic, the use of communication tools that enable teleconferencing, teleworking, online learning, and social contact has increased substantially (Mheidly, Fares and Fares, 2020). Teachers' satisfaction with their online teaching experience is primarily influenced by the perceived benefits of online courses, whereas students' satisfaction with their online learning experience is primarily influenced by the perceived effectiveness of online learning technology, perceived benefits of online courses, and their ratings of teacher performance (Lei and Sou, 2021). Distance learning is more in demand than ever in higher education institutions around the world (Saleh and Meccawy, 2021).

The results presented in this article represent a part of long-term research (Fejfar, Jadrná and Fejfarová, 2021) and are aimed at evaluating part of the results obtained. The main objective of the article is to evaluate selected characteristics of distance learning at the Faculty of Economics and Management of the Czech University of Life Sciences Prague (FEM CZU) during the first wave of the COVID-19 pandemic from the perspective of students. A partial objective is to examine the relationships between selected qualitative variables to verify the conclusions made. The main research questions we were dealing with were: Was distance learning during the COVID-19 pandemic period difficult? Did distance learning during the COVID-19 pandemic period have an impact on students' personal lives? Was the evaluation of distance learning during the COVID-19 pandemic period influenced by the assignments? Was distance learning during the COVID-19 pandemic period the reason to drop out of the studies?

The article is structured as follows. The first part of the article focuses on the theoretical background. The second part describes the research sample and 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 the results. The fifth part focuses on the overall conclusion and the sixth part includes a list of references.

MATERIALS AND METHODS

Primary data was obtained through quantitative research via a questionnaire survey involving a total of 292 respondents - students of the Faculty of Economics and Management of the Czech University of Life Sciences Prague (FEM CZU). The survey participants were selected by purposive sampling. The research was aimed at evaluating distance learning during the first wave of the COVID-19 pandemic (spring term 2020). This survey represents a part of long-term research focused on evaluating distance learning during the COVID-19 pandemic at FEM CZU (Fejfar, Jadrná and Fejfarová, 2021).

A total of 84 (28.8%) men and 208 (71.2%) women participated in the questionnaire survey. Respondents were grouped by the categories of 18-22 years (75, 25.7%), 23-29 years (144, 49.3%), 30-39 years (34, 11.6%), 40-49 years (31, 10.6%), and over 50 years (8, 2.7%). 192 (65.8%) of the respondents were full-time students and 100 (34.2%) of the respondents were studying in a combined form of study. Of the total of 292 respondents, 261 (89.4%) respondents work while studying, and nearly a half of them (121, 46.4%) are working in a field in which they can apply the knowledge gained in school. Respondents were also asked approximately what percentage of distance learning they participated. Most students attended 75-100% of the lectures (158, 54.1%). 55 (18.8%) of students attended 50-75% of the lectures, 33 (11.3%) of students attended 25-50% of the lectures and 14 (4.8%) of students attended only 0-25% of the lectures. 32 (11%) of students did not have lectures. 135 (46.2%) respondents participated in 75-100% of the seminars. 37 (12.7%) of students participated in 50-75% of the seminars, 23 (7.9%) of students participated in 25-50% of the seminars and 22 (7.5%) of students participated in 0-25% of the seminars. Participation in seminars is lower because for 75 respondents (25.7%), this form of

learning was not offered for seminars. The reason was also easier changeover to online lectures than to online seminars (students were given homework instead of online seminars).

After clarification of the key-dependent and independent variables, we formulated 4 null hypotheses that assume no relationship between the overall evaluation of distance learning and its difficulty (H_{01}), the burden on their personal lives (H_{02}), the form of assignments (H_{03}) and the quantity and structure of assignments (H_{04}). In the research questions, the respondents indicated their agreement with individual claims using the five-grade Likert scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree). The data have been processed by means of absolute and relative frequencies using the IBM SPSS Statistics 27. 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).

RESULTS

The results of the survey showed that distance learning suited most students (169, 57.9%), 74 (25.3%) students felt that it was half-and-half, and it did not suit 49 (16.8%) students. In terms of the effect that the acquired knowledge had on the respondents compared to conventional contact teaching, 124 (42.5%) respondents did not notice any difference compared to conventional contact teaching. When comparing the amount of schoolwork (assignments, online learning, working on credit requirements, exam preparation, etc.) before and after the cancellation of contact teaching, 128 (43.8%) students felt equally burdened, 91 (31.2%) more burdened, and 73 (25%) less burdened. More than half of the students (167, 57.2%) are interested in continuing their studies by distance learning online; for 68 (23.3%) students, it is fifty-fifty; and 57 (19.5%) students are not interested in continuing their studies in this form.

Characteristics of distance learning from the students' perspective

The results of the research showed that students who regularly attend lectures give courses a better evaluation 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. Whereas only 36.1% of the students whose attendance of lectures was up to 25% rate courses positively, students attending lectures quite regularly rate the courses positively in 74.8% of the cases. These results show that if a student attends lectures regularly, her/his evaluation of the courses is more positive. In terms of the effect that knowledge had on the students, most of the respondents who found that distance learning suited them agreed that they did not note any difference in the effect made compared to contact teaching. A positive finding is that more than half of the students (162, 55.5%) do not find distance learning demanding. These students also confirm that it is possible to engage in distance learning in the long term with the same effectiveness as contact learning. Another positive finding was that 202 (69.2%) students did not find that distance learning was more burdensome on their families' lives than contact learning. Therefore, the relationship between the overall evaluation of distance learning and its difficulty (H_{01}) and the relationship between the overall evaluation of distance learning and the burden on students' personal lives (H_{02}) were examined. 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 suits students) and its difficulty (H_{01}: $p < 0.001$, Cramer's $V = 0.438$) and the burden on their personal lives (H_{02}: $p < 0.001$, Cramer's $V = 0.302$). Based on the above, hypotheses H_{01} and H_{02}, were rejected. The strengths of the relationships are substantial and moderate. The above shows that if students find that distance learning suits them, they do not rate it as demanding in terms of its long-term learning burden and its impact on their performance, and it does not impose a greater burden on their personal lives than contact learning did in the pre-pandemic period.

Characteristics related to assignments from the students' perspective

In connection with the evaluation of distance learning, students were also asked about assigned tasks. These characteristics are shown in relative terms in Table 1.

Characteristics related to assignments	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The form of assignments suits me.	30.5	45.2	15.8	6.8	1.7
The assignments are meaningful.	28.8	41.1	24.3	5.1	0.7
The quantity and structure of the assignments suit me.	20.5	41.8	25.3	10.3	2.1
I would welcome more practice with respect to the material covered.	20.2	27.4	30.2	21.2	1
I would welcome more independent creative activities.	4.8	12.3	34.6	41.4	6.9
I would welcome more teamwork.	8.9	18.8	22.6	36.3	13.4
I supplement my studies with assignments at my own initiative.	3.8	20.2	32.5	33.2	10.3

Table 1: Characteristics related to assignments, 2020-2022 (source: own survey)

The survey results showed that most of the students (221, 75.7%) was comfortable with the form of assignments in distance learning. Students rated the assignments as meaningful (204, 69.9%) and the quantity and structure of the assignments (182, 62.3%) suited them. Almost half of the students (139, 47.6%) would have welcomed more practice with respect to the material covered. On the other hand, nearly half of the students did not desire independent creative activity (141, 48.3%) and more teamwork (145, 49.7%). Less than a quarter of the students (70, 24%) supplement their studies with assignments at their initiative.

Following the above, the relationship between the overall evaluation of distance learning and the form of assignments (H_{03}) and the relationship between the overall evaluation of distance learning and the quantity and structure of assignments (H_{04}) were examined. 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 suits students) and the form of assignments (H_{03}: < 0.001, Cramer's V = 0.385) and their quantity and structure (H_{04}: p < 0.001, Cramer's V = 0.191). Based on the above, hypotheses H_{03} and H_{04}, were rejected. The strengths of the relationships are moderate and low. The above shows that if students are comfortable with distance learning, they are also comfortable with the form of assignments, their quantity, and structure.

Online examination and tendency to drop out from the students' perspective

During the first wave of the COVID-19, the examination was conducted online for the first time. Most students (249, 85.3%) found that the form of examination suits them. Students were also asked whether they tended to use support materials in the online examination that they could not use during conventional exams. Surprisingly, more than half of the students (176, 60.3%) answered that they did not; however, this response may be distorted, as it is not possible to verify whether students were willing to answer this question truthfully.

In connection with distance learning and the COVID-19 pandemic, students were also asked whether they were likely to drop out. These results are shown in relative terms in Table 2.

Tendency to drop out	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I often think about quitting prematurely study (without obtaining a degree).	2.4	5.8	13	22.6	56.2
I may end prematurely next year study (without obtaining a degree).	0.7	2.7	8.6	28.1	59.9
I plan to finish my studies on time.	58.2	25.7	7.9	6.2	2.1
I plan to finish my studies, but I will extend my studies.	7.2	9.9	18.8	37.3	26.7

Table 2: Tendency to drop out, 2020-2022 (source: own survey)

A positive finding is that students did not tend to drop out and most of them planned to finish their studies as planned, even though contact teaching had been replaced with distance learning due to COVID-19. The relationships between selected variables could not be examined because the conditions for using Pearson's chi-square test of independence were not met.

DISCUSSION

Online teaching is becoming the new normal in academia. Teachers continue to switch to the new standard in teaching (Lagat, 2021). Yet, some teachers may lack the knowledge and expertise to create and facilitate an engaging, positive, and supportive online environment for their students (Hossein, 2020). This means that universities will also need to provide more training focused on creating and delivering quality online courses (Laplante, 2020). Aside from resources, staff ICT readiness, confidence, accessibility of students, and motivation play an important role (Ali, 2020). Those universities that already had a significant share of online learning enjoy a great advantage (Laplante, 2020).

The role of the teacher in the educational process is very important and, therefore, needs to be addressed. Makhzoum, Berri, and Ajami (2021) confirm that the teacher plays a major role in the success of the distance learning process, by having digital literacy skills and constantly working to discover and learn about emerging teaching methods. Teachers should communicate with their students more frequently, gather student comments, and be able to evaluate the effectiveness of different styles of instruction. Aside from sufficient training and support, students should be provided with quality technology tools, to ensure a seamless online learning experience (Lei and Sou, 2021). Al-Karaki, Ababneh and Hamid (2021) further state that the student engagement practices that are used today do not suffice to encourage student participation and interaction. Therefore, new innovative methods of engaging students are needed, as well. Silva et al. (2020) confirm that a key tool for distance learning is devices that allow interaction between teachers and students. Mintii, Vakaliuk, and Ivanova (2021) identified the main challenges faced by university teachers and students. These include hardware and software problems, poor internet connectivity, lack of self-discipline and self-organisation of students, absence of live communication, inadequate digital literacy skills, etc. Their results do, however, show that in the academic year 2020/2021, distance learning is better organised due to a sufficient structure of distance learning courses, the use of a single platform by an entire educational institution, digital competencies of senior teachers, the use of different resources, etc. According to the authors, the quarantine restrictions of COVID-19 became a catalyst for the use of distance learning in all educational institutions and a litmus test for identifying the problems associated with it.

The results presented in this article represent a part of long-term research focusing on the evaluation of distance learning during the COVID-19 pandemic in the period from 2020 to 2022

(Fejfar, Jadrná and Fejfarová, 2021). 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 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.

Conclusion

'Two years on, we could be entering a new phase in the pandemic with plausible hope for stabilization, yet too early to drop our guard' (Kluge, 2022). Therefore, higher education institutions must constantly pay attention to distance learning and improve distance learning tools. The results of the survey showed a positive finding. Students who regularly attend lectures give courses a better evaluation and students who rated their work in contactless teaching as excellent or very good. These results show that if a student attends lectures regularly, her/his evaluation of the courses is more positive. In terms of the effect that knowledge had on the students, most of the respondents who found that distance learning suited them agreed that they did not note any difference in the effect made compared to contact teaching. Most of the students did not find that distance learning was more burdensome on their families' lives than contact learning. A positive finding is that students did not tend to drop out, and most of them planned to finish their studies as planned, even though contact teaching had been replaced with distance learning due to COVID-19.

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CRITERIA FOR CLASSIFICATION OF DIGITAL EDUCATIONAL MATERIALS AND AI

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Abstract

The paper presents the results of a research study conducted within the project *AI Assistant for Pupils and Teachers.* The study focuses on how to use AI for classification and search of digital teaching materials. The numbers of digital materials are growing fast, and it is very difficult for a teacher to find a material that meets all the criteria they are looking for. The authors of this paper are developing a set of criteria on whose basis AI could be taught to classify, systematize and search in the existing digital materials. The study focuses on three frameworks for definition of criteria and key words (FEP, CERMAT and FE). The conclusion of the analyses conducted is that these frameworks do not make a good skeleton for building the system. Thus, the team is working on developing their own system of keywords and criteria that would allow the use of AI.

Keywords

Artificial intelligence, classification of materials, digital educational materials, digital libraries

Introduction

Information and communication technologies have played a very important role in the educational process for a long time and are the subject of systematic research. Within didactics of mathematics, this research focuses on five basic topics (Borba et al., 2016), one of which is digital libraries and designing teaching materials. A number of projects, whether academic, commercial or non-profit, focus on the creation of such materials.

However, not only commercial companies, non-profit organizations or academic institutions, but also teachers and students participate in development of teaching materials. In some cases, teachers are directly encouraged to design digital educational materials (in the Czech Republic, for example, in the Šablony project). This creates a number of teaching materials that are available for free, but are of very different quality. This trend has been further accelerated by the Covid-19 pandemic and the related emergency remote education or teaching (see Bozkurt et al, 2020, Hodges et al, 2021). In this period, many teachers began not only to search for, but also to create and share their own teaching materials. This expansion of the amount of teaching materials asks for solution of two basic problems: how to collect the teaching materials and subsequently, how to classify the collected materials and how to search in them effectively. This is also a question that the project of the Technology Agency of the Czech Republic called *AI Assistant for Pupils and Teachers* focuses on. The authors of this paper participate in this project and the here reported research is its part.

Digital libraries

One of the ways of publishing educational materials is through specialized libraries connected with either specific products such as GeoGebra (Tomaschko, Kocadere and Hohenwarter, 2018) or the Wolfram Demonstration Project (Gorgol, 2015), or projects such as the KhanAcademy (Vidergor and Ben-Amram, 2020).

Another approach is to create central national portals that collect information on available educational materials. An example is The Digital Repository of Ireland (DRI - Pierantoni et al, 2015). In the Czech Republic, a similar portal is operated by the National Pedagogical Institute, an organization established by the Ministry of Education. The portal is called EMA and currently offers tens of thousands of educational materials in the Czech language.

Classification and search in materials

However, development and posting of a large number of educational materials brings about the problem of how to search effectively for the material that the teacher could use in their teaching. The problem is not that such material has not yet been developed or that it would not be freely available, the problem is that there are too many materials and it is not easy for teachers to find their way through what is available. For example, if we search for "Pythagorean Theorem" on the Wolfram Demonstrations Project portal, we will immediately get 59 different materials. It takes time to view them all and compare them. The situation is similar on portals in national languages. The same search in the Czech language on the already mentioned EMA.RVP.CZ portal offers 41 materials.

The question we address in the project is whether artificial intelligence (AI) can be used for the process of classification and subsequent search for suitable teaching materials. The first step, which is the choice of criteria according to which the teaching materials will be sorted and searched for and the subsequent verification of the suitability of these materials by a team of researchers. In (Jančařík, Novotná and Michal, sumitted), a system proposed for classification of electronic teaching materials, based on existing curricular documents, was presented from the perspective of the content of materials. In the here reported research, the aim is to verify whether it enables to decide for each material unambiguously about its mathematical theme, age-level and quality. If not, the reasons for negative answer will be looked for and a modified system of keywords will be proposed. The results of the presented research will be used as the basis for teaching AI to recognize teaching materials. Moreover, it offered a valuable insight into the ways through which different curricular documents approach the system of teaching materials classification.

MATERIALS AND METHODS

One of the main criteria according to which teaching materials are searched for and sorted is naturally their content. The aim of the project is also to make it possible to use AI to determine which topic the given teaching material focuses on. As part of the research that we present in this paper, we came from three content classification systems that we have designated as FEP, CERMAT and Faculty of Education (FE).

Classification according to the FEP system is based on the curricular document Framework Education Programme for Secondary General Education (FEP SGE, 2007), which presents all the compulsory requirements for education on all secondary grammar schools in the Czech Republic. The materials are classified according to the expected outcomes the materials target (e.g. The pupil shall use the properties of the divisibility of the natural numbers.). This system was used, among other reasons, because it is used for classification of materials on the portal EMA.RVP.CZ, which is the source of materials that we classified.

Classification according to the system CERMAT comes out of the document The Catalogue of Requirements for the Maturita Exam (CERMAT, 2014), which also specifies the requirements for students who take the state maturita examination in mathematics. This system classifies teaching materials according to the skills that a student has mastered (e.g. the student can distinguish between prime and compound numbers).

The third used system of classification of teaching materials (called FE) is a system designed by the authors of the article and is based on the curricular document FEP EE (2021), which defines the compulsory requirements for education at all elementary schools in the Czech Republic. The authors of the paper have supplemented the system and expanded it in a way to meet the needs of classification better than for example the FEP. The authors do not rely on the expected outcomes, but use classification based on the content because in their experience it better corresponds to the way teachers approach teaching materials and to what parameters they use in their searches.

RESULTS AND DISCUSSION

Given the questions we are trying to answer in our research, we have divided our research into two basic stages described below.

Stage 1

The first goal was to find an answer to the question which keywords characterizing the task or which theoretical information about the concepts of school mathematics are clear enough to be recognizable by AI. We used the above listed three classification systems. The keywords we followed were agreed upon in collaboration with colleagues from other areas of education so that the research results could be used for other subjects. The following indicators were monitored:

- Quality (scale 1 – 5, 5 the highest quality)
- Inclusion in the topic in FEP, CERMAT and FE (it was possible to select one code, but also several codes if the material covered more areas, or not to select any code)
- Grade for which the material has been developed
- Activity (5 values: explanation, practice, discovery, combination of explanation with practice and explanation with discovery)
- Difficulty (3 values: basic, standard, difficult)
- Prerequisite knowledge (according to the codes in the CERMAT database)
- Time requirements (in minutes)

Obviously, if we – the authors of this paper – do not agree as evaluators on determining the keyword values, it will be almost impossible to use classified teaching materials to teach AI and AI will not be able to search for suitable materials.

This stage of research was divided into two phases that followed each other:

Phase 1: Individual assessment of materials from the EMA portal

Phase 2: Comparison of the assessment of 10 of them (random selection)

49 materials from the EMA portal were selected for the 1st phase. These 49 materials covered most topics. Each evaluator created a table in which they put their assessment in the different key words. Figure 1 is an example of one of the tables designed in this phase.

In the 2nd phase, 10 problems were randomly selected, and a comparative analysis of their assessment was conducted.

The findings of phase 2 are the following:

- The only unequivocal indicator is *Activity*.
- The differences in indicators *CERMAT* and *Difficulty* are small, they can be regarded as clearly distinctive.

- The previous situation is close to the use of classification according to the system *FE*.
- There is not one single agreement in the indicator *Time requirement* but the differences are small. The differences can be accounted for by the fact that time requirements depend on the individual characteristics of the solver. Thus, they are hard to compare.
- The indicator *Quality* is not distinctive enough. It is a subjective category and thus greater differences are not surprising.
- In case of the indicator *FEP*, there was not even one complete agreement and large differences in classification prevailed. This is due to the nature of the FEP, where the main attention is focused on the outcomes of individual stages of education, not on its course; therefore, in some cases, it is difficult to determine where to place the task.
- Two of the indicators, *Grade* and *Prerequisite knowledge* cannot be regarded as suitable for automatic search.

EMA URL	Name	Quality	RVP	CERMAT	PEDF	Grade	Activity	Difficulty	Prerequisites	Time
https://ema.rvp.cz/material/481	LINEAR FUNCTION	3	41	422	2231	9	4 - explanation	1 - basic		
https://ema.rvp.cz/material/697	LINEAR FUNCTION GRAPH	1	41	422	2231	9	2 - practice	2 - standard		
https://ema.rvp.cz/material/61838	PROPERTIES OF LINEAR FUN	4	41	422	2231	9	2 - practice	2 - standar	64	30
https://ema.rvp.cz/material/9223	FUNCTION - DETECTIVE	3	4	4	22	9	2 - practice	3 - difficult	326	90+
https://ema.rvp.cz/material/5735	PEXESO – LINEAR FUNCTION	3	41	422	2231	9	2 - practice	2 - standar	111	25
https://ema.rvp.cz/material/33389	LINEAR FUNCTIONS - GRAPH	3	41	422	2231	9	2 - practice	2 - standar	133	30
https://ema.rvp.cz/material/3615	EXAMPLES OF LINEAR FUNC	3	41	422	2231	9	1 - explanation	2 - standard		20
https://ema.rvp.cz/material/5312	LINEAR FUNCTION GRAPH	3	41	422	2231	9	1 - explanation	1 - basic		45
https://ema.rvp.cz/material/33436	LABYRINTH - LINEAR FUNCT	2	41	422	2231	9	2 - practice	2 - standard		25
https://ema.rvp.cz/material/2812	FUNCTIONS - GRAPH OF LIN	3	41	422	2231	9	1 - explanation	1 - basic	13	90+
https://ema.rvp.cz/material/702	LINEAR FUNCTION	3	41	422	2231	9	2 - practice	1 - basic	42	45+
https://ema.rvp.cz/material/5540	INDIRECT PROPORTION GRA	3	4	425	222	7	4 - explanation	2 - standar	611, 612	30
https://ema.rvp.cz/material/3751	INDIRECT PROPORTION	3	4	335	2223, 2222	7	4 - explanation	2 - standar	11	30

Figure 1: Extract from the table of assessment of materials according to specified keywords

Stage 2

At this stage, 338 digital materials were classified by the team of evaluators. Most of them were developed to practice the content (185 cases). The second most frequent type were materials containing explanation and practice (72 cases). In 51 cases the materials were designed as explanation of the given content. There were only 8 materials targeting pupils' independent discovery or construction of knowledge. Discovery combined with explanation was in two materials. Only in five cases we can talk about a material that addresses all – explanation, practice and discovery.

The difficulty of the materials was assessed on a three-level scale. Most materials (227) were assessed as Basic. 86 materials were of standard difficulty. 15 materials were assessed as difficult. From the occurrence of difficult tasks and materials designed for discovery, it can be concluded that most materials are intended to meet lower order thinking skills, they mainly focus on remembering and application.

As far as the quality of materials is concerned, the final assessment was based on a number of criteria. Both mathematical correctness and the use of appropriate didactic principles were included in the evaluation. Other factors of task evaluation were, for example, the originality of the material and its added value compared to the "analogue" form, visual processing or clarity. Among other things, the presence of task results where this was appropriate was assessed.

Each of the assessed tasks got one of five marks. The highest mark was achieved only by 18 materials. The second-best rating was achieved by 76 materials, the third 145, fourth 78 and the worst mark was given to 11 materials. (Figure 2).

The assessment of materials showed several repeated phenomena:

- What can be evaluated as positive is the large selection of materials and their diversity. In addition to PowerPoint presentations, which were together with worksheets most strongly represented, the materials also included videos, ideas for classroom activities, tests or various interactive environments for individual practicing. Materials in the form of didactic games were highly evaluated. These were often imaginative, original and suitable for use in the classroom. On the other hand, all of them were designed "just" for revision.

- What must be seen as negative is the fact that many materials did not provide any added value compared to non-digital form. A large number of presentations were disturbing due to inappropriate graphic design with too many colours, fonts and pictures in one slide. Also, there were a large number of presentations with inappropriately long sections of dense text. Factual errors and inaccuracies appeared in the materials, albeit in terminology, derivations or presented solutions. As the results in Figure 4 suggest, absolute minimum of tasks was constructivist-oriented. Usually the materials targeted simple information transfer. Although the richness and quantity of materials was mentioned, it should also be stated that some topics were less represented than others. For example, the topic of financial mathematics, which is one of the requirements for the national CERMAT entrance examinations, was almost not represented at lower and upper secondary school levels.
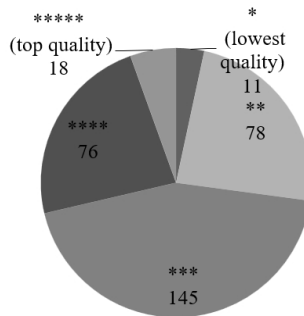
Figure 2: Quality of the assessed materials

The materials were further classified according to the topic they cover. The classification was done in three different taxonomies. The first taxonomy was the expected outcomes of the FEP. However, assessment according to this structure of topics did not prove to be quite suitable as the outcomes are often too general to be the basis for search for specific types of materials. Also, it was often difficult to match a topic with a defined expected outcome. Sometimes, it this was not possible at all, or only very inaccurately. In addition, the pupil, the parent and even the teacher cannot be expected to search for the material on the basis of the outcome stated in the FEP. Therefore, another taxonomy was used. These were the requirements for knowledge and skills that national CERMAT entrance examination is based on. In this case, it was possible to match most of the tasks with one of the defined requirements. However, the categories were not always specific enough. Therefore, these requirements were extended by other subtopics, often specific phenomena that the teacher, parent or pupil is more likely to be searching for. The mind map that was created for this purpose (see Figure 3) also outlines some of the relationships and connections between the various topics. These greatly facilitated the assessment when a material fell into more than one category. The tree structure with the mentioned interconnections made it easier to find such topics that are a suitable prerequisite or co-requisite to the given topic. These links in the curriculum were also mentioned in the assessed material, if it was possible and meaningful. This newly created taxonomy was linked to the outcomes of the FEP. This enables translation of the topics (in at least one direction) and easier assessment.
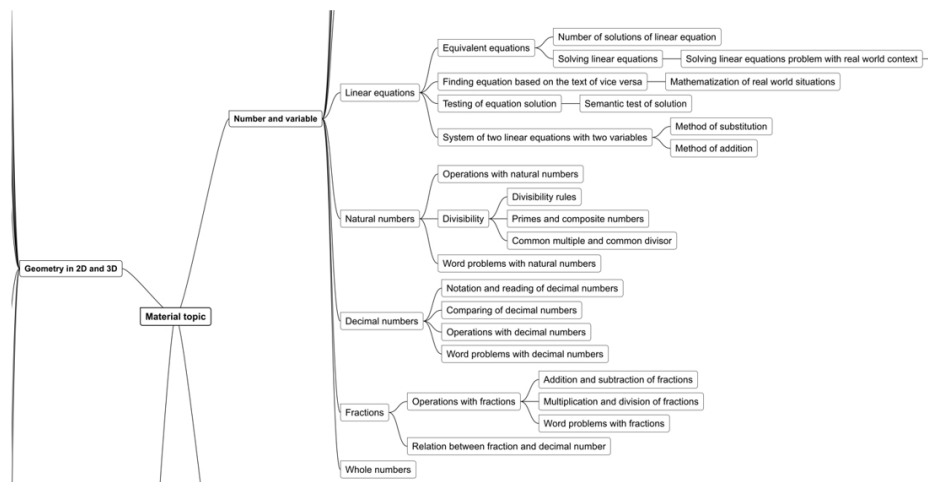
Figure 3: Third taxonomy (FE) – a fragment

CONCLUSION

The presented research served not only as a basis for subsequent teaching of AI to classify teaching materials, but also provided valuable insight into the way different curricular documents approach the content of the curriculum and understanding the basic links and into connections between the various topics in school mathematics.

These results show that when creating models of learning that AI should support, it is not possible to build only on organization of the content in the curriculum. Cross-links and interconnections of the areas that are presented separately in the curricular documents must be taken into account.

Another important finding is that it is very difficult to find not only in the individual materials but also in general the connection between the expected outcomes, the content and the subsequent requirements for the state maturita exam. This finding will require further in-depth study and can also serve as a very important contribution both to the ongoing discussions on the form of the Maturita exam and to the forthcoming revision of curricular documents.

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PORTFOLIO AS A TOOL FOR FORMING STUDENT-TEACHERS' PEDAGOGICAL BELIEFS

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Abstract

The paper presents a part of ongoing research. The research focuses on student portfolios at various levels. These levels are assessment of professional knowledge, professional skills and the process of personal development of the future teacher. The motivation for this effort is ongoing changes at schools, in approaches to teaching, in approaches to pupils and also our need to contribute to the improvement of mathematics education. We will present here a tested tool for analysis of research data, especially portfolios and interviews. The results of the research will be compared with similar foreign research. In the conclusion we also propose possible ways for further work and research.

Keywords

Personal development, student portfolio, self-confidence, teacher's beliefs

Introduction

In 2009, a discussion on the need to improve the quality of mathematics education in elementary schools was opened in the Czech Republic also at the level of the decision-making sphere. Especially the unfavourable results of Czech pupils in the international comparative studies TIMSS 2007 and PISA 2009 contributed to the opening of this discussion. The main problem was the negative attitude of pupils to mathematics and their attitude to learning in general. At present, the community of didactics of mathematics have already accepted that the decisive element in the didactic triangle pupil-subject-teacher and in the formation of pupils' attitudes to education is the teacher's personality and his/her approach to teaching. The McKinsey study (2010:4) is alarming: "To improve the quality of teaching, we need to change the attitudes and behaviour of people – in this case more than 100,000 teachers – and this is an extremely difficult task for any organization." Any changes in education tend to be difficult and long-term due to the considerable inertia of the school system. Especially since about half of Czech teachers are satisfied with the current situation and do not feel any need for change, as evidenced by research, for example (Straková et al., 2013; Voda, 2010). Changing the attitude to teaching mathematics and perception of the meaningfulness of mathematics, the attitude to pupils and their individualities, to their cognitive processes and learning requires a change in the hierarchy of values in pedagogical beliefs of the teacher (Žalská, 2012). Experience shows that the transformation of a teacher who tries to change their instructional teaching style built on previous experience into a constructivist teaching style cannot be achieved as a one-off decision, albeit their own. It takes several years. There are many obstacles and twists and turns on this path for the teacher, and the teacher usually has to exert a lot of effort. Some records of such a journey, for example, can be found in the diploma theses of students who are at the same time in-service teachers. In her diploma thesis (Hlavatá, 2014), the combined study student demonstrates how she was unable to overcome an obstacle that also

involved parents of her pupils and eventually returned to the "safety" of instructional teaching. She did not manage her transformation, which was already supported by solid arguments, for another two years.

In the paper, we focus on our students – pre-service primary school teachers and their change of pedagogical beliefs during their studies at the Faculty of Education. We see in this the promise that our graduates will be well prepared to accept the requirements for high quality teaching and for the current changes in elementary education: the use of modern theories of learning, active learning, assessment and autonomous assessment of the learning process, responsive education, etc.

Student portfolios are our research tool. We have been working with them for a long time, roughly since 2009. Portfolios of high quality can be used by our students as an alternative way of taking the final state exam (Birgin, 2011). The traditional format of the final state exam in didactics of mathematics, still selected by most students, is drawing two topics that they talk about. Defending their portfolio gives students the opportunity to demonstrate their strengths more comprehensively and in depth, taking responsibility for their own learning process, the ability to see the interrelations in both didactic content and interdisciplinary knowledge, to show the ability to reflect on both their own and their pupils' learning processes as well as personal and social phenomena. Birgin (2011) reports on a similar concept of portfolios in their research studies. Students do not receive any precise instruction on what their portfolio should look like in order not to limit their creativity. They are given only the following framework requirements: the mathematical content of the portfolio should to some extent cover the content of the "traditional" topics at the state exam, each input should be justified and should contain some student's own intellectual input, at least reflection. The originality of the approach and arrangement of the materials, the depth and coherence of the reflections are evaluated more than the graphic form.

Student portfolios were also used in our research. In the first stage, we focused on portfolio analysis, looking for the turning points in a student's development and impulses that led to any positive changes in a student's attitudes to mathematics (Slezáková et al., 2017). These consist mainly of their previous experience as primary and secondary school pupils, their experience with meeting teachers who provided them with the goals of mathematics education, such as carrying out calculations quickly and flawlessly, knowing formulas well, etc., but also of some of their personality characteristics such as self-confidence and autonomy in mathematics and social area. We continuously use all the gained information to improve pre-service teacher education, considering and respecting students' diversity both in cognitive and personal areas. As part of undergraduate primary teacher education, we strive to build in students the *model-for* creative, reflective, constructivist, inquiry-based education (Gravemeijer, 1999). In each mathematics subject, they learn the teaching style we want them to use in their practice.

The second stage of our research work with portfolios started with the Covid-19 pandemic. Students had to submit their portfolios in electronic form. Fortunately, students adapted to this quite easily and we got rich, easily archivable research material. With these materials, in the second stage of our research we focus on research of the level of students' pedagogical content knowledge and changes in their attitudes to mathematics, especially changes in their pedagogical beliefs.

In the following text we describe the theoretical background for our analyses of portfolios, present the main results, compare them with results in foreign studies and then suggest the directions in future research of work with portfolios.

THEORETICAL FRAMEWORK

As the theoretical basis for portfolio analysis with respect to the possibility of characterizing the mathematics teacher's educational style, we use the tool "20 parameters". The concept of this

tool was proposed by Hejný (2012). This tool was then further developed and illustrated by three case studies by Jirotková (2012). The tool consists of twenty parameters divided into four areas:

A. A teacher's beliefs
1. Relationship to mathematics
2. Goals of the teaching of mathematics
3. Educational style (transmission versus constructivist)
4. Interactional style towards the pupil, class
5. Interactional style towards colleagues, school government, inspection
6. A need to develop his/her competence

B. Life experience as a springboard for the teacher's pedagogical beliefs
7. Where it comes from
8. What it concerns
9. What is missing
10. How it is reflected (analyzed)
11. Which experience resulted in the shift of the teacher's beliefs

C. Personality
12. Self-confidence in the area of pedagogy
13. Self-confidence in the area of didactics
14. Self-confidence in the area of mathematics
15. Self-confidence in the social area (towards colleagues, school management, inspection, parents)
16. Assessment of one's own educational style (does it correspond to reality?)

D. Abilities / competence
17. Pedagogical: class management, individualization, creating and maintaining the climate, work with mistakes, patience, etc.
18. Didactic: motivation, conception of the ontogeny of concepts, relationships, processes, languages, problem, diagnosis of pupils (understanding their ideas), evaluation of pupils, re-education, etc.
19. Mathematical: knowledge of solving strategies, ability to experiment, to generalize, to pose problems with required characteristics, etc.
20. Social: interaction with colleagues, school management, inspection and parents.

Of these parameters, we are particularly interested in those that we can influence in pre-service education and thus contribute to formation of pedagogical beliefs and, as a result, to the educational style of the future teacher. These are namely relationship to mathematics (A1), self-confidence in the area of mathematics and didactics (C14, C13), both mathematical competence (D19) and didactic competence (D18) and life experience with the role of a teacher (B). A very important area that needs to be worked on with students is the area of self-confidence (C12-15). According to the OECD Teaching and Learning International Survey (TALIS) 2013 Results – Excel Figures and Tables (2015) analysis, Czech teachers were last but one from the 34 participating countries in this area.

In the following text we describe what research data we work with, how we collect them and what methods we use for their analysis.

Materials and methods

The richness of our research data enables analyses focusing on different aspects. The research reported in this paper is driven by the research question: Does a student portfolio in the area of didactics of mathematics contribute to the formation of pedagogical beliefs of pre-service primary school teachers?

Data collection

The research database consists of the following materials:

- written experience from work with portfolios since 2009,
- a collection of portfolios in electronic form ($n = 42$). The Covid-19 pandemic (since 2020) forced the students to submit their portfolios in an electronic form and university teachers to find efficient ways of their assessment. Thanks to this we have a very valuable research material that can be used for different research studies with different goals.
- selected answers from questionnaires filled in by our graduates-novice teachers ($n = 96$). In 2021, as part of one activity in the SPIN project (focused on the connection of theory and practice financially supported by the Czech Savings Bank Foundation and the Faculty of Education, Charles University) in which we focused on the care for our graduates – novice teachers, we organized an extensive questionnaire survey. Several questions concerned the creation of a portfolio during their studies, the use of the portfolio to demonstrate pedagogical content knowledge of mathematics in the final state exam and the work with the portfolio in their first years in practice. One of our activities in supporting novice teachers (Teacher novice café) is reported by Vybíralová (2021).
- transcribed structured interviews with fresh graduates who defended or did not defend their portfolio in the final state exam ($n = 15$). The interviews were conducted in 2021.
- materials created in cooperation with the Department of Primary and Pre-primary Pedagogy concerning the structure and assessment of student portfolios. Recently, we have been working within the SPIN project on strengthening cooperation with other departments that are involved in the education of the same future teachers. The area in which we find it necessary to connect is the area of portfolios – their creation, assessment and portfolios as the tool used to demonstrate pedagogical content knowledge in the final state exam.

Methods of analyses

The answers from the questionnaire were analyzed using coding. The above listed 20 parameters functioned as the codes. Other material was subjected to phenomenon analysis.

Results

The results of our student portfolio analyses are partially presented in (Slezáková et al., 2017). Data from pandemic time do not bring significant changes to the results.

Analyses of selected answers to open-ended questions in the questionnaire survey yielded similar results as analyses of structured interviews with recent graduates of primary school education. Therefore, we present only interesting and most frequent phenomena from the analyses of the transcribed interviews with the fresh graduates from the study field Primary School Education and illustrate them with graduates' opinions expressed in the interviews.

A very frequent phenomenon was the respondent's

(A) perception of meaningfulness of the portfolio that the respondents saw in the following three aspects.

- not memorizing but learning to understand

R1: "it makes sense to me because I do not have to learn quickly much information that I will forget soon."

R2: "I decided to go for the portfolio because of its meaningfulness. I could make use of most of my work from last six years. That seemed much more important than memorizing some topics."

- connecting theory and practice

R3: "Primarily it made me systematize theoretical concepts from didactics of mathematics. I went through the topics again and studied relevant literature, I was thinking like a mathematics educator.

- systematically processed materials

R4: ".... So that I would have better sorted and systematised materials from my studies."

Another phenomenon was *(B) benefit for the future.*

R5: "… because I think this is a material I can use in my future practice."

R6: ".... And also the school where I want to teach works with portfolios so it makes more sense to me."

R7: "… when working on the portfolio I followed the document Teacher competent for the 21st century and this document is used at my school for assessment of a teacher by other teachers so it is a structure I will be working with in the future."

Another identified phenomenon is *(C) self-development.*

R8: "… portfolio includes all that I had to discover on my own, I saw my growth and development, portfolio taught me a lot. "

An interesting phenomenon is the phenomenon of *(D) self-presentation.*

R9: "… I lent my portfolio to my assistant so that she could understand what I do, why I do it and how I mean it."

As already mentioned, an important phenomenon in professional development is *(E) self-confidence.* The respondents state that

- they needed more detailed information – they did not trust their creativity and their ability to create something autonomously and thus they did not feel safe.

R10: "… as I did not have enough information about the portfolio I did not think it was a safe option for me."

- on the contrary, portfolio meant support and security during the exam

R11: "… Because I am not very self-confident in mathematics and portfolio, although it was hard work to prepare, was more comfortable for me because I knew I would have something to rely on. The idea that it is made of materials that I myself created made me feel calmer."

- they did not trust the quality of materials they had collected during their studies

R12: "… I felt I did not have enough materials to succeed, that my materials were insufficient."

- they did not trust they were able to systematize their materials

R13: ".... I failed to find a system to organize those materials. I remember crying, throwing papers around the room, deciding not to do it because I didn't know how to put it together."

- they needed support, motivation

R14: "Everyone was giving up on it and you were one of the few who encouraged me to do it, that it was worth the effort. And that was what I needed to hear." (This was a consultation with an experienced graduate from a few years ago.)

Discussion

The analyses of answers to the open questions from the questionnaire survey for the graduates brought no new knowledge concerning the formation of pedagogical beliefs of our students during their studies at the Faculty of Education, therefore we do not present them here.

In accordance to Birgin (2011) we state that today's demands on development of skills and understanding, on work with data and development of information literacy from lower grades of primary school bring about changes in teacher education and, of course, in assessment. Elementary schools are on the way of abandoning traditional evaluation of isolated pupil's performance and assessment shifts to assessment of the learning process. We are adapting to this in teacher education. We have been using the defence of student portfolios as an alternative form of the final state exam successfully for several years. We believe that the alternative form of passing the exam in the form of drawing topics still needs to be maintained as different cognitive and personality types of students perceive things differently. Some students regard portfolio as safety, some on the contrary see it as a threat and prefer to avoid it. Some students see the portfolio as meaningful and useful for their

future practice and are willing to invest a lot of effort and time into its creation, others lack this motivation. Some students chose as a framework for their portfolio the officially accepted document defining a quality teacher (Teacher Competent for the 21st Century), which helps them see the portfolio as useful for the future. Similarly, in the study (Breault, 2004) student learning portfolios were assessed on the basis of the Interstate New Teacher Assessment and Support Consortium (INTASC) framework, which was designed to assess and support novice teachers in the USA.

Our results also provide negative feedback on the effectiveness of portfolio creation and its use in demonstrating pedagogical content knowledge at the final state exam as reported by students. These findings are also fully consistent with findings such as (Birgin, 2011; Bairral and dos Santos, 2012; Chamoso and Cáceres, 2009; Buchholtz et al., 2018). In fact, there is no consensus on the approach to portfolio assessment even among teachers. The more space is given to the creativity and student's self-expression, the more the portfolios show various aspects of students' knowledge, skills and attitudes. This in turn leads to difficult-to-adjust evaluation reliability, both among portfolios and among evaluators. We are currently cooperating with the Department of Primary and Pre-primary Pedagogy within the joint SPIN project on the issue of harmonizing the requirements for portfolios that can be defended at the final state exam and on the criteria for their evaluation.

Today's world offers new tools that we have learned to use in the time of Covid-19 pandemic. Among other, it has given us the opportunity to work with portfolios in electronic form. Inspiration for how students can work with e-portfolios and follow their own learning process, the ability to integrate different areas (geometry, algebra, psychology, technology, language, etc.) can be found in the study (Bairral and dos Santos, 2012). The new idea that we are planning to use in our further work is to provide a platform allowing to share portfolios among students. Then portfolios would become an important tool for exchange of information, for change of discourse and for promotion of ideas, concepts and ways of thinking, a tool supporting metacognitive thinking. In this form, the student portfolio will better serve our purpose, namely the effort to influence the pedagogical beliefs of our students.

Conclusion

In the paper, we tried to prove and by comparing with foreign studies to confirm the usefulness of creating a student portfolio for various purposes – demonstrating knowledge (content knowledge), demonstrating pedagogical content knowledge and documenting the development of the student's personality as of a future teacher and their preparedness to enter practice. In the Czech environment, Tomková has long been involved in student portfolios, and in her study (Tomková, 2018) she clearly shows that the portfolio is a meaningful tool for development of both students and teachers.

Our research question has shifted from the question of the importance of the portfolio for demonstrating skills and knowledge in exams to the role of the portfolio as a tool for development of pre-service teachers' personality. For this reason, we support long-term portfolio creation even by students who do not intend to use it as an alternative form at the final state exam. We are looking for an effective format of the portfolio that would eliminate as much as possible the above described difficulties in its creation and its evaluation, and at the same time would allow students to strengthen their didactic and mathematical self-confidence, would document the development of their relationship to mathematics, identify the stimuli that caused change, (Zemanová and Jirotková, 2020) and allow them to see their strengths and weaknesses.

The reported tool of analysis of interviews or reactions to open questions is especially suitable for discovering the ways in which it is effective to influence the student to be a confident, life-long learning, reflective teacher. We put a lot of effort to linking all our results to our teaching and to our work with students.

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AN EYE-TRACKING STUDY ON THE EFFECT OF KEYWORD HIGHLIGHTING ON STUDENTS' READING COMPREHENSION

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Abstract

Due to the COVID-19 pandemic and related safety measures, it was necessary to make the transition from full-time in-person learning to distance learning, significantly limiting the ability to conduct eye-tracking measurements. If necessary, these kinds of experiments need to be conducted rapidly or be able to be conducted remotely. For the needs of distance learning, we have developed a new method that allow us to conduct several research experiments in the field of eye-tracking using widely available consumer electronics. Using this method, we have enrolled a larger group of students in an eye-tracking experiment with the intent to observe possible differences in outcomes between students reading our regular unmodified text and those studying text with visually distinguished keywords.

Keywords

E-learning, distance learning, reading comprehension, gaze tracking, eye-tracking, saccades, fixations, regressions

Introduction

Nowadays more so than ever, e-learning has become an invaluable part of education at every level. We do not use it merely for presentation of study materials, but advanced adaptable e-learning software can adapt education, individualizing it according to students' needs (Šarmanová & Kostolányová, 2015).

E-course creators are often faced with the challenge of not only preparing the e-learning materials, but also how to present them to the student's so that they can study them to their fullest potential and understand the text and information contained within it correctly. This state, when achieved, is referred to as reading comprehension. An important source and an inspiration for our activities were authors (Adler & Van Doren, 2014), who in their book, «How to read a book», describe four levels of reading:

- *Elementary reading* – The reader can recognize letters, read them and understand the basic meaning of words.
- *Inspectional reading* – The reader reads actively and can answer the basic questions about the text: What is it about, what is being said in detail, is it true and how to act on the information in the text. Taking notes and underlining important parts are essential tools in Inspectional reading.
- *Analytical reading* - This type of reading assumes the reader knows what he is reading and why. It builds on inspectional reading in that the reader inspects the book, the title, subtitle table of contents, etc. Reader can summarize in a few sentences, analyze the organization of the text or a book, confront the author's intentions and identify key sentences.
- *Syntopical reading* – Builds on reader's analytical reading skills. Reader actively reads and analyses multiple books, creates their own terminology and propositions in order to find knowledge in an area common to the bibliography created by the reader.

The end benefit of the higher-level reading is the information that the text contains. The ability to understand the text is influenced by the skills of the readers and their ability to process information. If a student has difficulty recognizing words, they use too much of their cognitive ability, which prevents them from properly understanding the text being read. Unfortunately, in our experience, students, especially those in the first year of study often struggle with reading comprehension, not utilizing the resources provided by our institution to the fullest.

To increase the readability and attractiveness of our study materials, course creators have been including relevant illustrations, as per the recommendations by Mayer's sizeable body of work (R. E. Mayer, 2014, 2017; R. Mayer & Gallini, 1990). In our experience, even after repeated readings of our study texts, a large portion of the students still have difficulties understanding the materials and eventually fail to pass the end of semester written test or oral exam.

In order to solve this issue, we have decided to focus on improving reading comprehension. In this area of research, several approaches have been tried by various researchers and educators all over the world. Traditionally, this kind of research has been conducted via methods such as the think-aloud method in which the subject describes their mental processes. However, this way of studying cannot capture these processes in real-time and may color the results by distracting the subject from their task. In recent years, this method has been increasingly supplanted by Eye-Tracking technology, which allows researchers to capture the movements of the pupil, recording gaze positions and other data describing the subject's ocular behavior. This data allows us to gain insight into the inner workings of the subject's mind, as there is a distinct link between the gaze and the cognitive process (Just & Carpenter, 1980).

Based on the eye-mind theory and the works of other researchers studying the educational process and reading comprehension, we have designed an Eye-Tracking experiment aiming to shine light into the effect of highlighting important keywords in text meant to anchor reader's focus and point it towards relevant parts of a related illustration. In our past research (Kohútek et al., 2019), we have used a head-mounted Eye-Tracking device and software developed by Pupil Labs. For our current experiment, the use of this device has been considered not feasible, due to the health and safety precautions imposed by the restrictions caused by the COVID-19 pandemic. As it was not possible to continue with in-person classes, we were mandated to move on to further develop and establish way to continue our lectures and experiments in a distance-learning paradigm. For this reason, we have had to rethink our experiment and decided on utilizing an open-source gaze tracking library WebGazer (Papoutsaki et al., 2016) as the basis for creating a method of capturing gaze data using common off-the-shelf hardware from the safety of each subject's home.

The purpose of this paper is not only to describe ways to find problem areas in current e-learning courses and their subsequent content and formal editing, but also to describe tools created to help study reading comprehension processes by means of capturing and analyzing Eye-Tracking data. In order to set a goal accomplishable using our methods, we have established a null hypothesis and research questions to be answered by its use.

H(0) - students reading the content of the provided e-course process text at inspection reading level, ie. by viewing the text and scanning it, without significant evaluation.

Related to this hypothesis we pose these questions:

- Q1- Does the visual differentiation of significant terms or keywords have a positive and measurable impact on reading comprehension metrics?
- Q2 – Can we experimentally verify whether adding visual cues to the text has caused the desired increase in students' information retention?

Materials and Methods

In our experiments, we have been using our access to the students enrolled in courses taught by us and our colleagues. One of such courses has been the Logic Systems of Computers. In this

course, students are taught how the working principles of the basic computer components (such as diodes, transistors, logic gates). It is an introductory course which is mandatory for all students of the first semester of the undergraduate level of studies. From the e-course, we have selected three subchapters and performed measurements with subsequent knowledge post-tests. Each subchapter in the experiment was also divided into areas of interest according to their content. These were Areas of Interest (AOI) containing Text, Image and Blank (white space on screen).

The measurements took place during an otherwise regular lectures, and they were divided into two instances. Students participating in these measurements were randomly divided into two groups, an experimental and a control group. All students were taking the course for the first time and have fulfilled a questionnaire regarding their previous knowledge in electronics and informatics. The students also have taken an ungraded introductory test to determine, whether or not they are familiar with the topics taught in the course. The descriptive statistics of the questionnaire and pre-learnt knowledge are shown in Table 1 in *Results and discussion.*

The texts provided to the experimental group contained visually distinguished significant keywords (bold typeface), while the control group received the same text with no visual difference between regular and significant words. Students were instructed to read at their own pace; however it was unlikely that they would require more than a 5 minutes to read each text. This was shown to be a correct assumption, as even while reading the longest text (T2), the maximum duration a student spent reading it was 129 seconds in the control group, 127 seconds in the experimental group. During the first instance, the students were asked to read two short texts explaining basic terms related to electronics (T1) and electric current (T2). As the texts were connected in the topic and less dense information-wise, they were grouped together. Immediately after reading both texts, students were asked to take a short post-test containing 5 questions related subject matter. The second measurement session took place a week afterwards. Students had been read repeated instructions pertaining to the measurements. Afterwards, they were asked to read a third text (T3), with the topic of bipolar transistor. The text also contained a simple illustration showing the difference between an NPN and a PNP-type transistor. The post-test (P2) contained three questions related to the subject matter.

For the capture of the gaze data, we have opted for utilizing an existing eye-tracking JavaScript library (Webgazer), embedding it in a simple website showing the selected chapters of the e-course. This library allows us to outsource the load of running a resource intensive eye-tracking onto every client browser, using the built-in or regular off-the-shelf web camera for capturing the gaze and predicting it's focus point. In our experience, using this library allows users to capture gaze points with the relative accuracy of 100 by 50 pixels.

In our gaze tracking measurements, we have studied eye movements of subjects reading educational text and studying visual aids. Regular activity of the human eye consists of various distinguishable movements, the most important of which are the saccades and fixations. The saccades are very fast movements from one object of interest (e.g. syllables in a word), usually lasting less than 100 milliseconds. Fixations are longer periods of time, usually lasting from 100-600 milliseconds, during which the eye is almost motionless. While reading, eyes move by the way of continuous alternations of saccades and fixations, rather than smooth tracking. Another important type of gaze behavior are regressions, a specific combination of saccades and fixations. By regressions, we understand backwards jumps to previous words or to the beginning of sentences, often indicating confusion or misunderstanding. Their increased frequency may imply higher complexity of the text, but may also reflect the cognitive state of the reader (Walker, 2021)

When recording eye-tracking data, we focused on the following metrics - total time spent studying the material, total time, average lengths of fixations, and number of fixations in each AOI, number of regressions in the text (backward saccades greater than the length of an average word) and number of view transitions between illustration and text.

To map and visualize eye movement, we have used heatmaps, using a color scale corresponding to the gradient cold-heat (blue-red). As a result of applying a heatmap to a mapped region, we obtain a graphical representation that can help authors and teachers better understand how students work with the study materials provided.

To ensure the least possible variability of conditions, we used a classroom containing twenty laptops with the same hardware and a 720p webcam for the experiment. The students then used these laptops to access the course in an environment with uniform lighting conditions, webcam quality and screen size (standard FullHD 15.6"). 80 full-time students took part in the experiment, which we randomly divided into control and experimental groups. The control group read the text without visually distinguishing the keywords. The experimental group read the same text, but with keywords emphasized in bold.

RESULTS

Due to various problems (absence from classes, health problems, quarantine, indeterminate measurements), we gradually had to remove some students from participating in our experiments. All measurements and post-tests were successfully completed by 42 students, 18 from the control group and 24 from the experimental group. At the end of the semester, 29 of them successfully completed the class (17 from the experimental, 12 from the control), 13 students did not meet the conditions necessary for successful completion (7 from the experimental, 6 from the control group). Table 1 shows the knowledge background and the results from the entrance test.

	Knowledge background		Entrance test		P1 Post-test		P2 Post-test	
	C	E	C	E	C	E	C	E
Valid	18	24	18	24	18	24	18	24
Missing	0	0	0	0	0	0	0	0
Median	5.500	4.750	48.335	53.330	58.330	51.390	66.670	66.670
Mean	5.306	4.500	50.323	49.374	52.623	54.919	63.581	57.638
Shapiro-Wilk	0.959	0.955	0.895	0.935	0.928	0.963	0.896	0.871
P-value of Shapiro-Wilk	0.582	0.341	0.047	0.128	0.177	0.492	0.049	0.005
Minimum	0.500	0.500	32.500	17.500	11.110	0.000	16.670	0.000
Maximum	9.500	10.000	90.000	71.670	83.330	100.000	100.000	100.000

Table 1: Students' knowledge before taking the course and after the experimental readings

As we can see from the Table 2, there is no significant difference in the previously gained knowledge or upbringing between the experimental and control group.

	t	df	p
Knowledge background	1.057	40	0.297
Entrance test	0.219	40	0.827

Table 2: Student's Independent Samples T-Test on knowledge background and entrance test results.

Based on the related works from other researchers, we assume the number and durations of fixations, number of regressions, the presence in the two AOIs as well as the results of the post-tests as the measures of reading comprehension. As the tables containing inconclusive results would be to space-consuming, we will give access to the anonymized data at a request and present them at the time of presentation. However, we do include a table showing the correlation between the selected variables and the test results of the post-test taken immediately after the experimental readings (Table 3).

Correlated variable	T1 Total time	T1 Time on blank	T1 Regressions	T2 Time spent reading	T2 Time on image	T2 total number of fixations	T2 Fixations on text	T2 fixations on image
Pearson's r	0.338	0.301	0.406	0.305	0.284	0.264	0.303	0.287
P-value	0.014	0.026	0.004	0.025	0.034	0.046	0.025	0.032

Table 3: Pearson's correlation between P1 test score and eye tracking data from first two readings

Similarly, Table 4 shows the correlations of the measured data from the third reading against the results of the second post-test. The results of measurements in the third subchapter showed the opposite trend compared to intuition and previous work.

Correlated variable	T3 time on picture	T3 Fixation count	T3 fixations on image
Pearson's r	0.369	0.311	0.377
P-value	0.016	0.045	0.014

Table 4: Pearson's correlation between P2 test score and eye tracking data from third reading

Based on a study of the work of our predecessors, we assumed an increase in the concentration of attention on the text and the image and a reduction in stray glances outside the study material. However, our observations do not support this hypothesis. In addition, when composite heatmaps were formed, our suspicion was confirmed, and we observed a decrease in a slight, but not significant decrease in attention in the experimental group.
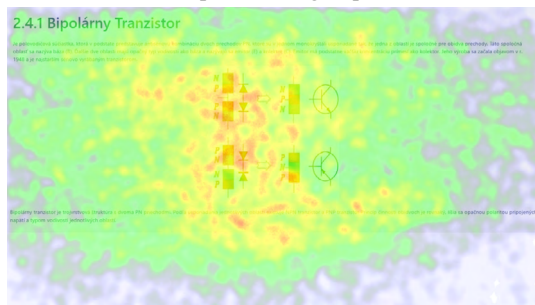
Figure 1: Composite heatmap - Text 3 without highlighted keywords

In this composite heatmap, we see that more attention of students was focused on the image, while less attention was paid by students to the educational text itself.
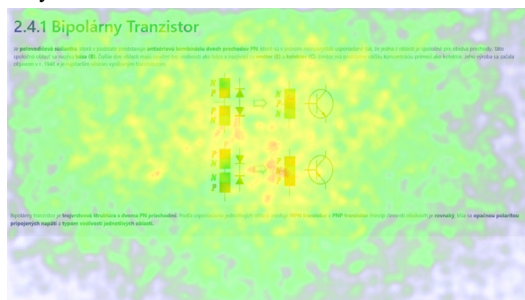
Figure 2: Composite heatmap - Text 3 with highlighted keywords

The weighted composite heatmap of the experimental group shows a lower concentration of the image, but without the expected shift of attention to the text.

We made other interesting observations when we moved on from the strict division into experimental and control groups and created new groups based on study results. After dividing the students into three groups according to the final score, we discovered unexpected relationships. While in the worst performing and average students the inclusion in the control and experimental groups was balanced (6: 6, 9: 9), in the best performing student group this ratio had a significant incline the experimental group. From the experimental group, 9 students were placed in the top 12 of the year, while only 3 were in the control group.
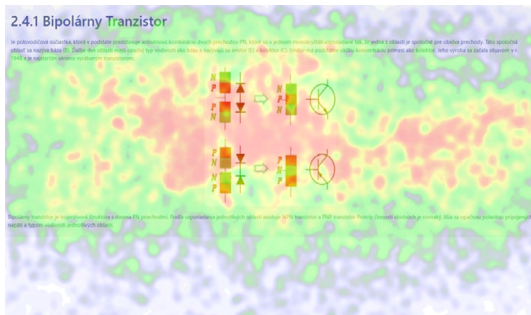
Figure 3: Composite heatmap - top tercile students according to final test score

As we can observe on these two composite heatmaps, while we haven't been able to reliably distinguish between the users in the experimental and control groups, we can clearly see the difference in gaze patterns between students lacking concentration, and those who are focused on learning from the provided courses. If further validated and developed, this may become an useful tool in identifying students that are in high risk of failing the course, so that the teachers may offer help or guidance to prevent this negative outcome.
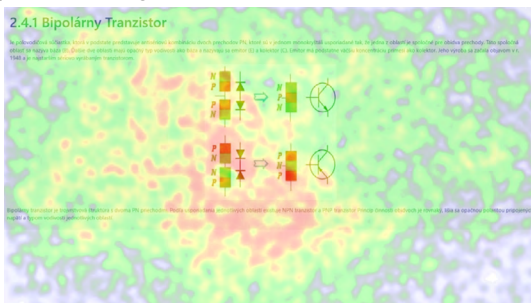
Figure 4: Composite heatmap - bottom tercile students according to final test score

Ultimately, we have concluded that the majority of our students simply briefly scan the text and do not work with the text to a greater degree. We have tried to measure to what degree would a visual cue help focus students' attention however we did not find any significant difference in the resulting knowledge, nor the gaze patterns exhibited by the students. For this reason we state that the visual differentiation has no measurable impact on reading comprehension metrics.

DISCUSSION AND CONCLUSION

Previous research suggests that students who study interpretive text with illustrations perform better than students who studied simple text. If the educational materials contains both verbal and visual information, the learning can be improved, however, students are sometimes forced to

divide their attention between text and illustrations in multimedia learning materials, causing a net negative effect. One of the proposed solutions to this problem is the spatial integration of related text and images (Sweller & Chandler, 1992). This design has been validated to find that learning outcome is better when related text and images are placed near the integrated study material, instead of being separated in space (Moreno & Mayer, 1999). Mayer has published several articles dealing with various aspects of the use of multimedia in teaching and puts forward a number of generally accepted hypotheses (Clark & Mayer, 2016; Fiorella & Mayer, 2017; R. Mayer, 2017; R. Mayer et al., 2014; R. Mayer & Estrella, 2014). Based on the eye-mind hypothesis, which states that there is a strong correlation between where one looks and what one thinks about (Just & Carpenter, 1980) it is possible to point out the relationship between eye fixation behavior (place, duration and sequence) and a cognitive processing model for both graphic and textual visual materials. Rayner emphasizes that longer fixation times generally indicate more processing and reflect difficulties such as meeting a low-frequency word or a word that is contextually unlikely (Rayner, 1998). Further research has suggested that the longer the fixation time recorded is associated with better transmission performance (Ozcelik et al., 2009). (Rayner et al., 2010) proposed eye movement parameters, such as the number of fixations, the average duration of fixation, and the total inspection time, which are particularly important for learning. In our experiments, we have not observed a connection between visual cues and highlighting of important keywords and changes in eye movements measurements.

Some studies using eye tracking as a method to examine students' attention distribution in relation to various components of teaching materials, such as text, graphics, illustrations, and so on, have been conducted to reveal how students spend their cognitive resources on multimedia information (Hyönä, 2010). Other approaches, measuring other physiological signals (Francisti et al., 2020) have been used to identify students' emotional state and may in the future be used in combination with eye-tracking techniques for automated adaptation of learning processes.

In order to validate Mayer's thesis, (Ponce et al., 2018) has been conducting eye-tracking measurements, stating that the combination of several different learning strategies can improve information retention, resulting in better overall performance in tests. In their experiments, subjects has been separated into groups based on instructed learning strategies - reading only, reading while highlighting passages, reading while making annotations, reading while filling in the graphical organization of ideas and all combinations of the two selected strategies. As for the selected eye-tracking metrics, they focused on the transitions between the upper and lower part of the study materials and on the durations of fixations. These transitions, often referred to as integrative saccades are gaze jumps from the first paragraph to the second and vice versa. The authors assume, that the elevated transitions may be connected to the cognitive information processing needed to organize and integrate knowledge. We have conducted a similar experiments, instead looking at the visuals of the study materials themselves. However, we did not find significant difference in the number of transitions nor the durations of fixations. We did, however, observe this difference between the best and worst performing students, with better achieving students conducting more eye-movements on average and spending more time looking at the study materials.

(Abundis-Guitiérrez et al., 2018) have studied the oculomotoric differences between less and more skilled readers. Similarly to us, they too observed differences between readers of various skill levels. In our case, however, it seems that less skilled and average skilled readers are somewhat similar in their approach to text, while exceptional students do show visibly different patterns in relevant metrics (time spent reading, number and durations of fixations, number of regressions).

The data obtained by our measurements partially refutes the assumption that the visual differentiation of keywords will improve students' ability to adequately process the provided

text and integrate knowledge. Despite expectations, the results of students in the experimental and control groups were not statistically significantly different, and even direct inspection of the visualization using heatmaps shows the opposite trend. It is possible that in the case of a borderline-optimized text written according to verified didactic principles, further interventions have an immeasurable or even counterproductive effect. Nevertheless, we found interesting phenomena in the measured data. While the first two subchapters showed a positive correlation of the P1 test results with the total time, time spent looking at a blank screen, reading, observing the image and fixation counts in the text and the image AOIs, the results of the second P2 test found correlations only in connection with time and number of fixations concentrated on the image. It is possible that this phenomenon is associated with the information density of the image in the third subchapter, but further experimental measurements need to be performed to verify it. Based on this, we think that although the eye-tracking method may not find suitable application in improving an already optimized text, it can have another, no less important function in education. It can help us not only identify students who need additional motivation or help understanding the lectures, but it also tells us which part of the multimedia study materials is most beneficial for the students. However, it is not a categorically strict decision between a greater emphasis on text or illustrative materials. We observed that in the case of the first post-test, repeated reading of the text (regression) had by far the strongest positive correlation with the amount of acquired knowledge, while in the second post-test it was time and fixations concentrated on the presented illustrative image

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LEVEL OF SELF-COMPASSION AND ITS CONNECTION TO ACADEMIC ACHIEVEMENT AND GENDER BY UNIVERSITY STUDENTS

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Abstract

The support of self-compassion is one of the crucial goals of mindfulness-based programs whose importance between well-being-centered approaches became unquestionable. This article follows the lineage of research on the self-compassion of university students. Its objectives consist of the assessment of the level of self-compassion by the students of the Faculty of Economics and Management (FEM) at the Czech University of Life Sciences (CZU) to precise the planned mindfulness-based intervention. For this purpose, the Self-compassion Scale was used. Further, we observed the connections of self-compassion with academic achievement as well as gender-related specifics. The results proved insignificant correlations between the self-compassion subscales and self-reported grades, but also subtle differences in the structure of the self-compassion by males and females.

Keywords

Academic achievement, mindfulness-based intervention, self-compassion, self-efficacy, university students, well-being

Introduction

The mental health of the population has been a research topic for decades. Also, it is one of the crucial conditions of efficient education. A student with considerable mental problems loses attention, general cognitive capacity, and – unfortunately – loses interest. Sadly, the current pandemic situation brings general impairment of mental health issues, although it evokes some positive changes in educational processes (Dvořáková et al., 2021). One of the recent trends that seek to improve the well-being in population is the expansion of mindfulness-based interventions (Carmody and Baer, 2008) that are successfully applied at various levels of the educational system (Altner et al, 2018) including university students (Medlicott et al, 2021).

To support an empirical validity of the mindfulness-based intervention programs, it is necessary to identify personality traits and abilities that are cultivated by these training and mediate the impact on general well-being. According to the research, the core concept of these processes is the self-compassion (Neff, 2015; Kirschner et al, 2019; Medlicott et al, 2021) understand as an emotionally positive, caring, and concerning attitude towards self especially in challenging or critical situations that 'entails three basic components: (a) self-kindness—extending kindness and understanding to oneself rather than harsh judgment and self-criticism, (b) common humanity—seeing one's experiences as part of the larger human experience rather than seeing them as separating and isolating, and (c) mindfulness—holding one's painful thoughts and feelings in balanced awareness rather than over-identifying with them' (Neff, 2003:89).

An inherent connection between self-compassion (SC) and educational processes is mirrored e.g. in the correlation between SC and self-efficacy (Liao, Stead and Liao, 2021). This attitude of belief in a capacity to manage own life events (Bandura, 1986) was further specified in the

area of education as the academic self-efficacy manifesting in specific achievement strategies (self-enhancing attributions, failure expectation, task-relevant behavior or activity vs. passivity) (Pajares, 1996). Similar impacts of SC were studied by Zhang, Kessler and Braasch (2021) who proved a positive correlation between SC growth mindset and intelligence growth mindset by university students. Aside from academic-specific self-compassion that reflects feelings in academic difficult situations and predicts university adaptation (Martin, Kennett and Hopewell, 2019), the general self-compassion influences the educational achievement of the individual also in the field of ethical judgment, improving the outcomes from the ethical training (Conway and Kotera, 2020).

SC affects academic achievement at many levels and significantly influences the mental health of students. According to Lee and Lee (2020), students with a high level of self-compassion may experience feelings of burnout as a consequence of the academic demands, nevertheless, they are at a lower risk of depression in comparison with their less self-compassionate peers. This finding is supported by the results of Poots and Cassidy (2020) who revealed that SC, psychological capital, and social support mediate the relationship between academic stress and well-being. The strong potential of SC and its influence on well-being was not proved by the study of Kroshus, Hawrilenko and Browning (2020). According to their results, no SC nor coping strategies buffered the effects of chronic stressors on negative outcomes. However, the SC was the strongest and most consistent predictor of a successful transition to college in their study. Interestingly, the level of self-compassion may be specific to the area of study. In the research of Kotera, Conway and Van Gordon (2018), students of business in the United Kingdom scored lower in self-compassion than students of social work.

Further, the level of SC and its elements seem to be gender-sensitive to a certain extent. The meta-analytical study by Yarnell et al (2015) refers to a slightly higher level of self-compassion by males in comparison with females, especially by the non-caucasian population. Neff, Hsieh and Dejitterat (2005) observed a lower level of female self-compassion in their study of achievement goals and coping with academic failure. Based on this knowledge, Smeets et al (2014) researched the impact of a self-compassion-directed intervention on the resilience and well-being of female university students. The results proved an increase in SC, mindfulness, self-efficacy, and optimism, whereas tendencies to ruminate decreased in comparison with a control group undergoing the course of time management. Nevertheless, the support of self-compassion turns out to be beneficial also for males, e.g. for lowering self-coldness associated with the gender role-specific stigma for seeking help (Booth et al, 2019).

Based on described studies, the goals of our research are to assess the level of self-compassion by bachelor students of FEM at CZU and reveal possible gender-related specifics and connections to the self-reported academic success. The grounds of these objectives reflect a planned involvement of the elements of mindfulness-based programs in the education of ethics at the Department of Psychology, as well as in the providing of Mindfulness-Based Cognitive Therapy (MBCT) to clients of university counseling services. Research background for these interventions is observable e.g. in the study of Conway and Kotera (2020) referring to the impact of self-compassion on the efficiency of ethical training or in the findings of Kotera, Conway and Van Gordon (2018) that point out to the lower level of self-compassion by the business students in comparison with the students of social work. Our results may support understanding of students' self-compassion at other Czech faculties dealing with business education as well as in international comparison.

Materials and Methods

In correspondence with our objectives, we used the Self-compassion Scale (Neff, 2003) to assess the level of respondents' self-compassion scores. Moreover, we added two demographical

questions (age, gender) and one question on the Self-reported grade mode (SGM), meaning the most frequent grade by the exam at university.

The Self-compassion Scale consists of 26 items that cover 6 subscales of self-kindness (e.g., 'I try to be loving toward myself when I'm feeling emotional pain'), self-judgment (e.g. 'I'm disapproving and judgmental about my own flaws and inadequacies'), common humanity (e.g., 'I try to see my failings as part of the human condition'), isolation (e.g. 'When I think about my inadequacies it tends to make me feel more separate and cut off from the rest of the world'), mindfulness (e.g. 'When something painful happens I try to take a balanced view of the situation'), and over-identification (e.g. 'When I'm feeling down I tend to obsess and fixate on everything that's wrong'). The internal and test-retest reliability of the instrument was verified by the research, as well as a good discriminative validity (Neff, 2015). The respondents answered on a 5–point scale from 1= 'almost never' to 5= 'almost always'. The negative subscales (self-judgment, isolation and over-identification) were coded reversely for our purposes.

The research sample was constructed by the method of convenience choice and involved 206 respondents with mean age 21.639 (median 21, min 19, max 28) and a gender structure of 127 females and 79 males. All respondents were students of bachelor programs of FEM CZU.

For data processing, the software IBM SPSS 27 was used. The strength of association between the variables was tested by parametric measures, Pearson correlation coefficient, and the *t*-test for equality of means. The normality of the distribution of Self-compassion was tested by the Shapiro-Wilk test of normality (sig. 0.883).

RESULTS

The descriptive dimension of our results aims mainly at the identification of the general level of self-compassion and its dimension in our research sample. The Self-compassion Scale (SCS) lacks the clinical norms that would ascertain some desirable level of the characteristics. The tool is mostly used comparatively. Nevertheless, the author suggested an indicative rating of mean scores 1.0-2.49 to be low, between 2.5-3.5 to be moderate, and 3.51-5.0 to be high (Neff, 2003). According to this guideline, all subscales in our research sample have moderate values with a highest value of Mindfulness by males (approaching the border of the higher rank) and a lowest value of Overidentification by females (approaching the border of the lower rank) (see Table 1). Higher values of means of Self-kindness and Self-judgement are due to the higher number of items included in the questionnaire in comparison with other scales. Therefore, means of scores are more relevant for mutual comparisons.

Subscale	Gender	Mean/scale	Std. deviation	Mean/score
Self-kindness	M	14.19	3.32	2.84
	F	15.25	3.79	3.05
Self-judgment	M	14.7	3.08	2.94
	F	15.28	3.79	3.06
Common humanity	M	12.37	3.13	3.09
	F	12.53	3.23	3.13
Isolation	M	12.68	3.53	3.17
	F	11.59	3.7	2.9
Mindfulness	M	13.62	2.87	3.41
	F	12.95	3.13	3.24
Overidentification	M	11.63	3.67	2.9
	F	10.59	2.84	2.65

Table 1: Subscales of SCS – descriptive statistic, 2021 (source: own calculation)

Using the measure of the Pearson correlation coefficient, we revealed no significant correlations between the Self-reported grade mean (most frequent grade by exams at the university) and the subscales of SCS (see Table 2). However, we found a significant correlation between the scales of the SCS which supported the inner consistency of the questionnaire as well as of the concept itself.

		Self-kindness	Self-judgment	Common humanity	Isolation	Mindfulness	Overidentification
SGM	Pearson Corr.	.112	-.013	.102	.111	-.001	.105
	Sig. (2-tailed)	.123	.859	.161	.127	.994	.148

Table 2: Correlation of the Self-reported grade means with the SCS subscales, 2021 (source: own calculation)

Further, we observed gender differences in our research sample. Levene's test for equality of variances proved similarity/equality by the vast majority of the subscales (Table 3). Thus, the *t*-test for equality of means was used. In terms of statistical significance, we found small but existing gender specificity by Self-kindness, Isolation and Overidentification (see Table 4). By the subscales with bordering values in Levene's test for equality of variances, the *t*-test values were similar even when the equality of variances was not assumed (Table 5). From the descriptive statistics (see Table 1), we can infer a higher level of self-kindness by females. The values of Isolation and Overidentification are higher among men. However, the negative scales of the SCS are reversely coded in our research, which means that both Isolation and Overidentification are stronger in females.

Subscale	F	Sig.
Self-kindness	1.883	.171
Self-judgment	4.597	.033
Common humanity	.039	.844
Isolation	.003	.957
Mindfulness	.813	.368
Overidentification	3.933	.049

Table 3: Gender differences; Levene's Test for Equality of Variances, 2021 (source: own calculation)

Subscale	t	df	Sig. (2-tailed)
Self-kindness	-2.050	204	.042
Self-judgment	-1.144	204	.254
Common humanity	-.351	204	.726
Isolation	2.096	204	.037
Mindfulness	1.536	204	.126
Overidentification	2.285	204	.023

Table 4: Gender differences; *t*-test for equality of means, 2021 (source: own calculation)

Subscale		t	df	Sig. (2-tailed)
Self-judgment	Equal variances assumed	-1.144	204	.254
	Equal variances not assumed	-1.200	189.74	.232
Overidentification	Equal variances assumed	2.285	204	.023
	Equal variances not assumed	2.155	135.34	.033

Table 5: Gender differences; *t*-test for equality of means by specific subscales, 2021 (source: own calculation)

Discussion

The first objective of our study was to assess a general level of the SC by students of FEM CZU to verify the relevance of using mindfulness-based methods in education and the counseling center. For this purpose, the Self-compassion Scale (Neff, 2003) was used. The mean scores in all subscales indicate that the level of SC is not literally low for our participants, however, there is still space to support it.

Many papers (Medlicott, 2021; Lee and Lee, 2020; Kotera, Conway and Van Gordon, 2018; Smeets et al, 2014) support the arranging of mindfulness-based interventions for students. We intend to use certain elements of mindfulness-based programs in the subject Psychology and Ethics in Business following a study by Conway and Kotera (2020). According to their results, the mindfulness-based methods support not only well-being but also ethical judgment. However, we do not plan to involve the whole mindfulness course in the education, because we appreciate the mandatory attendance in such activities. Thus, offering mindful training in university counseling services appears more relevant.

Our next research intention was to observe the relationships between the SC and academic achievement that was operationalized as the most frequent grade by exams at the university (Self-reported grade mean – SGM). Nevertheless, the correlations between the CGM and the SCS subscales were insignificant. This finding is in correspondence with the study by Neff, Hsieh and Dejitterat (2005) that found no significant correlations between the SC and Self-reported grade point average. We assume that the SC is not related to the academic achievement expressed by grades; however, the connections between the SC with other dimensions of educational achievement need further research in the form of comparative analysis as in meta analytical study by Liao, Stead and Liao (2021) that revealed larger associations between SC and self-efficacy by non-student than by students.

Further, our study dealt with the gender specifics of the SC concept. This question is the subject of several researches. Neff, Hsieh and Dejitterat (2005) proved slightly lower self-compassion by females in comparison with males, similarly to a meta-analytical study by Yarnell et al (2015) that also assigned women as more compassionate to others than men. Our results correspondence with described studies only to a certain extent. The scores from negative subscales (Isolation, Overidentification) were significantly lower among females; however, the self-kindness was significantly lower among males. Although the significance of these differences is not high, they are in certain correspondence with cited studies as well as with findings by Booth et al, (2019) who referred to male-typical self-coldness resulting in stigma for seeking help.

Conclusion

Mindfulness-based self-compassion-directed interventions belong to the current trends in the support of well-being. Nowadays, they become more urgent considering the negative impacts of the Covid-19 related restrictions, especially on children and young adults. According to the cited research, the cultivation of self-compassion by university students appears more than relevant to support their well-being as well as ethical judgment. Its suitability for the students of FEM CZU is supported by our results, revealing also gender specifics. Further research should concentrate on the relationship between self-compassion and non-grade indicators of academic achievement at different levels of the educational system. Also, subtle gender differences between dimensions of self-compassion should be further verified for possible gender-related adjustments of mindful-based interventions.

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WORD PROBLEMS IN KOSOVO'S MATHEMATICS TEXTBOOKS FOR GRADE 8

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Abstract

This study investigates whether Grade 8 Kosovo mathematic textbooks support teachers in their effort to develop their pupils' problem-solving skills as Kosovo's new curriculum requires. A textbook from the Dukagjini editing house approved by Kosovo's Ministry of Education, which comprises a basic book and its supplement with additional problems, was analyzed using three classifications. The first is concerned with how problems are presented. The second one is about their cognitive features, and the third is related to their contextual nature. In addition to the categorization of problems, we analyzed the representation of procedures based on Polya's problem-solving steps and specific heuristic strategies. The results reveal that the textbook does not provide enough opportunities to develop pupils` cognitive abilities. Most of the problems are pure mathematics, routine and non-contextual ones. Moreover, problem-solving procedures are rarely applied, leaving pupils with limited chances to develop their problem-solving skills.

Keywords

Heuristics strategies, mathematics textbooks, Polya's problem solving, word problems

Introduction

In recent years, literature and curricula have emphasized real-life situations in mathematics lessons (Hoogland et al., 2016). Problem-solving is a process that allows pupils to feel the power of mathematics in real-life (Cai and Nie, 2007) and should be taught in all grades (Reiss and Torner, 2007). They have been identified as a field of concern in many countries due to pupils' difficulty in solving them, and many teachers report that pupils in this area show the poorest performance (Novotná and Chvál, 2018).

Given the relevance of word problems in students' cognitive growth, their inclusion in mathematics textbooks is essential. According to Vicente, Sánchez and Verschaffel (2020), textbooks as a fundamental element in teaching mathematics represent a strong basis of the curriculum that determines to a large degree what is actually taught in class (see also Hiebert et al., 2003). As such, they impact the quality of mathematical lessons and can affect pupils' learning (Sievert et al., 2019; Heinz, Marschick and Lipowsky, 2009).

Problem-solving skills are not, however, promoted by solving word problems only as they support pupils in developing their problem-solving abilities. For example, Spanish mathematics textbooks have been demonstrated to be inadequate in addressing the teaching-learning process of problem-solving (Tárraga-Mínguez, Tarín-Ibáñez and Lacruz-Pérez, 2021). An analysis of textbooks from twelve countries revealed that most problems required a template-based solution, with just a small proportion requiring creative answers (Jäder, Lithner and Sidenvall, 2020). Singapore is one of the countries whose children acquire a significantly greater level of mathematical competence than children in other countries, according to TIMSS (Trends in International Mathematics and Science Study) (Mullis et al., 2019). This might be attributed, among others, to their mathematics textbooks, which provide sufficient instructional material for learning problem-solving (Vicente, Sánchez and Verschaffel, 2020). In the Kosovo context, Berisha, Thaqi and Jashari (2014) analyzed mathematics textbooks and found that they do not provide a solid foundation for enhancing learners' problem-solving skills. The analyzed textbook was particular to the 2004 curriculum. In this article, I present the results of the analysis of Grade 8 mathematics textbooks (Gjergji, Bllaca and

Edmond, 2021), based on the 2016 Kosovo curriculum. This curriculum aims to provide pupils with models that develop mathematical thinking and improve their calculation and problem-solving skills in everyday life (MASHT, 2016). As teachers from Kosovo rely on textbooks to a great extent, the question arises of how textbooks support them in terms of teaching word problems. Grade 8 textbooks were selected as it is expected that pupils will have learned the fundamental mathematical concepts required in word problems. The goal of eighth-grade mathematics teaching is to foster further development of mathematical concepts in the context of daily life (Kurrikulat lëndore/Programet mësimore për klasën e tetë, 2018). The study aims to answer the questions:

1. What types of problems are included in Kosovo's eighth-grade mathematics textbooks?
2. In what ways do Kosovo's mathematics textbooks promote problem-solving skills?

MATERIALS AND METHODS

In Kosovo, school textbooks can be produced by any publishing house provided they adhere to Kosovo's curriculum requirements. They must be approved for publication by the Ministry of Education, Science, and Technology before being used in the classroom and then provided to schools free of charge. One of the mathematics textbooks chosen by the reviewers, consisting of Mathematics teachers, Professors, and Pedagogues, in the year 2021, was from Editing House Dukagjini since it closely adhered to Kosovo's curriculum and based on the data by the Ministry of Education it is the most used one in the schools of Kosovo.

Mathematics textbooks

The analyzed textbook comprises two books: "Mathematics 8 - Basic textbook" (or BB) and "Mathematics 8 - Summary of Tasks," (or BT). The latter contains additional problems for pupils. The books include the following topics: numbers, algebra, functions, shapes, spaces, measurements, geometry, data processing, and probability. As my focus is on word problems, the analysis will concern the sections of numbers, algebra, and functions.

Analytical framework

By a problem, I mean a situation that needs a solution, regardless of whether the answer requires the use of an algorithm, strategy, or creative thinking. If the complete solution is provided for a problem in the textbook, such a problem will be called an example problem. First, I classified the problems according to their form of presentation (mathematical, textual, visual, mixed), their cognitive features (routine and non-routine), and the presence of context (contextual and non-contextual) (Berisha, Thaqi and Jashari, 2014).

- A pure mathematical problem consists just of symbols and mathematics expressions.
  Eg. 1. *Solve the equation* $2x - 5 = 3x - 4$.
- A problem in a textual form refers to mathematical tasks that present relevant information on a problem as text, instead of mathematical notation.
  Eg. 2. *Alica and Kiara went to the store to buy some eggs. Alica got half the box's eggs, and Kiara got half of the remaining eggs from that box. How many eggs did they take together if in a box were thirty-two eggs in total?*
- A problem that includes pictures is classified as a visual form of presentation.
  Eg. 3. *Find the set of solutions?*
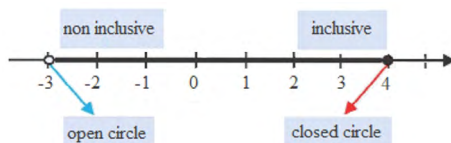
- A problem is presented in a mixed form when two or three of the previous categorizations are present.

Second, in terms of the context, problems that reflect reality or an imaginary reality are categorized as contextual problems (Hoogland et al., 2016) – see Fig. 1. Non-contextual problems concern pure mathematics (see, E.g. 1).

Third, we used Polya's work (1945, p. 171) and categorized problems as routine problems (which can be solved quickly and directly following a step-by-step solution to a previously solved problem without the necessity of creative thinking or imagination) and non-routine problems (require some level of creativity and originality.) Figure 1 shows examples.

Routine problem solving	Non-routine problem solving
Aria has 30 color pens. She gave some to her friend. She now has a total of 13 color pens. How many did she give to her friends?	The test consists of 45 questions. For each correct response, 5 points are granted, and for each incorrect answer, 3 points are deducted. Ana received a score of 185. What was the number of right answers she provided?

Figure 1: An example of a routine and a non-routine problem

The knowledge of problem-solving steps and heuristics is important for the pupil's ability to solve a word problem. Thus, it is important to see to what extent the textbook promotes them. The framework used for the analysis of textbooks consists of Polya's four problem-solving steps (Table 1) and problem-solving heuristics as used in Fan and Zhu's work (2007) (Table 2).

Polya's steps	Description
1. Understanding the problem	Determining the problem's aim, reorganizing the problem structure if needed, pointing out the main parts of the problem, the unknown, the data, the condition.
2. Devising a plan	Making a plan by choosing the suitable procedures or heuristic strategies, calculations, or constructions we have to perform to obtain the solution.
3. Carrying out the plan	Following the plan devised in the previous stage and implementing all the steps of the plan correctly to obtain the answer
4. Looking back	Reconsidering the result as well as the path that leads to the solution, checking all the steps, verifying the result, and generalizing or expanding the solution process.

Table 1: A description of Pólya's four problem-solving steps (Polya, 1945)

Heuristics strategies	Description
1. Act it out	The interpretation of what is taking place in a word problem in a physical way.
2. Draw a diagram	Make a model/sketch/picture to describe the situation.
3. Guess and check	Guess the solution and try the answer. If the answer is not what you were looking for, try again with a different guess that will get you closer to your goal.
4. Look for a pattern	Finding common characteristics that are repeated, such as numbers/items/shapes, to determine what the problem is asking.
5. Make a list or a table	Making a list/table is a way to organize facts presented in a problem to discover relationships and patterns among data. Then use the data to solve the problem.
6. Restate the problem	Summarize the problem in your own words in order to be more familiar with the problem and have a better understanding of the situation.
7. Think of a related problem	Using a solution of a related problem solved before to get the solution to the current problem.
8. Use a model	Creating visual representations using blocks, rectangular regions, lines, or other symbols to model the information involved in the problem.
9. Use an equation	Creating an equation to answer the problem using letters as variables
10. Work backward	Starting with the final results and working backward.

Table 2: Problem-solving heuristics (Fan and Zhu, 2007)

RESULTS

A total of 402 problems from the book BB (129 being example problems) and 110 from BT (36 being example problems) were found. Of the total, **91.3%** of problems in BB's book and **74.1%** of the BT's book were pure mathematics problems (Tables 3).

Problems / Chapters	Pure mathematics		Textual form		Visual form		Combine	
	BB	BT	BB	BT	BB	BT	BB	BT
Numerical sets	15	12	0	2	0	0	2	0
Powers	54	18	3	0	2	0	1	0
Square root	30	12	2	0	0	0	1	0
Algebraic expressions	193	29	0	1	0	0	4	0
Equalities	40	7	17	25	0	0	3	0
Inequalities	35	4	0	0	0	0	0	0
Total	**367**	**82**	**22**	**28**	**2**	**0**	**11**	**0**
	91.3%	74.6%	5.5%	25.4%	0.5%	0	2.7%	0

Table 3: Distribution of problems according to their form of presentation. Mathematics 8 - Basic book" (or BB) and Mathematics 8 - Summary of tasks" (BT)

In terms of cognitive features, most of the problems are routine (Table 4) in both BB and BT. An example of a non-routine problem is in Fig. 2.

Routine problem solving	**Non-routine problem solving**
Aria has 30 color pens. She gave some to her friend. She now has a total of 13 color pens. How many did she give to her friends?	The test consists of 45 questions. For each correct response, 5 points are granted, and for each incorrect answer, 3 points are deducted. Ana received a score of 185. What was the number of right answers she provided?

Figure 2: An example of a routine and a non-routine from Mathematics 8 - The basic book."

Problems/ Chapters	Routine	Non-routine	Routine	Non-routine
	BB		BT	
Numerical sets	16	1	12	2
Powers	57	3	18	0
Square root	31	2	12	0
Algebraic expressions	197	0	29	1
Equalities	42	18	7	25
Inequalities	35	0	4	0
Total	378	24	82	28
	94.03%	5.97%	74.55%	25.45%

Table 4: Distribution of the problems concerning their cognitive features

Most of the problems in both books appear in the non-contextual form (Table 5). For example, only 6 of the 402 problems of BB and 9 problems of BT are presented in the contextual form.

	Contextual	Non-Contextual
BB	6 (1.5%)	396 (98.5%)
BT	9 (8.2%)	101 (91.8%)

Table 5: Distribution of the problems concerning their contextual nature

For problem-solving procedures, from 129 example problems in BB, the most frequent is "Carry out the plan" (see Table 6). Several problems employed two of the four Polya's steps ("Carry

out the plan" and "Looking back," see an example in Fig. 3). A few used three, and none of the problems utilized all four. The same situation was in BT's book.

Routine	Non-Routine
Solve the equation: $$\frac{x}{3} - 1 = \frac{x}{2}$$	The traveler addresses the Shepherd who was protecting the sheep with these words "O shepherd with 100 sheep ...". The shepherd replied, "They are not 100, but if they were twice as they are now, and as a half of them, and as a quarter of them together with me would make 100". How many sheep are there?

Figure 3: An example that employs two of the four Polya's steps

Pólya's steps	BB	BT
1. Understanding the problem	5 (3.9%)	2 (5.6%)
2. Devising a plan	19(14.7%)	8 (22.2%)
3. Carrying out the plan	129 (100%)	36 (100%)
4. Looking back	9 (7%)	2 (5.6%)

Table 6: Numbers of problems with answers that employed Pólya's problem-solving steps.

A similar conclusion may be made for suggestions of heuristics strategies (Table 7). Example problems that include the heuristics "Draw a diagram," "Make a table," and "Guess and check" are presented in Fig. 4, 5. However, the diagram and the table were already provided as models.

Solve the equation $4x + 3 = 23$		Let's try the solution for $x = 5$
$4x + 3 = 23$		$4 * 5 + 3 = 23$
$4x + 3 - 3 = 23 - 3$	Subtract 3 from both sides of the equation.	$20 + 3 = 23$
$4x = 20$	Perform operations on both sides of the equation	$23 = 23$
$4x : 4 = 20 : 4$	Divide with 4 both sides of the equation	True
$x = 5$	Perform operations on both sides of the equation	

Figure 4: An example that employs the Use a diagram" strategy.

Proof if the statements below are true:

a) $N \subset N_0$ b) $N \subset Z$ c) $N \subseteq Q \cap N$
d) $Z \subseteq Q \cap N$ e) $N \subseteq Q \cap N_0$

Figure 5: An example that employs the Use the table" and Guess and Check" strategy

In other problems, pupils were expected to make a diagram or table based on the model. **For example:** Solve the equation $2x - 1 = x$ for some values of x, as in the example above. Some example problems were solved by using two or more heuristics, but the majority of them were handled without utilizing any of them.

	BB	BT
1. Act it out	1	0
2. Draw a diagram	11	5
3. Guess and check	5	1
4. Look for a pattern	3	3
5. Make a list or a table	1	0
6. Restate the problem	3	2
7. Think of a related problem	0	0
8. Use a model	4	1
9. Use an equation	4	3
10. Work backward	0	0

Table 7: Numbers of example problems that employed specific problem-solving heuristics

DISCUSSION

The analysis of the Grade 8 textbook used in Kosovo schools showed that the textbook does not provide enough support to teachers who want to develop pupils' higher-order thinking skills and master the curriculum learning outcomes of word problems. Most problems are presented in a purely mathematical form and belong among routine and non-contextual problems. Tárraga-Mínguez, Tarín-Ibáñez and Lacruz-Pérez (2021) bring the same conclusion to Spanish textbooks, revealing that most problems are presented as routine tasks.

In terms of problem-solving steps, the vast majority of the problems addressed in 8th-grade mathematics textbooks just illustrated how to carry out the plan, which is the third step in Pólya's model. Only for a few problems, all four problem-solving steps were provided. This finding is similar to Fan and Zhu's (2007) one for two series textbooks in China and Singapore in which heuristics were rarely used, with just a few of them mentioned in textbooks, such as "draw a diagram," "guess and check," "use an equation," or "use a model."

The study presented reached similar conclusions to the study by Berisha, Thaqi and Jashari (2014) which concerned older textbooks. Thus, there has not been any progress in terms of promoting problem-solving skills in the Kosovo textbook despite the changes in the curriculum.

The results imply that the analyzed books are not a good basis for developing pupils' ability in problem-solving. Because books are often considered the basis for pupils' learning, they need to be restructured, include more word problems, and present more heuristic strategies in order that the pupils be exposed to a greater variety of learning. Nevertheless, pupils need to think rather than just calculate when solving mathematical problems because, in that way, they become successful learners and creative thinkers and prepare for real-life situations.

In our analysis, we distinguished between routine and non-routine problems by considering one possible solution to them. This might also be considered a limitation as for some pupils, a problem may be non-routine, whereas, for others, the same problem may be routine since they are already familiar with the solution steps. It should also be noted as a limitation that the number of word problems in our study is relatively small in comparison with the articles indicated above (around 50% less), making findings difficult to compare.

CONCLUSION

This study examined to what extent a Kosovo eighth-grade mathematics textbook provides support for teachers to develop pupils' problem-solving procedures. This was accomplished by using an analytical framework that categorizes problems based on how they are presented, their cognitive features, and their contextual nature.

We can conclude that the analyzed books do not provide a strong basis to improve pupils` problem-solving ability. Most of them are pure, routine, and non-contextual problems. Concerning the general strategies, most problems do not use any of Polya's steps or heuristics.

The results show that there is a significant gap between what is promoted in the curriculum and what is included in the textbook. This gap should be acknowledged and addressed by Kosovo policymakers, curriculum developers, textbook authors, and teachers.

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UNDERSTANDING OF NOTION INDEPENDENCE IN SECONDARY AND UNIVERSITY STUDENTS

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Abstract

This paper presents results of a qualitative study on the teaching of probability and statistics at secondary schools and universities in the Czech Republic. It aims to reveal the understanding and intuitive perceptions of randomness and independence of pupils/students aged 15 to 23. The concept of independence is closely related to solving problems with repeating random trials, their calculation and intuitive estimation. Research has shown that pupils/students understand simple examples without great difficulties. But more complicated examples bring problems. A larger number of isolated models is important for a correct perception of independence. In this teaching process, so-called tree graphs are very useful.

Keywords

Independence, intuitive perceptions, qualitative research, teaching of probability

Introduction

Stochastic and statistical models not only have high importance in today's science and economic and technical fields but also in society and in schools as well, where the importance of stochastic thinking is not always sufficiently appreciated and valued. It is important that students pursue university education endowed with concepts related to uncertainty and randomness at the required level (Nemirovsky et al., 2009).

Many studies on probability teaching (Alonzo et al., 2021; Batanero et al., 2016; Batanero, 2015; Evans, 2006) show that students often have insufficient ideas about concepts related to uncertainty, randomness, independence, and probability when moving from secondary school to university. Students' ideas often suffer from misconceptions or misinterpretations of scientific models.

This study is a part of qualitative research focused on the teaching of probability and statistics at secondary schools and universities in the Czech Republic. The aim of the study is to provide insight into Czech students' understanding of independence, i.e., what independence means for them and how it can be used for determining probabilities. First, the concept of independence is briefly described.

Independence can be defined by the relation in which the intersection is converted into a product. Two random events A and B are said to be independent, if and only if

$$P(A \cap B) = P(A) \cdot P(B) \, .$$

This definition is symmetric and there is no need to assume a non-zero probability.

Another possibility uses conditional probability.

Understanding of independence is closely related to examples of repeated random events, such as repeated coin or dice tossing, lottery, spinning roulette etc. Such examples are useful in uncovering students' intuitive ideas about independence or conditional probability.

MATERIALS AND METHODS

Sample and research design

The respondents of the study are secondary school and university students. Since the research is qualitative, the condition of randomness was not sought. Secondary school and university students were invited to participate in the study by the author. Complete anonymity, protection of all personal data and disposal of all documents after the research were guaranteed to them. Out of the total number of 43 respondents who volunteered to participate, there were 18 females and 25 males. They were divided into three groups:

- group I - secondary school students who have not yet gone through the probability and statistics lessons (aged 14-18), $N = 12$,
- group II - secondary school or university students who have completed such classes at secondary schools but have not yet met any of these subjects at the university (aged 18-20), $N = 17$,
- group III. - university students who have taken a course on probability and statistics at the university (aged over 20), $N = 14$.

Individual task-based interviews (Maher and Sigley, 2014) were conducted among the respondents. They were asked to solve tasks and comment on their solution. The tasks were piloted with 14 students to ensure the comprehensibility and unambiguity of the formulations. Interviews lasted from 15 to 30 minutes and were conducted by the author.

Research tool

The respondents were first asked: what does independence mean? Next, they solved six problems. Problem 1: *Peter flips two ten-crown coins. What is the probability that both coins land on heads? Dusan flips two coins – a ten-crown and five-crown. What is the probability that both coins land on heads?*

The student has to decide whether the set of possible outputs Ω consists of ordered pairs of heads (H) and tails (T), $\Omega = \{[HH], [HT], [TH], [TT]\}$, which would lead to permutations, or unordered ones, $\Omega = \{[HH], [HT], [TT]\}$, which would lead to combinations. Tossing of two different coins can be divided into two independent tosses of a ten-crown coin and five-crown. The probability that the ten-crown coin lands on heads (event A_H) is P (A_H) = 1/2. Similarly for the heads on the five-crown coin (event B_H) is the probability P (B_H) = 1/2. The event that both coins land on heads (event C) can be expressed as the intersection $C = A_H \cap B_H$ and due to independence its

probability is calculated as follows $P(C) = P(A_H \cap B_H) = P(A_H) \cdot P(B_H) = \dfrac{1}{4}$.

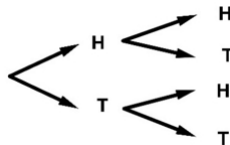This decomposition can be represented by a tree diagram as shown in Figure 1.

Figure 1: Tree diagram

It can be seen from it that a set of all outputs must consist of ordered pairs of H and T with repetition, i. e., permutations with repetition. When tossing two identical coins, it is important to realize that the situation is not fundamentally different. The idea that in this case, we should

consider the unordered pairs with repetition as all outputs $\Omega = \{[HH], [HT], [TT]\}$ must be rejected with respect to the above illustration.

The purpose of Problem 1 is to comprehend the principle of independence, and to realize the identity of the described two cases (with identical and different coins), hence the same results for Peter and Dusan. Experience shows that coins behave in the same way regardless of what is written on them, in other words, they are always distinguishable.

Problem 2: *We roll two dice. Is the probability of output five and six equal to the probability of output two sixes?*

The solution of problem 2 is based on a similar principle, but there are six possibilities, not only two. The correct answer is that the probabilities are different. We can use similar considerations as in Problem1 and we realize that the set of all outputs is formed by all ordered pairs of numbers 1 to 6 with repetition. Therefore, the probability of rolling five and six is 1/18 (pair [5,6] and [6,5]) and the probability of rolling two sixes is 1/36 (pair [6,6]).

Problem 3: *We toss a coin five times. Which of the following outputs have the greatest probability? Outputs: a) head, tail, head, tail, head, b) head, head, head, head, head, c) head, head, tail, tail, tail.*

With the help of tree diagrams, it is easy to see that the probability of all three possibilities is the same, i. e., 1/32. Similarly, it is shown here that the result of an individual roll is not affected by the previous result. Students sometimes misunderstand this conclusion in terms of intuition. They are aware of the principles they have heard about randomness, for example

- the outcome of one coin tossing can never be predicted,
- the results of one tossing vary unsystematically between the heads and the tails,
- a coin has no memory,
- the heads and tails have the same chance,
- the heads and tails will occur approximately equally often.

Some of these statements may contribute to the correct idea, others may rather suppress it. The consideration that "heads" and "tails" have the same chance may give the impression that the result of five heads (b) is less probable than the others. Similar problem has been solved in (Batanero and Sanchéz, 2013).

Problem 4: *We toss a coin five times. Which of the following results are most probable? Outputs: we will have in total a) heads on three coins and tails on the other two coins, b) heads on all five coins, c) heads on two coins, and tails on the other three coins.*

This problem is like the previous one but this time the order of heads and tails does not matter. The result in case (b) is 1/32, like in problem 4. However, in cases (a) and (c) the probabilities are 5/16. We can use tree diagrams again. To use the solution based on a set of all outputs it is necessary to consider an ordered five-tuples of heads and tails as a single output. A comparison of Problems 3 and 4 highlights the difference between one possible five with a given order and a group of five for which the order is not specified. In Problems 3 and 4, we tossed coins five times in a row. By solving them, students show their ability to distinguish the specific order of individual output from the total number of outputs with the same portion of heads and tails.

Above, we considered two repetitions of the basic experiment first and five repetitions of it afterwards. Next, we will look at eleven repetitions.

Problem 5. *We toss a coin repeatedly. The coin has been landing on heads ten times in a row. What is the chance of possibility that the eleventh output is again head? Offered options: a) Very small. b) Very large. c) Greater than ½. d) Equal to ½. e) Less than ½.*

Problem 6. *Peter and Dusan played table tennis together and Dusan has won ten times in a row. What is the chance that Dusan will win also in the eleventh match? Offered options: a) Very small. b) Very large. c) Greater than ½. d) Equal to ½. e) Less than ½.*

At first sight, Problems 5 and 6 seem to be similar, even the same options are offered. Nevertheless, there is a fundamental difference. We have to decide a question whether repeated random trials can be considered independent. This decision results us to adequate interpretation of probability for a given problem (classical, statistical, subjective). The result of Problem 5 in the classical concept of probability is ½, hence option (d). In accordance with Problems 3 and 4, we assume the independence of individual tosses.

In Problem 6, however, we will probably decide for a different interpretation, for the subjective one. We can estimate every next result based on our previous experience. Dusan can probably play table tennis much better than Peter, so our decision will probably be option (b) or (c). The abilities of Dusan and Peter in this case represent the way by which the individual outputs are related.

Data analysis

The interviews were recorded and transcribed. The transcripts and the interviewer's field notes were repeatedly read and significant statements were identified and grouped across specific topics.

RESULTS

The aim of the study was to uncover how pupils/students perceive the notion of independence. In many interviews, students characterized independence as a relationship of non-influence. They said, for example, that independence

"is a state in which the subject is completely unaffected by another,"

"is when the elements do not interact with each other,"

"is absence of a relationship between two variables."

Some students provided a general answer, saying that independence is "freedom", "self-sufficiency" or "non-dependence".

Next, we will present results related to the problems used in our study.

In Problem 1, we focused on the definition of the probability in specific situations in which we perform some sort of double attempts – tossing two coins and tossing two dice. Most respondents (37 out of 43) decided correctly that the situation is identical in both cases. They put forward arguments such as "both cases are identical, coins as coins" or "the value of the coins does not matter". However, some respondents were not able to calculate this probability correctly. The approach of Jirka (Group I) is worth attention. He initially concluded: "The probability is 1/4 when we toss ten-crown and five-crown coins, and the probability is 1/3 when both coins are ten-crown." Then he thought it over and added notion only to himself: "But no two coins are identical." Then we started a conversation about the possibilities of how coins can be different. If the coins are different in color, for example, they are not identical, but they can be considered as identical for a color-blind person. At the end, he insisted that "it depends on the assignment, if coins differ, the correct probability is 1/4, and if we guarantee that they do not differ, then 1/3".

The interviews showed that the basis for the respondents' decision was whether to consider ordered pairs even with the same coins. The turning point came when the student realized that we could toss coins gradually and that the result of the first coin would not affect the result of the second one. The tree diagrams (see Figure 1) have always significantly contributed to the correct ideas of the respondents.

Mathematically, the solution of problem 2 is similar to that of Problem 1 but the result for this problem is very different. Many students have not reached the correct result. Only minority of respondents (12 out of 43) realized that the probability of rolling a six and a five and the probability of rolling two sixes is different.

Despite the considerable similarity of the two previous examples, the students' thought step from the Problem 1 to the Problem 2 can be perceived as a very difficult one. This relatively

surprising conclusion shows that a slight generalization of the assignment by the teacher can mean a relatively demanding thought process for the student.

Similarly, from the mathematical point of view, Problem 3 is only a generalization of Problem 1. The correct answer that the probability is the same in all cases occurred in a very small number of respondents (9 out of 43), six of them were in Group III. Result (b) was considered the least probable, which was expected.

What applied to the Problem 2 also applies to the Problem 3.

When looking for the answer to Problem 4, many respondents noticed a connection with the previous assignment and realized that the total number of tails and heads is different from only one individual output. Alena (Group III) formulated it nicely: "It looks the same as the previous task, but it is not. There seems to be an arrangement overlooked here, which is the very important thing in terms of probability." There were more correct answers than in the previous task, but much remained wrong. Among the 43 respondents, 17 of them realized that the probability of results (a) and (c) is mutually equal and it is greater than probability in case (b), 9 respondents considered the result (a) and 12 respondents the result (c) as the most probable, none the result (b). There were 5 respondents who considered all three results equally probable.

The comparison of tasks 3 and 4 introduces another aspect of outputs description into the respondents' thought process. Students start to realize the difference between the output "head, head, tail, tail, tail" and "two heads and three tails in total". This finding leads to the conclusion that the second event contains 10 simple events.

As stated above, Problems 5 and 6 offered the same answers in two different situations. In Problem 5, when we ask about the probability that after 10 heads the next output will be again a head, the correct variant (d) occurred relatively often (in 28 out of 43 cases). However, more than one third respondents (15 out of 43) do not somehow intuitively perceive the independence of individual outputs in this case. Alena (group III) again appropriately expressed her decision, she answered (a) - very small: "[Probability] is small, but chance is a jerk." Another respondent supports his option (e) - less than ½, by the comment: "… it would be very regular".

These results indicate a problematic understanding of independence and the inconsistency of intuitive perception with theory and calculations. The discrepancy in this expectation is often related to the formulation of the question and the answer which we are looking for. There is a difference. We could ask for the probability of rolling the heads in the eleventh trial, i. e. we ask for the probability of rolling heads in one attempt after landing heads in the previous 10 tosses. It means something different than the probability that the heads will occur in all eleven tosses. In the first case, it is ½, in the second 1/2048. In the first case we are interested in the situation with one toss, in the second in the situation with 11 tosses. In the second case we can apply limit theorems, in the first case not.

Problem 5 brought great controversy, many emotions and lively discussions. Some respondents stubbornly rejected the fact that the probability of the output head is still 1/2 even after ten such outputs before in a row. This reveals the biggest contradiction of the intuitive understanding of independence and reality.

Problem 6 describes a chance of Dusan winning in the eleventh game after he has won in 10 previous matches. Most respondents realized that Dusan was probably a better player and chose (b) - a high probability (29 out of 43 respondents) or (c) - greater than ½ (8 respondents). Contrary to the previous problem, we do not use classical probabilities here, but rather a subjective concept. The respondent's thinking was reflected in the evaluation of Dusan's abilities: "It's about abilities." Only 6 respondents insisted on the principle of independence and indifference and submitted the answer (d) - equal to ½. Answers correspond to a subjective perception of probability which is based on the willingness of an individual to place a bet, and thus may be different for everyone.

The particular games of Peter and Dusan are not independent. They are mutually related and influenced by the abilities of both players.

For many students, it was somewhat problematic (in Problem 5) to come to terms with the fact that even after 10 outputs heads, the probability of head is still ½. The intuition of randomness is rather satisfied by a certain irregularity and rotation of partial outputs with approximate ratio 1:1. The erroneous principles of betting in roulette are based on similar ideas. On the contrary, in a similar case (in task 6), the respondents realized that the probability of Dusan winning again after the ten previous wins is relatively high, because we infer on the basis of a subjective concept of probability and not classical or logical.

DISCUSSION

The study revealed significant problems in students' understanding independence. Somewhat vague ideas about this concept were manifested especially in problems related to the repetition of partial random events. The incorrect conclusions consisted in assigning a higher probability to randomly distributed irregular k-tuples of the results and a lower probability to k-tuples where the partial events were repeated or showed a certain periodicity. Pupils/students often miss the principle that in the case of independence the probability of one partial event is not affected by the results of previous (or subsequent) partial event. So called Kahneman's law of small numbers (Tversky and Kahneman, 1971) manifests phenomena, where the probability of a partial event is also applied to small numbers of its repetitions, regardless of the low reliability of such a conclusion. This mistake is deeply ingrained in gamblers, and it is often called "gambler's fallacy (bias)". It considers in mistaken belief that if a random event has occurred more frequently than usual in the past it will occur less frequently in the future. Alan Graham appropriately explains the possible reasons for this mistake:

People sometimes appeal to the "law of averages" to justify their faith in the gambler's fallacy. They may reason that, since all outcomes are equally likely, in the long run, they will come out roughly equal in frequency. However, the next throw is very much in the short run and the coin, dice or roulette wheel has no memory of what went before. (Graham, 2006: 58)

It follows from the above that students' insufficient understanding of independence mainly affects the method of estimation and practical calculations of probability in specific cases when repeating partial experiments. The shortcomings are manifested especially in the description of the set of all outcomes of a random event. Pupils'/students' perceptions of independence differ slightly with respect to individual groups, with some improvement over age.

Understanding independence is closely related to the calculation of probabilities in solving elementary problems, in which the complex trial consists of the repeating implementation of simple random trials. The basis of solving simple problems by classical probability is a symmetry. Using it we can generalize suitable rules for double and then multiple tossing or drawing. Students should be able to accept and justify the correct result. For this purpose, it is usually appropriate to decompose the random experiments into individual steps and show the situation illustratively, we usually record the path to the outputs in tree diagrams. For example, Alan Graham appreciates their importance:

The tree diagram is a useful visual tool for teaching basic probability ideas. (Graham, 2006: 112)

CONCLUSION

The purpose of the research was to examine students' understanding of independence in connection with the estimation of probabilities of random events consisting of several repeated experiments. It turned out that the respondents have correct images in the simplest cases - the double repetition of the event with two results. If we consider multiple repetitions or more than

two results, the situation will become unclear for students. However, the biggest discrepancies between the intuitive respondents' perceptions and reality occur in the estimates of the probability of output "heads" in the eleventh coin tossing after ten outputs of "heads" in a row. The fatal problem in this situation is the misunderstanding of the Law of Large Numbers.

In the opinion of the author, two procedures or principles can contribute to overcoming this critical point in teaching.

First of all, the situation is useful to be decomposed into a process and illustrating situation by the use of tree diagrams.

Secondly, it is necessary to present enough examples - isolated models, from which the general model can arise subsequently.

Our results provide sufficient scope for further research and observation and require more detailed research.

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STUDENTS' READINESS FOR PERSONALISATION IN DIGITAL LEARNING: A CASE STUDY FOR TEACHER EDUCATION

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Abstract

The paper discusses students' readiness for personalised digital learning in the context of student agency, learning interactions, and management. The objective was to analyse the indicators of students' readiness for personalised learning. The research included an entrance and final survey of students, first semester 2021/22, while undertaking an e-course with the opportunities of personalised learning, based on the ideas of agency, content diversity, collaboration, and reflection. The results show that students adequately understand the essence of personalised learning, paying attention to time, effort, volume, and quality of autonomous work. They prefer not to go beyond the educational program and have a stereotype of following an educational trajectory given by the teacher because teacher-implemented monitoring and assessment do not always support self-assessment and peer assessment. Personalised learning experience helps to overcome the equation of personalisation and autonomy, and enriches this understanding with peer-to-peer learning and collaboration.

Introduction

Personalisation becomes especially relevant in the situation of digital learning when there are both a need and opportunity to adjust a learning content to specific learner's needs. Current research on personalisation in terms of digital learning includes various theoretical and applied problems: the personal learning environment (PLE), personalised feedback, personalised guidance, personal development (Klašnja-Milićević and Ivanović, 2021), competency-based user model, learner profile, precise learning, etc. "Personalisation involves giving learners choices in learning approaches, content, and pace to accommodate individual learning differences" (Jitpaisarnwattana et al, 2021, p. 2). "Personalisation refers to learners accessing customised activities which can lead to a sense of ownership and to control over the time, place and pace at which they learn" (Yates et al, 2021, p. 59).

Thus, Moore (1989) identified three components of critical interaction in educational contexts: learner–content interaction (L-C), learner–instructor interaction (L-I), and learner-learner interaction (L-L). Nehiri and Aknin (2021) underline that the contemporary learning continuum comprises formal, informal, non-formal learning, and collaboration. Therefore, to build a personal profile of a student, it is necessary to collect data not only from LMS but also from other digital services that are used in the process of non-formal learning.

To reach personalisation within an e-learning system, typical students' "models" should be created. Muhammad and Ariatmanto (2021, p. 3314) describe the following components of the model: "personal user characteristics (name, age, gender, cognitive, personality, and learning style); knowledge and skills, in the form of experience, knowledge, and psycho-motor skills; and system-related user characteristics (data, including objectives and requirements,

preferences, interaction styles, and motivation)". Some authors suggest integrating a two-way methodological approach to personalisation into the category of an individual educational pathway (Naumkin et al, 2021) – student's intentions (freedom and awareness of choice) and teacher's intentions (differentiation and individualisation of educational content).

Provided that personalisation is associated with student-centred learning, when in a broad sense every learner is an agent of continuing education, an important question arises – are students ready to implement personalised learning paths? According to Kearney et al (2012), personalisation is based on motivational theory (Pintrich and Schunk, 2002) and sociocultural theory (Vygotsky, 1978). The authors suggest a methodological framework (a model) for mobile learning comprising three distinctive characteristics – personalisation (agency and customisation), authenticity (situatedness and contextualisation), and collaboration (conversation and data sharing). Student agency is connected with the level of autonomy and power that a student has in the learning environment. "Student agency is defined as the capacity to set a goal, reflect and act responsibly to effect change" (OECD, 2019). Zeiser et al (2018) suggest the following student agency constructs: self-efficacy, perseverance of interest, perseverance of effort, locus of control, mastery orientation, metacognitive self-regulation, self-regulated learning, and future orientation. In a more publicist way, Bray and McClaskey (2022) described stages of learner agency, which evolve from teacher-centred to learner-centred and learner-driven PLE in the following categories: voice, choice, engagement, motivation, ownership, purpose, and self-efficacy.

The purpose of the paper is to identify and analyse the indicators of students' readiness for personalised learning in the digital environment. Particularly, are there differences between how students foresee their personalised learning and how they implement it? To organise the study, we integrated the ideas of student agency, interaction with learning digital content, and psychodidactic approach to the digital learning environment (DLE) modelling that is based on three concepts – digital content, learning interactions, and management of DLE (Noskova et al, 2021).

Materials and Methods

The research took place in the Herzen State Pedagogical University of Russia, Institute of Information Technology and Technological Education, Chair of Digital Education, and involved 50 bachelor students, future teachers, mastering the programme "Informatics and Information Technology". The sample included a balanced number of respondents from all undergraduate courses. During the first semester of 2021/22, due to the pandemic, all courses of this study programme were delivered in blended or e-learning formats. The Chair of Digital Education has carried out the research on personalised learning for several years (Yakovleva et al, 2021). Therefore, each bachelor student has the experience of undertaking an e-course with the opportunities of personalised learning, particularly based on the ideas of an active learning position, content diversity and variability of tasks, reflection, consciousness, collaboration, and responsibility. In terms of content diversity, special attention was paid to such assignments that supported students' interest and stimulated going beyond the educational program. By that, we understand assignments with a research orientation, assignments that require the search for additional information sources, assignments that encourage students to take part in extracurricular activities - competitions, grants, conferences, etc.

In this study, we focused on the following aspects of personalisation – personal learning objectives (associated with interests and motivation), personal strategies of learning interactions (with content, teacher, and peers), and personal self-regulation strategies (preferences in assessment and self-assessment). The logic of the study assumed an entrance and final survey of students,

in which, firstly, they had to project their goals in personalised learning, and, secondly, assess how their initial assumptions were realised. In the questionnaire, the respondents were asked to relate the statements to the 5-point Likert scale (1 – absolutely irrelevant, 2 – irrelevant, 3 – sometimes relevant, 4 – relevant, 5 – very relevant).

The statements in the entrance and final questionnaires were the same but formulated in the future and past tense according to the survey stage. Sample statements to evaluate personal learning objectives are the following: I want to achieve the planned results of the course with minimal effort and time; I aim at going beyond the educational program, conducting scientific research, showing creativity, participating in competitions, which require enhanced, personalised work, etc. Sample statements to evaluate personal strategies of learning interactions are the following: I prefer video lectures (the choice included also digital texts, hypertext, and knowledge bases) as learning resources; I prefer peer-to-peer learning; I prefer solving complex, interdisciplinary problems with social and professional contexts, etc. Sample statements to evaluate personal self-regulation strategies are the following: I prefer systematic monitoring and evaluation of learning progress and outcomes; I prefer quick information exchange at any time with a teacher, peers, and, if necessary, with other social partners, etc.

To analyse the obtained data, we used descriptive statistics, correlation analyses, and cluster analyses (Križanić, 2020).

Results

Descriptive statistics on entrance and final surveys are shown in Table 1. The table shows that, in general, the data of the entrance and final surveys do not contradict each other; major trends in student understanding of personalised learning persist. This means that students consciously approach goal-setting, selection of interaction approaches, and means and management of their learning.

However, there are a few important differences worth noting. In terms of learning objectives, we see a significant downgrading in the average values for the variables 1 "minimal effort and time and 4 "going beyond the educational program". This may mean that even without going beyond the educational program and basic content, students spent a significant amount of time on their assignments. This assumption is confirmed by the increase in the significance of variable 3 "increase of volume and quality of autonomous work".

In terms of personal strategies of learning interactions, the distribution of responses is more even. We can see a slight change in variable 10 "complete assigned tasks according to the program" which may indicate an even more accurate adherence to a given educational trajectory. Nevertheless, the value of variable 19 "intercultural communication", decreased from "sometimes relevant" to "absolutely irrelevant". Several reasons can explain this: students did not receive assignments aimed at intercultural communication; it was difficult for students to cope with the basic tasks, and they no longer had enough time and energy for more complex problems with an intercultural context. In any case, this issue requires further research.

In terms of personal self-regulation strategies, we see a slight increase of value for variable 20 "systematic monitoring and evaluation" and a slight decrease in value for all other variables, most notable for variables 22 "recommendations on completing assignments" and 23 "assessment criteria". This is quite understandable: systematic monitoring and evaluation are most likely to be implemented by the teacher (via LMS tools), therefore, for the student in such a situation, self-assessment tools, which include the listed ones, become less significant.

Cluster analysis made it possible to see more subtle correspondences between variables (Figure 1).

Nº	Variable	Entrance survey			Final survey		
		Mean	Median	Std.Dev.	Mean	Median	Std.Dev.
Learning objectives							
1.	Minimal effort and time	4.2	4.0	1.0	3.5	3.5	1.2
2.	Simultaneous improvement of all competencies	4.2	5.0	1.0	4.3	4.0	0.8
3.	Increase of volume and quality of autonomous work	3.5	4.0	1.2	4.4	5.0	0.8
4.	Going beyond the educational program	3.6	4.0	1.3	2.8	2.5	1.5
Personal strategies of learning interactions							
5.	Digital texts	3.6	4.0	0.8	3.7	4.0	1.2
6.	Video lectures	3.8	4.0	0.9	3.5	4.0	1.4
7.	Hypertext and knowledge bases	4.0	4.0	0.9	3.3	4.0	1.3
8.	Individually complete assigned tasks, solve practical cases	3.7	4.0	1.0	3.5	4.0	1.2
9.	Peer-to-peer learning	3.9	4.0	1.1	3.7	4.0	1.0
10.	Complete assigned tasks according to the program	3.7	4.0	0.7	4.3	4.5	0.7
11.	Solving complex, interdisciplinary problems with social and professional contexts	3.4	3.0	0.9	3.4	3.5	1.0
12.	Solving problems with information redundancy, showing critical thinking	3.6	3.0	1.0	3.5	3.5	1.2
13.	Solving problems with information deficiency, showing creativity and heuristics	3.5	3.0	1.1	3.4	3.0	1.3
14.	Written comments and judgments on a given topic (e.g., blog)	3.7	4.0	0.9	3.2	3.5	1.6
15.	Oral comments and judgments on a given topic(e.g., ZOOM)	3.7	4.0	0.9	3.8	4.0	1.3
16.	Participating in online discussion	3.6	4.0	1.0	3.3	3.5	1.4
17.	Preparing a video report, video message (e.g., video, scribing, voiced presentation)	3.3	3.0	1.1	3.6	4.0	1.2
18.	Participating in an open discussion (e.g., online community, social network)	3.5	3.0	1.0	3.3	3.5	1.4
19.	Intercultural communication (in a foreign language)	3.1	3.0	1.2	1.6	1.0	1.1
Personal self-regulation strategies							
20.	Systematic monitoring and evaluation of learning progress and outcomes	3.8	4.0	0.8	4.2	4.5	0.9
21.	Individual and group consultations	4.3	4.0	0.8	3.9	4.0	0.8
22.	Recommendations on completing assignments	4.4	5.0	0.8	4.0	4.0	1.1
23.	Assessment criteria	4.4	5.0	0.7	4.1	4.0	1.0
24.	Personalised analysis of the work performed and difficulties encountered	4.1	4.0	0.7	4.1	4.0	0.8
25.	Quality and diverse educational materials	4.4	5.0	0.8	4.0	4.0	1.0
26.	Prompt information exchange with a teacher, peers, and social partners	4.5	5.0	0.8	4.3	5.0	1.0

Table 1: Descriptive statistics on entrance and final surveys (source: own calculation)
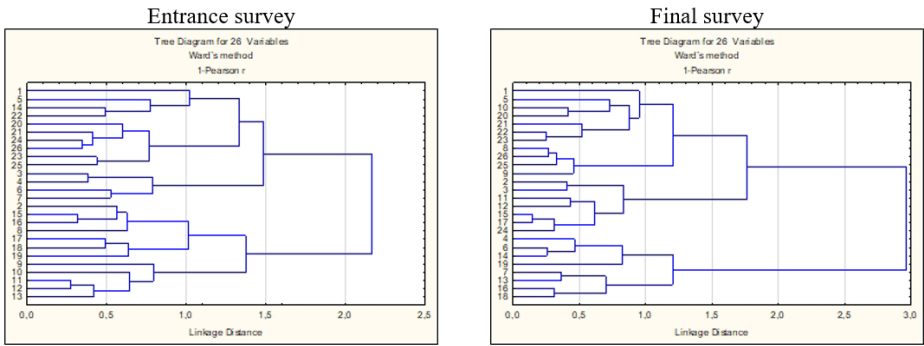
Figure 1: Cluster analysis on entrance and final surveys (source: own calculation)

In general, cluster patterns are similar; however, they differ significantly in content. According to the results of the entrance survey, the variables formed two clusters. The first (upper) cluster describes a strategy of autonomous study. It comprises variables that characterise personal goals, interactions with digital content, and personal self-regulation strategies. Noteworthy, for autonomous study, strategies of "minimal effort and time" and "going beyond the educational program" are possible. The second (lower) cluster depicts strategies of peer-to-peer and collaborative learning, which involves productive activity, content creation, discussion, and various types of interaction. Remarkably, none of the variables associated with personal self-regulation strategies joined this cluster. This means that students, on the entrance, did not associate cooperation and co-working with management, which required work to correct this incomplete understanding through the organisation of activities within the e-courses.

The cluster analysis of the final survey results shows that experience of personalised learning allowed to form a more balanced view of its possible strategies. The first (upper) cluster this time comprises more variables, and they belong to all three aspects of personalisation – personal learning objectives, personal strategies of learning interactions, and personal self-regulation strategies. The second (lower) cluster is associated with the ideas of going beyond the educational program because it demonstrates specific tools and technologies for that - information deficiency, creativity, discussion, comments, and intercultural communication.

DISCUSSION

The results of our research showed that there are several aspects of students' readiness for personalised learning that need extra attention. Firstly, students are accustomed to following the instructions of the teacher, and an overall situation of choice is a certain challenge for them. Similar results were obtained by Iterbeke et al (2022) who studied the "example choice" instructional method in a computer-assisted learning environment and showed that a varied choice of "out-of-school interest" learning contexts could complex learning process and on average, students do not show better results, and learners with low competencies even have more problems.

Secondly, when designing e-learning courses with the opportunities of personalisation, it is advisable to create situations of mutual learning, cooperation, and collaboration to expand the educational context. Danowitz (2021) showed that peer learning activities, "Teach What You Know Day" (TWYKD), was beneficial for content acquisition and positively influenced training results. Koh (2019) proposed several dimensions associated with student-centred learning - personalisation, higher-order thinking, self-direction, and collaboration. The author proves that students need more personalisation of learning choice and collaboration. Sunday et al (2017)

suggest a peer-matching algorithm based on ICT, which allows choosing peers for each student following the level of competence and training. In a situation of instability and rapid changes in education and lifestyle, cooperation and collaboration are especially important because they help to adapt flexibly to the changing situation. As Monika and Correia (2022, p. 9) note, students are positive about online collaborative learning. Therefore, "priorities in education related to cooperation, communication and showing emotional support" are important especially for future teachers for whom communication, interaction, and empathy are the main professional tools regardless of the learning model (face-to-face or distant).

Thirdly, it is advisable to pay special attention to the issue of management in personalised e-learning courses. Merma-Molina et al (2022, p. 2) bring together the concepts of critical thinking, effective personality, and management, noting that "an effective person is one who manages without major difficulties in the various areas of life, whether personal, academic and/or social".

Conclusion

In general, students have adequate ideas about personalised learning. They understand that it requires certain time and effort, volume, and quality of autonomous work. However, on average, do prefer not going beyond the educational program, but completing assigned tasks according to the program. Apparently, a stereotype of following an educational trajectory given by the teacher has stereotype formed in the learning process. To a certain extent, it contradicts the ideas of personalisation, especially in the context of goal setting and a conscious choice of educational objectives. Systematic monitoring and assessment implemented by the teacher (via various digital tools) do not always include support for self-assessment and peer-assessment, based on assessment criteria. Therefore, extra attention to self and peer assessment tools is required within e-courses.

Having little experience with personalised learning, students tend to equate personalisation with autonomy and oppose peer-to-peer learning, collaboration, and co-working. However, with experience, they begin to understand that personalisation does not contradict joint activities and mutual management but on the contrary, it helps going beyond the educational program because only interaction in a wide multiuser educational environment deals with information deficiency and redundancy, creativity, discussion, comments, and intercultural communication which is fully consistent with the challenges of the digital world.

Acknowledgement

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DISTANCE LEARNING IMPACT ON STUDY RESULTS WITH RESPECT TO LEARNING ENVIRONMENT

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Abstract

The rapid transition to distance learning at the Czech University of Life Sciences in the academic year 2019/2020, similarly to other universities and other types of educational institutions, was caused by an unfavorable epidemiological situation. It was a very non-standard situation until then, to which it was necessary to react immediately and adapt to it. In the spring of 2021, a survey was conducted to obtain feedback from university students about their experience with distance learning. The research examined students' attitudes to study during online learning and their experience in the context of study results. It is possible to say that an optimal environment is not a necessary condition for successful study. The absence of personal presence of teachers and classmates is one of the major disadvantages of distance learning. However, most students rate this experience as positive.

Keywords

Assessment, distance learning, education, environment, students, study results

Introduction

Distance education can take place both in the form of online teaching and in the form of off-line teaching. In general, online teaching is a type of distance learning that is usually implemented via the internet and is supported by a variety of digital technologies and software tools. Furthermore, it is possible to distinguish between synchronous and asynchronous online teaching. In synchronous teaching, the teacher is usually connected to students through a communication platform (e.g… MS Teams) at the same time (MEYS, 2020).

Substantial research results can be divided into three categories: Motivation, Environment, Technical Availability and Amenities. Students had the opportunity to compare the course of online teaching and their own motivation. Already in older studies, a warning about the risk of information overload can be found (Hill, 2002; Hew, Cheung, 2003; Hmelo-Silver et al., 2006), where students are surprised by the excess of communication tools available in teaching, including feedback. The results of the research show that the warning is still valid and does not only apply to communication tools, but in general to all online teaching tools. The use of online learning has also resulted in the disadvantage of an environment that is often argued as an advantage of online learning (a student can learn anytime, anywhere). Paradoxically, the environment is one of the barriers to disruption by Mungani (2003), because it is not motivating enough for some students to learn, such as a classroom or library. In contrast to Ali et al. (2018), where they point to the conflict between time for study and time for privacy. The issue of insufficient motivation to learn online is mapped in a number of other studies (e.g.

Regmi and Jones, 2020; Naveed et al., 2017; Liaw, Huang, 2011), but there is no clear connection to the home background. The technical background of the students was not a problem and the availability of the internet in 2020 no longer meant such an obstacle to online teaching as, for example, in a study (Kim, Liu and Bonk, 2005). Internet access (tablets, smartphones) and software is an advantage of online learning – the ability to play back and repeat recorded lectures, as shown by the first published studies on online learning during the covid-19 pandemic (Chen et al., 2020; Cengage, 2020).

Synchronous online teaching is demanding on the mutual communication interaction of content perception from the perspective of the transmitter (teacher) and receiver (student). This form of education must be adapted to the content, manner and pace of all involved. It can be assumed that time consuming can affect the maintenance of attention and fatigue from monitoring the monitor can occur. By analogy, in asynchronous teaching, online students do not meet and work individually at their own pace on assigned tasks. Various portals and platforms (e.g. Moodle) can be used for entering tasks and checking them. The digital technologies through which online teaching takes place bring many advantages, but also many disadvantages and limits that can affect the quality of teaching and its evaluation (Zounek et al., 2016). Among the positives from the students' point of view, of course, are benefits in the form of individualization, saving time, resources and finances, setting one's own learning pace and being able to learn anytime, anywhere and "from the students' point of view; location and distance are not an issue" (Ally, 2008, p. 17).

The objective of the article is to evaluate the experience and perception of distance learning implemented at the Czech University of Life Sciences in the school year 2020/2021 from the perspective of students in the context of study results and analyse its impact on study results.

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:
- analyze impact of distance learning on study results,
- evaluate the background and study environment during distance learning from the perspective of students,
- evaluate the experience with distance learning and its overall perception of students.

The Characteristics of Respondents and Survey Questions

Data collection for research took place from March to April 2021. 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 Sciences were asked to participate in the survey. The sample was intentional (each student filled the questionnaire only once). A total of 437 students took part in the research in the period under review. According to the student structure on the faculty, 162 men and 275 women were asked to fill in an online questionnaire. The most frequent age group (72 %), in agreement with the structure of students, was the 22-25 age group (315 respondents). Most of the interviewed students was bachelors (74 %), part was magisters (26 %). Most of them were full-time students (85%), some studied in the combined form of study (15%).

The questionnaire consisted of a total of 25 questions with a predominance of closed questions (22 closed, 3 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, the questionnaire focused on the perception of distance learning by students. Students were asked about their personal experience with the transition to distance learning in the school year 2020/2021 in comparison

with full-time teaching in the school year 2019/2020. Students were interviewed electronically at the beginning of the summer semester between March and April. The data was processed and subsequently evaluated using the MS Excel spreadsheet program.

The Analysis of Distance Teaching Impact on Students' Results

We used the attributive risk and odds ratio for the analysis of a specific factor impact on students' results. In particular, we compared the rate of resilience to selected negative consequences of distance teaching (worse grades and loss of motivation to study) between different groups of students (e.g. between different study degrees, study forms, gender etc.). The attributive risk (Schechtman, 2002) expresses an absolute effect of the observed factor (e.g. gender). It told us how higher the possibility to resist (not to be affected) was within one group (e.g. female students only) in comparison to another group (e.g. male students). It is calculated as follows:

$$AR = \frac{a}{a+b} - \frac{c}{c+d} \tag{1}$$

where a and b are numbers of students who resisted and were affected in the former group, respectively, and where c and d are numbers of students resisted and were affected in the latter group, respectively. It is also possible to calculate its relative form which is indicated as AF using the following formula:

$$AF = \frac{\frac{a}{a+b} - \frac{c}{c+d}}{\frac{a}{a+b}} \tag{2}$$

The odds ratio (Glass et al, 2003) assesses a chance to resist. It is calculated as follows:

$$OR = \frac{ad}{bc} \tag{3}$$

If $OR = 1$, there is no dependency between the observed variables. $OR > 1$ means that affiliation with the second group is a risk factor, and vice versa, $OR < 1$ means that the affiliation with the second group is a protective factor.

RESULTS

The transition to the full online form of teaching was not a reason for not meeting the requirements for the credit or exam. 82.2% of students stated that the change in the method of online teaching (2019-2020 summer semester and 2020-2021 winter semester) was not the reason for not meeting the credit / examination conditions in any of the subjects taught. Only 12.8% of students had difficulty meeting the requirements of some professional courses. It is possible to say that students do not perceive the transition to distance learning as a direct cause of deteriorating learning outcomes. For most students (265), learning outcomes remained almost the same or improved slightly (Fig. 1).
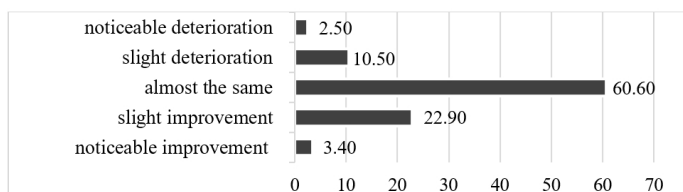

Figure 1: Change in study results during distance learning (%), (source: own calculation)

A very important prerequisite for the effective results of distance forms of education is a suitable environment. 31.8 % of students had a suitable environment that allowed students to work properly and also to concentrate. On the other hand, despite favorable environmental conditions, 34.1 % of students were unable to concentrate during online classes. At the same time, it is confirmed that the optimal immediate environment is not a necessary condition, because even though 22.2 % of students could not work in an ideal environment, they were able to concentrate on teaching. When asked whether students were more motivated to study during distance learning, 76.4 % of them answered that they did not agree with this statement (47.6 disagreed and 28.8 % strongly disagreed). On the other hand, 23.5 % of students were more motivated during online teaching (17.6 % agree and 5.9 % strongly agree). A positive finding is that despite all the complications and difficulties that were associated with distance learning and its organization, most students rate this experience as positive (79.4 %).

The Comparison of Distance Teaching Impact on Different Students' Groups

In the following analysis we endeavour to find out if and to what extent the negative impact of distance teaching differed between different groups of students (e.g. between different study degrees, study forms, gender etc.). Based on the respondents´ answers, we evaluated exam and credit failures, grades worsening and loss of motivation to study. Beside this, as distance teaching enables students easy cheating, we assessed also grades improvement to be unwanted.

We calculated the attributive risk and odds ratio for all these phenomena within each of the following couples of students' groups:

- students who stayed in the CR and who stayed abroad during distance learning,
- students who were allowed by the environment to concentrate adequately and who not,
- students who were allowed to work in an ideal environment and who did not have privacy,
- students of combined and full-time study form,
- students of master and bachelor degree,
- female and male students,
- students who used a computer and students who used other or different devices.

Within evaluation the impact on credits and exams failure we did not consider students who could not assess if they failed credit or exam just due to transition to distance teaching. In case of all the others consequences of distance teaching we considered all respondents.

	exam or credit failure	grades worsening	grades improvement	motivation loss
abroad – not affected	9	11	8	9
abroad – affected	2	0	3	2
abroad – not affected (%)	82%	100%	73%	82%
CR – not affected	350	369	314	94
CR – affected	54	57	112	332
CR – not affected (%)	87%	87%	74%	22%
OR for abroad	0.69	∞	0.95	15.89
OR for CR	1.44	0.00	1.05	0.06
AR	-5%	13%	-1%	60%
AF for CR	-6%	13%	-1%	73%
AF for abroad	-6%	15%	-1%	271%

Table 1: The comparison of distance teaching impact on students staying abroad and in the Czech Republic, (source: own calculation)

As presented in Table 1, the most significant difference was between students who stayed abroad (all of them were Erasmus students) and in the Czech Republic. First of all, none of abroad students got during distance teaching worse grades than during the period before the distance teaching began. A very significant difference between these two groups was in motivation loss. While among abroad students only approximately each fifth or sixth student lost the motivation to study, among students in the CR there were almost four-fifths of such students. In contrast, there was no significant difference in exam and credit success, students abroad were even slightly more likely to have problems.

	exam or credit failure	grades worsening	grades improvement	motivation loss
concentrated – not affected	195	214	163	85
concentrated – affected	32	22	73	151
concentrated – not affected (%)	86%	91%	69%	36%
not concentrated – not affected	153	156	149	18
not concentrated – affected	23	30	37	168
not concentrated – not affected (%)	87%	84%	80%	10%
OR for concentrated	0.92	1.87	0.55	5.25
OR for not concentrated	1.09	0.53	1.80	0.19
AR	-1%	7%	-11%	26%
AF for not concentrated	-1%	8%	-16%	73%
AF for concentrated	-1%	8%	-14%	272%

Table 2: The comparison of of distance teaching on students who could and could not concentrate, (source: own calculation)

	exam or credit failure	grades worsening	grades improvement	motivation loss
ideal environment – not affected	241	262	207	83
ideal environment – affected	36	26	81	205
ideal environment – not affected (%)	87%	91%	72%	29%
lack of privacy – not affected	107	108	105	20
lack of privacy – affected	19	26	29	114
lack of privacy – not affected (%)	85%	81%	78%	15%
OR for ideal environment	1.19	2.43	0.71	2.31
OR for lack of privacy	0.84	0.41	1.42	0.43
AR	2%	10%	-6%	14%
AF for lack of privacy	2%	11%	-9%	48%
AF for ideal environment	2%	13%	-8%	93%

Table 3: The comparison of distance teaching impact on students who had an ideal work environment and who did not have enough privacy, (source: own calculation)

Poor working conditions mainly affected motivation and grades (see Table 2 and 3). In particular, a student who could not concentrate adequately might five times easier lose motivation that one who can concentrate. Both lack of privacy and impossibility of concentration increased the risk of motivation loss and grades worsening at least twice. At the same time, on the other hand, students with good working environment tended to achieve grades improvement.

As the difference of distance teaching impact on students of different study forms and degrees is concerned, full-time students and bachelor students were more endangered. OR for losing motivation was 2.69 in behalf of combined form of study and 1.94 in behalf of master degree students. Bachelor students were more at risk of failing an exam or credit (OR = 2.22) while there was no significant difference in exam or credit success between study forms. We found out no significant differences both between gender and between students using different devices at distance teaching. Let us only note that female students and students who did not use (only) a computer were less at risk of all four observed consequences. In all the cases, OR was less than 1.7.

Discussion

It is clear from the responses of students that online teaching cannot fully replace full-time teaching. On the other hand, it can be stated that online teaching also had its pros (saved time for transport, study materials still available). All technical problems can be included as negative aspects due to the dependence of online teaching on the functionality of digital technologies. Full personal contact with the teacher is also not possible. But the research of Kučírková et al. (2012) confirmed that the use of e-learning tools in teaching can be beneficial in certain circumstances. In the approach to study, the primary differences between active and passive students appeared in that active students were able to create their own regime (Nadeak, 2020) and study independently on its basis (Černý, 2020). Passive students lacked leadership, motivation and control. Distance learning also had an impact on student test results, which was also confirmed by research by Moravec et al. (2022). The main shortcoming of online teaching is the absence of social contact and an unsuitable environment. Students developed a new type of stress, namely stress from failure of technical equipment, internet failure during the exam (Meeter et al., 2020). Students felt also social isolation and lacked friends, but also academia and cultural activities (Trnka, Lorencová, 2020; Aristovnik et al., 2020; Meeter at al.2020; Karalis, Rakiou 2020; Hussain, 2020). In general, for university students, this experience was a huge intervention in their lives, which made them think about life priorities.

Conclusion

According to the educational company Cengage (Cengage, 2020) in its research, the improvement of future online teaching can be seen in a significant transition from classic scripts to e-books and from classic classroom lectures with PowerPoint presentations to a higher share of multimedia teaching materials and camera-recorded lectures. Opportunities and barriers to online teaching can be easily divided into pedagogical and individual (Ali et al, 2018). The method, quality and content of online teaching can be counted among the pedagogical ones. Opportunities and barriers to individual learning are most represented by factors such as the often lack of motivation and the frequent feeling of isolation in the online environment. Regmi and Jones (2020) state that both internal and external reasons are to blame – low levels of involvement in teaching, high levels of anxiety and stress, lack of self-discipline, few interactions between students and teachers.

Despite the complications and difficulties associated with the implementation and organization of distance learning at the Czech University of Life Sciences during the school year 2019/20 and 2020/21), it can be said that it brought a number of positive experiences for students and teachers. That should be noted that the results of the study depend on the subjective interpretation of the analysed comments. Findings of facts, their interpretation and efforts to understand are influenced by the choice of questions and their context, which can affect the interpretation. The findings cannot be generalized and are valid only in the given context, environment and time.

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CONCEPT CARTOONS IN A MATHEMATICS CONTENT COURSE: FUTURE TEACHERS' REFLECTIONS

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Abstract

The contribution focuses on the use of educational vignettes (Concept Cartoons) in the professional preparation of primary school teachers. We introduce Concept Cartoons that were assigned to 67 future primary school teachers during a mathematics content course at the beginning of their 5-year professional preparation programme, and show how the future teachers reflected on the work with them. The Concept Cartoons focused on a topic closely related to the content taught at the primary school level – the topic of divisibility. The reflections consisted in written answers to an open question, and we analysed them qualitatively. The results of the study show that even future teachers at the beginning of their professional preparation are able to identify relevant aspects of educational vignettes and appreciate the benefits that this didactical tool might bring to initial teacher education.

Keywords

Concept Cartoons, educational vignettes, elementary school teachers, initial teacher education, mathematics education

Introduction

With the rapidly evolving capabilities of graphics hardware and software and its availability to the general public, new tools have emerged in the last decade that bring new possibilities and opportunities not only to everyday life but also to teacher professional preparation. Among these tools we may include educational vignettes – more or less complex stories representing school practice (Buchbinder and Kuntze, 2018). Formerly, vignettes usually took the form of text-, audio- or video-recordings, recently they have also taken the form of cartoons (Friesen and Kuntze, 2018; Skilling and Stylianides, 2020). With a suitable graphic tool, cartoon-based vignettes are easy to create or modify. In the *coreflect@maths* project, we work on developing such a tool, a digital environment called *DIVER* (*Developing and Investigating Vignettes in teacher Education and Research*) that will allow to create and modify various types of cartoon-based vignettes and implement them into teacher education programmes.

In professional preparation of mathematics teachers, cartoon-based vignettes usually represent classroom situations involving a group of students with a teacher (e.g., in vignettes used by Friesen and Kuntze, 2021), or a group of students without a teacher (e.g., in Concept Cartoons; Samková, 2020). Using the vignettes, teacher educators can develop or investigate various facets of teachers' knowledge. They can, for instance, let future teachers respond to hypothetical learning support situations (Friesen and Kuntze, 2021), or to hypothetical student ideas (Buforn et al., 2017; Samková, 2020), and assess the responses from the perspective of the three dimensions of pedagogical content knowledge according to Kleickmann et al. (2013): knowledge of tasks, knowledge of students, and knowledge of instruction. Additionally, they can also let future teachers respond to hypothetical ideas of other future teachers (Samková, 2022), or assess the responses

from the perspective of school-related content knowledge according to Dreher et al. (2018). Such an approach, which had been originally used in the context of professional preparation of secondary school mathematics teachers, allows to bridge the gap between academic and school mathematics, i.e., between academic mathematics such as calculus that the future teachers have learnt during their previous university studies and secondary mathematics they are supposed to teach in their future practice. Nevertheless, the concept of school-related content knowledge is applicable also with future primary school teachers. For them, it bridges the gap between secondary and primary school mathematics.

In the context of the professional preparation of primary school teachers, school-related content knowledge and cartoon-based vignettes, we introduce a qualitative research study that took place during a mathematics content course provided for future primary school teachers during the first year of their 5-year professional preparation programme. As a part of the study, we let the future teachers respond to Concept Cartoons with hypothetical ideas of other future teachers, and then we asked them to reflect on the activity. We analysed their responses to address the research question *"How do future primary school teachers at the beginning of their studies reflect on their work with Concept Cartoons representing primary-school-related mathematics content?"*

From the perspective of the ERIE conferences and the ERIES Journal, we follow on our previous work presented there that focused on future primary school teachers' knowledge revealed when dealing with Concept Cartoons representing primary-school mathematics content (e.g., the content of the meaning of a fraction in Samková, 2018), and expand the focus to primary-school-related content and future teachers' reflections.

The text is organized as follows: at the beginning, it introduces the participants of the empirical qualitative study, the Concept Cartoons, and the activities the participants performed with them. Then we describe the course of data collection and data analysis, the findings and their discussion.

MATERIALS AND METHODS

Participants

Participants of the study were 67 prospective primary school teachers in the first year of their 5-year university master degree programme. Within the programme, they are prepared to become generalist primary school teachers, i.e., to teach all school subjects belonging to the primary school curriculum in the Czech Republic. The primary school level in this country covers students from 6 to 11 years of age, the secondary school level covers students from 11 to 19 years of age. Future teachers usually come to the university immediately after finishing secondary school. To maintain the anonymity, the participants were assigned randomly selected code names from V1 to V67.

The Concept Cartoon and related tasks

One of the topics closely related to the primary school curriculum in the Czech Republic is the topic of divisibility: primary school mathematics deals with natural numbers as well as with the four basic operations and their properties, while secondary mathematics continues with prime and composite numbers, prime factorization, common multiples and divisors, and criteria of divisibility (NIE, 2022). Therefore, the topic of divisibility can be seen as representative for primary-school-related content, and we prepared two Concept Cartoons focusing on it. Both Concept Cartoons showed a group of four future teachers solving and commenting on a mathematical task; the first task was about divisibility by 18 (see Figure 1), the second one about establishing the last digit of a large number presented by its prime factorization (not presented here). As is usual with Concept Cartoons, some of the statements in bubbles were correct (Celest, David in Figure 1), and some

were incorrect and based on common misconceptions (Adele: overgeneralization, Ben: missing coprime condition). Both tasks were open in the sense of an open approach (Nohda, 2000), since they had multiple correct solution procedures.

The participants were assigned the two Concept Cartoons with three indicative questions (prompts) aiming at their professional knowledge: *What thoughts could be behind the student teachers' thinking? How could you help the other student teachers to correct their answers or to improve their argumentation? Write YOUR solution into the empty speech bubble.* For all of them, it was the first time they worked with Concept Cartoons. The participants were supposed to work individually and provide their responses as a compulsory written homework. Recently, we have conducted a qualitative research study about various kinds of content knowledge revealed in written data collected this way (Samková, 2022).

Data collection and data analysis

With the three content-related questions mentioned in the previous section, the participants were assigned also a fourth, reflective question: *What do you think: How can working with Concept Cartoons help you to improve your learning related to divisibility?* The study presented in this paper is based on written responses to this reflective question; 51 out of the 67 participants provided their response to this question.
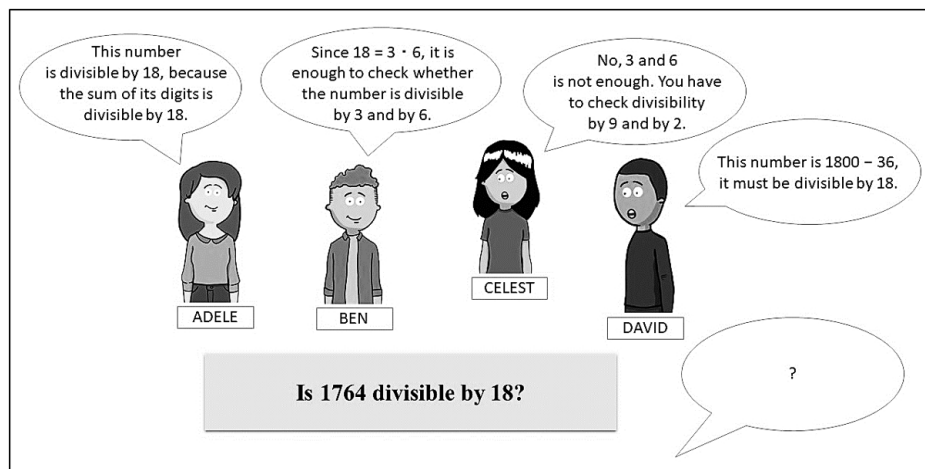

Figure 1: A Concept Cartoon on divisibility by 18, created with DIVER elements (source: own)

To find an answer to our research question, collected data went through qualitative analysis using open coding and constant comparison (Miles, Huberman and Saldaña, 2014). During data analysis, we openly coded all the material and looked for various aspects that the participants considered relevant. Then we applied the method of constant comparison – from the overall perspective, from the perspective of individual aspects mentioned in data, and from the perspective of individual participants across all aspects. Our goal was to assign each of the data excerpts and each of the codes to exactly one code category. At the end of the process, we got six different code categories; the categories are specified in the Results section, each of them having a sub-section with illustrative excerpts. During the analytic stage of the research, we processed just data related to the reflective question. However, during the interpretative stage, we also consulted data obtained through the three content-related questions, to get a better idea about the meaning of some the excerpts (see the code category Format as explained below).

Results

At first, the five following code categories appeared as relevant in the analytic process:

- Discussion (codes *discussion*, *small groups*, *whole classroom*, *communication*, *argumentation*, *cooperation*);
- Open approach (codes *multiple solution procedures*, *multiple perspectives*, *new ideas*, *alternatives*);
- Thinking (codes *thinking process*, *independent thinking*, *better concentration*, *better imagination*);
- Knowledge (codes *exercising*, *revisiting*, *assessment*, *anchoring*);
- Format (codes *challenging to understand*, *complicated*, *need for validation*; *clearly organized*, *innovative*, *attractive*).

However, with this set of code categories, some data excerpts were assigned two or three codes that were inseparable but each of them belonged to different code category (Open approach, Thinking, Knowledge). We put all these excerpts aside, studied their common features, and this additional analytic process resulted in the establishment of a new, sixth category labelled

- Comparisons.

Although the protagonists depicted in the Concept Cartoons were future teachers and the reflective question addressed personally the participants, quite a few responses were made not in relation to future teachers or respondents themselves but in relation to children (pupils, students).

Code category Discussion

The code category with the highest frequency in data (48 occurrences) consisted of codes related to opportunities that Concept Cartoons may provide for small-group or whole-classroom discussions, from a general perspective as well as from the perspective of argumentation:

V27 The work with Concept Cartoons is good for discussion in pairs or small groups.
V28 It can help to initiate a discussion among children.
V12 It "forces" children to cooperate.
V49 Pupils have a greater opportunity to discuss the problem.
V67 Everyone gets involved and says their opinion.
V65 [It] creates a space for classroom discussion. Pupils get involved in the topic.
V37 It teaches us to reason correctly, so that others can understand our statements.
V64 It develops pupils' communication skills – their argumentation whether a commentary is correct or incorrect.
V47 It is important for children to be able to express their views and to be able to discuss the given problem.
V19 [The method] helps to foster discussion and argumentation.

Code category Open approach

The code category with the second highest frequency in data (40 occurrences) consisted of codes related to various aspects of the open approach (multiple solution procedures, perspectives etc.):

V16 Working with Concept Cartoons helps us to think about tasks from multiple angles.
V34 [Work with Concept Cartoons] helped me to see other different solutions that I probably wouldn't have thought of on my own.
V43 We can see more procedures here that may also be correct => we will learn that there is not always just one correct procedure.
V18 I wouldn't have thought of so many ways to find the result just on my own.
V45 Children will get familiar with more counting and calculation procedures, if we show them, but they can also come up with one of their own.

V35   Children may learn other good solution procedures that are not in the textbook but may be more convenient for them.

Code category Thinking

Twenty-one occurrences belonged to codes related to the process of thinking and ways to support it, in general or in relation to the topic of divisibility:

V28   I think it can help to think more deeply about divisibility.

V5   We discover mistakes, but also have to think about why this cannot be done this way and how we need to proceed another way.

V11   … more independent thinking and development

V66   [It] supports the development of children's thinking.

V38   [It] teaches critical thinking and analysis of information.

V12   These pictures will captivate children and lead them to better concentration.

Code category Knowledge

Seven participants mentioned knowledge, understanding and subject matter issues in their responses, some of them valued the opportunities to assess, revise or practice their knowledge:

V59   Certainly, this work with Concept Cartoons tests us in whether we really understand what we have learned.

V21   [It] helps to understand the matter through another rendition.

V51   Working with Concept Cartoons can help me to learn, because I have to think about each bubble and figure out how to fix it. That is why I have to understand the matter. Also, it can help me to understand the matter better.

V3   Thanks to the Concept Cartoons, I was able to revise the criteria of divisibility.

V9   Correcting statements is a good way of practicing divisibility criteria.

V38   [It] verifies knowledge of divisibility.

V29   It appears to me as an interesting way to anchor my knowledge.

Code category Comparisons

As mentioned above, some data excerpts (4 occurrences) belonged to Open approach, Thinking and/or Knowledge categories at the same time, and thus we put them into their own code category. The authors of these excerpts showed that they were aware of the possibilities that the open approach methods could bring to the development of thinking and/or content knowledge:

V37   Definitely, [it helps us to] discover other solutions than those we are familiar with, and thus [it helps us to] think more about the topic and develop our thinking.

V14   I think it's a good idea. If people know how to solve the result, they immediately see where others are making a mistake and can practice their arguments about it. And if they do not know, they solve the example with the help of other people (bubbles) – they are getting advice "indicia" there with which they can somehow get to the result.

V58   There are children in the class who will do everything exactly as the teacher shows them, but other children are inquisitive and seeking their own ways, so it is good to observe the task from multiple angles, to get to know more types of thinking, more procedures leading to one goal.

V56   I can admit that my brain almost boiled down and that the matter has been etched into my memory quite well, because I had the results in front of me, but at the same time I knew that they were not quite right, or that they were not complete. It was a really great task for me.

Code category Format

The last category on this list differs from the previous five ones, since it is the only one that addresses directly the affective domain. It contains codes with beliefs about the nature of the work with the Concept Cartoons format (17 occurrences). There were positive as well as negative (or rather negative) reactions among them:

V58 It was completely different from solving an assigned textbook task. Solving this task completely prompted me to consider myself a teacher presenting the task to children after the instruction, and then observing how they understood my instruction, what they remembered from it, and how they work with the obtained information.

V7 I think the assignment is pretty clear, well organized.

V9 The pictures are more attractive, captivating.

V29 I like this way! At first glance, the task seemed complicated to me, but, actually, it is only about working with critical thinking and verifying facts.

V15 I was a little puzzled about it, at first, I didn't understand what to do, then I found it interesting and innovative.

V46 Concept Cartoons were difficult for me to understand… maybe with a better knowledge of this method I would work better than now… due to the unfamiliarity, I do not evaluate this method positively.

V63 For me, Concept Cartoons do not make sense at the moment, because I have no assurance that my solution is correct.

V34 I have to admit that answering the questions was often difficult for me and I am not sure about the correctness of my answers.

The last three responses stressing the lack of feedback (V46, V63, V34) attracted our interest so that we revisited data from the previous study on the three content-related questions that had been conducted with the same Concept Cartoons and the same participants (Samková, 2022). It showed that V46 belonged among the weakest in the group from the perspective of content knowledge, by providing several improper ways of argumentation such as overgeneralizing or confusing assumption with conclusion in the responses. V63 was successful with the task in Figure 1 (correctly responded to the statements in bubbles and offered a correct statement to the blank bubble) but provided almost no response to the other task. V34 was successful with both tasks, except one rather insignificant language shortcoming provided in response to one of the bubbles.

Discussion

The illustrative data excerpts in the previous section show that even future teachers at the very beginning of their professional preparation programme are able to identify relevant aspects of Concept Cartoons as educational tools. In particular, the future primary school teachers participating in our study were able to reflect on opportunities that vignettes such as Concept Cartoons bring to classroom discussion, recognize the open approach principles hidden in the structure of Concept Cartoons, and recognize the relevance of using Concept Cartoons for the process of thinking as well as for knowledge and the process of understanding. Moreover, several of the participants considered the tool in a more complex way and commented on the open approach, thinking and understanding (knowledge) in a joint way. Such a broad perspective was not originally expected by the researchers, however, the precise process of the constant comparison method (Miles, Huberman and Saldaña, 2014) equipped by the requirement to have each of the excerpts and each of the codes assigned to exactly one code category led to the revelation of such broad perspectives and to the decision to establish a separate code category for them. We really value these findings, also because they relate and indirectly refer to the results of recent research made in the domain of the development of

mathematics knowledge: in the four data excerpts that were located to the separate code category, their authors emphasized the link between various solution strategies provided simultaneously by Concept Cartoons and the advantages that studying and comparing these strategies may bring the people who work with Concept Cartoons. In mathematics education research, there have been several studies published during the last decade proving that the process of simultaneous comparison of various strategies significantly helps maintaining better conceptual understanding and procedural flexibility (Durkin, Star and Rittle-Johnson, 2017; Loibl and Leuders, 2018).

From the perspective of the Concept Cartoon format itself, we may state that for some of the participants the format was somehow confusing (e.g. V34), however, others admitted that after their initial uncertainty, they came to the appreciation of the tool (V29, V15). These other responses bring us the hope that the difficulty might have been caused just by the fact that the participants worked with the tool for the first time. This implicates that pre-service teachers need time and also specific guiding to get acquainted with Concept Cartoons as educational tools, similar to what has been observed related to the use of video in teacher education (e.g., Seidel, Blomberg and Renkl, 2013).

The two Concept Cartoons used in the study represented primary-school-related content. The high frequency of relevant codes in data (137 occurrences altogether) and the diversity of the excerpts confirm the importance of considering the concept of school-related content knowledge (Dreher et al., 2018) also in the context of the primary school level.

Conclusion

The study presented here has followed on previous studies focusing on Concept Cartoons from the perspective of future primary school teachers' knowledge of primary school content, and expanded the focus to primary-school-related content and future primary school teachers' reflections. The results confirm the potential that Concept Cartoons (and educational vignettes in general) have in professional preparation of mathematics teachers. The reflective responses that the future primary school teachers participating in the study provided about their experience with the tool offer inspiration not only for further work of teacher educators but also for further research.

Acknowledgement

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EXPERIENCED MATHEMATICS TEACHERS REFLECTING ON STEM-ORIENTED COOPERATION PROJECT

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Abstract

The contribution addresses the issue of the possible development of mathematics teacher education in a way that would support the implementation of the STEM approach. For this purpose, we contacted a group of experienced lower- and upper-secondary school mathematics teachers who had participated in a three-year STEM-oriented cooperation project under the international human resources development framework. The project had connected universities, secondary schools and industrial companies in order to promote connections between mathematics, technology and engineering, and we asked the teachers to reflect in written form on the cooperation in hindsight, one year after the end of the project. In this paper, we analyse the reflections qualitatively. The results show how the teachers value the cooperation with teacher educators and companies, how they perceive their students' participation in the project, and also what benefits the cooperation brought to their own educational environment.

Keywords

Human resources development framework, mathematics teachers, STEM education, workplace excursions

Introduction

Recently, the concept of STEM education (Moore, Johnson and Glancy, 2020) has been broadly discussed as a means of integrating science (S), technology (T), engineering (E), and mathematics (M) education. The origins of this concept date back to the 1980s when the US government faced the declining interest of students to study these four domains and, concurrently, the increasing demands of the labour market for workers in professions connected to the four domains. These days, similar opposing tendencies appear in many countries (Bruno and Faggini, 2021), and the concept of STEM gradually settles in various areas of human resources research as well as educational research (Li, Froyd and Wang, 2019). In that environment, decision makers often accent the need for implementing the STEM concept into the educational process (e.g. NAE and NRC, 2014) and teacher educators then ponder possible ways of developing their teacher education programmes that would support the implementation of the STEM approach. To enrich our perspective of teacher educators in that process, we choose one of already finished STEM-oriented cooperation projects that had been conducted under the *Interreg Programme Framework* (ANL, 2022), and contacted all the participating teachers from our country (there were ten of them) to reflect on the project in hindsight. Like this, seven experienced lower- and upper-secondary school mathematics teachers became the respondents of our qualitative research study addressing the research question "What aspects of STEM-oriented cooperation projects do experienced mathematics teachers consider relevant for their own teaching practice and their educational environment?".

This contribution belongs to a local educational project supported by the Grant Agency of

the University of South Bohemia in České Budějovice named *Key areas of the curriculum for the integration of educational content in the field of STEM*. Its goal is to bring together future teachers and teacher educators, and let them study the theoretical and methodological bases needed for the implementation of the STEM concept within our national educational environment. The emphasis is on finding key places in the curriculum that would enable the integration of science, technology, engineering, and mathematics contents at primary and secondary school levels, with implications for the teacher education level. The results of this particular contribution intent to offer a more general practical perspective on the studied issue that could help identify the proper meaning of the "key areas" in the given context and the ways of reaching them efficiently.

The text is organized as follows: at the beginning, it presents the background of the STEM educational approach, and the particular STEM-oriented cooperation project that is in the scope of this paper. Then the text describes the respondents of the empirical qualitative study, the course of data collection and data analysis, the findings and their discussion.

The concept of STEM in educational research

In spite of the fact that the concept of STEM is rather new (Holmlund, Lesseig and Slavit, 2018), educational research on the topic has been relatively extensive. From the pedagogical perspective, it has aimed at teachers, students, learning environments, curriculum, assessment, etc. (Li, Froyd and Wang, 2018). However, from the subject perspective, the research is rather unbalanced (English, 2016): mathematics and engineering are significantly under-represented in the studies, and most of the studies focus on STEM integration just from the point of view of one individual subject (e.g. science). Moreover, it also seems that mathematics also plays an understated role within the STEM education (Maass et al., 2019). According to Hallström and Schönborn (2019), the unbalance could be rectified by taking a rather general approach: by focusing on more STEM subjects at once, and by investigating general principles such as representations and models. In their opinion, the focus on the general principles could enable a unified common view on the four STEM subjects despite their different contents and different didactical frameworks. Such an approach was chosen e.g. in the paper (Samková, Rokos and Vízek, 2021) aiming at finding joint principles behind argumentation in mathematics and science subjects.

From the teacher perspective, many research studies investigate how teachers understand the concept of STEM teaching, what their beliefs are about the concept, and how they plan to implement the concept into their own teaching. For instance, Margot and Kettler (2019) present a meta-study of 25 empirical studies with teachers from pre-school to secondary education and show that these teachers appreciate the STEM approach but find it problematic and difficult to implement. The publication (NAE and NRC, 2014) based on another meta-study provides a list of three key recommendations for the STEM implementation. The recommendations say that the integration cannot be expected to be spontaneously initiated by students (it has to be explicitly mediated by the teacher), that it is necessary to support and develop students' knowledge in the individual disciplines (to have something to build on during the integration), and that the most beneficial seems to be a moderate integration realized in strategic moments. In addition to these recommendations, Beswick and Fraser (2019) elaborate on four components that would facilitate the development of teachers in STEM contexts: creativity, collaboration, communication and critical thinking.

In this paper, we focus on teachers, their students, and their learning environment. As for the subjects, we include mathematics, engineering, and technology, i.e. three of the four STEM letters. We refer to experienced mathematics teachers after three years of implementing STEM into their mathematics lessons, and inquire how they see their involvement in hindsight.

The STEM-oriented cooperation project

The project in the scope of this contribution was carried out under the Interreg third priority axis focusing on employment improvement and cross-border labour mobility (ANL, 2022). It brought together mathematics teacher educators from two universities located on the opposite sides of the Czech-Austrian border (University of South Bohemia in České Budějovice, and Johannes Kepler University in Linz), ten secondary school mathematics teachers on each side of the border, three Czech and six Austrian industrial companies, and the South Bohemian Chamber of Commerce. The Czech industrial companies were selected, contacted and connected to the project by the Chamber. Two of the involved companies are engineering factories (focusing on mechanical engineering, foundry, machinery, turnery, in manual as well as automated form), and the third one is a technological factory (producing monitoring, network and broadcast equipment).

The project named *Mathematical Path to Technics* (abbr. *MatemaTech*) evolved from previous collaboration between the two universities, from the long-term collaboration among the universities and in-service teachers in the region, and from the systematic recent experience of the Austrian part with the concept of STEM education (MatemaTech, 2022). One of the long-term common points of interest between the two universities had been the development of *GeoGebra* educational software (GeoGebra, 2022) and its implementation into mathematics teaching and learning; the main developers of GeoGebra reside at the Austrian university. The idea of actively involving the industrial companies was brand new in that context. Project activities took place on both sides of the border; our study focuses on the activities attended and provided by Czech teachers.

During the project, the Czech teachers acted as liaisons between their students and the industrial companies, while the teacher educators acted as consultants and supervisors. In the beginning, the teachers and teacher educators took part in workplace excursions to the three industrial companies to get acquainted with the environment. Then the teachers regularly met with company representatives guaranteeing the technical-educational side of workplace excursions, and consulted with them on mathematics-related topics suitable for the excursions attended by their own students. With the help of teacher educators, the teachers created sets of tasks for their students to accomplish during the excursion and in the classroom afterwards; the tasks consisted in maths-related problems, sometimes preceded or accompanied by hands-on activities. The realizations of these tasks with students were reflected after each excursion (with company representatives, with teacher educators, and also with other teachers involved in the project). The problems and activities were adjusted when needed, and then used during follow-up excursions attended by the same teacher but different students or by other project teachers. Some of the teachers created more sets of tasks for one company and thus were able to visit its workplace with the same students more than once. To get a broader feedback, the teachers and teacher educators also took part in several interactive exhibitions for the general public, where they could share their tasks with teachers outside the project, and try and test the tasks with students other than their own. The final sets of tasks have been shared with the industrial companies and are available now for their workplace excursions.

Additionally, to get some alternative perspectives on the interrelations between mathematics and technics, the teachers and teacher educators took part also in several excursions to museums and historical buildings that included hands-on study of historical mechanical tools and devices. Based on these historical excursions, other tasks were created by the teachers, consulted with teacher educators and other teachers, and tested with students. Some of the students then visited the historical buildings with their teachers. The complete set of all tasks created and tested during the project is available on the project web page (MatemaTech, 2022).

Materials and Methods

Respondents

As possible respondents in our study, we had approached the ten Czech teachers who were actively involved in the MatemaTech project. Seven of them agreed to participate in the study. So that the group of respondents of this study consists of three lower-secondary school mathematics teachers (teaching students of age 11 to 15) and four upper-secondary school mathematics teachers (teaching students of age 15 to 19), each of them from a different school (two schools being rural and five urban). All of them are experienced teachers with more than 20 years of teaching experience. In the Czech Republic, secondary-school teachers usually specialize in two or three school subjects. The seven respondents are, in addition to mathematics, specialized in descriptive geometry, chemistry, physics, technical education, biology, financial literacy, English language, and German language.

Data collection and data analysis

One year after the end of the MatemaTech project, we asked each of the respondents to provide a written reflection on their participation in the project as well as on the project and its activities in general. In order to find an answer to the research question, we analysed collected data using qualitative analysis, namely open coding and constant comparison (Miles, Huberman and Saldaña, 2014). During open coding, we focused on all aspects that the respondents considered relevant, and then we looked for commonalities among these aspects that would allow us to sort them into qualitative categories.

Results

The following three code categories appeared as relevant at the end of the analytic process: Students (codes *students and tasks*, *students and excursions*, *students and motivation*, *choice of profession*), Teacher (codes *teacher and excursions*, *professional growth*, *sharing experiences, overcoming burnout*), and Educational environment (codes *curriculum, school cooperation*). The codes and categories found are specified below, in the same order as here, accompanied by illustrative excerpts. In the excerpts, the upper-secondary school teachers are labelled T1 to T4, the lower-secondary ones T5 to T7.

Students

The first code category covers the parts of reflections that addressed the participation of students in the project. The respondents commented what opportunities the tasks arisen from the project and the excursions brought to the students:

T1   Tasks that were usually complex, developed mainly the ability of students to apply the acquired theoretical knowledge in the process of solving practical problems, often with the use of fitting software.

T6   Excursions to the companies involved in the project were a great benefit for the students. Students were able to see the workplace, get acquainted with the production and operation of the company. They could also try out some simple work operations that are performed during production.

T1   Historical excursions, which were thematically related to some of the solved tasks, also proved to be educationally valuable. The ability to see the studied object or device in a real environment and at the same time in operation makes it easier for students to mathematically model the problem. This way, students are also aware of the connections between theory and practice, and have the opportunity to get acquainted with the historical development of technologies.

Most of the respondents pointed out the way in which the participation in the project affected motivation of their students:

T3   I have included a number of my own teaching materials and some of my colleagues' materials in my teaching, which has always received a positive response. Students positively evaluated both the new teaching methods with the help of GeoGebra software, and the interestingness of the topics.

T7   [Project] worksheets attracted students' attention, the students willingly dealt with them.

T1   Students dealt with the new teaching materials with interest and enthusiasm…. As a part of the project, I participated in all the prepared activities, which always clearly contributed to the students' interest in mathematics, physics, technics, etc.

T4   Students were thrilled to diversify their lessons by visiting a real company and solving practical tasks.

Some of the respondents also mentioned possible connections between the project and the choice of profession (the field of future studies) of their students:

T5   [Students'] involvement in the project influenced the choice of profession – technological vocational schools were chosen.

T4   Among the group of students who were involved in the project, three are now studying at technical universities. If their participation in the project contributed to their decision to study the technical field in any way, I think it fulfilled its role.

Teacher

The second code category covers the parts of reflections that addressed the participation of the teachers themselves. The respondents commented what opportunities the workplace excursions and the cooperation with the company representatives brought to them:

T2   My main role was to create teaching materials based on real practice (workplace excursions to companies and communication with their authorized representatives helped a lot here).

T7   All data in the worksheets were consulted with experts from *[the name of the engineering factory]* to be in accordance with the real situation…. they willingly participated in the creation of worksheets by supplying specific production information (prices of materials, purchase prices of scrap metal, time required for the production)…. for the students, they produced 15 workpieces similar to a child's toy and also supplied a sample of the steel log from which the workpieces were made. This was very useful in creating a realistic idea of the tasks that were solved.

Most of the respondents valued their own professional growth and indicated implications that the project brought for their own profession:

T2   My participation in the project has moved me a lot professionally. I got a specific idea about the possibility of cooperation between universities preparing future teachers and in-service teachers from various types of lower- and upper-secondary schools.

T3   I was able to study selected topics with the help of GeoGebra software and thus delve deeper into the possibilities of its use…. The [workplace] visits deepened my view in the technical field,… inspired me to create new teaching materials and search for new connections.

T4   Proceeding from students' reactions [to the project tasks], I re-evaluated the assignment of some problems in various areas of mathematics in order to target students' creativity based on estimates rather than direct facts.

T2   I gradually began to apply the experience gained from the project in my pedagogical work. In addition to the use of the project worksheets, I have also created the assignments for school-graduation exams and for school-graduation theses in mathematics in such a way that the students elaborate selected mathematical topics in real life contexts. Many times, I presented my experience with selected methodological materials to teachers at professional development courses.

The most frequently mentioned were the opportunities for sharing provided by the project:

T2   I was given the opportunity to engage in mutual discussions and share my own experiences, get to be inspired (I also managed to visit some colleagues during their lessons).… I got a specific idea about the possibilities of cooperation between universities preparing future teachers and in-service teachers from various types of lower- and upper-secondary schools… They have proven to complement each other and help each other well.

T5   The tasks we solved were of an interdisciplinary nature. Our school had a team of teachers who dealt with them.… It was very important to me to share the experience with the other teachers involved.

T6   Mutual meetings between the teachers involved in the project and the transfer of experience among them were important for the development of new knowledge in our lessons.

One of the teachers confided that the participation in the project was empowering and helped overcome the incipient burnout syndrome.

Educational environment

The third code category covers the parts of reflections that addressed the educational environment in general. The respondents mentioned several times issues related to school curriculum:

T1   Similar project supplements of upper-secondary education are missing in the current curriculum, while their contribution to the education of students is significant and irreplaceable in its form of implementation.

T5   Overtaking the time – just now, polytechnic education is becoming a topic of interest – we already have it, we are one step ahead thanks to MatemaTech.

One of the respondents commented on follow-up cooperation of their school with the subjects involved in the project as well as on new cooperation with subjects that were not involved in the project (yet their interest increased as the consequence of project activities):

T5   Establishing permanent cooperation with *[the name of the project technological factory located in the same town as the school]*.… Establishing cooperation with the South Bohemian Chamber of Commerce – still ongoing, developing further towards career counselling.… The school contacted by another company *[the name of a textile factory located in the same town as the school]*. A new cooperation was established on the basis of the MatemaTech project.
Thanks to the project, companies and the school were connected – the goal – for students to stay in *[the name of the town where the school is located]*, to be able to find interesting work here.

DISCUSSION

As illustrated by the excerpts in the previous section, the seven experienced teachers involved in the MatemaTech project reflected on their participation in the project from three main perspectives: the perspective of their students, their own perspective, and the perspective of their educational environment. The appreciation of and for the workplace excursions runs across all three perspectives. The teachers see the excursions as a great benefit for their students (their motivation, their ability to observe practical situations from the mathematical point of view, their ability to apply theoretical knowledge in practical situations, their choice of future profession) as well as for themselves (their professional growth, the way how they create new mathematical tasks and choose new topics for their lessons, how they can support the process by GeoGebra software, how they can communicate with other teachers, teacher educators, representatives of industrial companies).

From the four components that Beswick and Fraser (2019) introduce as facilitating the development of teachers in STEM, the respondents of our study explicitly mentioned three: creativity, collaboration

and communication. Critical thinking was not explicit in the reflections; however, it was implicitly hidden e.g. behind the comments about the process of creating and solving authentic tasks related to industrial workplace. Contrary to the meta-study findings of Margot and Kettler (2019), none of the teachers in our study mentioned any problematic moments or difficulties regarding the implementation of STEM in their teaching. Having included teachers with more than 20 years of experience in mathematics teaching might play a role in this result. Such a finding can also indirectly inform about the suitability of the structure of the activities in the reflected project. However, the results of our study cannot be generalized as the research design was qualitative.

From the overall perspective of STEM integration (Hallström and Schönborn, 2019), the results indicate that the MatemaTech project was able to make visible the mathematics hidden behind engineering and technological production processes, and show that (and how) the excursions accenting the collaboration of teachers and company representatives can form a suitable cornerstone for the TEM integration. Having fully included mathematics and engineering in our study, according to English (2016) or Maass et al. (2019), we have enriched the research on the less represented or understated STEM subject(s).

As mentioned in the introduction, this study intends to offer initial ideas for the organization and specification of research investigations on areas of the curriculum that might be the key ones in STEM integration. Regarding this issue, we may state that the workplace-related subject matters seem to be a good starting point for such investigations. Since the main investigators in the key-areas project will be future teachers, and future teachers are known as needing help in connecting subject matter explicitly with workplace matters (Nicol, 2002), the reflections and recommendations of experienced teachers reported in this study might facilitate the engagement of the future teachers in workplace-related subject matter investigations.

Conclusion

This paper introduced a model of cooperation among teachers, students, teacher educators, and industrial company representatives, established with the aim of supporting implementation of mathematics, engineering and technology subjects in the sense of STEM education. The results of the presented qualitative study show that the realization of the model really made visible the interrelations between school mathematics, technology and engineering, and thus could support the participating mathematics teachers in implementing the concept of STEM into their teaching and in creating teaching materials suitable also for teachers that did not take part in the cooperation. The teachers involved in the cooperation also reported on opportunities that such a model provided them, their students, and their educational environment. The aspect that these teachers found most important in their reflections consisted in active engagement of industrial companies: in workplace excursions that the teachers attended with their students, and in collaboration between teachers and company representatives that resulted in creating mathematics tasks related to authentic workplace practice.

Acknowledgement

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FAKE NEWS LABELLING

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Abstract

In our article we investigated the third person effect in relation to fake news impacts, ability to defend against them and knowledge of fake news topic. Our research focused on university students. We aimed at the effects on self-determination which consists of three aspects of autonomy (behavioural, emotional, functional), skills and abilities determinants of respondents' defence against fake news. We found out respondents were aware of the risks related to fake news. They tend to evaluate the risks related to themselves as smaller than the ones related to others. They also evaluate their own abilities to defend against fake news as better than those of others.

Keywords

Autonomy, fake news, fake news labelling, self-determination theory, third person effect

Introduction

Fake news (FN) is news that are similar to classical news and are distributed to serve some interests (Shin et al., 2018), (Lazer et al., 2018). They belong into the categories of misinformation and disinformation that are based on intentionality. Misinformation is undelibaretely false, disinformation is intentionally false (Torres, Gerhart and Negahban, 2018). However, the identification of intentionality is very problematic (Nielsen and Graves, 2017). That is why it is easier to focus on the deviance from truth that can concern various elements of the message – both content and its context. (Quandt et al., 2019) differentiate three aspects of the message that can be deviated: (1) the core content of the information (textual information, imagery, audio elements etc.); (2) accompanying meta-information (headlines/titles, author information, tags, and keywords); and (3) contextual aspects (positioning, references to other articles, framing).

There are various levels of fake news from misleading although factually correct information through additions (enrichment) or deletion (omitting) of information to completely fabricated information. Even though fake news is not a well defined concept, usually the intention is necessary for information to be classified as fake news.

The effects of fake news range from misleading in judgements through changing people's attitude to devaluation of the trustworthiness of the whole news system (Nyhan and Reifler, 2010), (Shu, Wang and Liu, 2019). Considering the harms, there have been many attempts to detect fake news. The methods of fake news detection include professional fact checkers that manually verify news usually on the basis of notification of common user's notification, there are also computational approaches available that allow automatic fake news detection (Granik and Mesyura, 2017). The problem with manual fake news detection is the big amount of news that have to be verified and reliability of the human verifier. It can represent the governmental institution, a private company, an independent non-profit institution. The disadvantage of the detection algorithms consists in their unexplainable way of operation. When the fake news is detected, further measures must be taken.

There are many studies investigating the difference between the perception of media effects

on oneself and on other people (Perloff, 1999), (Schweisberger, Billinson and Chock, 2014). This discrepancy is usually called the third person effect. It states that communication has stronger impact on other people than on oneself. People tend to underestimate the media effects on themselves and refer to situations and circumstances as the causes of the effects. On the other hand, they overestimate the effects of media on others using an explanation similar to the magic bullet theory. The situation and circumstances are disregarded (McLeod, Eveland and Nathanson, 1997). The effect's strength is dependent on situations. E.g., positive contents are perceived to have stronger effect on oneself than on others, socially undesirable content supports the third person effect (Perloff, 1999). The effect influences both the perception and the behaviour – people tend to behave in accordance with the expected effects of the news.

We attempted to analyse the effects of fake news on the self-determination as it is defined by the self-determination theory (Deci and Ryan, 2012). It consists of three aspects: autonomy, competence and relatedness. In our opinion fake news affect especially autonomy and competence, not so much relatedness. That is why we focused on these two aspects. As for the autonomy measures, we used the classification of autonomy by (Noom, Deković and Meeus, 2001). They differentiate three types of autonomy, the attitudinal, the emotional and the functional. Skills and abilities were measured with one general question.

Fake news spread especially on social media. Students are their frequent users and so are exposed to fake news a lot. For some of them it is difficult to distinguish fact from fiction. They rely on social networks also for political news (Leeder, 2019). Some of them even share fake news. They are in contact with the generation of older people and so may expose this generation to fake news, too. (Surjandy, Alianto and Chandra, 2017) investigated the effect of fake news distributed during online game playing when young people meet new friends that they don't know in person and who can expose them to fake news.

Our research question concerned the third person effect with regard of fake news and was transformed into 7 hypotheses about the difference between the FN effects on oneself and on others and one's and others' defence against it. As for the FN effects, we focused on the self-determination theory (Deci and Ryan, 2012). We investigated FN impacts on three aspects of autonomy (Noom, Deković and Meeus, 2001) and on skills and abilities. Ability to defend which can be subsumed under self-efficacy, knowledge of FN topics and attractiveness of FN was taken over from Yang and Tian (2021).

In our analysis we focused on the effects of fake news and defence against them with regard to the third person effect. That is why we investigated the following 6 hypotheses:

H1: There will be a difference between how respondents perceived confusion caused by fake news on themselves and on others.

H2: There will be a difference between how respondents perceived pressure to agree caused by fake news on themselves and on others.

H3: There will be a difference between how respondents perceived effects of distraction from one's goals caused by fake news on themselves and on others.

H4: There will be a difference between how respondents perceived the effects of impairing one's skills and abilities caused by fake news on themselves and on others.

H5: There will be a difference between how respondents perceived their ability to defend against FN and others' ability to defend.

H6: There will be a difference between how respondents perceived their knowledge of fake news topics others' knowledge.

H7: There will be a difference between how respondents perceived attractiveness of FN for themselves and for others.

First, we describe the methods used to get and evaluate the answers, then we present the results and finally we discuss them.

METHOD

We collected the answers using an online questionnaire during February 2022. We used the 5-point Likert scale in answers with 1 meaning "definitely yes" and 5 "definitely no". The results were described by means of descriptive statistics. To test the existence of the third person effect we used the t-test and the Levene's test for the equality of variances. If the Levene's test was significant at 5% significance level ($P < 0.05$) we rejected the null hypothesis of equal variance of the samples and used the t test results for samples with unequal variance provided by SPSS 26 which was used for all calculations. If the Levene's test was not statistically significant we used the t test results for samples with equal variance provided by SPSS.

RESULTS

We received 85 responses, 42% of males, 58% of females in our online questionnaire. The respondents were bachelor students of the Prague University of Economics and Business. We focused on the difference between the FN effects on themselves and on others on which the third person effect is based. The answers were independent on respondents' gender.

The questions and means (M) and standard deviations (SD) of the answers can be found in tables 1 and 2 which includes the effects on self-determination on oneself and on others, in table 3 which includes one's and others' ability to defend against FN, in table 4 consisting of one's and others' knowledge of FN topics and in table 5 where the attractivity of FN on oneself and others can be found.

	M	SD
FN confuse me and make my decisions more difficult	3.2	1.4
FN make me agree with opinions that I'm not sure of	3.6	1.2
FN distract from the goals I set for myself	3.6	1.0
FN impair my skills and abilities	3.5	1.1

Table 1: Effects of FN on one's autonomy (source: own calculation)

	M	SD
FN confuse others and make their decisions more difficult	2.7	1.4
FN make others agree with opinions that they are not sure of	3.2	1.3
FN distract from the goals others set for themself	3.2	0.88
FN impair others' skills and abilities	3.3	0.92

Table 2: Effects of FN on the autonomy of others (source: own calculation)

	M	SD
I am able to defend myself against FN	2.2	0.87
Others are able to defend themselves against FN	3.1	1.1

Table 3: Ability to defend against FN (source: own calculation)

	M	SD
I know enough about FN topics I encounter	3.0	1.2
Others know enough about FN topic they encounter	3.3	1.1

Table 4: Knowledge of FN topics (source: own calculation)

	M	SD
Fake news attracts my attention.	2.8	1.0
Fake news attracts other's attention.	2.4	1.1

Table 5: Attractivity of FN (source: own calculation)

In table 6 the results of hypotheses testing can be found.

	FN effect	Levene's test for equality of variance		T test for equality of means	
		F	P	t	P
H1	Confusion	0.03	0.86	2.37	0.02
H2	Pressure to agree	1.13	0.25	1.99	0.047
H3	Distraction	2.48	0.12	2.69	0.01
H4	Impairing skills and abilities	3.82	0.052	1.29	0.20
H5	Ability to defend	3.43	0.07	-6.12	0.00
H6	Knowledge of FN topics	1.23	0.27	-2.21	0.03
H7	FN attractiveness	0.17	0.68	2.74	0.01

Table 6: T-test of the mean difference between the FN effects on the self and on others

Table 7 shows the risks associated with FN labelling.

	M	SD
Labelling fake news is associated with the risk of manipulation by the labeller.	2.7	1.3

Table 7: Risks of FN labelling (source: own calculation)

We confirmed the existence of third person effect in 6 hypotheses at the 5% significance level, in the case of FN skills and abilities impairment the third effect was not confirmed.

Discussion

As for the statistical description of our results, the means of the respondents' answers varies around 3 which is the middle point of our Likert's scale. For one's confusion from FN, their pressure on agreement, distraction and skills impairment it achieved values above 3, similarly to the effects on others with the exception of others' confusion from FN which was below 3 which shows respondents' pessimistic opinion. Respondents are to some extent afraid of the risks of manipulation associated with the FN labelling. Our respondents think they are quite able to defend against FN in contrast to other people. They also think they know more about FN topics than other people. Interestingly, they report FN attracts their attention, but less than others' attention.

As far as the third person effect is concerned, we confirmed its existence in three types of autonomy but not in FN effect on skills and abilities. It may be the case that the mechanism of FN skills impairment is rather complicated and that is why our respondents don't see the difference between them and others. The third person effect applies on the ability to defend against fake news, on the knowledge of FN topics and FN attractiveness, too. Our respondents tend to evaluate the effects of FN as weaker on themselves than on others. They also think FN are for others more attractive than for them. As for the defence against FN the respondents think they know FN topics better than other people and are able to defend better than them.

There are articles confirming the third person effect of fake news both in the perception and in the behaviour in the USA (Jang and Kim, 2018) and in Europe (Ștefăniță, Corbu and Buturoiu, 2018). Because people want to maintain a positive image of themselves, they tend to underestimate media effects on themselves and overestimate the effects on others. Many articles focused on the effects of social distance on the third person effect (Meirick, 2005). Yang and Tian (2021) confirmed the existence of third person effect with regard to the FN attractiveness, but didn't research this effect the individual FN impacts or respondents' abilities. Our research supplements the missing results of his research.

In further research it would be interesting to further specify „others" as (Ștefăniță et al., 2018) found that the third person effect is stronger when distant others are considered compared to close others.

The third person effect can be dangerous as people can ignore the risks and think they concern others only. They may also overestimate the positive effects on themselves. That is why in the education process the media literacy must be paid attention to. Theoretical explanation must be combined with practical skills development to show students how vulnerable by fake news they are and how they can defend against them.

Conclusion

In our article we confirmed the existence of the third person effect in both fake news effects and defence against them. Our respondents differ in their opinions when considering themselves and other recipients of fake news content effects and the ability to defend against fake news. Our respondents are aware of the risks related to fake news, but tend to overestimate their resistance against it and underestimate FN negative effects on themselves. This thinking can be risky and that is why the skills of media and information literacy must be developed during the educational process.

Acknowledgement

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UNIVERSITY GRADUATES' SKILLS FROM THE PERSPECTIVE OF EMPLOYERS

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Abstract

One of the important results of education is school graduates' employment in the labour market. A university needs to know the views of employers on the extent to which graduates' knowledge and skills meet their requirements.

The paper aims to use the results of the survey of selected employers to evaluate the level of skills of graduates of the Faculty of Economics of VSB Technical University of Ostrava at the time of their employment. The qualitative survey focused on employers' satisfaction with the "quality" of university graduates.

The results showed a good level and up-to-date theoretical knowledge of graduates. Employers see shortcomings in their ability to apply theoretical knowledge in practice. Graduates have very good soft skills in a proactive approach, productivity, cooperation, lifelong learning, planning, organizing, exploring, and orientation in information and independence. Employers see reserves in soft skills: leadership, creativity, influencing others, and effective communication.

Keywords

Skills, university graduates, employer, labor demand

Introduction

In the period after 2008, the countries began to pay much more attention to the issue of the employability of university graduates in the labor market. During this period, the applicability of graduates was included in the evaluation of the quality of universities.

A significant barrier to the entry of university graduates into the labor market is the competition that the individual must face. It is not only competition from classmates of the same age, but also older, more experienced employees. On the one hand, the lack of practical experience and insufficient level in some areas that are considered important by employers is a great barrier for recent graduates.

Garcia-Aracil and Van der Velden (2008) dealt with the issue of graduates' skills in the European Union. They perceive skills as an important element for sustainable economic growth.

Soukalová and Gottlichová (2015) investigated what would facilitate the entry of university graduates into the labor market. Based on the results of the analyzed international studies, they state that soft skills are considered a very important factor that affects the employability of graduates in the labor market.

The OECD study (2019) deals with significant barriers to the entry of graduates into the labor market in Mexico. The problem is seen here mainly in the mismatch between the skills of graduates and the needs of the labor market. Another problem mentioned by the employer is the lack of practical experience, which relates to both technical orientation and other professional

skills. Addressed employers report an insufficient link between the knowledge and skills acquired through university programs and the needs of the labor market.

Balcar and Knob (2016) focus on whether more emphasis is placed on specific or general skills in the Czech labor market. They state that employers give approximately the same weight to both types of skills, but the preference for specific skills slightly prevails. However, if there is a focus on only general skills, then employers consider the so-called soft skills more important.

Balcar (2016) states that soft skills are as important and beneficial as hard skills. Therefore, they are considered an important resource that ensures efficient work performance and economic growth. Even though employers attach more weight to soft skills, this is not the case in their development. Not only in the Czech Republic but also in other countries, especially hard skills are deepening and developing in preparation for future employment. The reason for this disharmony is different views on the importance of hard and soft skills in the labor market.

Succi and Canovi (2020) compare students' and employers' perceptions regarding the importance of soft skills in different European countries. Results show that 86% of respondents indicate an increased emphasis on soft skills over the last 5-10 years and that employers consider soft skills more important than students/graduates.

Balcar and Dokoupilová (2021), for example, examine the requirements for communication skills in Czech and English in the Czech Republic and their profitability.

Matsouka, Mihail (2016) identify differences between the views of the graduates and the employers. The results are discussed in relation to the changes needed in higher education institutions and the importance of appropriate interaction and collaboration between employers and universities.

Balcar, Šimek, and Filipová (2018) describe the requirements of employers for the level of soft skills of Czech university graduates. They then compare these requirements with their perceived fulfillment. They also report the perception of the same by graduates of selected universities.

The aim of the paper is, to use the results of the survey of selected employers, to evaluate the level of skills of graduates of the Faculty of Economics of VSB Technical University of Ostrava ((hereinafter referred to as VSB-TUO) at the time of their employment.

The paper is divided into several consecutive parts. After the introductory part, the survey methodology is characterized, as a sample of respondents, including regional restrictions. The next section presents selected findings. The obtained results are then discussed about the results of previously conducted surveys of a similar nature. Recommendations about the management of the faculty are also formulated

Material and Methods

Information of various kinds can be used to assess the labor market employability of university graduates.

One of them is the information on employers' satisfaction with the "quality" of university graduates. As a rule, these are the results of questionnaire surveys of employers focusing, for example, on the level of acquired professional knowledge, hard and soft skills, etc. For example, the consistency of employers' requirements with the skills level achieved after graduation or after a certain period of employment may be analyzed.

In our results section, examples of the survey conducted by the VSB-TUO in 2018 are presented. This qualitative survey among employers aimed to obtain information based on which the VSB-TUO could better adapt its education process to the requirements of employers. The selection of employers was made from the set of employers provided in the payroll sector of the employees in the territory of at least one of the three regions: Moravian-Silesian, Olomouc, and Zlín. The selection was made by the methodology used in the Average Earnings Information System

(hereinafter referred to as ISPV). A 30% of the relevant number of VSB-TUO graduates in the payroll sector captured the qualitative survey. 872 employers were approached as part of the questionnaire survey. The survey among employers was carried out in the form of a structured electronic questionnaire. A graduate was defined as an employee who graduated in 2013, 2014, 2015, 2016, 2017, and 2018. The survey among the employers aimed to obtain responses from all employers (i.e. those employing graduates of the VSB-TUO and those not employing graduates of the VSB-TUO). The questionnaire assessed the professional skills of graduates as well as their level of soft skills. For professional skills, the questions focused on the level of theoretical knowledge, language skills, and ICT skills. For soft skills, the level of graduates was defined by 15 specific skills. In the case of foreign languages, employers' satisfaction with the language skills of graduates of individual faculties of VSB-TUO was also surveyed as well as their needs. The response rate was 56%, i.e. more than half of the approached employers completed the questionnaire or responded using another format (e.g. email). The survey has yielded applicable responses from 459 employers. (Trexima, 2018).

Empirical results

From the 2018 employer questionnaire survey, information was obtained on 2196 graduates of VSB-TUO who graduated in the period 2013-2018, which represented 10% of all graduates in this period.
Below, only responses regarding 669 graduates of the Faculty of Economics (11% of all graduates of the Faculty of Economics) are presented. The survey focused on their level of professional knowledge (skills), general skills, and soft skills.
Employers rated the level of skills using the following scale:
- Extremely competent graduate: the graduate's knowledge and skills are above the level normally required of an employed worker in the organization.
- Capable graduate: the graduate's knowledge and skills are at the level normally required of a well-established employee in the organization.
- Ordinary graduate: the knowledge and skills of the graduate are at the normal level required of a 'newcomer' in the organization.
- Below average graduate: the knowledge and skills of the graduate are below the level normally required of a 'newcomer' to the organization.

Professional skills at the time of starting work

This part is focused on the professional level of graduates of the Faculty of Economics of VSB-TUO. It includes the level of theoretical knowledge of graduates, the timeliness of theoretical knowledge (timelines therapeutic knowledge), and the ability to apply theoretical knowledge in practice.
From the point of view of the level of theoretical knowledge (depth and scope), 62% of graduates are rated by employers as extremely able or able. Only 1% of employers consider this level to be below average. The topicality of graduates' theoretical knowledge is assessed extremely above-average or above-average by 57% of employers. Worse results were recorded in the evaluation of the graduates' ability to apply theoretical knowledge in practice. Only 52% of employers consider graduates to be extremely capable or capable. 2% of them consider this ability to be below average.

General skills at the time of starting work

The qualitative survey also examined the satisfaction of employers with the language skills of graduates both in terms of their mother tongue (Czech) and in terms of foreign languages. Knowledge of the mother tongue should be a matter of course on the Czech labor market.

However, this does not mean that graduates always speak their mother tongue excellently. Most employers consider graduates of the Faculty of Economics to be above average (84%).

50% of employers rated the language skills (foreign language) of the graduates of the Faculty of Economics as above average. However, there are often employers who have below-average graduates of the Faculty of Economics (12%) for language skills related to foreign languages. The most sought-after knowledge was English. 36% of employers stated that active knowledge of English is a condition for employment and 48% consider it an advantage and 16% of employers did not require this knowledge.

Employers did not place so much emphasis on knowledge of the German language. Only 9% of employers required active knowledge as a condition for employment, and 24% of employers considered it an advantage.

Active knowledge of Russian is required by employers to a much lesser extent than English or German. Most employers do not see any competitive advantage in their knowledge of the Russian language. Only 8% of employers consider an active knowledge of the Russian language to be an advantage.

No employer has established an active knowledge of the French language as a condition for the performance of work. 4% of employers consider it an advantage for the performance of work for graduates of the Faculty of Economics.

Also, active knowledge of Spanish was not set by any employer as a condition of work and was considered an advantage by 2% of employers.

2% of employers consider the knowledge of Korean to be an advantage and 1% of employers consider the knowledge of Chinese.

The level of ICT skills of graduates of the Faculty of Economics was assessed by the majority of employers (67%) above average.

Soft Skills

The survey also identified a level of 15 soft skills.

Employers rated graduates very well (extremely capable and capable graduate) in the following skills:

Proactive approach (80%) = willingness to work beyond duties, requirements, and expectations. Practical manifestations of this approach are proposals for improving work procedures, intensifying work performance, finding or creating new opportunities, or solving problems.

Productivity (79%) = interest in working well or by a standard of excellent performance.

Cooperation (78%) = readiness and ability to take an active part in group work responsibly.

Lifelong learning (78%) = ability and willingness to receive new information and participate in short-term or long-term educational programs.

Planning and organizing (76%) = systematically and objectively planning and organizing the work of oneself and others, considering the goal, priorities, resources, resources, and time.

Exploring and orientation in information (76%) - the ability to search, identify and select valid and objective information appropriate to the purpose.

Independence (75%) = the ability to work focused, consciously, and persistently on one's task.

The high representation of average ratings (in some cases even below average) was graduates of employers in these soft skills.

Leadership (53%) = ability to take on the role of a group leader. It represents the desire and determination to lead others not only from the position of formal authority)

Creativity (46%) = the ability to actively seek opportunities and initiate change and new ideas to achieve higher performance, economic growth, higher efficiency, quality, or otherwise defined success and result.

Influencing others (44%) = persuading, influencing, influencing others to gain their support for their cause or significantly influence them.

Effective communication (43%) = ability to communicate actively, including the ability to present well and also the ability to listen and argue well.

The summary results are shown in Table 1.

Skills		Graduates of Faculty of Economics of VSB-TUO			
		1) %	2) %	3) %	4) %
Professional skills at the time of starting work	Level of theoretical knowledge	10	52	37	1
	Timeliness theoretical knowledge	10	47	53	0
	Ability to apply theoretical knowledge in practice	4	48	46	2
General skills at the time of starting work	Czech language	32	52	16	0
	Foreign language	1	49	37	12
	ICT skills	11	56	32	1
Soft Skills	Effective communication	9	48	42	1
	Cooperation	26	52	21	1
	Creativity	26	28	43	3
	Flexibility	37	35	26	2
	Customer orientation	20	46	33	1
	Productivity	14	65	20	1
	Independence	21	54	25	1
	Problem-solving	27	35	35	3
	Planning and organizing	27	49	23	1
	Lifelong learning	17	61	19	2
	Proactive approach	20	60	18	2
	Stress resiliency	10	55	34	1
	Exploring and orientation in information	26	50	24	0
	Leadership	3	44	48	5
	Influencing others	1	55	41	3

1) *Extremely capable graduate*
2) *Capable graduate*
3) *Ordinary graduate*
4) *Below average graduate*

Table 1: Skills of the graduates of the Faculty of Economics of VSB-TUO from the perspective of employers (source: Trexima, 2018, own processing)

Discussion

VSB-TUO has been monitoring the employability of graduates in the labor market for a long time. Gottvald et al. (2008) focused their research on the applicability of graduates of the VSB technical university of Ostrava and the evaluation of the level of their professional skills, general skills, and soft skills according to individual faculties. The level of professional skills of graduates was evaluated positively by employers. The results of the survey already showed that the competencies of the graduates were considered very important. The employers have appreciated the graduates' ability to solve problems (not by the results) and independence (by the results). Shortcomings were identified in foreign language communication skills, which fully corresponds to the obtained results. The results also largely coincide with the findings presented in Balcar, Šimek and Filipová (2018). In both cases, a low skill gap is identified between the regulated level of skill and the

real level of skills of graduates in Exploring and orientation in information, Life-long learning, Proactive approach and Productivity (however, these are not only graduating of the Faculty of Economics VSB-TUO). The level of English language proficiency is assessed differently, where a survey among VSB-TUO graduates showed a higher skill gap.

A significant limitation of research into the applicability of university graduates to employers seems to be their very difficult identification and obtaining the necessary information. The research can be approached on the one hand in the form of a qualitative survey among employers, where very detailed information on the level of skills achieved can be obtained. Another way is to use information from the information system on average earnings, where employers are not directly contacted. In this way, it is possible to identify, for example, the job position and the level of earnings. Both methods are costly and cannot use publicly available data sources. The issue of the employability of VSB-TUO graduates in the labor market is one of the key activities of the Technology for the Future project, which is being implemented at the university in the period 2016-2022. The result of the solution in this part is the introduction of a system of regular monitoring of labor market needs, and the ability of graduates to adapt to the labor market. Mutual relations between the university and its graduates are strengthened through the Alumni program.

Based on the results of the survey, it would be appropriate to strengthen foreign language teaching. A foreign language is taught within VSB-TUO, but this requirement to deepen the knowledge of foreign languages was often mentioned by the employer.

The results of the survey showed a need for a greater focus on practice. As part of their university studies, students (future graduates) are provided primarily with theoretical knowledge. Within the teaching of theoretical subjects, it would be appropriate to strengthen lectures by involving experts directly from practice.

Furthermore, it would be appropriate to strengthen and deepen the soft competencies of students. It is, for example, the introduction of such elements into teaching that would improve soft skills.

Conclusion

In the area of specific skills, the results of the survey proved a good level and up-to-date theoretical knowledge of graduates of the Faculty of Economics of VSB-TUO. Employers see shortcomings in their ability to apply theoretical knowledge in practice.

Graduates from the pooled point of view of employers have very good soft skills in a proactive approach, productivity, cooperation, lifelong learning, planning, organizing, exploring, and orientation in information and independence. Employers see reserves for soft skills: leadership, creativity, influencing others, and effective communication.

The results of the survey show the need to strengthen the level of foreign languages of students and graduates, to focus teaching more practically on the introduction of a system of compulsory internships, or to involve more practitioners in teaching. In the area of soft skills, it is desirable to introduce more elements into one's teaching, which will strengthen soft skills.

Further research concerning the employment of university graduates with employers is appropriate to focus on the compliance of the field of study (program) with the employment of the graduate in a specific job position, the development of a working career over time, and the level of their earnings.

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THE DESIGN OF A KNOWLEDGE TRANSFER MODEL IN TOURISM

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Abstract

As the business environment constantly changes, tourism is becoming increasingly complex. Key variables such as technology, consumer preferences and human resources are still evolving. It is therefore appropriate to ask how educational institutions respond to the variability of the environment and how knowledge is created, shared and transferred. Changes in the tourism environment require different approaches than ever before, including working with a better understanding of what the consumer wants. The aim of the paper is to propose a model of knowledge transfer in the tourism destination and suggest area for further research in the field of knowledge transfer, especially from the academic sphere towards tourism businesses.

Keywords

Knowledge, knowledge transfer, knowledge management, tourism, tourism destination

Introduction

Knowledge is one of the most important resources of an organization. Knowledge and skills in creating their own knowledge are particularly important, as these skills are essential in creating new products and services and/or in improving existing ones. In order tourism businesses could also compete in a knowledge-intensive and globalized world, they must constantly create knowledge, acquire them, effectively use, share and transfer. This in turn leads to the creation of new knowledge. Businesses that are able to generate new knowledge are in a better position to eventually gain a competitive advantage in the market.

However, business knowledge cannot be created without interactions between individuals, as new knowledge is a combination of information and know-how with others in solving problems. Knowledge transfer is not just about communicating or sharing information or making it available to those who need it. It also includes knowledge dissemination, application and assimilation. Knowledge transfer is effective only if the receiver understands and can use knowledge in practice.

The aim of the paper is to propose a model of knowledge transfer in the tourism destination and suggest areas for further research in the field of knowledge transfer, especially from the academic sphere towards tourism businesses. To meet this aim, knowledge, knowledge management system and knowledge transfer are characterized. Furthermore, the need to create an effective system of knowledge sharing and transfer in tourism is justified.

Knowledge, Knowledge Management, Knowledge Transfer

It is the human factor, knowledge, personal ability and reaction to market changes that form competitive advantage. It is Kanigolzar et al. (2013), who claim that education, knowledge and its management, innovation and perpetual improvement, are key business factors for its daily management and competitiveness. According to Abou-Zeid (2003), knowledge brings up competitive advantage to the individuals who use it because they can better handle information such as on customer needs and market situation for their own benefits.

According to Limpopo (2017: 4) "knowledge means the acquisition, understanding and interpretation of information". Knowledge is a set of facts and principles collected over time. Yet,

there is also more practical approach to definition of knowledge, such as in the relation of data-information-knowledge (Bureš, 2007), where knowledge might be understood as analytically formed information so that it is used for problem solving and decision making. More profound approach to knowledge may be found in knowledge hierarchy (Bender and Fish, 2000), which is extended by expertise, or know-how. Data is defined as mere numbers, or facts. An information is a set of processed data, while knowledge is embodied in the information used. Above all there is expertise, which is defined as profound, specific knowledge gained in time as experience, training, and education.

Besides the definition of knowledge, we need to also mention rather wide range of knowledge typology, such as that introduced by: Badaracco (1991), who describes migrating and imbedded knowledge. Stewart (1997), who distinguishes between cognitive knowledge (Know-what), skills (Know-how), system understanding (Know-why). Ruggles (1997), who divides knowledge to process, factual, and socio-cultural. Carlsen and Skaret (1998), who describe individual and collective knowledge. Probably the most used classification of knowledge was made by Polányi (1967), who distinguishes knowledge: implicit (tacit, or also personalized knowledge, coming from personal experience), and explicit (that is knowledge that can be specifically expressed in numbers, words or rules).

Narvaez et al. (2017) classifies knowledge by characteristics such as What, Why, How and Who, which is especially desirable for VUCA environment: declarative knowledge (Know-what), is fact-based knowledge, i.e. on information itself; causal knowledge (Know-why), knowledge that is more specialized because it relates to goals and objectives; procedural knowledge (Know-how) is related to our abilities to do something, i.e. in practical way, while it can be combined with other know-hows; knowledge of resources (Know-who) is probably the most important as it shows who can handle the task and how.

Note: VUCA is an acronym, which stands for Volatility, Uncertainty, Complexity and Ambiguity. Volatility: is a degree of instability, changes. Uncertainty: is a degree of unpredictability, lack of information. Complexity: is a degree of mutual dependency, unclear causality. Ambiguity: ambiguity of data and their interpretation, inability to make decision.

In the academic sector the emphasis is often laid on exact typology of knowledge, while pragmatic needs in daily practice are often neglected. Quite interesting knowledge typology can be found in Trevithick (2008). The author proposed three main, mutually interlocked, kinds of knowledge: theoretical, factual, or practical knowledge, or their combinations.

Naturally, to provide the best results, knowledge must be appropriately managed, used, or handled. That is called knowledge management, or KM. Knowledge management has been used in many publications, where it is mostly defined as a set of processes consisting of the generation, identification, collection, processing and sharing of individual and collective knowledge using information technology (e.g. Ciampi, 2008). Similar definition is provided by Limpopo (2017: 5), who says that knowledge management means "an ability of an organization to use its collective knowledge through a process of knowledge generation, sharing and exploitation enabled by technology to achieve its objective".

Another important activity of KM is esp. knowledge transfer, or KT. According to Liyanage et al. (2009), knowledge transfer is about finding and identifying available knowledge which de-facto already exists within the organization and then applying it in practice to form new ideas in order to boost and improve the whole process. The authors also claim that KT is not simply about using available knowledge, but also about how best handle it and effectively use it to get maximum. According to Gilbert and Cordey-Hayes (1996), the knowledge transfer consists of specific steps or actions which then become daily routines. This involves acquisition, communication, application, and assimilation.

Knowledge Management within the Tourism System

According to Palatková (2006), having effective system of KM and KT is inevitable for competitiveness of tourism areas due to their size and geographic distances. The terms of "learning tourism destination" and "knowledge management" are frequently used across Europe and in countries with highly developed tourism, such as France, Spain, Austria, Germany, they are effectively put into practice. Even in the Czech Republic such good practice should be applied and incorporate them into our conditions. In Austria, for example, the KT into practice is divided to knowledge acquisition, its presentation and transfer to final users, i.e. individual tourism subjects. This model is used in the sharing of visions, strategies, legislation or organizational procedures (Pechlaner et al., 2003 In Palatková, 2006). Similarly, it is Bartl and Schmidt (1998), who assigned a key role of KM to the whole tourism development system.

According to Žemla (2016), a destination is a primary analytical element of tourism, it is a place of interactions of businesses with tourism institutions. Naturally, destinations may also be seen as a network. Therefore, to analyse an effective KT at the destination level, it is necessary to consider the complexity and interdependency among stakeholders operating in a tourism destination (Palmer and Bejou, 1995) on the basis of coordination and cooperation, incl. creating alliances and networks among tourism organizations (Wang and Fesenmaier, 2007), or multi-stakeholder public-private networks (Halme, 2001). Also, Pearce (1996) presents tourism organizations as a series of interorganizational networks. Bąkowska-Morawska (2014) shows the importance of tourism networking, called Tourism Supply Chain (TSC).

This indicates that such networking approach to tourism destination analysis is desirable because destinations include a large number of small and medium size enterprises (SMEs) operating in a turbulent business environment (see VUCA concept). This results in rather high fluctuation of employees at one hand and low number of experienced people on the market on the other. These enterprises are thus not able to promote competitive strategies and sustainable development (Halme, 2001).

MATERIAL AND METHODS

The research, which aimed to design a model of knowledge transfer in the tourism destination and suggest direction for further research in the field of knowledge transfer, was carried out at the end of 2021. Online questionnaire surveys, discussions with experts and analysis of available literature have been used.

Secondary data was obtained through an analysis of publicly available literature focused on the knowledge management system and the creation of knowledge models. These included books, conference materials and articles. The primary data were obtained using the technique of interviews with five experts in the field of marketing and knowledge management, and online questionnaires targeting managers in tourism. The link to the questionnaire was distributed via e-mail. The questionnaire, which took about 20 minutes to fill, contained a total of 20 questions, including identification questions. The questionnaire focused on mapping managerial competencies and marketing skills (practical managerial skills, decision-making skills and problem solving), as well as on knowledge transfer within the organization and destination, development and training of employees. The target group of respondents were managers of all levels of management working in various tourism institutions throughout the Czech Republic. That included regional and municipal authorities, tourism associations, tourism information centres, Local Action Groups and institutions providing direct tourism services – accommodation and food services (e.g. hotels, spas, boarding houses, etc.). A total of 276 respondents were contacted in two waves, the response rate and evaluability of the questionnaires was 7% (19 questionnaires). Upon these discussions, questionnaires and also using data that was obtained through analyses of publicly available

literature, the author summarized data and categorized them into basic assumptions. Based on this, the knowledge transfer model in tourism destination was designed.

Results

The design of the knowledge transfer model in tourism destination (see Figure 1), has been built on and integrated these theories, resp. assumptions:

1. Flows of knowledge are the critical success factor in a company (e.g. Snider and Nissen, 2003, In Koskinen and Ajmal, 2008).
2. Knowledge transfer process consists of individual activities that logically follow each other (e.g. Gilbert and Cordey-Hayes, 1996; Aerts and Haezendonck, 2017).
3. There is emphasis on the technical side of knowledge transfer – knowledge transfer itself is not a mere knowledge transfer, but involves various stages of transforming knowledge into a usable form (e.g. Seaton, 2002; Zahra and George, 2002).
4. Knowledge transfer process has two main components: knowledge source (has the knowledge and is willing to share it) and knowledge receiver (acquires the knowledge for its further use) (e.g. Liyanage et al., 2009).
5. There are different ways of knowledge transfer, i.e. different ways of knowledge passing and receiving it (Nonaka and Takeuchi, 1995).
6. Decision making is a part of the knowledge transfer process (e.g. Choo, 1998).
7. There is emphasis on the behavioural side of knowledge transfer – i.e. cooperation and communication between the source and recipient of knowledge (strong connection or relationship between them, willingness to share knowledge, willingness and ability to receive and use knowledge) (e.g. Liyanage et al., 2009).
8. Tourism is seen as a system affected by a number of factors (e.g. Szulanski, 1996).
9. The primary source of knowledge is the academic sphere.
10. There is heavy influence of risk factors on the knowledge transfer process, i.e. risk of knowledge shortage, obsolescence, leakage or loss of knowledge (e.g. Ferraris (2019).

The proposed knowledge transfer model for tourism destination consists of seven main steps: searching of knowledge, knowledge identification, knowledge acquisition, knowledge transformation, knowledge interconnection, knowledge application and knowledge sharing. System approach to tourism and knowledge management inevitably leads to analysis of surrounding environment, which is understood as a mixture of external factors (PESTLE and VUCA factors) or driving forces that influence business function.

As shown in Figure 1, the primary source of knowledge is the academic sphere as an intellectual source of knowledge, i.e. universities, scientific and research institutions. Academic institutions study tourism environment primarily for educational purposes; research results being published are often given to the public. Research is made in a combination with other disciplines, such as marketing, management, economy, sociology, psychology. That is called a multidisciplinary approach. At the same time, tourism is also studied from many perspectives, including environmental impact, or client satisfaction, and that by applying various methods and techniques, such as interviews, questionnaires and surveys, or observations. As a result, academic work comes up with new theories, models, or tools, whose effectiveness is then verified by business practice in tourism.

Other sources of knowledge are tourists (represented by their needs and wishes) and natural resources (as a primary potential for tourism, i.e. mountains, sea, rivers, lakes, volcanoes, forests). Furthermore, it is a public administration that has tacit knowledge of local tourism systems and at the same time has access to explicit knowledge through consultations and cooperation with the academic sphere.
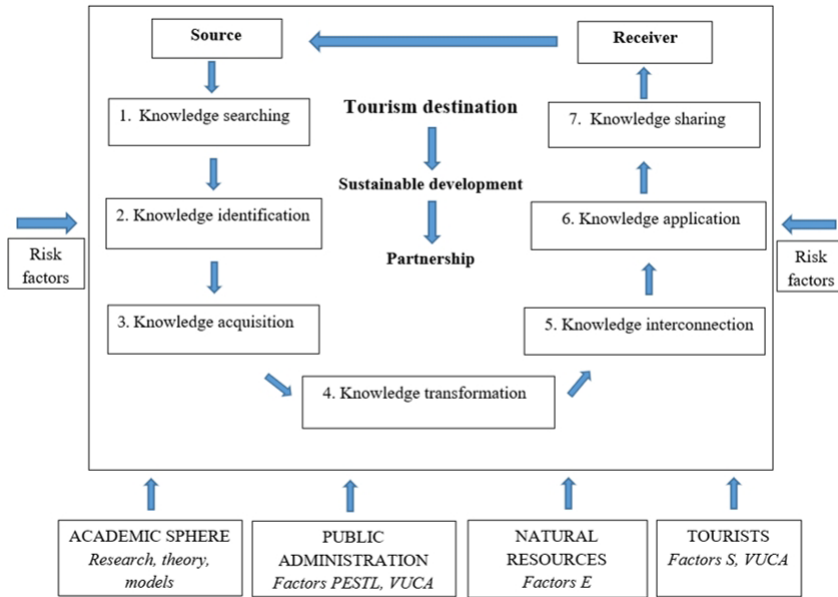
Note: PESTLE factors: P: Political factor, E: Economic factor, S: Social factor, T: Technological factor, L: Legislative f., E: Environmental factor; VUCA: Volatility, Uncertainty, Complexity and Ambiguity.

Figure 1: Design of a knowledge transfer model in tourism destination (source: author's own compilation, using Liyanage et al., 2009)

DISCUSSION

When making a knowledge transfer model, one should always consider knowledge flows in a business. According to Snider and Nissen (2003, In Koskinen and Ajmal, 2008), the knowledge flow is critical for the business.

Knowledge transfer models were developed by researchers with the aim of building and providing effective flows. Nowadays, there are many models available, such as Hansen (1999), Kwan and Cheung (2006), Liyanage et al. (2009), Narteh (2008), and Szulanski (1996). The author for its work preferred models of Liyanage et al. (2009) and of Szulanski (1996).

The knowledge transfer model of Liyanage et al. (2009) is a process model built on holistic approach (reflects the fact that knowledge transfer may be influenced by many factors, both positive, but also negative). Knowledge transfer is then realized in these basic steps: knowledge awareness, knowledge acquisition, knowledge transformation, knowledge association and knowledge application. The Liyanage model is built on two theories – theory of communication and theory of translation. The primary idea of the model is that if knowledge transfer should have any value, then it should be successfully transferred to recipients, and be applied in practice. That may be reached by effective communication and cooperation (i.e. theory of communication). Additionally, important is timely and effective feedback, in which knowledge value may be enhanced not only for its recipient but also knowledge source.

The Szulanski (1996) model is built on four stages in the transfer process: initiation, implementation, ramp-up and integration. According to Szulanski, there are four attributes that may impact knowledge transfer: characteristics of the knowledge transferred, source of knowledge, knowledge recipient and the transfer itself.

The positive side of both models (Liyanage et al., 2009; and Szulanski, 1996) is the inclusion of both, positive and also negative, factors influencing the knowledge transfer process. The disadvantage of these models is that they do not involve risks that may put the whole knowledge process to doubts, such as the risk of knowledge shortage, obsolescence, leakage or loss of knowledge (Ferraris, 2019).

Conclusion

The paper highlights the importance of knowledge, its management and creation of knowledge transfer systems. Use of knowledge for the benefit of tourists, visitors and residents come to the light of interest in tourism and is becoming an important factor in the creation and sale of tourism products. Equally, knowledge is an important tool in competition.

Literature analysis, interviews and questionnaires showed that further research should focus on detailed mapping the competencies of actors in tourism destination and on specification of key knowledge for communication, decision-making and problem-solving competencies that should be part of knowledge transfer in a tourism destination.

Knowledge transfer is effective when knowledge of what and/or how (often called know-what and know-how) becomes available to those who have not previously had access to it. Further, specifically-oriented research, will be necessary to find answers to questions such as: *What makes knowledge available to others? What role does it play in creating educational competencies and what type?* Besides market needs the focus should also be made on educational institutions, which should be a source of new knowledge and its transfer. And thus, questions such as the following should be answered: *What knowledge visions do educational institutions have? Should educational institutions provide teaching and learning through KM? Should educational institutions be knowledge-generating entities?*

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ANALYSIS OF PROSPECTIVE MATHEMATICS TEACHERS LESSON PLANS

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Abstract

The paper focuses on the skills of prospective mathematics teachers (PMTs) when planning lessons on primary and secondary school levels. The paper is based on a thematic analysis of PTMs' mathematics lesson plans developed within the frame of undergraduate courses at the Faculty of Education, Charles University in Prague, and Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava. Analysis of individual lesson plans, discussions with their authors, and comparison of the Czech and Slovak groups' lesson plans resulted in detecting and explaining the differences between the production of the two groups. The findings are of interest to teacher educators in general, researchers interested in teachers' lesson planning as well as practicing teachers.

Keywords

A priori analysis, curricular spider's web, lesson planning, mathematics teacher education, thematic analysis

Introduction

The way how teachers reveal their knowledge rather than what they know is one of the reasons that makes mathematics teacher knowledge specialized (Scheiner et al., 2019). This specialized knowledge includes mathematical and pedagogical content knowledge as well as reflecting this knowledge on practice. Therefore, teachers of mathematics should master solving mathematical problems by selecting the most suitable problems and procedures for their pupils. Moreover, they should plan and present the lessons to stimulate pupils' cognitive processes. When discussing with teachers about their experiences from their professional life, they often mention the importance of having a good lesson plan. The form and level of details are not unified. It depends on many factors, e.g., the length of their teaching practice, self-confidence, and others. Some components can be found in nearly all lesson plans, others are based on the taught school subject or the teacher's personal preferences. For a successful starting of their teaching, PMTs need to be acquainted with the role and creation of lesson plans and their components.

The paper focuses on research in the domain of didactical engineering as defined and described in the Theory of Didactical Situations in Mathematics (TDSM) (Brousseau, 1997). The study enquires into lesson planning by PMTs at two universities, Charles University in Prague (Czech Republic) and Comenius University in Bratislava (Slovakia). The paper describes research designed and carried out to discover the key points that the participating PMTs consider as essential and include in their lesson plans. The well-prepared lesson plan contributes to the effective teaching and learning process.

The history of both countries, Slovakia and the Czech Republic, is connected in their past histories, even from the 833 AD. The educational systems in the current two independent countries develop separately, but they have many similarities. Several studies are documenting it in teacher education

(see, e.g., Slavíčková and Novotná, 2022). On both faculties there are similar study programmes focusing on preparation of mathematics teachers. Differences are mostly in the emphasis put on the various components.

At both universities, the design of lesson plans is dealt with in the lessons of Didactics of mathematics at the Master's level of study. A deep analysis of lesson plans created by PMTs offers data for comparing the lesson plans, showing and explaining differences both locally and internationally.

Several studies are focusing on lesson plans from different perspectives. We present those that we used for making the list of the components used in this study. The list cannot be exhaustive, but it covers the main views on lesson planning. As our list of references documents, lesson plans are focused on in older as well as contemporary publications.

Brousseau (1997) presents a priori analysis as a crucial part of teachers' lesson planning. The theoretical background for a priori analysis is TDSM, and it is considered as one of the teachers' tools that they have when planning their lessons. Based on the lesson description, the teacher strives to estimate its course: uncover individual phases of the lesson, think about possible pupils' and the teacher's reactions (obstacles, errors, possibilities of preventing or correcting them), find out possible solving strategies for the problems that are planned to be solved (both correct as well incorrect ones) and preliminary knowledge needed for each strategy. In (Nováková and Novotná, 2011), real lesson plans of in-service teachers with a priori analyses according to TDSM are presented.

Rys (1975) categorizes lesson plans into three types. The 1st type answers the questions *What?* and *How?*. The 2nd type answers the questions *What was before?* and *What do I want to achieve?*. The 3rd type is the didactical analysis of the subject matter. The teacher works with aims describing what pupils should learn and to which extent, puts the didactical unit into the content and time structures (in the relationship with what was and what will be, see also Figure 1).
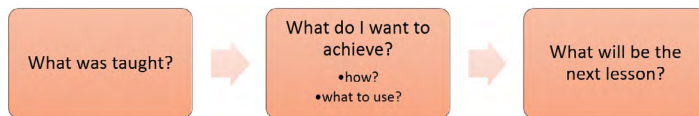

Figure 1: Teachers thinking about the lesson plan (according to Rys, 1975)

Rys classifies the questions into seven categories: questions about aims, content and teaching methods, specific didactical points of view, educational possibilities, organization of the teaching unit, timing, and realization of the lesson. Rys' view is near to that in (van den Akker, 2010), who presents the lesson plan components in the form of the so-called Curricular spider's web (Figure 2).

The Generalitat de Catalunya (2012)[1] considers as the common components for lesson planning content, teaching aims, learning outcomes, assessment, communication, cognitive skills and activities, resources, and procedure. The authors also list a set of reasons for planning a lesson, among which they incorporate the guidelines for planning, namely to: meet the students' needs and cater for different styles, control the time, assess students' performances, set targets, structure lesson-in, task, revision, plan for scaffolding, support the lower and higher cognitive skills according to Bloom's taxonomy[2].

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1   This study focuses on lesson plans for CLIL (Content and Language Integrated Learning – teaching a non-linguistic subject in a language different from pupils' mother tongue), but it can be transferred to other lessons as well.

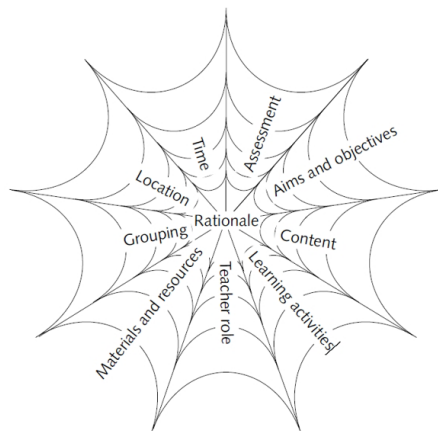2   https://evawintl.org/wp-content/uploads/Blooms-Taxonomy.pdf

Figure 2: Van den Akker's (2010, p. 182) Curricular spider's web

The structure of the paper is as follows: the introduction is followed by the description of the methods for collecting and analysing data. Then the results are presented and discussed. After the discussion of results the conclusions are formulated.

In the paper, the following research questions are answered:

RQ1: What are the key components of lesson plans created by PMTs at the two universities?

RQ2: Do the Czech and Slovak PMTs' lesson plans components that they elaborate in their lesson plans differ, to what extent, and why?

MATERIALS AND METHODS

As mentioned in the Introduction, we worked with lesson plans from two groups of PMTs from Charles University, Faculty of Education ($N = 20$) and Comenius University, Faculty of Mathematics, Physics, and Informatics ($N = 19$). The analysis of the final versions of lesson plans was accompanied by discussions with the authors on the plans.

This research presents a content analysis of the 39 lesson plans. The approach can be characterized as thematic analysis. Braun and Clarke (2006) describe this method as "a method for identifying, analysing and reporting patterns (themes) within data" (p. 79). Based on literature and thematic analysis of PMTs' lesson plans, we created a list of key components.

We did not give participating PMTs a template to fill in. The preparation of their lesson plans was discussed in several lessons of didactics and didactics of mathematics. Therefore, some common schemes, but also significant differences among different groups of PMTs were identified in PMTs' lesson plans. When identifying key components, we did not consider those, which were not explicitly present in the lesson plan.

In both groups, PMTs could choose the topic for their lesson plans at their will. There was only one condition – it has to be focused on grades 5-13 (age 11-19). Looking at received lesson plans, we observed almost evenly distributed topics according to main school mathematics areas (Arithmetic; Algebra; Functions; Geometry and measurement; Combinatorics, probability, and statistic; and Reasoning and proof).

RESULTS

When categorizing PMTs' lesson plans, we used van den Akker's key components (2010) supplemented by three others (*Preliminary pupils' knowledge, Possible obstacles*, and *Summary*)

that were found frequently in PMTs lesson plans (Table 1). This helped us also to look at Rys' "timeline" (Figure 1) and identify whether participating PMTs connected previous knowledge to the actual goal. Then we looked for connections (if any) to the future lesson(s).

Observing our data, we noticed that all PMTs included *Aims and Objectives*, *Content*, *Materials and Resources*, *Location* and *Time* in their lesson plans.

Aims and Objectives were formulated using the official state document (RVP in the Czech group and ŠVP in the Slovak group)[3]. Not all PMTs reformulated the official document sentences to fit the aim of their lesson plans.

Key characteristic	Czech Republic (max. 20)	Slovakia (max. 19)
Aims and Objectives	20	19
Content	20	19
Learning activities	7	19
Teacher role	20	3
Materials and Resources	20	19
Location	20	19
Time	20	19
Preliminary pupils' knowledge	5	19
Possible obstacles	4	3
Assessment	11	10
Summary	5	8

Table 1: Key components and their occurrence in lesson plans

Material and Resources were identified in every analysed lesson plan. PMTs proposed different resources and sources. Even though textbooks were the primary source, some PMTs included e-sources, applications (e.g. GeoGebra, Kahoot!), instructional videos (mostly YouTube), and their own notes from secondary school.

Location and *Time* had almost the same structure in analysed lesson plans. *Location* was always in the classroom; *Time* was split into smaller slots for different activities in the hypothetical classroom. In some cases, the time estimation was not realistic, but PMTs have no (or small) teaching experiences, so it is a natural phenomenon.

In the other key components, there were visible differences in their occurrence in PMTs' lesson plans. We focus on them in a more detailed way.

The category *Learning activities* was identified in 7 out of 20 Czech PMTs' lesson plans, while all Slovak PMTs considered this characteristic as important. On the contrary, the category *Teacher role* was present only in 3 out of 19 Slovak PMTs' lesson plans, but all Czech PMTs found it crucial to mention. These two points can be explained by the following reason: while the Czech group focused more on the teachers' role and wrote the lesson plan focusing on him/her, the Slovak group found out the learning activities more important and omitted the teachers' role in them. All 23 lesson plans contain creative learning activities, 6 PMTs considered also preparation for online teaching, not only offline. Manipulation with physical or virtual objects was identified in all lesson plans (e.g. introductory activity for making a hypothesis about the sum of inner angles in the triangle).

The other significant difference between the two groups is in considering *Preliminary pupils' knowledge*. While in the Czech group, only 5 PMTs explicitly mentioned those, in the Slovak group, all PMTs did so. A possible reason could be the influence of the teacher educator. While in

3   RVP and ŠVP are systems of curricular documents for training students from 3 to 19 years. They define a binding framework for education. They are public documents available for teachers and non-teaching public.

the Slovak group, higher emphasis was put on the Rys' "timeline" (Figure 1) during the lessons, in the Czech group on Bloom's taxonomy. All Slovak PMTs tried to connect preliminary pupils' knowledge to the *Aims and Objectives* of the current lesson and to at least one following lesson. Moreover, one PMT made a connection to another topic area (his chosen topic was combinatorial numbers and he connected it also to probability). All Czech PMTs tried to assign tasks to different levels of Bloom's taxonomy.

We observed very close results in lesson plans in both groups concerning the categories *Possible obstacles*, *Assessment*, and *Summary*. Together, 7 PMTs (out of 39; 4 from the Czech group and 3 from the Slovak group) explicitly mentioned *Possible pupils' obstacles* during the lesson.

The unexpected phenomenon in both groups was the lack of *Assessment* in the PMTs' lesson plans. Explicitly stated assessment was in the lesson plans of 11 Czech PMTs and 10 Slovak PMTs. In several cases, the proposed assessment was vague (e.g. I'd ask them some questions), hypothetical (e.g. I'd give them a test), or completely missing. But there were individuals who suggested creative formative assessment or self-assessment of pupils (e.g., unfinished sentences like *I found out…*, *I learned…*, *I disliked…*).

Although TDSM (Brousseau, 1997) is dealt with in PMTs' didactical courses, the category *Summary* (corresponding with institutionalization in TDSM) was included in 13 lesson plans only. Among them, 5 Czech PMTs and 2 Slovak PMTs assigned institutionalization to the teacher, the others suggested making the summary by students themselves (e.g., exit tickets, class discussion, etc.)

DISCUSSION

The list of key components of lesson plans is the result of our analysis of those created by 39 PMTs. The participating PMTs had minimal teaching practice, therefore their lesson plans were based mainly on the knowledge gained during their teacher education courses. Their experience from their own school attendance may also contribute to differences in their lesson plan production. For teacher educators, it is of great importance to know what they can expect their students to know and to what it is important to pay greater attention.

When we compared our list of key components included in lesson plans with those published by other authors, we see that all of them have a common intersection but are not identical. The differences can have different reasons, e.g., differences in the organization of school systems, educational traditions, length of teachers' teaching practice, etc.

We found all the key components from our list in Brousseau's a priori analysis. Participating PMTs did not cover all Brousseau's categories, e.g., the analysis of obstacles and possible incorrect solving strategies were not considered in several participating PMTs' lesson plans. Nováková (2013) presents a detailed comparison of pre- and in-service teachers' lesson plans and a priori analysis and explains the detected differences.

We observed that PMTs tried to link the planned activities and the context of tasks to real-life. The inclusion of interdisciplinary connections was more frequent in the Slovak PMTs' lesson plans. We assign this difference to the fact that the Czech PMTs study resulted in obtaining the qualification as mathematics teachers, while the Slovak group has a two-subject study program (to become a teacher of mathematics in combination with another subject). It is obvious that this difference influenced the PMTs' template used for lesson plans.

In the presented results, participating PMTs did not adequately emphasize possible pupils' obstacles but they focused rather on the content and in most cases on the interaction with content. As Carrillo-Yañez et al. (2018) stated, understanding the nature of learning mathematics, which includes students' mathematical thinking, their interaction with content, and their strengths and weaknesses in learning the concept, is crucial for preparing lesson plans. Therefore, in our preparation of PMTs, more emphasis should be put on it.

Moraová and Novotná (2017) focused on PMTs' skills when planning CLIL lessons on primary and lower secondary school levels. Their attention was paid to the selection of topics the students find appropriate for a CLIL lesson, to the scope of activities they include, and to other components specific for CLIL lessons. In our groups of PMTs, the selection of the topics was given to their will. We identified more than half of the lesson plans focused on the introductory lessons.

To make a good lesson plan, a collaboration of teacher educators and PMTs is crucial. Stigler and Hiebert (1999) indicated four main phases of working on lesson plans: investigation, planning, enactment, and reflection. In our case, PMTs went through the first two phases. They set a learning goal and build a lesson plan. The created lesson plans were discussed with the peers and teacher educator. Savuran and Isikal-Bostan (2022) confirmed our observation from the presentation of lesson plans, that awareness of making the instructional decision can create PMTs' own path by being aware of the strengths of the pupils rather than applying the lesson plan as it is in the enacting phase.

CONCLUSION

In the presented paper we answered two research questions. Based on the literature review and thematic analysis we identified key components of the PMTs lesson plans. Based on their occurrence we compared two groups of PMTs and identified possible factors in differences in the lesson plans as described in detail in the text.

The analysis of the 39 PMTs' lesson plans showed that in general, PMTs are able to create utilizable lesson plans. Although making lesson plans is not the favourite activity of PMTs, it is an important part of their preparation for the career of mathematics teachers. It helps them realize what to pay attention to, what is important to focus on during teaching sequence, etc. When these lesson plans are discussed during the seminars, PMTs could see a different perspective and focus more on what is essential. If this part of PMTs' preparation is omitted, it could lead to a more difficult start of their full-time teaching practice.

The presented research pointed to the importance of doing thematic analysis of PMTs' lesson plans in order to finding the problematic parts, discussing them in a group, knowing how to start the lesson, what should be the next step, etc. A very similar idea was presented by Harmer (1992) who considered as one of the key questions for teachers' lesson planning the following: "What is it that my students will feel, know or be able to do at the end of the class (or classes) that they did not feel or know or were not able to do at the beginning of the class (classes)?" (p. 259).

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SCHOOL SUCCESS AND DISTANT LEARNING: PERSPECTIVE OF 2ND GRADE PUPILS

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Abstract

The Covid-19 pandemic was a great challenge for education. In the Czech Republic, three shutdowns of schools have occurred from spring 2020 to spring 2021. For all students, it was new experience. How did pupils see the distant learning caused by Covid-19 pandemic? The study asked pupils in 2nd grade of primary school how they liked the distant learning ($N = 669$). The data were collected two times in school year 2020/2021 just after re-opening present lessons after school shutdowns. For each pupil, the information about level of their school success or failure evaluated by their teachers. Based on this, students' experiences with distance learning were compared.

Keywords

Distant learning, pupils, school, success

Introduction

The Covid-19 pandemic has been an extraordinary educational and social disruption in the lives of students around the world. To help stop the spread of pandemics, educational systems adopted strategies of the closure of schools, which impacted over 90% of students over the world (Grewing et al., 2021).

In the Czech Republic, the school closures took place three times during the Covid-19 pandemic – in spring 2020, autumn 2020, and spring 2021. These three waves were different. The first school closure was a shock. Neither schools nor families were prepared for this kind of situation, and they did not have measures in place to address the risks associated with distance learning. In these periods, the schools had already been provided with methodological and material support from the Ministry of Education and from the municipalities, who were aware of the danger of growing educational inequalities.

The Czech education system shows high selectivity and strong social inequality in education. (Mateju and Strakova, 2006). Educational inequalities become most apparent after the transition to the lower secondary level (ISCED 2), but they exist also at the primary and pre-primary levels (ISCED 0 and 1). The Czech School Inspectorate subsequently concluded that this general trait of the Czech education system became even more marked during the closure of schools in spring 2020. In the given period, up to 10% of pupils did not participate in distance education and the extent of communication between schools and parents also decreased (CSI, 2020). Across countries, distant learning has a negative effect, especially on children with low socioeconomic backgrounds (Drane et al., 2021; Smetackova and Stech, 2021).

Studies show that school closure and distant learning had strongly negative effects on the majority of students with respect to their well-being and learning outcomes (Vaillancourt et al., 2021). Regarding school achievements, the long-term negative effects on pupils are supposed to be even higher than on adolescents. The reason is that younger pupils have built yet not strong foundations

for reading, writing, and mathematics. Their schooling was slowed down by pandemics. On the other hand, younger pupils are more adaptable and therefore the consequences of the increase in mental disorders may not be so strong (Westheimer and Schira Hagerman, 2021). Distant learning might be positive experience in some ways, especially for some groups of students who have problems with anxiety, attention or following teacher´s instructions in a hectic environment of classrooms. However, distant learning is very challenging in other ways as well, especially for students in the beginning of educational career when their writing, reading and mathematical skills have not been yet established (Drane et al., 2021. With respect to uniquity of Covid-19 pandemic, consequences for education (and other fields) need to be considered (Grewenig et al., 2021). For this, not only achievements of students but also their emotional reactions and attitudes should be taken in the account. That is why this study was focused on students´ evaluation of distant learning.

In the present study, we focus on the primary education level. Children attending the 2nd grade of primary school in the school year 2020/2021 have a unique experience. They did not experience school attendance without the intrusions of distance learning. The Covid-19 pandemic led to the closure of schools and the relocation of teaching to the home environment during their 1st and 2nd school grade. During the 1st grade when school closure took place in spring 2020, pupils were too young to fill the questionnaire. However, during the 2nd grade when the Covid-19 pandemic continued, they might have been examined. The aim of the study was to find out how the 2nd year students evaluated distance learning during school closure due to a pandemic. The study was focused not on school achievements but on complex evaluation of distant learning from pupil´s perspective.

MATERIALS AND METHODS

The study followed three research questions: 1) What was the total level of satisfaction with distant learning (specifically with cognitive, social, and family aspects of distant learning) among pupils in 2nd grade of primary school?, 2) Was the level of pupil´s satisfaction the same or different across the distant learning in fall 2020 and spring 2021?, 3) Was the level of pupil´s satisfaction different with respect to school success of pupil?

The study was conducted in 27 classes in the 2nd grade of primary school. Schools were in small villages, towns, and big cities across six regions of the Czech Republic. Recruiting of classes followed three criteria: 1) teachers were seen as a great professional from the perspective of principals, previous pupils and parents, and the school inspectorate; 2) no alternative educational approach was applied in the class; 3) all pupils and parents were willing to participate in the study. Within the data set, there are a total of $N = 669$ respondents, including 325 boys (48.58%) and 344 girls (54.42%).

Respondents were addressed twice – in fall 2020 and spring 2021 (it means in the first and second half of the school year). In these periods, schools were closed for several weeks, and pupils attended distant learning. When schools were re-opened, children were immediately asked to fill out a ten-item questionnaire on distance learning. In the case of spring measurements, there are two more classes, which asked to participate in the study. All values are adjusted so that in some cases reverse items are already used.

The questionnaire was developed based on a literature review and interviews with teachers. Each item represented a positive or negative statement on different aspects of distant learning. With each statement, the respondent either agreed (in such case, the child colored the picture next to the statement) or disagreed (in such case, the child left the picture empty). To agree meant that the child said or could say a similar sentence about their feelings; so, the statement matched the child´s view. The colored picture next to the statement was scored as 1; the empty picture

was scored as 0. The negative statements needed to be reversed. A total score is 10 maximum. The higher the values the respondent achieved, the better his/her relationship with the distance learning during the school pandemic shutdown.

Independently to the pupil´s questionnaire, teachers from the involved classrooms were asked to identify the level of school success of each girl or boy. For each pupil, teachers answered the question: Is the pupil seen by you as school successful, partly school successful, or school unsuccessful? Based on teachers´ answers, pupils were sorted in three groups and their evaluation of distant learning were compared.

Results

The questionnaire contained 10 statements referring to the efficiency of the learning process, social relationships, and family background. The formulation of half statements was positive, half negative. The negative statements were reversed, so the sum of individual scores showed a good impression of distant learning. The level of pupils´ average evaluation for each statement is shown in Table 1. The average might be interpreted as a level of agreement. The negative statements are already reversed, so they must be interpreted in an opposite way (eg average of 0.05 for the statement *I missed my classmates* means that 95% agreed with the statement and thus only 5% of pupils did not miss their classmates).

	Fall 2020	Spring 2021	p - level
I learned well over the computer.	0.47	0.34	.003***
I missed my classmates. (reverse)	0.05	0.06	.7386
I was often bored with learning. (reverse)	0.51	0.39	.0006***
I liked that I had more free time.	0.82	0.83	.7065
My parents had time to help me learn.	0.71	0.58	< .001***
I missed the bench and normal learning. (reverse)	0.22	0.24	.4765
I enjoyed the learning tasks.	0.59	0.53	.0408**
I liked that we were more with the family.	0.89	0.91	.5575
My parents had to force me to learn. (reverse)	0.57	0.65	.0133**
At school, I do learn better than at home. (ereverse)	0.13	0.16	.2493

Note: * - 10% level of significance, ** - 5% level of significance, *** - 1% level of significance

Table 1: Average evaluation of statements in two period and significance of differences

Pupils' evaluation of distance learning was slightly negative. The children were aware of the complexity of this learning form. Most children reported that they were learning better at school and missed normal learning at school. Of course, they also missed other children. For a substantial part of the children, the tasks were not fun, they were bored with learning and their parents had to force them into learning. On the other hand, the period of distance learning meant more intensive contact with the family and more free time, which both children appreciated.

A comparison of pupils' views on the autumn and spring periods of distance learning indicates a deteriorating trend. In five statements, children reported significantly different experiences with distance learning in spring 2021 than in autumn 2020. In the spring, pupils reported being more bored with learning, they did not enjoy the tasks so much, parents had less time to help children, and they needed to force pupils to learn. A greater negative impression was indicated despite better competencies of teachers on how to organize distance learning.

The exception was a greater appreciation of leisure time and family togetherness, as well as less parental regulation. From the pupils' answers, it can be concluded that during the school year more children gained a more independent approach to learning and their parents did not have to force them so much. Dominantly, however, the spring wave of distance learning was more

challenging for children. While in the autumn almost half of the children stated that they managed computer learning well, in the spring it was only a third.

The study ran in 29 classrooms which were repeatedly visited and both children and teachers were asked about the progress of learning. The previous table 1 presents average evaluations for the whole research sample. However, the analyses sorted by classrooms showed that average evaluations by pupils attending individual classrooms differ.

Despite the fact that the framework of distance learning in all monitored classes corresponded to the recommendations of the Ministry of Education, Youth and Sports and the Czech Academy of Sciences, the specific procedures applied by teachers differed. Pupils in each class also had specific family backgrounds and their own educational needs, due to which they prefer a certain teaching and learning style. Graph 1 shows the average evaluation of distance learning in both periods in each class. Box-plots confirm the significant differences among classrooms.
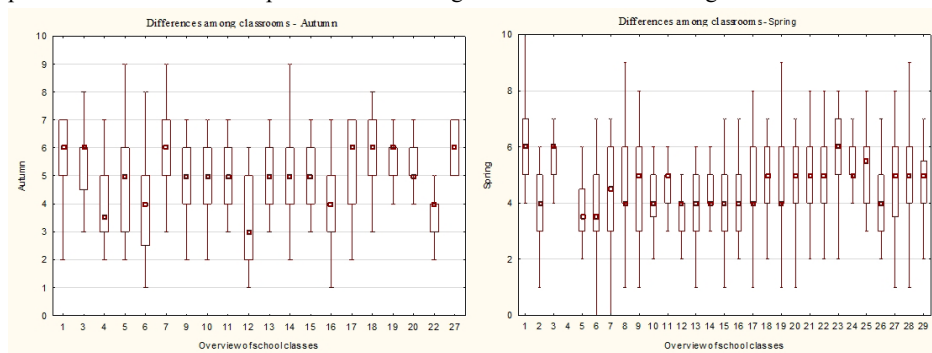
Graph 1: Average students' evaluation by classrooms (*n = 27 for autumn, 29 for spring*)

In the next analytical step, pupils were divided into three subgroups based on teachers´ assessment of school success assessed by teachers. Teachers were asked if they consider the individual pupil as fully school successful, partly school successful or school unsuccessful. We examined whether children marked as school-successful evaluated distant learning differently than children marked as school-unsuccessful.

For individual statements, the difference in pupils' answers was determined according to their school success. In each monitored period, a significant difference was found between the five statements. A significant difference (p <.05) was found between the two statements in both autumn 2020 and spring 2021. Table 2 shows the wording of the statements and the proportion of children who agreed with them in both periods. Less school-successful pupils perceived a greater need for external motivation and even pressure from parents to engage in a home-based learning environment. At the same time, however, they did not associate school learning with a feeling of smoothness, understanding and success so often as school successful pupils.

		Fall 2020	Spring 2021
My parents had to force me to learn.	School successful pupils (1)	43%	31%
	Partly school successful pupils (2)	38%	46%
	School unsuccessful pupils (3)	72%	52%
At school, I do learn better than at home.	School successful pupils (1)	88%	86%
	Partly school successful pupils (2)	85%	79%
	School unsuccessful pupils (3)	63%	68%

Table 2: Rate of pupils confirming the statements

Besides individual statements, it is important to follow the total score. Table 3 shows the global evaluation of distant learning for three subgroups identified as school successful, partly school successful, and school unsuccessful. The evaluation of distance learning between autumn and spring has deteriorated. In the spring of 2021, pupils were more critical of distance learning than in the fall of 2020. This trend manifested itself in a group of school-successful and partly successful pupils. However, the opposite trend was found in the group of pupils who were marked as unsuccessful by the teachers. On the contrary, these pupils gradually improved their assessment. However, it should be noted that the group was very small.

		N	Mean	F	Minimum	Maximum	SD
School successful pupils (1)	Fall 2020	284	4.82	75.00	1.00	10.00	1.61
	Spring 2021	447	4.63	102.00	0.00	10.00	1.71
Partly school successful pupils (2)	Fall 2020	97	5.03	25.00	1.00	9.00	1.54
	Spring 2021	124	4.46	30.00	0.00	8.00	1.53
School unsuccessful pupils (3)	Fall 2020	11	4.64	4.00	1.00	8.00	1.86
	Spring 2021	19	4.84	5.00	2.00	9.00	1.68

Table 3: Pupils´ evaluation of distant learning sorted by school success

Discussion

The study compared students' assessment of distance learning in two periods - autumn 2020 and in spring 2021. Analyzes showed a deteriorating trend. Pupils were gradually more critical of distance learning. This result may seem paradoxical. Teachers have improved distance learning practices since spring 2020 when schools were closed for the first time as a result of the Covid-19 pandemic. CSI analyzes (2020, 2021) also confirmed that the quality of distance learning was increasing. Teachers improved in the methods of distance learning, from a technical and didactic point of view, teaching was more systematic, and schools had more materials at their disposal. It follows that deteriorating student assessment cannot be explained primarily or only by the quality of teaching. A similar pattern was shown by other studies as well (Drane et al., 2021).

Rather, it is a consequence of the overall exhaustion of the difficult pandemic period. What initially seemed to be a positive part of distance learning (eg more time with family or more time for hobbies) gradually lost its attractiveness. Each situation has its advantages and disadvantages. Pupils assessed both aspects of distant learning. It turned out that the ratio of advantages and disadvantages during the autumn period was better than during the spring period. The advantages later failed to balance the disadvantages.

Pupils are not an internally homogeneous group. Some previously published studies have compared the views of students from different socio-economic backgrounds (Westheimer and Schira Hagerman, 2021; Vaillancourt et al., 2021; Smetackova and Stech, 2021; Grewenig et al., 2021). In our study, we focused on whether the assessment of distance learning differs between students who, according to teachers, manage school demands well and are successful in school, and those who fail either partially or fully in school criteria.

The analysis confirmed that school-failing students rated distance learning more negatively than school-failing students. It is therefore likely that distance learning was another type of burden for them, which exacerbated the already frequent failures.

Conclusion

The closure of schools was a unique experience for all actors in education. The research confirmed

that from the point of view of most pupils in the 2nd year of primary school in the 27, resp. 29 classes monitored, distance learning was associated with certain positives, but also with certain negatives. The positives receded into the background during the school year, so that the evaluation of distance learning became more critical. Because the study took place in long-term follow-up classes, we can say that the deteriorating assessment does not correspond to the declining quality of teaching. On the contrary, teaching was gradually better. It is therefore more a consequence of the exhaustion of children (and their parents who had to help with distance learning), which gradually grew with the length of the pandemic. This trend of growing criticism was found in a slightly stronger form for students who were perceived by teachers as partially or completely unsuccessful in school. We can therefore argue that distance learning exacerbates existing educational inequalities. Therefore, increased attention must be paid to their removal.

Acknowledgement

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RESULTS IN NEW ACCREDITATION OF ICT STUDY PROGRAMME IN COVID-19 PERIOD

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Abstract

The Bachelor study programme of Applied Informatics at the College of Polytechnics Jihlava was reaccredited in 2019/20, bringing content updates and curriculum reorganization. The routine monitoring of the outcomes of the update was complicated by the impact of emergency remote teaching in the COVID-19 semesters. The paper evaluates student results in four sample ICT-oriented courses, distinguishing those where changes are expected due to the update and those impacted only by the emergency remote teaching, and interprets the development with the aim to evaluate the effects of the organizational changes and how the college managed to deal with the limitations of the pandemic. The study programme update proves satisfactory even within the COVID-19 limitations, but online and hybrid teaching and learning, despite certain positive externalities, encountered serious obstacles such as disabling access to laboratory equipment, limited teachers' assistance and online tests proctoring.

Keywords

Accreditation, COVID-19, e-learning, subject success rate, teaching methods

Introduction

As a part of its endeavours to continuously improve quality, the College of Polytechnics Jihlava regularly updates its study programmes to reflect current development in corresponding fields, changing requirements of employers, and feedback from students and graduates.

The Bachelor study programme of Applied Informatics, which has been provided by the Department of Technical Studies since the academic year of 2007/2008, was significantly updated in 2019/2020 with the aim to shift the original general ICT orientation towards a more specific programming focus demanded by both the labour market and students. At the same time, the individual subjects were reorganized within the curriculum to incorporate the results of a prior analysis of the original form of the programme. The Department of Technical Studies has been monitoring the indicators of students' achievements with a focus on the expected impact of the changes on the student success rate. However, the unexpected limitations to standard teaching methods due to the COVID-19 pandemic intervened in the summer semester of 2019/2020 and have been influencing the results of the newly accredited programme until now.

Since March 2020 when emergency remote teaching replaced students' presence in schools in the Czech Republic due to COVID-19 epidemic measures, schools have gone through periods of distance teaching, online teaching, and hybrid teaching. Although long-term impacts of the epidemic emergency measures on students and their results are yet to be evaluated, a significant number of studies deal with the phenomena and issues of this unprecedented situation.

The Internet had been positively received as a useful learning platform even before the COVID-19 pandemic (Cacheiro-González et al., 2019). As it became the obvious tool for emergency communication between teachers and students and numerous studies, e.g., Dhawan (2020), Kirsch et al. (2021) or Bird et al. (2022), look up to e-learning as a possible solution for lockdown

education with minimal negative impacts, one of the central concerns was the technological readiness and computer skills of all concerned, both teachers and students. While the most serious shortcomings were apparently in primary educational institutions (Pleskačová, 2021), the tertiary educational sector had already had substantial experience, especially in using asynchronous teaching materials, as described, e.g., by (Dlouhá et al., 2015), and in defining the specific role of the teacher in e-learning (Rohlíková, Zlámalová, 2005). The College of Polytechnics Jihlava had used some form of e-learning since its establishment in 2005 and had started using LMS Moodle in 2009 (Vojáčková et al., 2011), going through several systematic updates (Kuncová, Vojáčková, 2015). The benefits of semi-virtual teaching and blended learning for solving certain educational issues were studied by Šlechtová et al. (Šlechtová, Vojáčková, Voráček, 2015) even before COVID-19. The period of emergency remote teaching, however, initiated systematization of e-learning modules across the institution and an increase in the explicit use of learning outcomes. The next concern, whose legitimacy may yet be proven in future, is whether the quality of students' learning has been impacted by the emergency teaching methods. Some authors described the technological, visual, and ethical specifics of online teaching (Jandová, 2020) and compared students' understanding of concepts in subjects such as mathematics before and during COVID-19 (Novotná, 2020). Bączek et al. (2021) notice, besides the commonly known benefits of e-learning, its limitations at teaching skills and social competencies and lower student activity. This paper describes the existing situation by interpreting the fluctuations in the students' success rate in the context of what emergency teaching method was used in the semester in question.

There is general agreement that, despite the difficulties caused by emergency teaching practices, the resulting improvement of electronic study materials available online and computer skills enhancement will remain beneficial even in future. The comfort and flexibility of studying from home appealed to the majority of students, despite its drawbacks (Fejfar, Jadrná, Fejfarová, 2021). It was necessary, though, to redefine or define more precisely the key terms such as distance learning, online learning, or hybrid teaching (Neumajer, 2020). The situation helped to put into wider practice the long-discussed learning outcomes as a form of fixed statements by means of which teachers can better communicate their goals with students (Volfová, Lososová, Miovský, 2020). The College of Polytechnics had been working with learning outcomes before the COVID-19 pandemic, but now it took the opportunity to introduce them systematically to all subjects where applicable and held a series of training seminars for its teachers on evidence-based teaching.

The least tangible but not the least serious effect of emergency teaching practices is the psychological impact of lockdowns and studying from home, which influenced students' well-being and increased their stress levels, but also altered students' learning self-regulation. Indeed, rising levels of stress and anxiety levels due to changes in the form of teaching were reported in education systems around the world (Peloso et al., 2020). Research shows that students' learning patterns have changed significantly due to emergency teaching practices during the COVID-19 period (Holzer et al., 2021) and that stress and increased anxiety and depressions incidence in students studying from home negatively impacts their ability of learning self-regulation (Stránská, 2021).

The paper evaluates the outcomes of the 2019/2020 update of the study programme of Applied Informatics and interprets the development in the context of the emergency measures that impacted learning and teaching during the pandemic. The outcomes are studied by analysing student results in two core theoretical subjects whose content and position in the curriculum were altered within the accreditation update in comparison with two subjects that stayed the same. The aim is to identify the changes in students' results and to interpret what was caused by the programme update and what, on the other hand, by emergency teaching methods. The paper will

reveal the lessons learned from the COVID-19 period, recognizing what can be useful even after the pandemic and what improvements need to be made.

MATERIALS AND METHODS

Description of the changes in the curriculum

The professional focus of the Bachelor study programme of Applied Informatics was altered from general informatics with elements of electronics and programming to a deeper focus on web design while preserving the programming content. Moreover, the credit load of some core theoretical subjects was increased.

The number of mathematics-oriented subjects was reduced, some of the strictly theoretical content abandoned and the remaining content updated and reorganized. For example, the subjects *Mathematics 1* and *Fundamentals of Linear Algebra* were newly combined in a subject called *Mathematics*; the subjects *Mathematics 2* and *Numerical Methods* were removed from the Bachelor study programme and *Statistics* remained the same. The original number of seven mathematics-oriented subjects in the first year of study was reduced to two. The aim of this part of the reorganisation was to adjust the amount of mathematics to the real needs of future ICT professionals, to provide more space for programming-oriented subjects, and to avoid the situation where first semester students could easily fail to obtain a significant number of credits necessary for their successful passing to higher semesters if they had problems in mathematics. The subjects *Essentials of Electrical Engineering* and *Safety in Electrical Engineering* were abandoned due to changing labour market requirements.

The above-mentioned changes enabled placing a higher number of informatics-oriented subjects in the first semester. The aim was to supply fundamentals for core theoretical subjects in higher semesters. Moreover, the fifth semester was newly dedicated to students' practical placements in companies. Transfers of former fifth-semester subjects to different semesters were of organisational character and are not expected to influence success rate.

Monitoring outcomes of the programme updates

To monitor the impact of changes to the study programme curriculum, the shares of students who passed individual subjects are used as the main indicator along with the development of students' classification results in subjects completed by an examination. The data from semesters before the update are compared to the data after the update. The results are interpreted with a view to whether emergency teaching methods were used in the given semester.

This paper works with two core theoretical subjects whose content and position in the curriculum were altered within the new accreditation and two core theoretical subjects that were updated but stayed in the same semester. These are supposed to show the impact of emergency teaching. The subjects in question are as follows: *Web Technologies 1* (3rd semester) that changed into *Website Creation* (1st semester), *Web Technologies* 2 (4th semester) that was transformed to *Web Technologies* (3rd semester). *Theoretical Foundations of Informatics* (1st semester) stayed in the same semester and became *Discrete Structures*, increasing the amount of graph theory, and *Operating Systems* that remained in the 4th semester and stayed the same with only minor content revision.

Where the form of students' evaluation remained the same after the change, the results are compared using the chi-square test of independence, categorical data being students' marks and semesters (Kanji 2006). The average number of students in the sample is 100. We worked with the following hypothesis:

H_0: *COVID-19 emergency teaching did not influence the students' success rate in subjects that were not shifted to a different semester during the study programme update.*

The hypothesis is statistically evaluated in case of the transition of the first-semester subject of *Theoretical Fundamentals of Informatics (TFI)* into *Discrete Structures (DS)*. The same statistical method cannot be used in the case of other subjects as higher semesters have not been taught enough times yet; moreover, the form of evaluation (pass/fail or evaluation by marks A–F) changed. For that reason, only the changes of the share of successful students were monitored. Here, the average number of the students in the sample was 40. Special considerations were given to analysing the results in subjects transferred to the first semester from a higher semester. The first semester is specific because the experience shows that a certain number of students enrol into it just to try out what university study or the study programme look like, and they drop out soon disregarding the qualities of the programme; some even never start their studies. This fact complicates getting reliable success rates for the first semester subjects. For the paper, students who give up their studies during the first semester without participating in assessment activities are not included in the numbers of students who fail the subjects.

RESULTS

The first examined change is the transition of the subject of *Theoretical Fundamentals of Informatics (TFI)* into *Discrete Structures (DS)*. As stated above, this subject did not experience significant changes and is supposed to act as a reference sample. In Figure 1, the first bar in each semester shows the percentage of students who passed the subject. As a specialized first-semester subject, it traditionally has a substantial share of fails. Although this did not change dramatically after the accreditation update, the average success rate has slightly improved. Figure 2 shows detailed results of the students who passed. The standard ECTS grading scale (A: excellent, B: very good, C: good, D: satisfactory, E: sufficient, F: fail) is used in the graph for the comparison of changes in marks distribution. Where the average students' result was calculated, the numerical values were based on valid college rules (A: 1, B: 1.5, C: 2, D: 2.5, E: 3). Results in winter 2019/20 before the COVID-19 pandemic show standard distribution but the following two winter semesters experienced worse average results, indicating that despite the online classes and improved learning materials, the ideal learning conditions were disturbed.
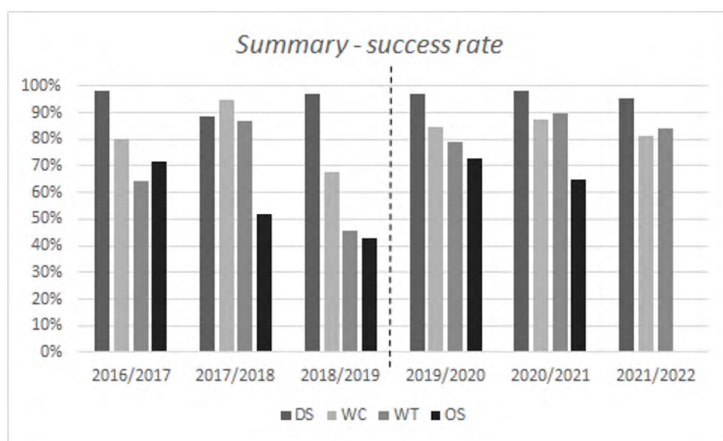

Figure 1: Students success rate in the monitored subjects

TFI and its new version DS represent a subject where we have enough data for statistic evaluation of COVID-19 pandemic impacts as the semester and the form of evaluation did

not change. We used the pre-pandemic winter semesters of 2018/2019 and 2019/2020 for the evaluation and got the chi-square test value of 2.751, when the critical value at the significance value of 5% is 11.07. Next, we performed statistical comparison of winter semester 2019/2020, when students were present at school, and winter semester 2020/2021, when both lessons and tests were performed online. We got the chi-square test result of 10.956. As the last step, we performed statistical comparison of winter 2020/2021 with winter 2021/2022, when there were hybrid classes and students sat tests in person at school. Here, we got the chi-square test result of 8.291. Since the values are less than the critical value, we accept the null hypothesis for the TFI and DS subjects, meaning that students' results were not significantly influenced by the COVID-19 emergency teaching forms. Despite certain drawbacks and complications, the e-learning platform, online teaching and other methods of teacher-student communication provided the necessary education relatively successfully.
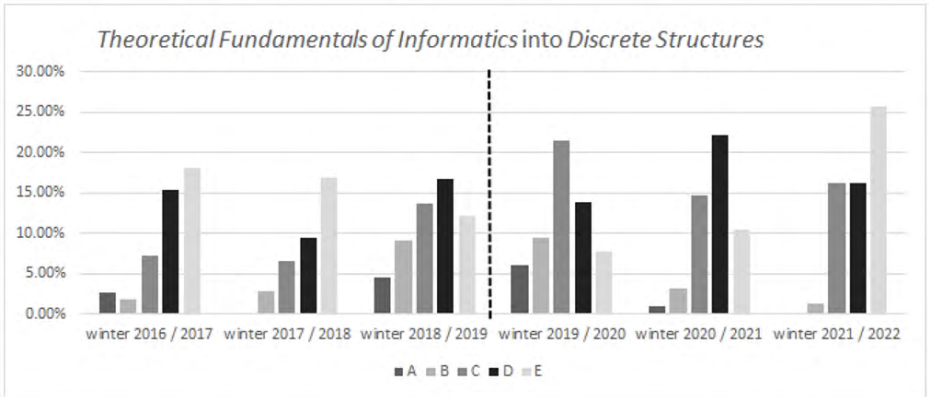

Figure 2: Successful students result distribution for TFI and DS

Statistical evaluation by chi-square test was not carried out in other subjects since the form of students' evaluation did not remain the same in them (examination changed to pass/fail result or vice versa) or, as in the case of *Operating Systems*, the newly accredited version is only in progress now for the first time.

The subject of *Web Technologies 1 (WT1)* was transferred into *Website Creation (WC)* and moved from the 3rd to the 1st semester. In Figure 1, the success rate in these subjects is shown by the second column for each year. Both the subjects have taken place in winter semesters, therefore when the new *Web Creation* was taught for the first time in 2019/2020, it was before the COVID-19 pandemic and traditional methods were used. The following winter semester was the period of online classes; in the winter semester of 2021/22, hybrid teaching was used. Despite these differences, we can see relatively balanced results after the update. The lack of wider professional outlook in the 1st semester students was not a significant problem for this subject. The academic year 2018/2019 before the update shows deterioration in most subjects, mainly since the part of students who were not satisfied with the mathematical or electronic content of the study programme quit to start again in the updated programme. In Figure 3, detailed results of successful students after the update show certain problems in 2021/22 where hybrid teaching placed additional demands on students and teachers and some students struggled at regaining the self-discipline after home study. The small improvement during online teaching in 2020/21, however, may fuel the concerns that tests written online in emergency conditions were not sufficiently proctored.
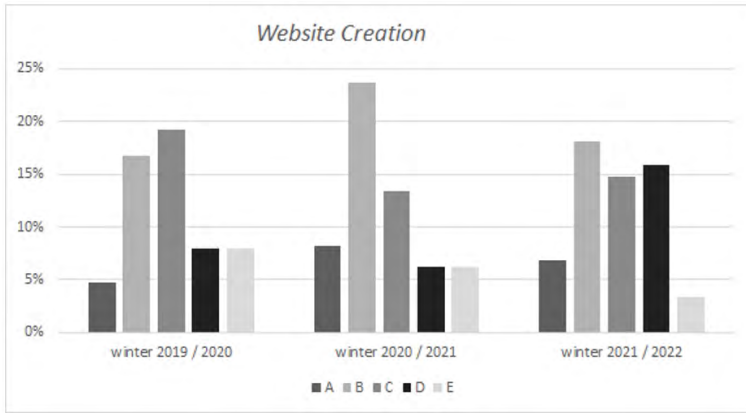
Figure 3: Successful students result distribution for WC

The subject of *Web Technologies* 2 *(WT2)* was transformed to *Web Technologies (WT)* and moved from the 4th to the 3rd semester. Newly, it is completed by an examination. Figure 1 shows an improvement in the third column for the last two years that had the updated 3rd semesters. A higher number of theoretical subjects in the first year obviously provide students with sufficient professional outlook. Figure 4 shows detailed results in 2020/21, when lessons took place online, and in 2021/22, when hybrid lessons prevailed. The course of the curve for the semester of online learning is not typical, reflecting the fact that some parts of evaluation had to be replaced or omitted as software available in college classrooms was not accessible and that the credibility of results of online tests taken from home was limited. In 2021/22, the results were closer to standard.

The subject of *Operating Systems (OS)*, which stayed in the 4th semester and experienced only minor changes, is supposed to show the impact of the emergency remote teaching most clearly. The summer semester of 2019/20 was the time of the first lockdown when there were no regular online lessons and students worked with e-learning materials distantly, communicating with teachers in writing. Part of the full-time students found that challenging and some materials were not suitable for work from home.
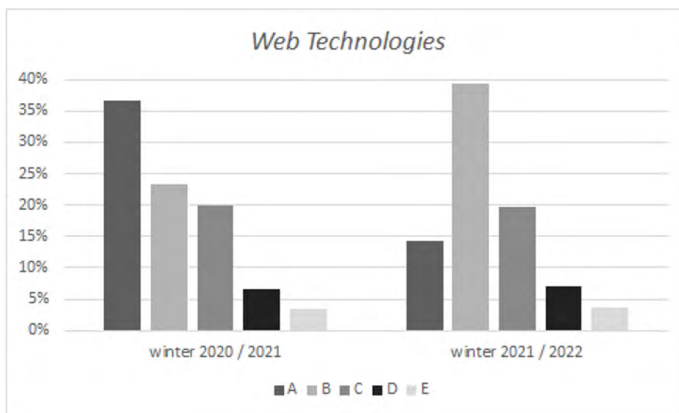

Figure 4: Successful students result distribution for WT

The results in Figure 5 show corresponding deterioration. The online lessons in summer 2020/21 provided better contact with the teacher but some technical limitations persisted. However, as seen in Figure 6, the average results of successful students did not change much in 2020/21 even though the result distribution is more realistic there than with online tests written from home in the previous year. As we can see, professionally oriented subjects dependent on computer laboratory equipment suffered a great deal from the emergency remote teaching. Although we do not have results for the summer 2021/22 yet, the situation is expected to improve now as students have returned to school.
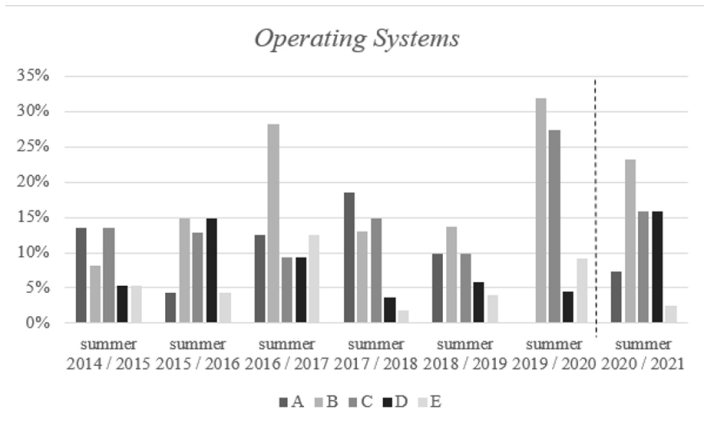

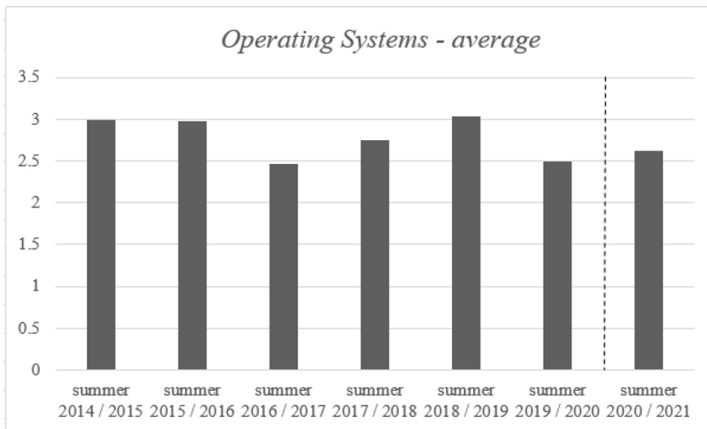Figure 5: Successful students result distribution for OS

Figure 6: Average results of successful students for OS

DISCUSSION

The obtained results show a number of interesting findings. The case of the first-semester subject of TFI and its new version DS where the complete statistical evaluation by chi-square test was carried out testifies that students' results were not significantly influenced by the COVID-19 emergency teaching forms. Despite certain drawbacks and complications, such as the unprecedented changes in students' learning patterns in emergency teaching (Holzer et al., 2021), the college e-learning

platform, online teaching and other methods of teacher-student communication proved sufficient readiness and provided the necessary education relatively successfully, which is in accordance with other studies, e.g. Cacheiro-González et al. (2019). Students had been working with e-learning platforms even before the COVID-19 pandemic, as Kuncová and Vojáčková (2015) describe in their earlier paper. A key role was played by the existence of quality e-learning materials for all subjects and the experience of academic workers with using e-learning in their work, as mentioned e.g. by Dvořáková and Smrčka (2021).

Analysing the type of changes represented by the transitions of WT1 to WC and WT2 to WT where subjects moved to lower semesters and the form of their completion changed (examination vs. pass/fail) disproves concerns that results in lower semesters may suffer by limited professional outlook of students. The results after the update remain at a comparable level as before the update. This proves the strategy of the study programme update successful. However, the detailed analysis of the results distribution indicates that the COVID-19 pandemic and resulting online teaching impacted the student outcomes negatively. Not only did the increased levels of stress, uncertainty and anxieties complicated the work from home in some students, just like mentioned by Stránská (2021), but some parts of evaluation had to be replaced or omitted as software available in college classrooms was not accessible, and the credibility of results of online tests taken from home was limited.

The deterioration in the fourth-semester OS results testifies that professionally oriented subjects dependent on computer laboratory equipment suffered the most from the emergency remote teaching. Although we do not have results for the summer 2021/22 yet, the situation is expected to improve now as students have returned to school.

Conclusion

Analysing the impacts of changes in the study programme of Applied Informatics on student's success rate is complicated by four semesters of emergency remote teaching during the COVID-19 pandemic. Moreover, students' average success rate in the year preceding the update was distorted by the fact that a share of students interrupted their studies to start over in the updated study programme that they found more attractive. These facts present the limitations of the research. For that reason, more prior semesters were used for comparison to achieve a more realistic picture. Nevertheless, none of the monitored subjects shows a significant deterioration when compared to the situation before the update. Core theoretical subjects benefit from the fact that students gain more theoretical knowledge in the first semester.

Although the emergency remote teaching brought about also some positives such as systematisation of e-learning modules, learning outcomes utilization or computer skills improvement, it primarily presented hindrances both in the organisation of learning and in students' learning self-regulation. Students were not able to make use of computer laboratory equipment, some assignments had to be redesigned for study from home. The assistance of a teacher was limited and so was proctoring during tests. Students were less active in online classes. Results show that even hybrid classes with some students present as school and others communicating online proved more demanding than expected; the attention of a teacher was split between the two forms, and it was inconvenient for the teacher to leave the computer, use standard tools or assist present students individually. Tests written online from home had higher average results than those written at school, but the knowledge gained did not correspond to them, indicating possible insufficient proctoring. Technological solutions for online proctoring are recommended for the future. The missing consideration for the long-term value of the obtained knowledge (can students remember what they learned in the distance form?) is another limitation of the research presented in this paper. Further research is needed to evaluate the quality of knowledge that students gained during the COVID-19 period and will be expected to apply later.

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STANDARD FORM VS. TWO ALTERNATIVE FORMS OF WRITTEN EXAMINATIONS IN MATHEMATICS

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Abstract

The aim of this article is to describe and compare the results of written examinations in mathematics at the University of Finance and Administration in Prague, which were conducted in three different forms: standard (face-to-face), correspondence (individual test preparation sent electronically for checking) and online (under the direct supervision of an examiner via camera). The main objective is to determine whether the two alternative forms (correspondence or online) are suitable substitutes for the standard form. For a better comparison, the results of the summer semesters of three consecutive academic years, when a different form of examination was used each time, are used. Statistical evaluation showed that standard and correspondence forms of testing led to similar student performance, while students were less successful online. Possible reasons for the results are analysed.

Keywords

Form of examination, mathematics, online exam, statistical evaluation, written test

Introduction

Exam results may depend on many factors. For example, Fajčíková et al (2020) points out the influence of the field of study, Joyce and al (2015) study the impact of class time on academic performance, Ulrychová and Bílková (2018) investigate the impact of students' gender on their mathematics exam results, Majovska (2015) deals with the influence of online mathematics programmes on students' results, Darolia (2014) analyses the effect of working on the academic performance.

Exam results could also be affected by the form of face-to-face or online teaching, but many studies report that learning outcomes are not strongly influenced by the form of teaching. For example, Pasáčková (2021) found that student success rates in mathematics did not change with the conversion from full-time to online teaching. This topic has come to the forefront of many scientific publications in recent years due to the restrictions accompanying the Covid-19 pandemic. However, trends towards alternative online learning were already emerging before the Covid-19 pandemic. Thompson and McDowell (2019) conducted a research study at an undergraduate college, comparing student successes in a mathematics course offered fully online, blended and face-to-face, and concluded that the level of students' performance is independent of the form of teaching. Cahapay (2020) states that online or blended learning will become a common part of the curriculum.

The above studies are mainly concerned with the form of teaching, not so much with the form of testing. In contrast, this article focuses specifically on the form of testing. Its aim is to compare the results of tests conducted in the standard way with two alternative forms. The article deals with the mathematics exams at the University of Finance and Administration (Prague). Mathematics is taught as a two-semester course at this school, Mathematics 1 in the winter semester and Mathematics 2 in the summer semester, both of which culminate in an exam. From the summer

semester of the 2019/2020 academic year, examinations have been conducted by alternative means due to school closures caused by the Covid-19 pandemic. The aim of this paper is to assess whether these alternative forms were an adequate substitute for standard examination and whether the inferior ability to check the authorship of the test did not lead to better results to a greater extent. The summer semesters of three consecutive academic years, when the tests were administered in a different form each time, are chosen to compare the results.

At the University of Finance and Administration, mathematics examinations are conducted standardly face-to-face. In the summer semester 2019/2020, examinations could not be held in a standard way due to the situation caused by the Covid-19 pandemic, specifically the closure of schools. However, sufficient conditions have not been created to allow the online exams to be conducted in a form that best matches the standard format. Therefore, an "emergency" non-traditional form of testing was chosen: students independently worked out tasks corresponding to the tasks from the regular exam test and sent the finished tasks for evaluation. In the academic year 2020/2021, examinations in both semesters were conducted exclusively online due to the ongoing pandemic.

This article compares the results of mathematics exams in the year 2018/2019, when the standard form was used, with the results in the 2019/2020, when the correspondence form was used. Further there are compared the results of the standard form in 2018/2019 with results of the online form in 2020/2021. In this article there are not compared the results of all three forms as well as of both alternative forms. The main objective of this thesis is to determine whether the correspondence form and the online form are adequate substitutes for the standard form of the examination, since the alternative forms do not allow sufficient checking whether students are working independently.

The article is structured as follows. The Materials and Methods section describes the various forms of testing in more detail and specifies the data and statistical methods used. The Results section provides an evaluation of the survey results. The Discussion section compares the results with those of other studies and considers possible reasons for the results. The Conclusion section provides an overall summary of the findings.

MATERIALS AND METHODS

Teaching of mathematics (lectures and seminars) was carried out in the standard way until the winter semester 2019/2020, as well as in the early part of the summer semester 2019/2020. After the closure of schools due to the Covid-19 pandemic, students were referred to supervised self-study for several weeks, for which special support study materials were promptly created. Later, online streaming of standard lectures (from empty classrooms without students) was enabled. Compared to standard teaching, students had an advantage – recordings of lectures were made, which students could replay as needed. The disadvantage was that there were no seminars in which students could learn the necessary concepts and computational procedures in cooperation with the teacher. In the academic year 2020/2021, only online teaching, both lectures and seminars, was realised at all times. The lectures were recorded. While the lectures were fully comparable to the standard ones, the seminars were more problematic, mainly due to the difficulty of checking the students' work. The curriculum was the same in all considered three academic years.

The exam tests had the same structure in all three forms of examinations described in more detail below. They consisted of ten tasks – calculating exercises from the field of mathematical analysis (behaviour of a function of one variable, Taylor polynomial, indefinite and definite integral, derivative of a function of two variables).

In a standard exam, students write a test in a classroom under the supervision of examiners. They quickly review each test before final submission, approve the correct tasks, and allow students

to correct the remaining tasks (errors are not specified by the examiner at this stage). To pass the exam, the student must correctly solve at least 50 % of the ten tasks. For each incorrect task, the mark is reduced by one grade.

In the correspondence form, students prepared a paper corresponding to the type of the test and submitted it through the university information system at any time during the examination period. However, each student first had to create his or her individual assignment according to strict rules and instructions. This significantly limited the possibility of transferring calculations and results among students. Due to the format, which allows students to consult the test material with anyone and to work on the test for a sufficiently long time, the assessment was more rigorous. To pass the exam, students had to correctly solve all ten tasks (which corresponded to the regular test). For a better grade, extra exercises had to be worked out (for each correctly solved task the grade was one grade higher). These tasks were selected from topics that are not regularly included in tests (but are part of the curriculum).

In the online form of the exam, students took the test at home (with a camera and microphone on) under the supervision of an examiner (on the given exam dates). The students made a copy of the test and immediately uploaded it in the prescribed format to the school information system. The tests were of the same type as in the standard exam and the assessment criteria were the same. Compared to the standard exam, the time to solve the test was extended by ten minutes to make a copy of the test and upload it to the information system. In case of technical problems, students could operatively solve the situation with the examiner. However, students did not have the advantage of a preliminary check before final submission as in the standard form.

Methodology and research organization

We had 101 results from the standard exam in the summer term in the academic year 2018/2019 (AY/S 2019), 96 results from the correspondence exam in the academic year 2019/2020 (AY/S 2020) and 111 results from the online exam in the academic year 2020/2021 (AY/S 2021). The test results were converted to the numerical value, Excellent (A) = 1, Excellent minus (B) = 2, Very good (C) = 3, Very good minus (D) = 4, Good (E) = 5, Failed (F) = 6. We calculated the sample average value (E), the unbiased estimate for variance (V), skewness (S), kurtosis (K). The number of tests was denoted (N). We used the Bowman-Shenton skewness and kurtosis test for normality at a significance level of 0.05 (Bowman and Shenton, 1975).

Based on our experience and assumptions, we formulated two hypotheses:

H01: The average values of the exam results in the summer semesters AY/S 2019 and AY/S 2020 are the same.

H02: The average values of the exam results in the summer semesters AY/S 2019 and AY/S 2021 are the same.

Both hypotheses were tested at the significance level of 0.05.

We did not differentiate between women and men.

RESULTS

We stated hypothesis H01 that average values of exam results in summer terms in the academic year 2019/S and 2020/S are the same. The examined data are in Table 1.

AY/S	N	E	V	S	K	Normality
2019	101	3.545	2.512	-0.074	1.804	No
2020	96	3.688	2.765	-0.283	1.837	No

Table 1: Examined data H01, 2019 and 2020 (source: own)

The hypothesis H01 was tested using a two-sample t-test (Snedecor and Cochran, 1989). This

test can be used if the test of the equality of variances did not reject the hypothesis of equality of variances. Violations of normality can be tolerated in this test (Anděl, 1978). We used the *F*-test for the equality of two variances with the following results:

$$F = 1.101 \qquad (2Tailed\ P\_value = 0.634)$$

Quantile 0.025 *F*-distribution with (95,100) degrees of freedom = 1.489
The hypothesis of equality of variance was not rejected at the significance level of 0.05.
The results of two-sample test are following:

$$|T| = 0.618 \qquad (2Tailed\ P\_value = 0.537)$$

Quantile 0.025 *t*-distribution with 195 degrees of freedom = 1.972
The two-sample *t*-test indicates that there is not enough evidence to reject the null hypothesis. The hypothesis H01 was not rejected at the significance level of 0.05. The results of the standard exams and the correspondence exam are not different at the 0.05 significance level.

The hypothesis H02 stated that the average values of the exam results in summer semesters AY/S 2019 and AY/S 2021 are the same. The examined data are in Table 2.

AY/S	N	E	V	S	K	Normality
2019	101	3.545	2.512	-0.074	1.804	No
2021	111	4.135	2.936	-0.516	2.029	No

Table 2: Examined data H02, 2019 and 2021 (source: own)

The hypothesis H02 was tested using the same test as the hypothesis H01, i.e. the two-sample *t*-test.

We used the *F*-test for the equality of two variances with the following results:

$$F = 1.169 \qquad (2Tailed\ P\_value = 0.428)$$

Quantile 0.025 *F*-distribution with (110,100) degrees of freedom = 1.472
The hypothesis of equality of variance was not rejected at the significance level of 0.05.
The results of two-sample test are following:

$$|T| = 2.595 \qquad (2Tailed\ P\_value = 0.010)$$

Quantile 0.025 *t*-distribution with 210 degrees of freedom = 1.971
The absolute value of the test statistic, $T = 2.595$, is greater than the critical value of 1.9673, so the null hypothesis was rejected and we conclude that two averages are different at the 0.05 significance level. The results of the online exam in 2021/S are worse than those of the standard exam in 2019/S.

DISCUSSION

We compared the results of standard testing and alternative forms of testing. Statistical evaluation shows that the results of online testing are worse than the standard form. The consistency of results in the correspondence and standard forms of testing is rather surprising.

In the correspondence form of the examination, students had the advantage of being allowed to work on the tests for a few months and had the opportunity to consult the tasks with anyone or have them checked before submission. The examiner was concerned that a large proportion of students would thus obtain an excellent mark in the exam, regardless of their actual knowledge. On the other hand, the students had a more difficult situation with the creation of their own tasks and especially with the tougher assessment of the test. It turned out that many students were satisfied with completing the compulsory part of the test (and not always getting it right) – they did not attempt the extra part for a better grade. This may have been because the extra part consisted of tasks that were the content of the unpresented material, where students were referred to self-study, while the compulsory part was largely taught before the schools closed. However, students may have considered it sufficient to pass the exam regardless of the grade. The fact that the students

did not have the same assignment may also have played a role. The concern that in many cases someone else authored the test instead of the student was not confirmed. In case of doubts about the authorship of the test, students were asked to take an individual online examination, but these cases were quite rare.

In the online form of testing, students were disadvantaged by the fact that they had not experienced face-to-face teaching at all since the beginning of their studies at the university, teaching was only online. Online lectures, transmitted via a camera or a graphic tablet, were an adequate substitute for face-to-face lectures, and students had the option of replaying the recording. However, online learning may not suit all students. Kemp and Grieve (2014) found that students preferred face-to-face rather than online activities, but there was no significant difference in their test performance on the two alternatives. Mendoza et al (2021) argue that students' increasing anxiety during the pandemic has significantly affected their performance and that the transition to distance learning led to significant differences in students' understanding of mathematical concepts. Fejfar, Jadrná and Fejfarová (2021) assesses the advantages and disadvantages of distance education from the students' perspective. The online form of the examination may have been more stressful for many students than the standard form of testing. In addition to the fact that they may not have been comfortable being watched by a camera, students may also have been nervous about the potential failure of technology, either during the exam or in copying, correctly formatting, and saving the finished test. Nervousness may have negatively affected the outcome of the exam. Elsalem et al (2020) report that a third of students find online exams and the associated technical problems more stressful than standard exams. Furthermore, a not insignificant number of cheating attempts were detected. In this case, the result of the test was directly assessed as insufficient. When in doubt, students had to take an individual online examination. A significant factor may be that, unlike in the standard exam, students did not have the opportunity to correct some tasks after the examiner had previously checked them.

Among other studies comparing the results of standard and online exams, we mention in particular those conducted at schools whose focus and mathematics curriculum correspond to the University of Finance and Administration. For example, Klůfa (2021) compares the results of the oral part of the mathematics examination at the University of Economics in Prague, Otavová and Sýkorová (2021) from the same university compare the results of midterm tests, final tests and final grades depending on the form of teaching and examination. The online form of testing led to better results than the standard form, unlike the results presented in our paper. In the online form of testing, however, it depends very much on the conditions set; these are not specified in the above articles. For example, if the online exam is not supervised by cameras and students only upload a completed test, the results may be highly biased.

Covid-19 pandemic changed teaching forms at universities and forced teachers to use computers much more, as shown by research (Hvorecký et al, 2021). Our further research could focus more significantly on issues of possible cheating related to the use of ICT in testing. Here it is necessary to start from the latest research in cybersecurity, for example according to Rahmani et al (2021).

Conclusions

The aim of this paper is to compare the standard form of the written examination in mathematics with each of two alternative forms (correspondence and online) separately and to assess the significance of these alternative solutions. Surprisingly, it turned out that the correspondence form, where students took the test with almost no time constraints and stress, did not lead to better results than the standard form; the results were very similar in both forms. The results in the online form of the examination were worse than in the standard form, possible reasons for this are analysed in the Discussion section. Thus, concerns that alternative forms of testing

would allow a significant number of unprepared students to pass the exam were not confirmed. From this point of view, both alternative forms of examination, as they were conducted at the University of Finance and Administration, appear in retrospect to be an acceptable substitute for the standard examination. The correspondence form can, despite the favourable results presented in this article, only be considered as an emergency solution in terms of objectivity (compared to conventional testing). The online form is uncomfortable for both parties, students and examiners, in many respects, and the results are less demonstrable compared to standard testing. However, in conditions where it is not possible to test face-to-face, the online form of testing under the conditions described above (use of a camera, etc.) is the best solution.

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IS THE LEVEL OF DIGITAL SKILLS OF PUPILS AND TEACHERS IN SLOVAKIA INCREASING?

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Abstract

The paper discusses selected results achieved by Slovak pupils, students and teachers of primary and secondary schools in framework of a regularly organized monitoring of digital skills of Slovak population. Participation in the public testing provided primary school pupils and students of eight-year grammar schools with an opportunity to get a clear idea of whether they are able to work with computers and the Internet at a currently appropriate level. Similarly, it gave primary and secondary school teachers a relevant picture of where they stand in terms of digital skills and what they need to strengthen in this area to be able better cope with demands placed on their teaching in the future. Analyses of the results document a deterioration in the level in basic IT skills and knowledge, as well as in the ability to apply them in solving practical tasks and problems of practice, in both groups.

Keywords

Assessment, digital skills, IT knowledge and skills, primary and secondary schools, pupils and students, teachers

Introduction

The crisis caused by the COVID-19 pandemic is testing the digital skills of all of us for almost two years now. For the first time, teachers have been left with no choice but to use digital means to deliver education and training. This pandemic has been a great opportunity or challenge for teachers to improve their use of digital teaching tools. Several published studies say that in the new conditions of lockdowns, those teachers who were able to adapt to the new situation, including through better digital skills, were better able to overcome obstacles in their teaching activities (Leonidovna Antonova, Borisovna Abramova and Popova, 2021; Nilsberth et al., 2021; Pavlíková et al., 2021). Despite the many extensive limitations of face-to-face teaching in schools during the ongoing pandemic crisis COVID-19, we think that this situation has convinced teachers of the necessity to continuously improve their digital skills, without which they will not get far in their private and professional lives (Barnová, Krásna and Gabrhelová, 2020). Teachers should get used to the fact that the future will be a hybrid form of education, in which some pupils attend classes in school classrooms in person, while others learn from home at the same time (Singh, Steele and Singh, 2021). It is therefore the duty of every educator to be prepared for this model of teaching and to make full use of the potential of digital didactic tools (Perifanou, Economides and Tzafilkou, 2021).

Research Sample and Methods

Since 2009, Slovak citizens have had the opportunity to (voluntarily) test their digital knowledge and skills through the IT Fitness Test tool and get a realistic picture of their level compared to the European average. The priority target groups of the testing are pupils in the final years of primary

school or eight-year grammar schools, and graduates of primary schools or eight-year grammar schools aged between 14 and 16, students of secondary schools and universities older than 15 years old, last but not least, teachers of primary and secondary schools. The content structure of the IT Fitness Test is designed by a team of experts from the Technical University of Košice and teachers from primary and secondary schools. In 2021, because of the COVID-19 pandemics, the IT Fitness Test edition was administrated through an on-line form. In 2022, the test has returned back to its paper administration. For schools that meant to administrate the tests during the lessons in class environment.

For the knowledge and competence part of the IT Fitness Test, focused on the practical verification of the respondents' digital skills in various IT areas, two types of testing tools are administered. The first instrument designed for the age category from 14 to 16 years is conceived by the authors with a view to verifying the digital skills of graduates of regional schools for the continuation of their studies at a higher level of education or their application in professional life. The second tool is designed for solvers over 15 years old. This group includes secondary and higher education students, teachers of schools and school facilities and various age categories of other employed citizens of the Slovak Republic (hereinafter referred to as SR). The tasks in the IT Fitness Test 2021 came from the five thematic areas of *Internet, Security and Computer Systems, Complex Tasks, Office Tools, Collaborative Tools and Social Networks*. Each topic area contained a certain number (4, 5, 20 or 25) of questions/tasks depending on the age group of the solvers.

The tenth edition of this most extensive testing of IT knowledge and skills in SR, the IT Fitness Test 2021, produced interesting results in that all the target groups for whom this digital skills validation was intended to finish worse than in 2020 (Kučera and Jakab, 2021). The deterioration in results is evident in basic IT skills and knowledge, but also in their connection to practice. It can be observed from the testing results that the difference in the year-on-year success rate achieved by solvers in the tasks varies from 0 to 30 percentage points. However, this cannot be interpreted as an absolute deterioration, as other factors are also reflected, such as a change in the research sample or a minor change in the wording of the questions, etc.

Based on the results of the success rate in 2020 (Kučera and Jakab, 2020), the authors of the IT Fitness Test in 2021 tried to increase the difficulty of both test variants in order to bring the final success rate of the test as close as possible to the middle of the interval of optimal success rate of 50 to 60% in each category of test takers. A success rate in this range will help to maximize the discriminatory power of the test (i.e., the sensitivity of the test), i.e., the test will be able to distinguish between solvers with good and poor knowledge and skills.

Results

In the 10th edition of the IT Fitness Test, 27 436 solvers took part in its harder version for the target group over 15 years old (up from 13 649 in 2020), an increase of 50.25% year-on-year. The overall average success rate in this version of the test was 40.18%. Compared to 2020 (61.65%), there was a decrease of almost 21.5 percentage points. Students from secondary and higher education institutions from 535 educational institutions took part in the test, compared to 376 in 2020. More detailed basic psychometric parameters of the IT Fitness Test 2021 compared to 2020 for the group of solvers over 15 years old are tabulated at the top of Table 1.

The lighter version of the digital skills and knowledge assessment, designed for primary schools, involved 16 698 test takers in the 7 to 16 age group. Interestingly, there has been a significant increase of almost 57% year-on-year, with 7 246 test takers in 2020. On the other hand, the success rate has dropped to around 40%, from around 64.98% a year ago. The success.

Pupils from 790 primary schools took part in testing the digital skills of 7 – 16 years old, while in 2020, pupils from 445 educational institutions took part. The success rate of the easier version of the test in the primary age group of 14 – 16 years old is 42.53%, which means that it is 7.47percentage points below the required range (the range of optimal test success rates is 50% – 60%). For the whole group of test takers involved in the easier version of the test, i.e., the age group of pupils aged 7 – 16 years, the pass rate is 10.01 percentage points below the required range of optimal pass rates. The success rate in the IT Fitness Test 2021 for the primary age group (14 – 16 years old) of pupils has decreased by approximately 26 percentage points from last year's results. A detailed percentage picture of the average success rate for each age group of solvers participating in the lighter version of the test is tabulated at the bottom of Table 1.

Test for solvers over 15 years old	2021	2020
Number of test takers over 15 years of age	27 436	13 649
Overall average success rate of all solvers	40.18%	61.65%
Average success rate of students from secondary schools/universities	38.25%	60.60%
Average success rate of teachers	52.23%	70.55%
Average success rate of other employees	54.64%	68.44%
Sensitivity of the test	58.65%	63.28%
Test Reliability (Cronbach's alpha)	0.846	0.870
Test for primary school pupils and graduates aged 14 to 16	2021	2020
Number of test takers aged 7 – 16	16 698	7 246
Overall average success rate of solvers aged 7 – 16 years (of the whole test)	39.99%	64,98%
Average success rate of solvers aged 7 – 13 (full test)	36.72%	59.49%
Average success rate of solvers aged 14 –16 (full test)	42.53%	67.94%
Sensitivity of the test	51.01%	54.26%
Average success rate of teachers	57.61%	73.19%
Test Reliability (Cronbach's alpha)	0.730	0.787

Table 1: Basic psychometric parameters of the IT Fitness Test 2021 vs 2020 (Source: Kučera and Jakab, 2021)

The test for solvers older than 15 years of age was completed by 2 396 respondents who indicated that they were teachers (up from 414 in 2020). As also shown in Table 1, the average success rate of teachers in the test was 52.23% (in 2020 their success rate was 70.55%; in 2019 – 73.19%), which means that the success rate in verifying the digital skills and knowledge of this group of solvers is in the range of the optimal test success rate of 50% – 60%. The easier version of the IT Fitness Test was completed by 547 solvers who indicated that they were teachers (in 2020 – 136 teachers; in 2019 – 243 teachers). The average pass rate achieved by teachers in the easier version of the test was 57.61%, a decrease of almost 16 percentage points (15.58%) compared to 2020 (73.19%).

Table 1 shows that the best results achieved in the more difficult version of the IT Fitness Test 2021, designed for the target group of solvers over 15 years of age, were achieved by the category of other employed, last year it was the teachers with a pass rate of 70.55% in the test. In 2021, teachers ranked second and secondary/tertiary students ranked third in the validation of digital skills and knowledge (Table 1). The overall average success rate of teachers in the test reached approximately 1.37 times the overall average success rate of secondary school and university students (in 2020 it was 1.16 times; in 2019 – 1.33 times). Based on the IT Fitness Test scores obtained from previous years, there has been a trend of narrowing the gap in test scores between secondary school/university students and teachers each year. In the 2021 testing, the achievement gap between the two groups was more pronounced (Table 1).

	Average success rate in each category			
Testing area / Category of solvers	All respondents	Teachers	Secondary school/ University students	Others
Internet	49.83%	62.96%	47.89%	62.20%
Security and computer systems	46.52%	56.24%	44.89%	59.57%
Complex tasks	31.30%	39.86%	29.68%	46.44%
Office tools	37.17%	54.46%	34.49%	55.94%
Collaborative tools and social networks	36.10%	47.63%	34.28%	49.07%

Table 2: Achievement in each category of solvers with respect to the queried subject area in the test for solvers over 15 years old (Source: Kučera and Jakab, 2021)

	Average success rate 14 – l6 yrs. solvers		
Testing area / Year of testing	Year 2021	Year 2020	Year 2019
Internet	52.46%	79.19%	70.46%
Security and computer systems	37.84%	60.70%	43.15%
Complex tasks	39.50%	71.71%	51.60%
Office tools	31.82%	42.83%	41.89%
Collaborative tools and social networks	38.78%	70.46%	51.02%

Table 3: Achievement in each category of 14 –16 years old with respect to the queried subject area in the easier version of the test (Source: Kučera and Jakab, 2021)

In Table 2 we present the average success rate achieved in each of the five subject areas for the whole group of solvers, as well as separately for the groups of teachers, students of secondary schools/universities and other employed citizens of the Slovak Republic of different age categories. From the results we see that the group of teachers achieved the highest success rate in the Internet subject area. Moreover, the strongest digital skills just in this area were demonstrated also in the whole group of the solvers, without differentiating them into individual categories (searching for information on the Internet or using Internet services). This positive result can be noted, despite the fact that the success rate in all target groups of researchers decreased by about 25 percentage points compared to the previous year. The overall average pass rate for test takers over 15 years old was 49.83% (Table 2), rising to 75.18% in 2020.

In the easier version of the test for 14 to 16 years old, the success rate in this subject area was 52.46% (Table 3). Based on the analysis of the results obtained in the tasks of this area of inquiry of the IT Fitness Test 2021, it can be deduced that the success rate in searching for information on the Internet decreases if a constraint is embedded in the task or if the task contains a more detailed specification of the information sought. If the information to be searched is in some complex structure from which only a certain part needs to be selected, the success rate of the solvers in the task also decreases. More challenging are also tasks in which the information has to be laboriously retrieved and then the correct answer has to be reached through several steps.

From the results of the IT Fitness Test 2021, we can conclude that in the questions on *digital security and computer systems*, the more difficult version of the test from a global perspective, i.e., without differentiating them into individual categories, was solved by the solvers with an overall success rate of 46.52% (teachers: 56.24%; students of secondary schools/universities: 44.89%; other employed citizens: 59.57%), which is again this year the second highest success rate compared to other testing areas (Table 3). In the easier version of the test, the group of participants in the 14 – 16 age group achieved a success rate of 37.84% (2020: 60.70%) in solving the items in the *Security and Computer Systems domain*, which is also the second lowest success rate this year compared to other testing domains (Table 3).

The Complex Tasks category included tasks aimed at solving problems of an algorithmic nature, at

complex file handling skills, at tasks to find information in an interactive graph and then evaluate it, as well as at tasks to discover the control and setup of a certain sequence of commands in a program notation. The group of solvers completing the more challenging version of the test, i.e., those older than 15 years, had the lowest overall success rate (31.30%). Similarly, the lowest success rate in this variant of the test was also achieved in the categories of test takers – teachers (39.86%), students (29.68%) and other employed Slovak citizens (46.44%). In the category of pupils aged 14 to 16 years, the average success rate in the thematic area of *Complex Tasks* was 39.50% (Table 3).

Tasks in the *Office Software Tools* domain focus, for example, on formatting and copying text, copying set format properties of text within the structure of a large text document, tabular data processing and graphical visualization. The IT Fitness Test 2021 has again, as every year, revealed large gaps in the area of working with *office software tools*, yet office skills are one of the basic conditions for a successful position in the labor market today. It has long been an observed trend from testing results in previous years that in this area of digital skills testing, the biggest difference in success rates between teachers and pupils/students is, of course, in favor of teachers – more than 20 percentage points.

In the *Collaborative Tools and Social Networks* testing category, the success rate of the IT Fitness Test 2021 in the group of students completing the more challenging version of the test – secondary school and university students (34.28%) was comparable to the success rate achieved in the *Office Tools* category (34.49%) (Table 2). However, this is still almost 15 percentage points below the lower limit of the optimal average test pass rate (50 – 60%). Based on testing the same digital skills compared to 2020, we see a minor deterioration in the teachers´ category (2021: 47.63%; 2020: 54.85%). In previous editions of the IT Fitness Test, teachers' success rate in this area of testing was lower than, or at least comparable to, that of students. This year, teachers' success rate was 13 percentage points higher compared to students. Nevertheless, we still see room for significant improvement in the level of digital skills in the group of teachers as well as in the group of students older than 15 years (secondary and university students) completing the more difficult version of the test. In the category of pupils in the final year of primary school or eight-year grammar school and graduates of primary school or eight-year grammar school aged 14 to 16 years completing the easier version of the test, the average pass rate was 38.78% (2020: 70.46%), which is about 11 percentage points below the lower limit of the optimal average pass rate (Table 3).

Discussion, Conclusions and Recommendations

We agree with the opinion of Treľová and Krásna (2021) that digital competences are currently necessary not only in studying or at work, but also in normal life. The IT Fitness Test is a tried and tested method of testing digital skills and knowledge, which has given school graduates a clear idea of whether they can work with computers and the Internet at the level commonly required by employers in today's job market. It showed regional education teachers (i.e., primary and secondary school teachers) a relevant picture of where they stand in terms of digital skills and where they need to strengthen this area in order to be able to better overcome obstacles in their teaching activities in the future.

The measurement results achieved in the IT Fitness Test 2021 clearly show us that we cannot remain satisfied with the demonstrated level of digital skills and knowledge among the target groups of respondents – pupils in the final years of primary schools and eight-year grammar schools or graduates of these schools aged between 14 and 16, secondary and university students preparing for their future careers in society, and last but not least, the group of primary and secondary school teachers. It is clear that there is a need to focus first and foremost on the circumstances surrounding

the development of digital literacy among pupils in primary schools and to address investment in this area of education as well. It is also necessary to start more actively influencing the awareness-raising of students in secondary (vocational) and higher education, as it is constantly confirmed that the extent to which students acquire digital skills at school will have a high impact on their life chances to enter the labour market later on (Hrmo, Mistina and Kristofiakova, 2016). Already today, surveys of employers indicate that for the majority, the ability to use a computer at a basic level is an expected and key skill in a potential employee with a secondary education (Feijao et al., 2021; Khuraisah, Khalid and Husnin, 2020). At the same time, however, some of them note the lack of preparedness of school leavers in this area.

The presented outcomes from the measurement of the IT Fitness Test 2021 suggest to us that there is a need to emphasize the undergraduate preparation of future teachers. In this context, we agree with Stoffova and Horvath's (2019) assertion that it is essential to focus attention on the area of academic disciplines that, in the context of undergraduate education, prepare future teachers to be erudite in the application of digital didactic tools and software applications in the teaching of the subjects of their apprenticeship. Therefore, it remains for discussion and assessment by the relevant experts how to adapt the teaching of the relevant educational disciplines – in their content, time allocation and the way of inclusion in the curricular structure to the curricula of teacher education programmes at the tertiary level of education in the context of the current needs of pedagogical practice with regard to the formation of professional digital skills of teachers (Tóblová, 2021).

We are convinced that the European investments from the Slovak Recovery Plan, where considerable funds are earmarked not only for digitalization of teaching, but also for improvement of education itself in this area, will contribute to further raise the level of digital skills of Slovak pupils/students and teachers in the near future. We consider a modern and innovative approach to the way education and training is delivered in particular areas to be crucial in the process of a smooth digital transformation of education in Slovakia.

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TOWARD TAX CULTURE TRANSFORMATION AND VOLUNTARY COMPLIANCE BY TAXPAYER EDUCATION

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Abstract

Tax culture, education, and compliance are highly interlinked issues, to which many countries do not pay enough attention. Although taxpayer education can be a key tool to transform tax culture and increase voluntary compliance. All the tax system stakeholders such as taxpayers, officers, schools, business associations, and non-governmental organisations have to be constantly educated in order to increase the willingness to comply voluntarily. Based on that fact, it helps countries raise revenues and build trust in the tax system's fairness. Using content analysis of the Czech popular media and Google search, the paper examines the incidence and the context of tax education and financial literacy topics with regard to tax compliance. The findings are important for tax administrations, government departments, or other institutions such as schools, business associations, and non-governmental organizations that can participate in the tax culture transformation.

Keywords

E-tax-learning, tax citizenship, tax culture, tax literacy, tax morale, taxpayer education

Introduction

What would the world be like if citizens, based on their knowledge and understanding of the tax system, paid all taxes voluntarily? If they were aware of moral principles, public interests, and reasons for paying taxes. Various studies confirm a positive relationship between tax education and taxpayers' attitudes toward tax morale, honesty, and willingness (Yee, Moorthy and Choo, 2017; Nurkhin, 2018; Indriyarti and Christian, 2020; Triandani and Apollo, 2020). Mohamad et al (2013) mention that tax knowledge emphasizes the liability to meet taxpayers' obligations. Tax culture is not only about the attitude and behaviour of taxpayers, but also about tax-collectors and formal and informal institutions connected with the taxation system. E-learning integrated into e-government (Šperka, 2016; Sonntag, 2003) is only one of the many ways to raise awareness for the exercise of tax citizenship (Zichová, 2021).

Some researchers describe the process of using e-learning platforms to train local authorities' officials in order to successfully implement e-governance software (Panda and Swain, 2009; Pappel and Pappel, 2011; Veljković and Stoimenov, 2011). Šperka (2016) suggests e-learning support for the public e-administration. Furthermore, he emphasizes a solution for an education portal for serving public administration employees, students, and citizens and he points out the advantages of the portal. Additionally, ICT training programs significantly increase the learners' self-efficacy regarding the use of e-government applications and encourage more equitable usage of public services (Chohan and Hu, 2020). Governments and local authorities worldwide should make the effort to find effective ways to teach and communicate tax properly and to encourage tax compliance by providing modern and effective e-administration tools (OECD, 2021).

Since the Covid-19 pandemic has significantly increased demands on countries to provide public goods, the role of voluntary compliance and healthy taxpaying culture became crucial to tackling fraud, tax evasion, and tax avoidance. Governments should spread the information about the

relation between tax education and tax morality and explain the role of tax in society. The missing references in the media and on relevant sites of state institutions represent obstacles to the tax transformation process. Czech e-government websites make it easier for people to fulfil their obligations to the state, but they are not designed to educate citizens to increase tax incentives. The absence of educational potential can also be noticed in the media and on social networks of the Financial Administration, especially on the currently very controversial social network of the ex-Minister of Finance full of shallow self-centred photos and populist stories.

Following the important role of taxpayer education in the context of tax voluntary compliance, the aim of the paper is to empirically document the frequency and the context of tax education topics appearing in the media. The purpose of the analysis is to determine whether and how the topic of tax literacy is covered in the media or to highlight its lack of coverage. Specifically, the manuscript focuses on three research questions. RQ1: With what frequency of occurrence the topic of tax literacy appears in the Czech media and Google search in comparison with the topic of financial literacy? RQ2: What is the most common context of the financial education topic in the media? RQ3: What taxpayer education initiatives can be offered by financial administration? The results provide interesting findings for tax administrations, government divisions, and other state, public and business institutions that can participate in the tax culture transformation.

The paper is divided into four sections. The first Materials and Methods section describes the content analysis method and dataset used for obtaining answers to the research questions. The findings are then plotted and illustrated using two tables. The discussion integrates the results into a broader background and compares them with other relevant studies. This part also outlines possible solutions to the problem and points out the applicability and limitations of the research. Finally, the most significant outcomes and possible future directions are summarized in the conclusion.

Materials and Methods

A content analysis of the Czech media articles is performed to find out the frequency of occurrence of the topic of tax literacy and the context of tax education. The sources of data include different articles, published during the period 1st January 2012–31st December 2021, from ideologically different, nationally circulating media. As relevant online newspapers, magazines, print and internet sources of articles were firstly chosen: the 5 most frequently used Czech media brands in 2020 (Štětka, V. and Reuters Institute for the Study of Journalism, 2020): 1) Seznam zprávy (seznam.cz), 2) Aktualne.cz, 3) zpravy.iDNES.cz, 4) Mladá Fronta DNES, 5) Novinky.cz; 6) Ministry of Finance website (mfcr.cz); 7)–8) Internet Info magazines: 7) Lupa.cz, 8) Mesec.cz and 9)–10) websites for entrepreneurs and personal finance: 9) Podnikatel.cz and 10) Penize.cz. The media are chosen through the database Anopress according to the following attributes: most read, online searchable, written by a different type of author, entrepreneurs oriented, owned by various groups of investors. The different types of Czech media read by the general public were chosen because a healthy tax culture and tax education should be spread throughout society, not only among taxpayers. Widespread education of all citizens to build tax morale is essential for the government. The media can help understand why taxes exist and for what they are used.

However, after finding out the absolute absence of references to tax education / literacy and related topics in the ten selected media, the frequency analysis of the term tax literacy was applied to a wider range of information media. Concretely national dailies, TV and radio, regional dailies and magazines, other magazines and internet articles except for social networks and web monitoring. Due to the persistent non-inclusion of the term tax literacy, the search was extended to the Google search engine.

As the keywords related to the study are primarily chosen: "daňové vzdělání" (in English

"tax education"), "vzdělání daňového poplatníka" (in English "taxpayer education"), "daňová gramotnost" (in English "tax literacy"), "daňové kurzy" (in English "tax courses"), "finanční gramotnost" (in English "financial literacy"), "finanční vzdělání" (in English "financial education"), "dodržování daňových předpisů" (in English "tax compliance"), "daňová kultura" (in English "tax culture") etc.

The content analysis is performed using the WordStat 9 text mining software because it quickly extracts salient themes and trends. Furthermore, it allows the advanced quantitative content analysis approach that uses a taxonomy, lexicon, or dictionary approach to accurately measure certain topics. Both conceptual and relational analysis is used. The conceptual analysis is applied to determine the existence and frequency of selected concepts in the media articles. Additionally, the relational analysis examines the relationships among concepts. Titles and content of articles are studied to find variables and to determine the presence of certain words, themes, or concepts within qualitative data. Messages stated as words or phrases are converted to the code categories based on applied arguments. Each statement that describes financial literacy and education and associated topics is assumed as an argument. The repeated arguments within the same article are considered one occurrence. The most common contexts of financial literacy are selected based on the continuous analysis of content categories. These frameworks are then inductively developed and documented to reveal patterns in communication content and to identify the intentions, focus and communication trends.

In the last part of the results the taxpayer education initiatives, as proposed by the OECD (2021) in the report *Building Tax Culture, Compliance and Citizenship,* are summarized.

Results

An unexpected finding was discovered right at the beginning of the content analysis, when no mentions of tax education and tax literacy were found in the last decade in the ten most frequently used and read Czech media brands. While financial literacy was mentioned in 946 articles, none of them had a direct link to tax literacy. Table 1 describes the most common contexts of the financial education topic in the media. Incomparably more attention is paid to financial literacy as a superior term for tax literacy. The topic of tax morality is presented in a total of 18 articles. The results from STEM research from 2015, commissioned by the Financial Administration under the Ministry of Finance, are often cited. The research shows that 60% of Czechs consider tax morale in the Czech Republic to be bad. None of the articles relates the taxpayers' morals and education. Articles with a negative impact on the tax culture were also searched for comparison. The results brought sorrowful findings. A total of 3 764 articles on tax evasion issues were found and about 64 on tax avoidance, which is more difficult to find due to the various possibilities of translating this term into English.

Category	Examples
The Importance of Financial Literacy	„Don´t get caught by fraudulent funds, learn to understand finance."
Exaggerated Confidence in Financial Knowledge	„Czechs think they understand the investment. But they´re next door, the counsellor warns."
The Inflation Problem	„Don´t be afraid of inflation, calm down."
Problem of Executions	„The number of Czechs in execution is constantly growing."
Problem of Loans	„Don´t borrow if you don´t have the money."

Table 1: Content analyses of the financial literacy topic in Czech media, 1ˢᵗ January 2012–31st December 2021 (source: Author)

Expanding the sample of media sources did not yield more optimistic results in terms of the occurrence of the topic of tax education. In addition to a significant predominance of negative

connotations to taxes, there has been an increase in articles on tax morale to 190 articles. Unfortunately, the topic of tax literacy in connection with tax morale still does not appear either in a larger sample of media.

Finally, Google search results highlight the occurrence of the tax literacy in the topics of bachelor's, diploma, and dissertation theses. The Faculty of Business and Economics of Mendel University in Brno presented the research project Tax Literacy, the aim of which is to map, evaluate and present the level of tax literacy of secondary school students. The project is sponsored by the Ministry of Education, Youth and Sports, BDO is the main partner. The frequency of occurrence of the topic of tax literacy in the Czech media and Google search in comparison with the topic of financial literacy is almost zero. At least in the academic environment, the topic is beginning to be addressed, but it is still in its infancy.

Figure 1 shows the distribution of typology of taxpayer education initiatives proposed by the OECD survey (OECD, 2021). It responds to the research question about possible taxpayer education initiatives offered by the tax administration. The most commonly used types of initiatives are teaching young people (29%) to spread knowledge about taxes, information campaigns (18%) to communicate on tax, and offering direct assistance (11%) to simplify taxpayers' obligations.
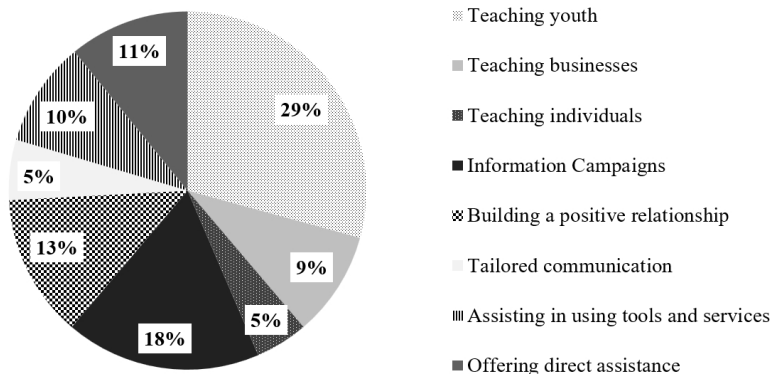

Figure 1: The eight sub-categories of taxpayer education initiatives (source: OECD Survey on Taxpayer Education Initiatives)

DISCUSSION

The conceptual analysis points to a considerable lack of knowledge about the positive impact of tax education on tax morale. The OECD study (2021) demonstrates that increasing tax literacy can play an active role in forming a country's taxpaying culture, in which citizens realize the effects of paying and not paying taxes. Over 80% of taxpayer initiatives reported improvements in the intrinsic motivation to pay taxes. While the development of a sustainable taxpaying culture is a long-term process, greater attention to tax morale may provide a way to increase voluntary compliance.

Two related problematic areas were selected for discussion in order to outline a possible solution. Firstly, it is essential to find ways by whom and how to spread information about tax education and tax morality in the media. The next section is devoted to a proposal on how the state could support the citizens' tax literacy for a tax system that is fair and equitable for all citizens. The classification of the education initiatives is based on the OECD survey.

Various institutions are responsible for disseminating significant scientific studies and reports. In the area of taxpayer education, primarily state institutions, such as the Ministry of Finance

and Financial Administration, should deal with this issue. The responsibility also falls on local authorities, other ministries, NGOs, schools, academic institutions, and other educational institutions and relevant associations, companies, organizations, and institutes. When designing powerful channels for informing citizens (television, newspaper, web, social network etc.), education level, habits and other characteristics of the target group should be considered (Grabe, Kamhawi and Yegiyan, 2009).

Financial administrations could offer free educational programmes and support either in the online interface of e-government or even offline in person. There are countless ways to educate in the field of taxation (Mehrotra, 2005; Zichová, 2021). According to the OECD (2021) report *Building Tax Culture, Compliance and Citizenship*, which analysed a dataset of 140 taxpayer education initiatives deployed in 59 developed and developing countries around the world, taxpayer education can take different forms. The report identifies three main methods: 1) Teaching tax, through in-depth, long-term engagement with young people, adults or entrepreneurs., 2) Communicating tax, through higher-level awareness-raising engagement (social media campaigns, tax fairs, TV shows, scientific approaches drawing on behavioural economics to personalize communications to encourage positive reactions)., 3) Encouraging tax compliance by providing practical and direct support to facilitate the use of modern e-administration tools. Supporting taxpayers, especially vulnerable taxpayers, in their tax commitments, including reporting requirements.

A content analysis method may bring some theoretical and methodological challenges. Because of the author's partially subjective perception of the context, coding errors can never be eliminated but only minimized, especially when coding the implicit terms. A high level of abstraction and interpretation difficulty (of words, phrases, contexts, and other linguistic elements) are considered other trustworthiness limitations. A process should be inherently reductive, particularly when dealing with complex texts. Coding issues in content analysis make it problematic to generalize across content analyses, because researchers may interpret the variables and messages differently. The researcher has to find a representative sample and remain attentive to the research question or hypotheses to avoid coding too narrowly or too generally (Maier and Allen, 2017).

CONCLUSION

The study highlights insufficient awareness of the taxpayer education importance in the context of voluntary compliance. Content analysis of articles from popular and business-oriented media over the past decade has revealed insufficient emphasis and exclusion of tax literacy from the concept of financial literacy and almost no discussion about a positive relationship between tax education and tax morality. The results are very surprising and unexpected, especially in comparison to the results of tax evasion terms. There is no doubt that the tax literacy and tax education topis is so far an almost completely undiscussed topic in the Czech media. Hopefully, the paper will help to encourage further research, debates, and initiatives to offer citizens educational opportunities in tax matters. Citizens should be aware of the positive aspects of tax self-education so that they can take an active part in it as lifelong voluntary education. Furthermore, governments have to increase tax literacy to strengthen tax morale and the tax compliance of taxpayers.

The content analysis offers a thorough range of research that can support initiatives to inform about significant contexts in various areas of education. Supplementary aspects could be considered in other research, such as: categorization based on media weighting, page number, use of multimedia visuals, graphic elements and formatting, information in the first paragraph, author credibility, and social media. A meta-analysis of Web of Science or Scopus scientific studies could bring new meaningful findings because the popular media often tend to take over the official press releases.

Following this study, it would be encouraging to compare the results according to a different group of readers and types of media. A comparative content analysis of the international awareness of the topic can be performed to enhance monitoring of different conceptualizations of taxpayer education and to increase awareness of its importance for tax culture transformation and voluntary compliance.

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