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In this last editorial of ERIES Journal in 2020, I would like to touch two important remarks. First, the whole year has been affected by the global pandemic situation of the COVID-19. This situation resulted in a huge and rapid switch from face-to-face learning to distance learning. In some cases, the educational institutions, professors, teachers, as well as students, had to break their routines in order to comply with such new conditions. Those, who were familiar with distance learning and/or were using any type of information technologies in their classes, were able to adapt faster with less complications. Nevertheless, it does not matter whether the process of adoption took faster or longer, teachers in all countries had a clear objective to guarantee education and learning of the highest quality. After the first several weeks, everybody with that objective went successfully through all the obstacles.

However, what is next? What should we focus on now as our objectives for the next year to at least maintain the quality? After the whole year of disruptive changes in our routines, we see the benefits of all the changes we have made in our teaching and learning processes. We can communicate with our students in distance using different technologies; we can incorporate in a greater extend information technologies in the learning process; we were forced to modify structures and contents of our courses; we were pushed to think differently. This all has created a demand for new competences, such as leadership, communications, supervising, among others. Experts from diverse areas in business stress that in 2021 the most demanded competencies will be related to digital area, big data, coaching, as well as to creating favorable environments that support team working. This is without any doubt true for education. We should adapt the content of our courses to train such competencies so students will be capable of utilizing them in their professional lives. For me personally, I would stress the necessity to promote creativity and innovation in the learning process. Students must be able to use all the tools and their knowledge to generate unique solutions for presented problems. To do so, everybody must step out from their comfort zones, which would create the field of creative thinking generating new ideas and solutions.

The second remark I would like to touch is linked to the important achievement of ERIES Journal. At the beginning of the year, the journal was, for the first time, included in the SCImago Journal Rank (SJR) indicator. We were more than pleased that ERIES Journal is ranked in Q3 in the Education category. This affirmed that all our previous steps we had taken to improve the journal quality were managed correctly and that the journal has taken the right direction to become one of the most important scientific journals in the education area within Central Europe. Achieved success is not a sign to relieve. Contrary, it is a sign to keep searching areas of opportunities to position ERIES Journal higher in the global rankings. That is why, we have extended our base of reviewers for more experts from different countries around the world; we began using advanced editorial analytical tools to better position the journal; we have increased our visibility in social networks; we have enlarged the editorial board team; among others. We are sure that this effort will be reflected in the upcoming years and ERIES Journal will reach higher recognition within the scientific community.

The last volume of the year 2020 (vol. 13, no. 4) includes four articles whose central topic is motivation to change our teaching environment to ensure better learning outcomes:

The first article "A Study on the Relationship Between Burnout and Job Satisfaction of Iranian EFL Teachers Working in Universities and Schools" form Ibrahim Safari, study the degree of burnout and job satisfaction in English as a foreign language (EFL) teachers of universities and Schools in Iran. For this purpose, the author applied the Maslach Burnout Inventory questionnaire to a sample of 159 teachers who work at universities and schools in Iran. The results indicate a negative correlation between teachers' burnout and their job satisfaction. In this case, the perceived burnout decreases by increasing the level of job satisfaction. To do so, it is important to focus the attention on the workplace conditions that directly influence teachers' satisfaction. The author recommends providing EFL teachers with a teaching feedback, which would reduce their job stress leading to lower degree of burnout.

The second article "Impact of Using Personalized E-Course in Computer Science Education" from Marián Mudrák, Milan Turčáni and Jaroslav Reichel analyzes the possibilities of using adaptive tools that are offered by learning management system (LMS) Moodle when creating a personalized e-course. For this purpose, the authors present a methodology for adjusting e-course's content based on each student's characteristics stated by his or her initial knowledge, learning style, and motivation. Statistical analysis revealed that the use of personalized e-course has a positive impact on students' activity, motivation, and their level of output knowledge. The results also showed that students in all surveys have a stronger tendency to prefer the same learning styles over the years.

The third article "School Staff-centered School Development by Communicative Action: Working Methods for Creating Collective Responsibility - From the Idea to Action" from Stefanie Hillen describes

EDITORIAL

CONTENT

how teachers together with paraprofessionals can contribute to school-development. The school staff–driven development approach makes use of the Dialogue Café and the reflection cycle. The combination of these working methods is seen as appropriate support for school staff–centered development of the School-In project based on the idea of collective responsibility. The analysis showed that school staff was able not only to work collaborate collegially but also to enact measures based on their initiative and engagement to participate in school development.

The fourth article "Mathematical Calculations within Physics Lessons and Their Popularity Among Learners" from Petr Emanovský and Dalibor Gonda analyses learners´ attitudes towards using mathematical calculations within physics lessons. The authors used a sample of 230 primary and secondary school pupils to determine their attitudes towards the mathematical calculations. Moreover, the authors investigated the influence of pupils' grade and gender on the attitudes. The analysis shows slightly negative learners' attitude to the mathematical calculations, which does not help them to understand incomprehensible physics. In this case, the use of real-life word problems in mathematics lessons can lead to an increase of student's success in solving physics problems.

We hope that all our readers will find this last issue of the year 2020 interesting. We also hope that ERIES Journal will contribute to the field of efficiency and responsibility in education as it has contributed so far. With the end of the year 2020, we would like to thank all the authors who have submitted their manuscripts to ERIES Journal, to all reviewers who carefully reviewed all these manuscripts, as well as to all members of the Editorial board who contributed to increase the ERIES Journal quality.

We wish you Merry Christmas and all the best in 2021.

Sincerely

Martin Flégl
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A STUDY ON THE RELATIONSHIP BETWEEN BURNOUT AND JOB SATISFACTION OF IRANIAN EFL TEACHERS WORKING IN UNIVERSITIES AND SCHOOLS

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ABSTRACT

A teacher plays an important role in the development of the students' potential and helps to form their future. This research intends to study the degree of burnout and job satisfaction in English as a foreign language (EFL) teachers of universities and Schools in Iran, as well as their association with demographic characteristics. To measure teachers' burnout, Maslach Burnout Inventory questionnaire was applied, which has also been validated by experienced teachers for the Iranian population and the Employee Satisfaction Inventory questionnaire, prepared for the Iranian population, was applied to estimate job satisfaction. Questionnaires were answered completely by 159 teachers, who work at universities and schools in Iran. After data analysis, the findings showed a negative correlation between teachers' burnout and their job satisfaction; their experience relatively moderate burnout levels, and their job satisfaction level is high. The findings also represented that the type of workplace influences satisfaction regarding the factor "job conditions". The study was for the first time that Iranian EFL teachers' burnout and job satisfaction in universities and schools were investigated and the findings showed that by increasing the level of job satisfaction, the perceived burnout decreases, where burnout and job satisfaction presented medium to high negative correlation.

Highlights

- *University teachers have a higher level of job satisfaction and lower burnout in comparison with those who work in schools.*
- *Sub-scales related to the EFL teachers' job satisfaction have a negative association with their burnout sub-scales.*
- *By increasing teachers' job satisfaction, their perceived burnout decreases.*

INTRODUCTION

Teachers communicate with large numbers of students, parents, and principals whom each have different demands and problems. This important responsibility as a teacher needs to better understand social norms and values. By a better understanding of the norms and values, teachers can become role models and community will identify with them. According to Maslach, Jackson, and Leiter (1996), the stress experienced by teachers whose job is in direct contact with other people as their recipients of service, is called burnout. Syndromes of burnout emerge in the form of frustration, loss of the job, doubtful attitude towards students, dissatisfaction with self-esteem, and high frequency of changing the job for various reasons.

In Iran, many EFL teachers are highly motivated to teach when they begin to teach. These teachers think of the ways to be more creative and innovative in order to help their students in learning English as a foreign language effectively. They like to interchange different ideas with other colleagues and learn new things. Therefore, these teachers may lose the excitement and pleasure of teaching in time, or they may begin seeing their workplace as a stressful environment. Öztürk (2013) stated that the things according to students, colleagues, administration, and coursebooks do not make them happy anymore or these things may even give rise to a negative and stressful psychological condition.

Job burnout can affect the quality of work-life at school. According to the Sitohang (2004), school administrators should be cautious about teachers' situation because they are not only concerned with burnout and teacher job satisfaction but also how to improve the quality of work-life at school. Other consequences of burnout caused by a reduction in job satisfaction. This means that a person's psychological syndrome such as burnout can have a negative impact that it decreases that person's level of job satisfaction therefore increased their degree of absence and increased their carelessness in the job. As stated by Maslach and Jackson (1981: 99), burnout is 'a syndrome of emotional exhaustion and cynicism that occurs frequently among individuals who do 'people-work' of some kind'. Later, Maslach (1982: 3) described burnout as 'a syndrome of emotional exhaustion, depersonalization, and reduced personal accomplishment'. Emotional exhaustion happens when people feel that they have been overextended by contact with other people. Depersonalization related to considering other people as ordinary things or dehumanizing them. Reduced personal accomplishment points out the decrease of self-efficacy on the job or a decline in professional competence (Bibou-Nakou, Stogiannidou, and Kiosseoglou, 1999; Soroor, Afsaneh, and Zargham, 2015).

Another factor related to the EFL teachers, which is extensively discussed in the literature and is expected to affect their career success, is *job satisfaction*. There is a wide range of research in organizational psychology that considers the strong relationship between job satisfaction of the teachers and the quality of their teaching (Landsman, 2001; Rahman, et al., 2014; Seashore and Taber, 1975). Having a job as one of the determinants of social health is an important part of people's life. As a consequence, job-related conditions and job satisfaction have become one of the essential factors for promoting health and life satisfaction. It concerns the extent to which the job is responsive to the teacher's abilities, needs and personality traits.

According to some researches, job satisfaction has been one of the important subjects in recent years which is a positive emotional condition that arises from the valuation the people's job characteristic and position (Aziri, 2011; Terason, 2018; Vousiopoulos, et al., 2019; Wu, et al., 2016). As stated by Blandford (2000), it can be argued that paying attention to the importance of the concept of job burnout and awareness of factors affecting burnout is significantly increased. Helping people, achieving positive changes and improving students are the main consequences of teachers' job satisfaction and their participation at work.

In the last decades, numerous studies have been done in the fileds of job satisfaction and job burnout. According to Barrick (1989: 35), 'the linkage between stress, job satisfaction, and the work environment is critical to the study of burnout'. As stated by Brewer and McMahan-Landers (2003: 37), 'Misfit between demands and abilities induces coping and defense mechanisms, which in turn influence objective and subjective environments'. Further, Brewer and McMahan-Landers (2003: 126) argued, 'Stress can occur if there is a mismatch between the reality of the work environment (objective) and an individual's perceptions of the work environment (subjective).'. Some of the researchers (Farber, 1998; LeCompte and Dworkin, 1991; Troman and Woods, 2001; Vousiopoulos, et al., 2019) pointed out that those teachers who are stressed for a long time may experience more burnout.

Keeping the two mentioned variables into consideration, changes in the possible associations between these variables are quite likely to affect the outcome of an educational program and therefore need to be widely investigated. In other words, because effective teachers are essential to the achievement of educational goals and objectives, it can be quite clear to examine the factors affecting the burnout and job satisfaction of EFL teachers in particular.

LITERATUE REVIEW

This section is purporting to present an overview of the theoretical underpinnings of the study as well as the empirical research conducted about the main variables under investigation, namely EFL teachers' burnout and job satisfaction.

Teacher burnout

Burnout is a psychological stress syndrome when a person in condition with high emotional engagement request for continuous and long extent of time. Teachers' burnout happens when there is inequality between excessive demands and resources available. Teachers who have job burnout, can not succeed and always tackle the failures of the past. According to Johnson et al. (2005), burnout is defined as permanent and deep exhaustion with cognitive, emotional, physical, and social symptoms, arising from long term job stress, especially in professions with high responsibility for others and never-ending human interactions.

According to Azeem (2010), burnout is an important element that negatively influences teachers' job involvement and effectiveness. In this vein, Cephe (2010) pointed out that teaching is a job which is performed in front of individuals and that it's effect may be frustrating not only for teachers but also for students and education systems. Later, Farshi and Omranzadeh (2014) stated, it is necessary to understand the affecting factors on teachers' burnout, measuring the degree of their burnout and preventing them from being burned out. Further, Demirel and Cephe (2015) argued that teachers' burnout is a threat for both sides of the learning and teaching process and that teachers should be free from burnout syndrome to teach effectively. Because burnout can happen in most of the jobs, it seems to be generally known among specialists who enable individuals to deal with their everyday problems (Gavish and Friedman 2010; McCormick, 2011; Rakovec-Felser, 2011; Vousiopoulos, et al., 2019). Thus, jobs like teachersshould have specific capabilities and job skills to control the stressors. Otherwise, they have to wait for results such as depersonalization and emotional exhaustion.

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According to the job demands, teaching became a target audience for burnout symptoms (Jarvis, 2002; Maslach, 1982; Weisberg and Sagie, 1999; Vousiopoulos, et al., 2019). Emotional exhaustion, one of the more extreme varieties of job stress, exhibits itself in teachers as a general loss of feeling, concern, and interest (Van Jaarsveld, 2004) generally bring about absence from the classroom and chronic health problems (Lee, 1990). In this vein, Balkin, White, and Bodey (2003) pointed out that burnout results in a lower quality of teaching, isolation from the society, and early departure from the job. It was argued that burnout predicts subsequent thoughts about leaving the job. As stated by Straquadine (1990), teachers generally find themselves working well beyond a week as they supervise student projects, evaluate their job and prepare lessons. It is argued that the long time working, also the stress of teaching could ultimately result in disabling health problems. Later, Croom (2003: 11) pointed out that 'agriculture teachers appear to be energetic and engaged professionals who were accomplishing something worthwhile for the benefit of students'.

Burnout and job satisfaction have been the issue of intense studies' interest during the last decades. In a study, Sotirios et al. (2019) investigated the teachers' burnout and job satisfaction in the Minority and Public Sector Schools. The findings showed a negative correlation between burnout and job satisfaction; teachers experienced moderate burnout levels, their job satisfaction level was high. The findings also represented that when job satisfaction increases, the perceived burnout decreases, where job satisfaction and burnout presented medium to high negative correlation. In another similar study, Karavasilis (2019) revealed a negative statistical relationship between these variables in which there was a very low degree of burnout syndrome and a high degree of job satisfaction for Greek teachers. In the same vein, Kroupis, Kouli, and Kourtessis (2019) intended to estimate the levels of burnout and job satisfaction among Greek Physical Education teachers. Their findings showed that Greek teachers were more satisfied by the job itself and supervision and dissatisfied by promotion and even more by pay while experiencing medium to low burnout.

Teachers have an important role in developing their students' potential and success. As stated by Roy and Kumar (2018) in their study, job satisfaction is an essential necessity for teachers' commitment towards their responsibilities. Moreover, teachers' burnout is the result of different responsibilities which is given to them. Later, Kara (2020) investigated the burnout and job satisfaction of 308 Turkish teachers in terms of some variables such as age, gender, marital status, experience and workplace. The results showed that teachers' burnout and job satisfaction represented significant differences according to gender, marital status, experience and workplace. Additionally, there was a significant negative relationship between their burnout and job satisfaction.

Although various researches have been done to study teachers' burnout regarding factors like age (Kırılmaz, Çelen and Sarp, 2003; Güven, 2010; Özkanal and Arıkan, 2010), gender (Hastings and Bham, 2003; Güven, 2010), educational background (Kurtoğlu, 2011; Öztürk, 2013), teaching experience (Öztürk, 2013; Ceylan and Mohammadzadeh, 2016), institution (Koruklu et al., 2012), weekly course load (Kurtoğlu, 2011; Öztürk, 2013), administrative duty (Azeem and Nazir, 2008; Konakay and Altaş, 2011), monthly income (Lackritz, 2004; Bilge, 2006; Ceylan and Mohammadzadeh, 2016), few numbers of researches have been conducted to study EFL teachers' burnout regarding the variables in the EFL teaching context.

Teacher Job Satisfaction

Job satisfaction was defined in different ways according to the social contexts, agrees to the fact that it is a multidimensional concept. As stated by Locke (1976), job satisfaction is an emotional situation as a consequence of people's job experience. Moreover, Spector (1985) indicated job satisfaction as an emotional and perceptual response to the specific characteristic of a job. Further, Wagner and Hollenbeck (1992) argued that job satisfaction is a pleasant feeling that comes from the insight that people's job satisfies or allows for the satisfaction of one's outstanding values came from their work. Later, Tukiran (2014) pointed out, satisfaction and commitment are necessary factors in order to improve the teaching and learning process.

Castillo and Cano (2004) categorized job satisfaction into two types: general satisfaction and specific satisfaction. General satisfaction is the overall and comprehensive satisfaction that is defined as an overall assessment of a people's perception of their work. Specific satisfaction has been defined as an assessment of different aspects of the work. Some of the examples related to these aspects consist of monetary benefits, working conditions, and relationships with colleagues and superiors, and the nature of the work itself (Petty, Brewer, and Brown, 2005; Vousiopoulos, et al., 2019).

According to some of the previously conducted researches (Maslach, Schaufeli and Leiter, 2001; Schaufeli and Enzmann, 1998; Schmidt, Neubach and Heuer, 2007; Taris, 2006; Vousiopoulos, et al., 2019), people who experience burnout often report reduced job satisfaction, cognitive performance impairment, especially fatigue, and physical complaints. Correspondingly, teachers with a high degree of burnout feel dissatisfied at work and experience various physical complaints that ultimately affect their teaching. Additionally, the results were supported by Taris, (2006) which suggested that the higher intrinsic factor of job satisfaction leads to the lower burnout. Accordingly, extrinsic factors of job satisfaction, number of people to teach (overcrowded class), excessive workload, work routines, and the administrative job that goes beyond people ability and capacity.

In the field of teaching, Konert (1997) indicated that teachers who experience job stress also suffers from low personal accomplishment and emotional exhaustion. In another similar study, Tan (2006) represented that job satisfaction has a negative relationship with emotional exhaustion but a positive relationship with the length of time a person is having a career. At the same time, Lim (2005) pointed out that the degree of teachers' stress in Malaysia was low and there was a significant inverse correlation between job satisfaction and burnout. Three years later, Anbar and Eker (2008) conducted a study to find the association between job satisfaction and burnout of academics in Turkey. Their findings were in line with the results of Lim's study, in which they found a negative association between job satisfaction and burnout.

Lately, Yu-Hsia and Mei-Hsiang (2019) investigated the relationship between job satisfaction and burnout. The findings indicated that both of the 'personal burnout' and 'external satisfaction' had the highest mean sub-scale score; there was a statistically significant relationship between job satisfaction and burnout; 'personal burnout', 'work-related burnout', and the 'over commitment to work' were related to the 'inner satisfaction' and the 'external satisfaction'. These results provided guidance and evidence for the requirement to increase job satisfaction in order to decrease burnout. In the same year, Wisnu (2019) intended to study the statistical relationship between job satisfaction and burnout. This study found two results: First, emotional exhaustion as one of the sub-scales of burnout had a significant negative effect on job satisfaction. Second, job satisfaction had a significant positive effect on performance.

In another related study, Atmaca (2017) explored the possible causes of burnout in different schools of Turkey. The results demonstrated that there was a low negative relationship between job satisfaction and burnout. The results also showed a relatively strong positive relationship between emotional exhaustion and depersonalization in addition to the strong positive correlation between the intrinsic and extrinsic job satisfaction levels. Accordingly, some main factors such as self-efficacy, shareholders, physical and social environment of the school were found to have a necessary role in EFL teachers' burnout. Similar to the results obtained by previous studies, Robinson et al. (2019) showed that there was a statistically significant relationship between job satisfaction and burnout among special education teachers.

In addition to the studies mentioned above, Torkaman et al. (2017) investigated the statistical relationship between job satisfaction, burnout and job stress among teachers in exceptional schools of Qazvin Province in northwestern Iran. According to the results, there was a direct and significant relationship between job satisfaction and burnout in which Job satisfaction and burnout negatively correlated with the dimensions of stress. It was also revealed that failure to satisfy these teachers' motivational needs over time causes their dissatisfaction with the working process, which result in job burnout and stress. Consequently, interventions to decrease stressors and strengthen the resources to manage teachers' burnout would be an important factor of their job satisfaction.

In one of the related studies, Azlina and Noryati (2012) represented the low level of job satisfaction and job stress at a moderate level. Their findings were consistent with the researches conducted by Norul Azlin (2005) who investigated the degree of stress up to one-hundred and twenty teachers who teach in exam classes in ten primary schools which showed that the overall degree of stress at a low level. As result, the review of the literature indicated that there was a negative association between job satisfaction and burnout among teachers.

Moreover, Higgins (1987) stated that if teachers feel important, and valuable, they will experience job satisfaction as a teacher because they are successful in their job and the consequences are excellent. Higgins also pointed out, achieving job satisfaction puts a person into a balanced state or a state of actual ideal self-gap absence. All in all, job satisfaction is people's like or dislike towards their job and the degree to which their expectations regarding job have been realized.

Problem of the Study

Human resources of each organization as the most important factor in achieving their goals play an important role and is considered the driving force of the organization. Job burnout is defined as emotional exhaustion, depersonalization and reduced personal accomplishment in which teachers are more susceptible to burnout because of their job nature. Since job satisfaction is an important variable and can affect rate and time of burnout, the relationship between job satisfaction and job burnout is studied.

Objective of the Study

The objective of this research was to investigate the nature of job satisfaction and burnout among Iranian EFL teachers of the universities and schools in Tehran and Ardabil provinces. The main objectives of the empirical section of the present study were:

1. To find out the degree of job satisfaction among Iranian EFL teachers of universities and schools.
2. To explore the degree of burnout among Iranian EFL teachers of universities and schools.
3. To examine the association between teachers' job satisfaction and burnout.

MATERIAL AND METHODS

Context and Participants

The participants for this study consisted of 159 Iranian EFL teachers (96 males and 63 females) serving at universities and schools in Tehran and Ardabil provinces. It is necessary to mention that from these participants, sixty-eight teachers worked in universities, while ninety-one teachers worked at schools. These teachers filled out the questionnaires and sent them back in two months, which formed the main data for the study. These participants consisted of both novice and experienced teachers with their active working years ranging from 5 to 35. They ranged in age from 25 to 65 with most teachers aging between 30 and 40. Upon distributing the questionnaires, all EFL teachers were introduced to the objectives and importance of completing the questionnaires. The confidentiality of the results of the research was also announced to these teachers in order to participate more confidently.

Instrumentation

To collect the data, two questionnaires were used, namely, (1) Employee Satisfaction Inventory (ESI) and, (2) Maslach Burnout Inventory- Educators' Survey (MBI-ES).

Employee Satisfaction Inventory (ESI)

To measure Iranian EFL teachers' job satisfaction levels, Employee Satisfaction Inventory by Koustelios and Bagiatis (2016) was applied. This questionnaire consisits of 24 items, which is used to measure six dimensions of a job: the job itself (four items), pay (four items), promotion (three items), supervision (four items), working conditions (five items) and organization as a whole (four items). The reliability (Cronbach's alpha) for each aspect were: for job itself (0.79), for pay (0.82), for promotion (0.64), for supervision (0.85), for working conditions (0.86) and for organization as a whole (0.79). Responses were given to a five-point scale ranging from strongly agree (Maslach and Jackson, 1981) to strongly disagree (Aziri, 2011).

Maslach Burnout Inventory- Educators' Survey (MBI-ES)

To measure Iranian EFL teachers' burnout levels, Maslach Burnout Inventory- Educators' Survey (MBI-ES) by Kokkinos (2006) was employed. This 22-item measurement scale consists of three sub-scales, namely *Emotional Exhaustion (EE), Depersonalization (DP) and Personal Accomplishment (PA)*. The frequency scale ranged from zero (never) to six (every day). High scores on emotional exhaustion and depersonalization and low scores on personal accomplishment are indicators of burnout. The scoring is as follows: emotional exhaustion: Nine items 1, 2, 3, 6, 8, 13, 14, 16, 20, which identifies feelings of being emotionally overextended and exhausted by job, depersonalization: Five items 5, 10, 11, 15, 22, which explains a doubtful attitude and impersonal response between oneself and service recipients, and personal accomplishment: Eight items: 4, 7, 9, 12, 17, 18, 19, 21, which illustrates feelings of efficacy and achievement in employee's work with individuals. The reliability number of the scale was 0.88.

Data Collection Procedure

When the questionnaires were piloted with a group of 26 teachers, minor modifications were made in the wordings of some items in order to improve their intelligibility. In addition, the scores obtained from these participants were given into Statistical Package for the Social Sciences (SPSS) and Cronbach's alpha was estimated for the scales (see instruments section above for details) to make sure the scales were sufficiently reliable. It should be noted that a group of colleagues in Tehran and Ardabil provinces of Iran were contacted and asked to distribute the questionnaires among their own colleagues and ask for their cooperation. As mentioned before, the questionnaires were delivered to 72 teachers in person and 87 copies were sent via email or social networks (mainly Telegram and WhatsApp). In total, one-hundred and fifty-nine teachers answered the questionnaires and returned them back. These questionnaires were scored and the obtained data were fed into SPSS. It is worth mentioning that the negatively worded items were reverse-coded and the necessary preliminary computations were run to prepare the data for the SPSS.

Data Analysis Procedure

All data were analyzed employing the Statistical Package for Social Sciences (SPSS version 24). In the present study, descriptive statistics were used to indicate demographic characteristics, dependent and independent variables. This study had six independent variables: teacher specialty, type of school, locale, sex, marital status and seniority. Moreover, nine factors were employed: six from the ESI and three from the MBI questionnaire. To estimate the reliability of sub-scales, Cronbach's alpha was applied. In addition, Pearson product moment correlations were employed to represent the direction and strength of the relationships between the main variables of the study. An alpha level of .05 was set a priori. MANOVA's and ANOVA's were used to investigate possible differences between the sub-scales of independent variables. It is worth mentioning that ANOVA is used to find the statistical significance of bilateral relationships among different variables. As the purpose of the present research was rather straightforward, it was not considered relevant or necessary to employ advanced data analysis methods and procedures like structural equation modelling.

RESULTS

As mentioned above, a number of statistical procedures were implemented to answer the research questions. Two questionnaires were used to examine the relationships between EFL teachers' job satisfaction and burnout level. To evaluate the statistical significance of Pearson's correlation coefficient, it was necessary to have bivariate normality, but this assumption was difficult to estimate. Thus, a property of bivariate normality was depended on; in particular, if bivariate normality existed, both variables were normally distributed. Hence, the normality test for both variables was needed. To evaluate the normality of data in the present study, Shapiro-Wilk test was applied. Based on the results of the normality test in table 1, it can be claimed that teachers' job satisfaction and burnout scores were normally distributed ($p > .05$).

Shapiro-Wilk	Statistics	*Df*	*p*-value
Job Satisfaction	0.957	158	0.457
Burnout	0.979	158	0.513

Table 1: Test of normality, 2019-2020

According to table 2, the Pearson correlation matrix, mean values, Standard Deviation and Cronbach's alpha rates of EFL teachers' burnout and job satisfaction are presented. The findings of the study represent that the burnout and job satisfaction were correlated, since all the sub-scales of job satisfaction were negatively correlated with the main aspect of burnout, being emotional exhaustion. This means that when teachers' emotional exhaustion increases, their perceived job satisfaction decreases and vice versa.

Sub-scales	1	2	3	4	5	6	7	8	9
1. Working conditions 1	1								
2.Pay	0.055	1							
3.Promotion	0.042	0.210**	1						
4.Work itself	0.265**	-0.052	0.037	1					
5. Supervision	0.272**	0.098	0.093	0.428**	1				
6.Organization as a whole	0.359**	0.070	0.092	0.294**	0.549**	1			
7.Emotional exhaustion	-0.170**	-0.097	-0.107*	-0.369**	-0.208**	-0.157**	1		
8. Personal accomplishment	-0.032	0.111*	0.089	-0.362**	-0.134**	-0.149**	0.456**	1	
9.Depersonalization	0.152**	-0.293**	0.007	0.419**	0.103*	0.033	-0.167**	-0.391**	1

**p < 0.01; *p < 0.05

Table 2: Correlation matrix for MBI and ESI sub-scales, 2019-2020

Table 3 represents the means, the Standard Deviation, as well as the *p*-value of the Employee Satisfaction Inventory and Maslach Burnout Inventory sub-scales for the universities and schools.

		Schools (*n* = 68)		Universities (*n* = 91)		Sig.
		M	SD	M	SD	p
Job Satisfaction Factors	Working conditions	3.45*	0.772	3.72*	0.670	0.011
	Pay	2.08	0.850	2.21	0.900	0.111
	Promotion	2.49	0.836	2.58	0.619	0.181
	Work itself	4.24	0.537	4.26	0.589	0.624
	Supervision	3.93	0.923	4.09	0.757	0.050
	Organization as a whole	3.25	0.814	3.38	0.858	0.103
Burnout Factors	Emotional exhaustion	20.20	10.745	20.95	10.605	0.465
	Personal accomplishment	39.60	6.621	40.14	6.170	0.379
	Depersonalization	3.22	4.110	3.14	3.715	0.838

* = statistically different, p < 0.05

Table 3: Means, standard deviation, and p. level of the ESI sub-scales for school type, 2019-2020

Considering job satisfaction, the findings revealed that there were statistically significant differences for workplace, $F (6.321) = 3.18$, $p < 0.01$. In the separate analysis of variance (ANOVA's) that followed, there were found statistically significant differences for the 'working conditions' $F (1.326) = 15.39$, $p < 0.01$. It is necessary to mention that no significant differences were found for the variables 'pay', 'promotion', 'work itself,' 'supervision' and 'organization as a whole.' On the other hand, the factor 'workplace' seems to be associated with the working conditions, as teachers working in schools seemed to be less satisfied than teachers working in universities. According to the burnout, there was no statistically significant difference for the workplace. Therefore, it can be assumed that the workplace type did not influence the sub-scales of burnout, as there was not found any statistically significant difference in this item.

DISCUSSION

The objective of this research was to examine the relationship between job satisfaction and burnout and to evaluate differences in job satisfaction and burnout between EFL teachers working in universities and schools in Iran. As reported by the results, university teachers had higher job satisfaction and lower burnout levels than those who work in schools. This difference could be due to the diversity in demographic characteristics, the nature of the job, and the workplace. The findings also represented that job satisfaction aspects of EFL teachers had a negative relationship with their burnout aspects. These results also revealed that by increasing teachers' job satisfaction increases, their perceived burnout decreases. Accordingly, experienced teachers were more satisfied with their jobs than novice teachers. In other words, teachers' job satisfaction increased with increasing their experience.

The results obtained were in agreement with findings from other studies, where job satisfaction and burnout had a high negative relationship (Atmaca, 2017; Charalambous, 2012; Daniilidou, 2013; Kara, 2020; Karavasilis, 2019; Papastylianou, Kaila, and Polychronopoulos, 2009; Robinson et al., 2019; Sotirios et al., 2019; Torkaman et al., 2017; Vousiopoulos, et al., 2019; Wisnu, 2019; Yu-Hsia and Mei-Hsiang, 2019). According to Papastylianou, Kaila, and Polychronopoulos (2009), factors which could possibly influence teachers' job satisfaction, are the existence of strong and consistent social relationships. Moreover, the aspects of teaching as a permanent job and the lack of any formal evaluation also play a pivotal role in the low degrees of burnout (Platsidou and Agaliotis, 2008). In addition, Kara (2020) argued that teachers' burnout and job satisfaction represented significant differences according to gender, marital status, experience and workplace.

According to this study, the five aspects of job satisfaction were negatively related to burnout, except for the aspect of

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pay. In the case of payment, teachers' dissatisfaction with salary resulted in increasing their burnout level. The results of the present study are in line with the results of Kroupis, Kouli, and Kourtessis (2019). Kroupis, Kouli, and Kourtessis pointed out that Greek teachers were more dissatisfied by payment while experiencing medium to low burnout. The problems of living and inequality between salaries and inflation seem to influence the level of burnout in EFL teachers. The findings also represented that by increasing teachers' emotional exhaustion, their job satisfaction decrease. These findings are in line with the results obtained by some of the previously conducted studies (Atmaca, 2017; Bhana and Haffejee, 1996; Kara, 2020; Koeske, et al., 1994; Vousiopoulos, et al., 2019), where job satisfaction and burnout represented medium to a high negative relationship. According to the results of the study, teachers reported high degrees of dissatisfaction regarding promotion, which was in parallel with the study of Tye and O'Brien (2016). On the other hand, some of the researchers (Kroupis, Kouli, and Kourtessis, 2019; Grundy and Blandford, 1999; Vedder and Hall, 2000; Vousiopoulos, et al., 2019) in their studies indicated that Pay, as well as promotion have a positive influence on the levels of burnout and, therefore, the state should improve job satisfaction. In addition, the aspects of burnout related to the *supervision* and the *work itself* are negatively associated with the main aspects of burnout, which are *depersonalization* and *emotional exhaustion*. On the other hand, these aspects are positively related to one of the main aspects of teachers' burnout namely, *lack of personal accomplishment*. It implies that those teachers who had low degrees of personal achievements reported high degrees of job satisfaction. According to Kolbadinejad, Ashraf Ganjouei, and Haji Anzehaei (2018), It is notable that the findings represented a significant association between job satisfaction and its components with the enhancement of performance and its sub-scales. Therefore, the low levels of burnout lead to the high levels of job satisfaction. Some of the studies proposed that job satisfaction is related to the two aspects of burnout namely, lack of personal accomplishment and emotional exhaustion (Skaalvik and Skaalvik, 2009; Wisnu, 2019).

The results of the present study are in line with the results of Yu-Hsia and Mei-Hsiang (2019), in which there were significant relationships between the sub-scales of teachers' job satisfaction. Regarding the findings, working conditions are associated with the organization as a whole, the work itself, and the supervision. Further, the work itself is associated with the supervision, the organization as a whole and the working conditions. On the other side, the supervisor is positively associated with the organization as a whole. The findings also showed that the supervisor affects the teacher's attitude towards school and the profession itself. Teacher's stress is influenced by factors like, poor infrastructure, absence of training programs parents' demands, limited state support, influencing, therefore, the degrees of job satisfaction.

According to the above mentioned discussions, burnout is considered to be a potential problem for all EFL teachers, particularly in universities and schools, where teachers have to deal with students and other colleagues. Another substantial point related to the teachers' burnout was its direct and indirect costs and damages. Accordingly, the implementation of measures to control the level of burnout, results in improving teachers' mental health, teaching effectiveness, interpersonal relationships and finally their job satisfaction.

CONCLUSIONS AND IMPLICATIONS

Effective teachers have a pivotal role in the performance and success of educational systems and different psychological and sociological factors can influence their success and failure. According to Wisnu (2019), job satisfaction has a significant positive effect on the teachers' performance. For this reason, the present research intended to investigate two important factors influencing the performance of EFL teachers. More specifically, it aimed to investigate the interaction and relationship between two determining aspects of EFL teachers' behavior, namely burnout and job satisfaction. One-hundred and fifty-nine Iranian EFL teachers from different universities and schools participated in the study. As the main data collection instruments, two questionnaires were submitted to the participants in three different ways: email, social networks and in person, and they were requested to complete and send them back. After data collection, SPSS version 24 was employed to find the relationship between the main variables. The results of the study represented that, university teachers have higher job satisfaction and lower burnout levels in comparison with those who work in schools. Furthermore, the EFL teachers' job satisfaction aspects have a negative association with their burnout aspects. It was additionally concluded that by increasing teachers' job satisfaction, their perceived burnout decreases.

Because of the important role of teachers in developing their students' achievement and success, some investigators have raised concerns over the competence, well-being and their sense of satisfaction of being a teacher. According to Roy and Kumar (2018), teachers experience burnout due to several responsibilities given to them in the workplace. On the other hand, job satisfaction is a necessary requirement for higher dedication and commitment of teachers toward their responsibilities at the workplace. It was also recommended that teachers should be presented a variety of significant tasks since monotonous and routine work often results in job dissatisfaction. In agreement with the results of Torkaman et al. (2017), lack of satisfaction from teachers' motivational needs over time makes them dissatisfied with the work process leading to job burnout. As a result, interventions to reduce stress and to reinforce resources for self-management are important factors for their job satisfaction.

Any language teaching investors or stakeholders, such as educational policy-makers, teachers, and researchers might benefit from the findings of this research. Moreover, this study can help educators and administrators to better understand the psychological and sociological aspects of EFL teachers and take measures to remove barriers in this regard and foster the achievement of educational objectives. The education policy for EFL teachers should concentrate on developing skills for different aspects of the educational process, because of the teacher's multifaceted role. It has been proposed that teachers should achieve their potential skills and develop the proficiency which are necessary to manage the classroom. EFL teachers are recommended to be trained on how to deal with conditions and challenges related to the social environment of Iran. According to this study, it is recommended to assist the EFL teachers by giving feedback to reduce their job stress and increase job satisfaction.

This study has different limitations which should be kept in mind in order to interpret the findings. At first, it is necessary to mention that, as the sample included EFL teachers from specific areas, that make it impossible to generalize the findings to other teachers. As a second limitation, the present study did not consider the differences among cultures, religious beliefs, and their educational autonomy. Studying the previously mentioned aspects of EFL teachers are recommended to get more precise conclusions. In spite of the limitations, the findings have provided new insights that deserving additional studies.

Further studies could be intended to investigate deeply into other factors regarding job satisfaction and burnout. Future researches could study whether the fact that Iranian EFL teachers usually work in more than one university or school, could also influence the levels of job satisfaction. Because this parameter was not studied in the present research; therefore, it is a good area of interest for future researches. Further study, determining the relations of burnout and job satisfaction to other variables like commitment, self-efficacy, professional development, engagement, leadership, etc., can be carried out. Developing and extending this study may involve a greater sample size, involving various types of educational workplaces and demographic examples.

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IMPACT OF USING PERSONALIZED E-COURSE IN COMPUTER SCIENCE EDUCATION

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ABSTRACT

At current e-learning platforms, is often seen non-efficient usage of their possibilities when creating educational content. This article deals with the possibilities of using adaptive tools that are offered by learning management system (LMS) Moodle when creating a personalised e-course. The methodology created by the authors of the article for personalised e-course adjusts the study content based on characteristics of each student stated by his or her initial knowledge, learning style, and motivation. The article is aimed at the presentation of the created methodology and its impact on the level of student's output knowledge as well as overall learning efficiency. By using the methodology, there was an opportunity to compare the impact of two different approaches – the personalised one and non-personalised. Statistical analysis revealed that the use of personalized e-course has a positive impact on students' activity, motivation, and their level of output knowledge. The results showed that the attended secondary school has no or only minimal impact on the output knowledge if the students studied through the personalized e-course. An interesting finding was that students in all surveys have a stronger tendency to prefer the same learning styles over the years.

KEYWORDS

Adaptive approach, the effectiveness of education, e-learning, learning management system, Moodle, personalised e-course

HOW TO CITE

Highlights

- *A wanted grade from a subject affects the student's result from the final exam.*
- *Personalised e-course has a positive effect on the output knowledge of students.*
- *Using adaptive tools in e-learning raises motivation to study regularly.*
- *The majority of students from the research sample do not have a preferred learning style.*

INTRODUCTION

Improving ICT and their application affects sharing and transferring knowledge (Mudrychová et al., 2018). Today's students can study "anywhere and anytime". They use technologies not only for formal but also informal learning which they directly use in their study units at school or home using any device connected to the Internet. Using a virtual learning environment (VLE) affects planning, learning, proposing, checking, and assessing the educational process and providing educational content.

Collective education in a classroom or via standard e-learning is not able to react to the individual needs of students. Some students can get new information faster than this education form can do which leads to their dissatisfaction. On the other hand, for some, the pace is too fast and they cannot understand the problem to the needed extent. Students who are fine with the way of learning might not fancy the teaching method of a particular teacher. Later, these students might develop repulsion to the teacher and subject that he or she teaches which can lead to worse grades and results (Brusilovsky, 2003; Kostolányová, 2012; Magdin and Turčáni, 2015).

Mudrák, Turčáni and Burianová (2019) suggest solutions that lead to the personalisation of content in e-learning courses based on the characteristic classes of enrolled students. As for this issue, it is necessary to deal with forms of education that focus on the personality of the student and that are possible to use within blended learning as well as in distance learning with the e-learning support.

Personalised teaching or personalised educations mean that the student takes over the responsibility for his or her learning and adapts to possible changes. Personalisation reacts to the needs and interests of students and it also teaches them how to manage their learning – take over control and responsibility. It is not something that is done for them but something they take part in (Basye, 2018).

Personalised learning is often drafted through instruction methods that involve adaptive technologies intending to help all students achieve a high level of education, a so-called mastery (Basye, 2018). Mastery learning says that students cannot be divided into "good ones and bad ones" but it can be done only based on the pace of learning. The founder of the psychodidactic theory of Mastery learning, B. S. Bloom (1968), is convinced that if students have limitless time and optimally adapted learning, each student can learn the material on mastery level (it means 80-90% of the material).

Kostolányová and Šarmanová (2016) understand the term personalisation as an adaptation of solutions to various problems, situations, surrounding and other specific conditions and requirements of individuals. They also mention that when solving personalisation itself, these questions need to be answered: Who is it designed for? What is going to be adapted and in what way?

According to Despotović-Zrakić et al. (2012), each student is determined by a set of individual characteristics. These are expectations, motivation, learning habits and styles, needs, etc. Based on these attributes we can divide the students into individual characteristic groups.

Personalised learning based on Klašnja-Milićević et al. (2017) is an adaptation of methodology, syllabus, and educational environment in a way it will suit the needs and learning style of individual students. Moreover, the difference between regular e-learning, which takes students as a homogenous entity, and personalised e-learning is that the latter considers students as a heterogeneous mixture of individuals. Personalisation of e-learning can be seen as a process of deciding about the highest value for an individual from a set of possible choices. It can be implemented into a selected LMS by applying various adaptive criteria such as level of knowledge, motivation, study goals, and style of studying (Brusilovsky and Millán, 2007).

One of the personalisation techniques is the selection of appropriate learning content for a particular student or group of students (Caputi and Garrido, 2015; Perišić, Milovanović and Kazi, 2018). Another possibility mentioned by Kostolányová and Nedbalová (2014) is the division of students into different learning groups based on their level of knowledge and preferred sensory modality. The above-mentioned authors found out that this approach can bring many benefits to e-learning such as faster material grasping and long-term, higher quality memorizing of learned knowledge.

Based on the authors' findings dealing with the issue when creating the concept of personalisation of education, it is appropriate to use the solution via VLE, which has already been applied for a longer time.

There are 2 main forms of implementation presented. Some authors decided to create their own VLE based on their specific requirements such as the WELSA system (Popescu, 2010), TSAL (Hwang et al., 2008), DeLeS (Kinshuk et al., 2011), Protus 2.1 (Klašnja-Milićević et al., 2017) and more. The disadvantage of these systems is their focus on a particular educational purpose and therefore not having wider usage. On the other hand, there are those authors who chose using paid or open-source VLE, which allows the implementation of plug-ins or the possibility of editing the integrated modules.

The suitability of Moodle is shown by Despotović-Zrakić et al. (2012), who invented a method for creating adaptive educational courses for distance education in this LMS. The courses are organized and adjusted to 3 groups of students according to their learning styles. The authors use the Felder-Silverman learning styles model (FSLSM – see subchapter: Model of learning styles supporting personalisation of university education), while they leave out the sensing and intuitive dimension. They use only the pre-set functions of Moodle.

Based on research findings, Karagiannis and Satratzemi (2016) incline to implementation of adaptive techniques into Moodle rather than creating a new VLE. They suggest using an adaptation of the "hybrid dynamic user model", based on the knowledge and behaviour of users. They also use static user modelling based on the Index of Learning Styles (ILS) questionnaire (see subchapter: Model of learning styles supporting personalisation of university education) results and study goals. Obtained data are used to adjust the e-course at the beginning.

Gao et al. (2015) offer a solution of personalisation via the Particle Swarm Optimization algorithm. This algorithm was tested and applied in personalised e-course. The algorithm was simulated with 150 students divided into 5 capability levels. The other parameters of personalisation are: the difficulty of study materials, way of learning, expected study goals, and required time to read the study material.

Some limitations are named in Moodle by Caputi and Garrido (2015). One is no possibility to create complex relations between course activities and student profiles due to a lack of information in them. The next limitation is that it is not possible to make separate types of views of the e-course in a way that every student sees only his or her personalised content. To eliminate these flaws, they used standard functions of Moodle. To generate the ways in e-course they use automatic intelligent planners (LPG and SGPlan). To check the methodology, they use quantitative analysis of an artificially created sample of students and e-courses. As a second experiment, they created a qualitative evaluation aimed at educational content planning in which smaller groups of teachers and students took part.

Garrido, Morales and Serina (2016) suggest myPTutor, which uses planning techniques through artificial intelligence to create totally adapted educational ways as learning object sequences which meet with teachers' and students' requirements.

Zounek et al. (2016) make education via Moodle based on constructivist principles, project, and group education. The students themselves became creators of e-courses by which they adjust it and together with teachers make one working team. Teachers are in the role of tutors or couches of groups and give students feedback to their work.

Magdin and Turčáni (2015) edited the *Book* activity in Moodle which provides advanced adaptive behaviour of the previous module and named it "*Adaptive Book* ". The authors use the

ILS questionnaire to assign an appropriate learning style to each student.

Using adaptive mechanism implemented in Moodle which adjusts the educational content to qualities of students expressing their learning styles is presented by Perišić, Milovanović and Kazi (2018). The learning style of a student is dynamically determined by tracking activities of a student during the learning process and finding out behavioural patterns that describe each learning style. They use semantic web technologies. To research the effectivity of the created model, they verify the differences between experimental (personalised educational content) and control (standard e-course) groups.

Petri nets modelling is used by Kuchárik and Balogh (2019) to create e-courses for LMS. In the e-course, they use adaptive navigation using the completion tracking and access restriction tools. Based on the student's behaviour in the e-course and the use of Fuzzy logic, a prerequisite for his or her final evaluation is created.

Evaluating the effectiveness of the educational activities used is an important aspect of e-learning. One of the possibilities presented by Balogh and Kuchárik (2019) is the correlation between the final evaluation of students and the materials and activities visited in the e-course.

Nowadays there are ongoing efforts to suggest more effective conception possible to use in VLE. Authors of the article use integrated system tools that will identify the above-mentioned individual characteristics of students. From the findings we can learn that the more aspects are taken into consideration, the more precise personalisation of the study plan can be created.

The goal of the article is to verify the effect of the methodology created by us on the level of acquired study results in computer science education. We stated the main goal based on personal research in the selected area and from gained findings of the above-mentioned renowned authors' outputs. In the article, we present our results, which were calculated from a comparison of data from measures in the control and experimental group. The groups were formed from bachelor's degree students of the Department of Informatics (DI), Faculty of Natural Sciences (FNS) at Constantine the Philosopher University in Nitra (UKF). The created methodology was applied and verified in the teaching of the subject Logical Systems of Computers (LSC).

The article has the following structure. In the chapter Materials and Methods, one can find a presentation of the personalised e-course methodology. Next, there is the research methodology presented. The results of applied research are shown in the Results chapter. In the Discussion chapter, we evaluate the used methodology in computer science education at the 1st degree of university level. The Conclusion chapter summarises our findings, previous and future work.

MATERIALS AND METHODS

Model of learning styles supporting personalisation of university education

The selection of an appropriate LMS is only the first step in the successful personalisation of education. In fact, it is a quite complicated process. It is necessary to make a complex analysis from various aspects that affect the educational process. An important step is to focus on the personality of a student and, while creating the learning content, respect his or her individuality. Every student is strongly characterized by the way he or she studies.

There are many definitions of learning styles but widely accepted by theoreticians is the one from Keefe (1979: 2) as: 'Learning style is a combination of characteristic cognitive, affective and psychological factors that serve as stable indicators of how a student perceives, interacts and responds to the learning environment'.

Kaliská (2014) says that learning style is a biologically and developmentally determined set of predispositions that must be first identified by student or teacher and then encouraged, developed, and also controlled. Later she says that using learning strategies that respect the variety of learning styles positively affects the student's approach to learning.

Despite the different points of view and definitions of learning styles, we can say that the fundamental idea of learning styles is that each student has a certain style and prefers materials presented that way (Akbulut and Cardak, 2012).

There have been many theories in the area of learning styles models. In one of them, Coffield et al. (2004) identified 71 models of learning styles. They categorized 13 main models based on their theoretical importance in the field, extent of their use, and their effect on other models of learning styles.

One of the conceptions of learning styles that activates a wide variability of learning styles is Felder-Silverman's model of learning styles. The FSLSM is one of the last models of learning styles that were created in the environment of university education. Thanks to its strengths mentioned below it has become the most used model in the area of VLE. The advantage of this model compared to others is that R. Felder and L. Silverman describe learning styles in a more particular way, specifying the differences in learning based on 4 dimensions that reflect the typical learning behaviour (Kaliská, 2014; Karagiannis and Satratzemi, 2018).

The FSLSM consists of 4 dimensions based on:

1. processing information - *active* and *reflective* type,
2. type of information noticed by the student first – *sensing* and *intuitive* type,
3. preferred modality when presenting the material: *visual* and *verbal*,
4. way of solving problems – *sequential* or *global* approach.

Felder and Silverman complement their theoretical model with the possibility to identify the preferred styles of students via the ILS questionnaire and also offer exact manuals on how to create education that would come directly from students' needs preferring a particular learning style (Kaliská, 2014).

To identify the learning style, we will use the ILS questionnaire created by Felder and Soloman (2002). To designate a learning style, it is usually a long process that often needs using more diagnostic methods. The main advantage of using the ILS questionnaire is that it identifies the learning styles of students at the beginning of the term. It means it solves the time issue when diagnosing learning styles. As Magdin and Turčáni (2015) put it, the ILS questionnaire provides a very exact quantitative estimate of students' preference for each dimension of FSLSM. The ILS questionnaire contains 44 items of dichotomic character, distributed in accordance with the four dimensions of learning styles of FSLSM where one option increases while the other decreases the score of each dimension (Magdin and Turčáni, 2015). The questionnaire evaluation is conducted based on the FSLSM – Figure 1.

- Active learners learn by direct interaction with the material; prefer group communication,
- Reflective learners like to think about the material; prefer individual or very small group communication.

- Visual learners are better able to remember images they have seen (charts, graphs, pictures),
- Verbal learners are better able to remember written or spoken words.

- Sensing learners are detail-oriented and practical with a preference for concrete facts and real world application,
- Intuitive learners have a creative disposition and are drawn to the theoretical and abstract.

- Sequential learners prefer learning linearly, with logical steps,
- Global learners prefer a holistic approach and seem to learn almost randomly by fitting pieces together into a big picture.

Active or Reflective | **Visual or Verbal** | **Sensing or Intuitive** | **Sequential or Global**
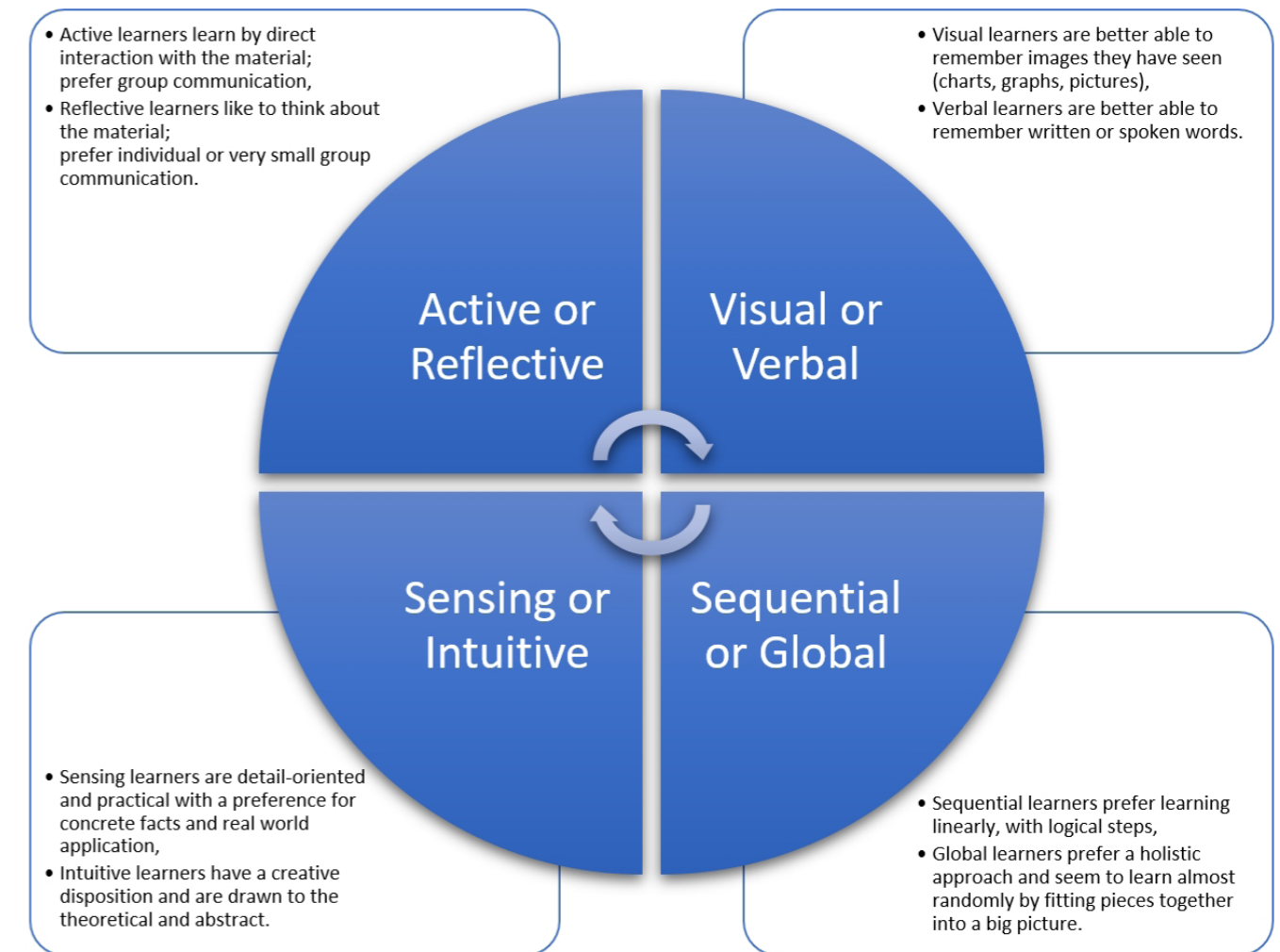
Figure 1: Felder-Silverman learning styles model, (source: Cater, 2011)

In the performed research, the ILS questionnaire was used for the experimental group.

As it was mentioned above, besides learning styles it is necessary to take into consideration some other characteristics too. For this purpose, we used a questionnaire as one of the tools of personalisation of education at the start of an e-course. To create the entry questionnaire that was applied at the LSC subject, the following steps were taken, described in Gavora (2010). It was a 10-item questionnaire with 5 open and 5 closed (3 dichotomous and 2 simple choices) items. The entry questionnaire was put together at the beginning of the e-course. This questionnaire aimed to get specific information about individual students such as motivation to study, information about previous studies, etc. Based on this information it was possible to create a student model before starting studying a subject. According to the student model, the e-course was adjusted to the student in advance to suit his or her needs the most. After this phase of preparing a personalised e-course, the following very important phase is tracking student activities in VLE in real time. The system saves these data about the student to its database. After evaluation, it adapts its content, appearance, etc. to the particular student. By Karagiannis and Satratzemi (2016), better results are achieved in the second phase of tracking and evaluating the activities, in a so-called dynamic approach, because in the first, static approach, we operate only with the initial state of information about the students and not specific state as in this dynamic approach.

Based on the above-mentioned information and results from the previous research seen in Mudrák (2018) a solution was prepared with a combination of these approaches. With the static approach, we can find out information via diagnostic methods that we could hardly get from student's activities in the e-course. It then helps to adapt the e-course to new students at the beginning. With enough data about each student, it is more appropriate to do more adaptations with a dynamic approach.

The principle of a dynamic approach is personalized feedback. It consists in generating the study material or its part based on the test result, the form of which is specified according to the chosen approach to the student. Students are divided into

groups for this purpose. Depending on the group in which the student is included and his/her activities in the e-course, the student is automatically allowed or denied access to various parts of the e-course. The dynamic approach was also applied by using activity tracking and access restriction tools in Moodle.

The methodology of a personalized e-course

The authors of the article created an e-course with attributes of personalisation, which they implemented into LMS and it meets the requirements given by Paramythis and Loidl-Reisinger (2004). Based on a survey they conducted, a personalised educational system (personalised e-course) meets the following requirements:

- monitors activities of its users,
- interprets their activities by specific domain models,
- deduces requirements and preferences of users from their activities,
- appropriately represents them via connected user modules,
- appropriately reacts based on available information about its users to dynamically make the learning process easier.

From these defined requirements, it was necessary to analyse and identify the flaws of currently used e-courses in LSC subject.

LSC is a subject for first-year students at the Applied Informatics study program (AI) realized during the winter term by blended-learning form. In addition to the e-course, there are seminars and lectures provided to students weekly (11 weeks in total). This subject is focusing on the area of logic circuits, their functionality, division, and on solving tasks in a field of analysis and synthesis of logic systems. An elaborated didactical e-course with study content is available for students in the form of multimedia. The e-course content is divided into study units according to weeks in the term. It means 11 units overall. There are an introduction unit, 9 topics units (lessons), and a final unit. The introduction unit contains general information about the successful passing of the subject, *Forum, Feedbacks, Workbook*, and the pre-test (described below), etc. Every topic unit contains the introduction and edited *Book* activity consisting of text, pictures, and interactive animations (5-20 pages of the theoretical curriculum). The material is extended by external sources such as videos and websites. The output of each topic unit is a *Quiz* activity for classical teaching (Autotest – 10 questions from the new curriculum). In the case of the personalised e-course, the *Quiz* activity contains personalised feedback (Revision – 10 questions from the new curriculum plus 2 random questions from each completed topic unit). This results in the following structure of every topic unit:

- Introduction to the unit,
- edited *Book* activity,
- other sources (websites, pdfs, videos, docs),
- *Assignment*,
- Revision (Autotest for classical teaching).

Moreover, adaptive navigation was created based on learning styles and the current knowledge of experimental group students. The final unit contains the evaluation questionnaire (only for the experimental group of students) and the post-test same for all students, which is also the credit exam. The credit exam (post-test) consists of 38 questions (answer types: 33 multiple-choice, 3 short texts, and 2 numerical) which are the same for all students. Students must complete the credit exam to take the final exam. The LSC course is ended by a written final exam, which consists of 4 questions. The first two questions are focused on the ability to draw circuit diagrams and perform analysis, and synthesis of logic circuits. The remaining 2 are randomly selected theoretical questions. Each question is evaluated by a grade and a final grade is calculated as the arithmetic mean of these grades.

The implementation of the correct LMS methodology for its users, according to Balogh and Koprda (2014), means that there is a detailed model that covers all aspects of the system. The authors have created the universal model of the student's e-course transition in LMS determined by using Petri Nets. Some parts of their model were followed by developing the methodology described below.

After the ILS questionnaire (described in more detail in the chapter Research methodology) evaluation by the experimental group of students, they were assigned into two sub-groups within the e-course according to the way of grasping learning material either globally or sequentially. Passing the e-course by students of the two groups were different:

- For the sequential group (58 of all records; 27 of the cleaned records) in order to access the *Quiz* activity, he or she is supposed to study the content of these activities containing the study material (*Book, Adaptive Lesson, external resources*, etc.). The *Quiz* activity was chosen as the main checkpoint of each unit to verify student knowledge and provide personalised feedback (Mudrák, Turčáni and Burianová, 2018). In case of a sufficient number of correct answers (corresponding to the chosen level of mastery learning in the *Quiz* activity - 80%), the sequential student gets access to the next unit. If the student does not reach a sufficient percentage, after completing the *Quiz* activity he or she can learn about his or her mistakes via results in personalised feedback. After evaluation of the knowledge test of the selected unit, the system will refer the student to a specific place in the e-course, or to external sources, where all the information about that issue is located. It is only after re-studying the problematic issue that the student can take the *Quiz* activity again. In order to maximize the reliability of the *Quiz* activity, its content is limited by time, with the possibility of generating questions, selecting from a file, and also limited by the number of attempts. The content of the *Quiz* activity also takes into account the pedagogical-psychological principles of forgetting. As the student progresses through the e-course, the *Quiz* activity contains randomly generated

questions from previous units, which support the systematic repetition of the already learned material. If the student fails in the *Quiz* activity more than twice, he or she is advised to consult a teacher personally using the interview method, to find out the reason for the failure. Based on the consultation, the teacher/tutor will modify the study recommendations for the student to eliminate failure in the next lessons.

- In the global group (36 of all records; 17 of the cleaned records) do not use conditioned access to each unit but have access to the entire content of the e-course. The teacher/tutor wants them to fulfil the appointed activities by a particular date and time.

The model on which the methodology of passing the course by the experimental group students is based is shown in Figure 2.
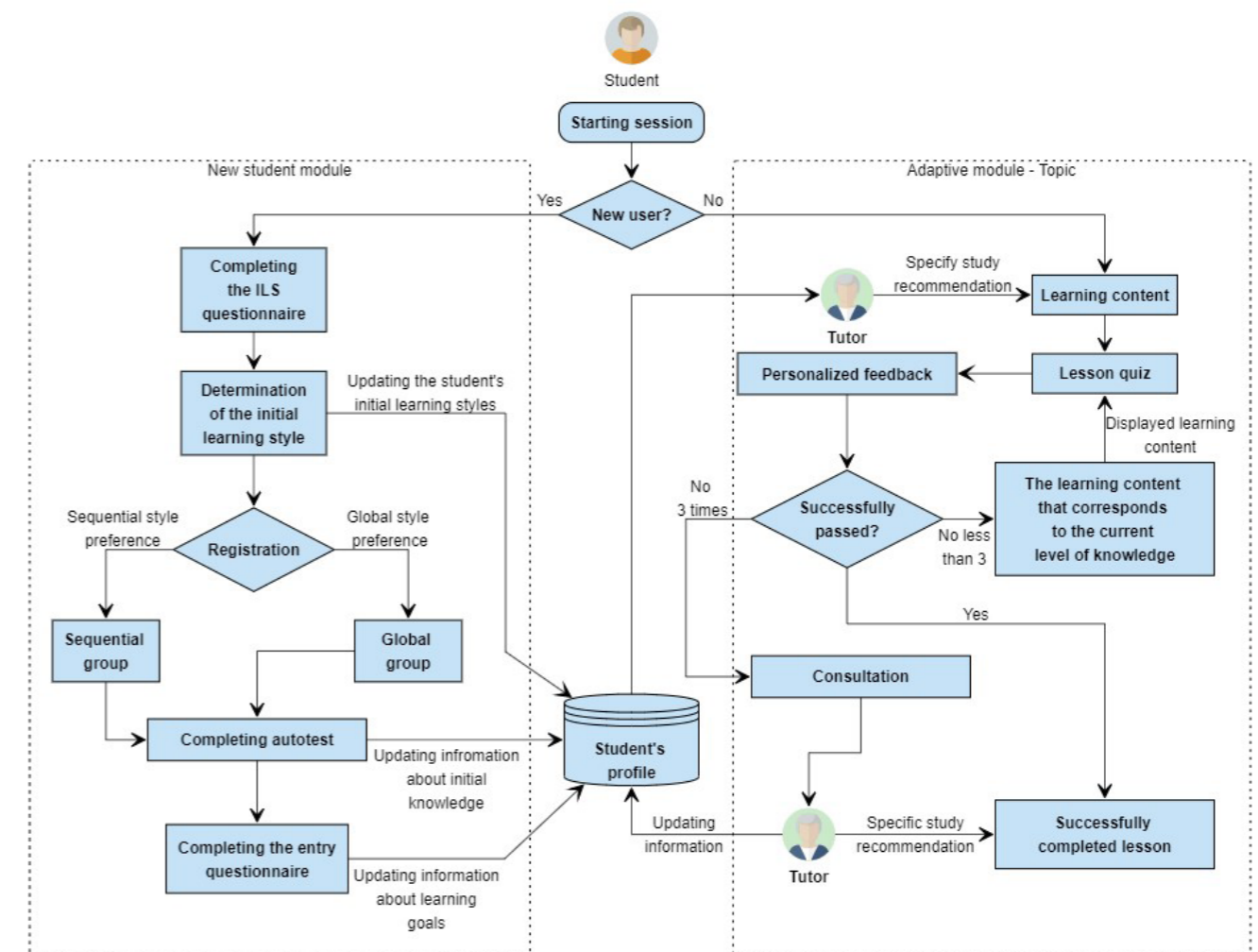

Figure 2: Passing the e-course by experimental group students, (source: own design)

The control group students have the same study material as the experimental group of students. However, at the beginning of the term, their learning style was not discovered. It follows that there is not recommended the most appropriate study content for students' learning styles, in this case. Course activities are not conditioned for students in the control group and all units are open for them throughout the term. Instead of customized *Quiz* activity, they use activity *Autotest* without personalised feedback. However, the test questions are the same, generating questions from previous units is not used and the correct answer is given immediately after completing the *Quiz* as student's feedback. Students of both groups have the same conditions for completing the subject.

After its evaluation students of EXP group were assigned into two sub-groups according to the way of grasping learning material either globally (EXP_G) or sequentially (EXP_S). This division was created only for the methodological point of view. The use of the ILS questionnaire is described in more detail in the chapter Research methodology.

Research methodology

These research questions were stated by us:

Q1. What is the level of initial knowledge of new students of DI?

Q2. Does the type of previous secondary school affect the output knowledge of students?

Q3. What level of study motivation do the new students possess?

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Q4.   How does the created methodology affect the quality of output knowledge?
Q5.   What learning styles have new students at DI?
Q6.   What impact has the used methodology on the learning activity of students?

In order to obtain relevant answers to some research questions and their qualitative evaluation, the following research hypotheses were stated by us:

H(1a):   There is no statistically significant difference in input knowledge between groups of students from different types of schools.
H(1b):   Initial knowledge of students experimental and control group from LSC subject is at the same level.
H(2):   There is no statistically significant difference in output knowledge between the EXP_TS and EXP_OS group.
H(3):   A wanted grade from the subject affects the results of students from exams.
H(4):   There is no statistically significant difference in output knowledge between the control and experimental group students.

All students received questionnaires and a pre-test at the initial lesson. The *Feedback* activity was used to create the entry questionnaire (described in chapter: Model of learning styles supporting personalisation of university education) in Moodle.
Students in the experimental group filled in the ILS questionnaire and the results were interpreted in e-course via the *Feedback* activity too. A standardized questionnaire was selected because of its reliability, simplicity, and free availability on www.webtools.ncsu.edu/learningstyles/.
ILS questionnaire aimed to identify the learning styles of students. There were recommended individual study way and learning activities to students which correlate the most with their learning style according to the ILS results. This was followed by enrolment in the course and a pre-test. The pre-test was carried out in the form of a *Quiz* activity and it contained 13 questions, 11 of which were Multiple-choice type and 2 Numerical-answer type. The pre-test aimed to find out information about the students entering the course, concentrating on their initial knowledge. The pre-test does not count into the final grade, but it has to be passed by students to unlock study content.
With students of the experimental group, it was tried to use the possibilities of Moodle such as conditioned access, fulfilling activities, gamification (Level up!). Besides, personalised feedback was created through *Lesson* and *Quiz* activities for learning management.
Based on the above-mentioned research methodology, necessary research files were created to verify the presumptions. To test hypotheses and answer research questions concerning differences in knowledge between different groups of students (hypotheses H(1a), H(1b), H(2), H(4), research questions Q1, Q2, Q4), the *t*-test was used for two independent variables (Munk, 2011) and formula (1) was applied:

$$T = \frac{\bar{x} - \bar{y} - (\mu_1 - \mu_2)}{\sqrt{(n_1-1)s_1^2 + (n_2-1)s_2^2}} * \sqrt{\frac{n_1 n_2 (n_1 + n_2 - 2)}{n_1 + n_2}} \quad (1)$$

Where μ_1, μ_2 are the mean values of the variables being compared and s_1^2, s_2^2 are the variances of the variables.
The statistical dependence between the wanted grade and the real final exam result of the LSC subject (hypothesis H(3)) was examined by means of the correlation analysis (Munk, 2011) with the application of the formula (2) for calculation of the correlation coefficient:

$$\rho_{XY} = \frac{\sigma_{XY}}{\sqrt{\sigma_X^2 \sigma_Y^2}} \quad (2)$$

The significance level for testing the hypotheses was chosen to be α = 0.05.
The reliability of the evaluation questionnaire was calculated by using Cohen's kappa coefficient (Chráska, 2016). The formulas (3) and (4) were used for this purpose.

$$\kappa = \frac{p_p - p_o}{1 - p_o} \quad (3)$$

where

$$p_p = \frac{1}{n}\sum n_s \text{ and } p_o = \frac{1}{n^2}\sum n_I * n_{II} \quad (4)$$

The application of Cohen's kappa coefficient κ assumes a random division of respondents into two groups of the equal size. The meaning of variables in formulas (3) and (4) is:

κ - Cohen's kappa coefficient for one questionnaire item
p_p - the observed proportion of agreement
p_o - the expected proportion of agreement (the overall probability that the respondents would randomly agree)
n_s - number of identical answers for each variant of the questionnaire item in both groups of respondents
n - total number of answers to the questionnaire question
n_I, n_{II} - number of answers for each variant of the questionnaire item in the first and in the second group of respondents

For the purpose of calculating the reliability of the evaluation questionnaire, we divided students of the experimental group into two random groups of the equal size. Then for the individual questions of the evaluation questionnaire, matrices capturing the agreement of the answers were created and reliability values were calculated. The average value was obtained from the measured reliability values (the calculated reliability is stated in chapter Results).
Statistical software STATISTICA, version 7.0 was used for calculations.

Research sample

The research sample was a group of first-year students of AI studying at UKF in Nitra. One experimental and one control group was created. Students in the control group had unlimited access to all educational material during the term and studied based on the original methodology using the basic e-course.

Students in the experimental group studied via the created personalized e-course based on the created methodology. Raw research sample before removing inconsistent records was made of 114 students. The students were divided as follows:

- 20 control group students,
- 94 experimental group students.

A selection of compact groups was used, which were created using data recorded in the Academic Information System (AIS) database. Only records of students whose data were complete were used in the final research sample. The complexity of the data needed to test the individual hypotheses was also distinguished separately. This means that the final research sample did not contain, for example, records of students who passed the post-test but for some reason did not solve the pre-test and other similar cases. However, if they completed the ILS questionnaire at the beginning of the semester, these records could also be used for some analyses.
The data return for the pre-test and post-test was 51.75% (59 students, who have passed both pre-test and post-test). This sample was used for hypotheses testing.
Based on the above-mentioned parameters, the following groups were created to test the hypothesis:

- CON – control group students who have completed all the necessary activities.
- EXP – experimental group students who have completed all the necessary activities.

The division into CON and EXP groups was used to test hypothesis H(4), which belongs to the research question Q4. A more specific division of these groups was needed to verify further research questions. This was done based on the way the course was completed. To test hypothesis H(2), which belongs to the research question Q2, it was necessary to divide the EXP group in another way. In the case of attended secondary school, we divided the EXP group of students into two subgroups:

- EXP_TS group, which included all students with finished technical secondary schools,
- EXP_OS group, which consisted of students from other schools.

The composition of each group is shown in Table 1. Experimental and Control group are the numbers of all students who participated in the LSC course. The Final research sample is a sample of students/records that contained all the results needed to evaluate the research hypotheses (pre-test and post-test score; in the case of the Experimental group also the result of the ILS questionnaire). The CON group is thus a subset of the Control group and Final research sample records. The EXP group is a subset of the Experimental group and Final research sample records. The EXP_TS and EXP_OS groups were created by splitting the EXP group records based on whether or not the student attended a technical secondary school. Part of the analysis was created according to questionnaires results, where took a part 94 students of the experimental group.

Group	Students
All students of the subject LSC	114
Experimental group (raw)	94
Control group (raw)	20
Final research sample	59
EXP	44
EXP_TS	15
EXP_OS	29
CON	15

Table 1: Number of students of each group, 2019 (source: own calculation)

RESULTS

Hypothesis H(1a) is based on the presumption that there are students accepted to the FNS of the UKF from secondary schools with a different focus. As some of the students addressed the basics of the subject matter, which is already linked to the content of the LSC subject at secondary school, it was assumed that they would perform better in the pre-test than students who had come from other secondary schools. The results of the measurements are shown in Table 2.

Variable	Average EXP_OS	Average EXP_TS	*p*-value
Pre-test (percentage)	61.15	79.49	0.004

Table 2: Comparison of pre-test results based on the type of secondary school (*t*-test for two independent variables), (source: own calculation)

Based on the *t*-test results, a statistically significant difference was found between the EXP_TS and EXP_OS groups in the pre-test results. In particular, the EXP_TS performed better after the pre-test than the EXP_OS group.
The *t*-test method was also used for the hypothesis H(2) testing. There were compared post-test results for the EXP_TS and EXP_OS groups. The results are shown in Table 3.

Variable	Average EXP_OS	Average EXP_TS	*p*-value
Post-test (percentage)	78.95	80.66	0.742

Table 3: Comparison of post-test results based on the type of secondary school (*t*-test for two independent variables), (source: own calculation)

The data in Table 2 and Table 3 suggest that although there was a statistically significant difference in initial knowledge between the EXP_TS and EXP_OS groups, these differences were balanced out at the end of the term. After the post-test, it showed that there was no significant difference in output knowledge between these groups.
The purpose of the further analysis was to test hypothesis H(3), which is based on Q3. The motivation of a particular LSC student was assessed by the answers in the entry questionnaire. The questionnaire contained the question: "What grade would you like to get from the LSC course?" We assumed that if students stated that they wanted a better grade, they were

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motivated to develop in this area. If they answered that would be fine with a worse grade, they probably did not care about this issue and were, therefore, less motivated. Based on these presumptions, hypothesis H(3) was stated. The results of the correlation analysis of the dependence between the wanted grade and the exam results are shown in Table 4.

Variable	Exam
Wanted grade	0.4422
	$p < 0.001$

Table 4: Correlation analysis of dependence between the wanted grade and the exam results, 2019 (source: own calculation)

The results of the correlation analysis indicate that there is a statistically significant dependence between what grade the students wanted at the beginning of the semester and result of the exam.

The main objective of the research was to verify whether the methodology used for teaching through a personalised e-course is more effective than a traditional e-course. To investigate this problem, there were formulated hypotheses H(1b) and H(4) and tested by experiment. The post-test results of the CON and EXP group were considered to be decisive in verifying the output knowledge. However, it

was necessary to verify that the initial knowledge of the students in both groups was the same. Therefore, a t-test for two independent samples was used to compare the pre-test results of the EXP and CON group. The calculated results are shown in Table 5.

Variable	Average EXP	Average CON	p-value
Pre-test (percentage)	57.59	80.28	$p < 0.001$

Table 5: Comparison of results from pre-test for the EXP and CON group (t-test for two independent variables), (source: own calculation)

Based on the results in Table 5, we can see that the groups are not equal. Therefore, it was not possible to compare the results of the EXP group and the CON group only based on the results from the post-test but it was necessary to calculate the difference score. This value is obtained by calculating the difference between the score obtained in the pre-test and the post-test. By this difference score, which is a form of expressing student progress, we can verify how much the students in the groups have improved. To illustrate, the result of calculating the difference score is also shown in Figure 3 using a box graph.
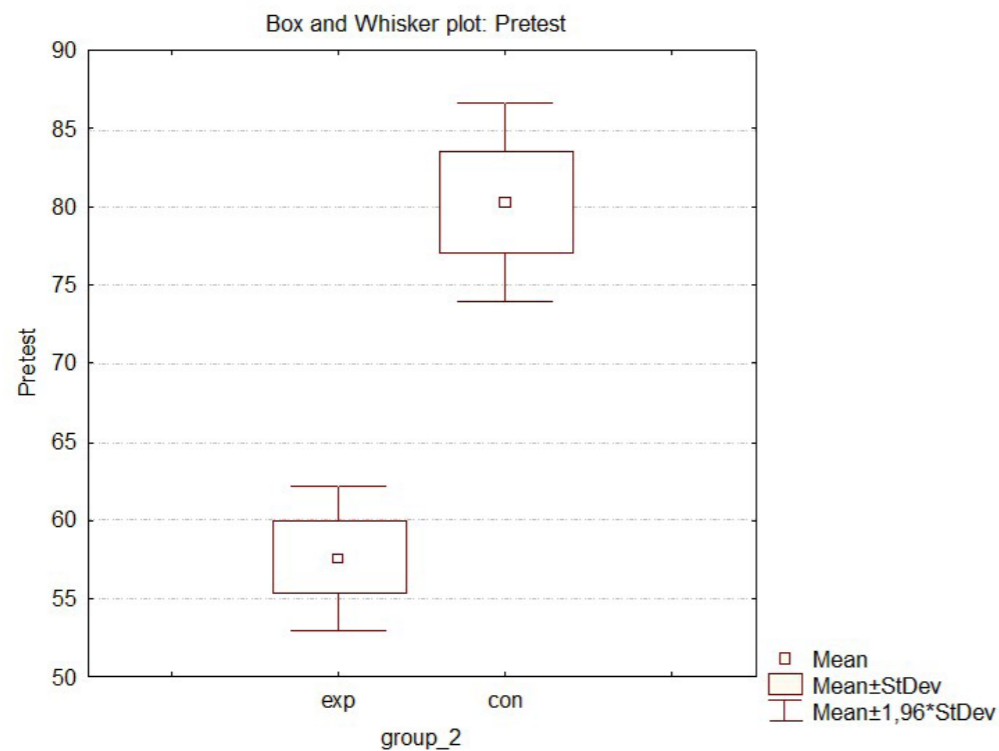

Figure 3: Results of a pre-test for the EXP and CON group, (source: own calculation)

After calculating the difference score, the presumption expressed in H(4) could be tested. The results in Table 6 and Figure 4 show that there is a statistically significant difference between the EXP and CON group differential scores.

| Variable	Average EXP	Average CON	p-value
Dif_score (percentage)	26.54	-13.87	$p < 0.001$

Table 6: Comparison of difference score of post-test for EXP and CON group (t-test for two independent variables), 2019 (source: own calculation)
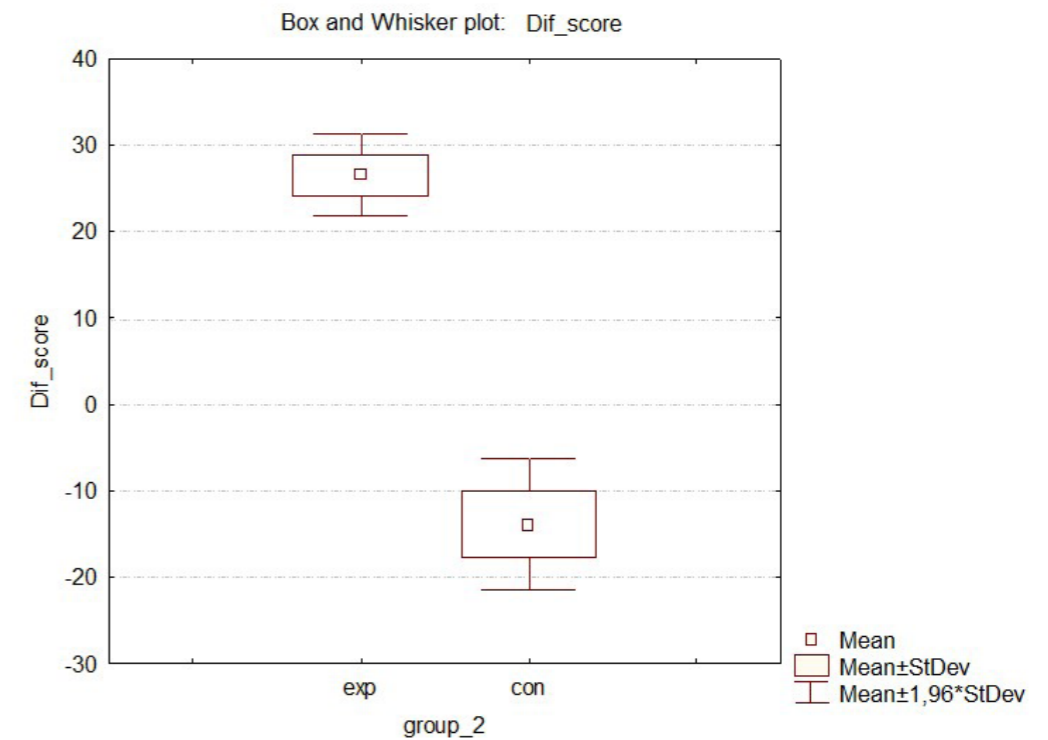
Figure 4: Difference score of post-test for EXP and CON group, (source: own calculation)

Based on the above, it can be concluded that visibly better results were confirmed in the evaluation of the output knowledge of the EXP group compared to the CON group. An important factor was to determine the extent to which the students' learning styles affect them. According to the FSLSM, students were divided into 3 categories: balanced (lowest impact, ILS result value between 1-3), moderate (ILS result value between 5-7), strong (ILS result value between 9-11) (Mironova et al., 2013; Grzybowski and Demel, 2015). The arrangement of the categories is shown in Figure 5. From Figure 5 it is clear that more than half of the students (54%) do not incline to any particular learning style within the FSLSM. Furthermore, 35% of students have moderate preferences for at least one learning style and only 11% of students have strong preferences for at least one of the learning styles.
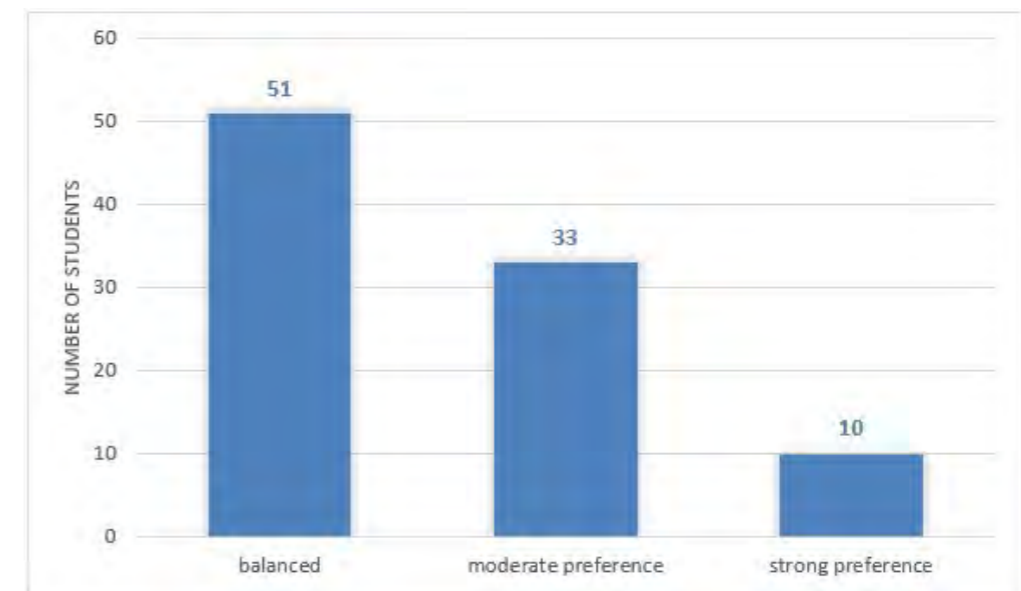
Figure 5: Arrangement of students based on the extent of the impact of learning styles preference, 2019 (source: own calculation)

For each category, the count of students for each learning style listed in Figure 6 was also evaluated. For the Balanced and Moderate categories, there is a representation of each of the FSLSM styles. However, the Balanced category is not really significant in terms of particular learning styles, as the learning styles contained in this category do not significantly affect the student's learning style. More interesting were the results of the Moderate category, where the largest representations of learning styles were Visual, Sensing, and Active. In the Strong preferences category, the most notable learning styles were Sensing and Visual.
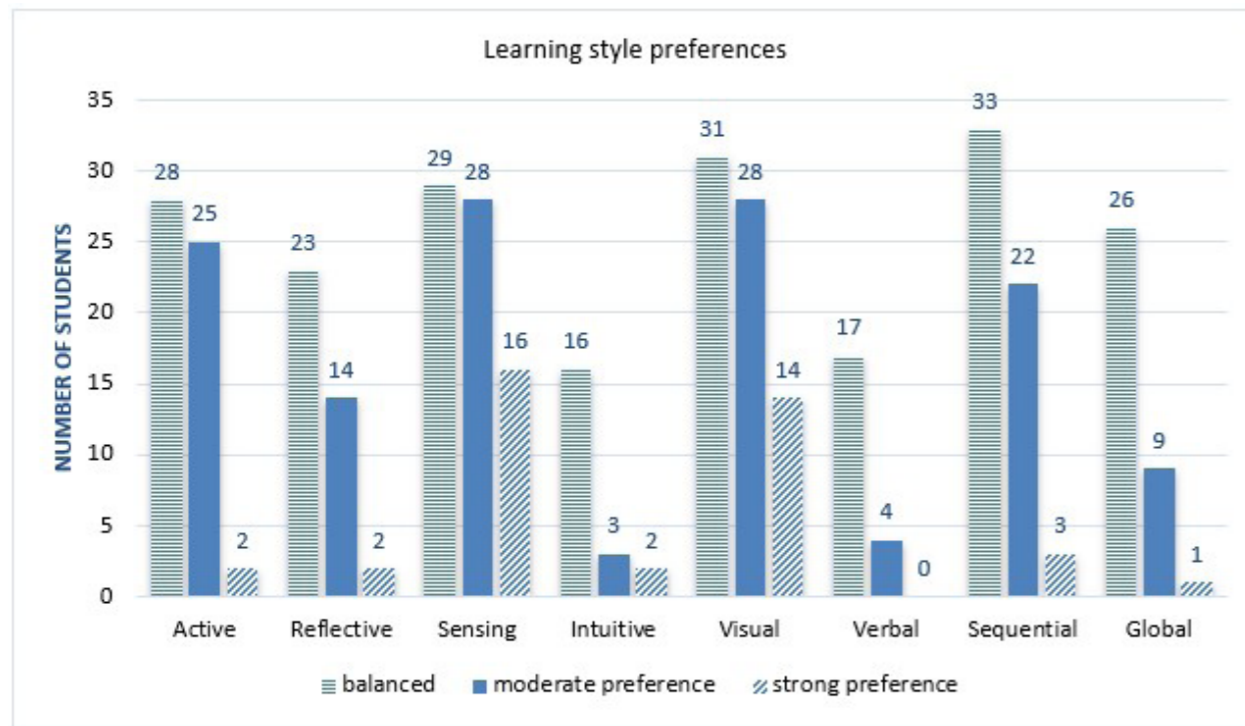
Figure 6: Representation of learning styles in each FSLSM category, (source: own calculation)

Based on the above mentioned and summary of our experience it was evaluated the obtained results as quite logical for the studied subject of the AI. In general, this means that AI students prefer mainly materials processed in graphic form (images, animations, videos, etc.), they like to work actively with the given study content and for their study, it is appropriate to engage as many senses as possible. So, they are more practical. Concerning the continuity of the materials; they prefer a sequential approach, so they prefer to synthesize and prefer a logical continuity of materials.

For the answer of Q6, it was important to find out the impact of the described methodology on student activity in the personalised e-course. The task of the proposed methodology was to use such tools that would motivate students to study at regular intervals and voluntarily, without any external influences such as credits and so on. Via adaptive tools provided by Moodle, in addition to the personalisation of learning content, the intention is also to motivate students to study regularly. Moreover, there was an effort to eliminate students' procrastination during the term, which could positively affect the study effectivity, level of knowledge, and reduction of the stress factor before exams.

One of the problems of the original e-course, which was created classically, was that students accessed the e-course only before the exam. Using the *Reports* analysis tool in Moodle, the student activity was evaluated and compared during the winter terms 2016 to 2018. This activity is shown in Figure 7 and Figure 8.

In 2016, the education was done through the original e-course (99 students). In 2017, the research was launched, and the first changes were made in the e-course (the e-course was attended by 107 students). Based on the findings in 2016 and 2017, the e-course was adjusted using the methodology described in this article. From Figure 7 and Figure 8 a significant increase in the activity of experimental group students (research sample of 94 students) in the e-course is observed.

To avoid basing data only on logs obtained from Moodle, the evaluation questionnaire was used at the end of the term. Students of the experimental group evaluated the impact of the applied methodology on their motivation to study on a scale from 1 - no impact to 5 - significant impact.

Research also showed that 60.65% of students evaluated that the methodology used had an impact on their motivation to study and 25% had a neutral attitude. Only 14.35% of students were in favour of the possibility that the methodology used did not affect their motivation to study.

The reliability of the evaluation questionnaire result is given by Cohen's kappa coefficient $\kappa = 0.812$. According to Chráska (2016), the calculated value of κ can be considered as satisfactory.

Figure 7: Student – activity and content views, 2016-2018 (source: own calculation)

Figure 8: Student posts, 2016-2018 (source: own calculation)

DISCUSSION

We understand that the issue we are dealing with is not new and has been addressed internationally for a longer time. In general, the vast majority of authors believe that if we want to educate students effectively through e-learning, it is necessary to take into account their personal qualities, which affect how students learn. The material can be then adapted to individual students or groups of students.

In the study of this issue, it was found that many authors remain only in the theoretical model of personalisation of e-courses and their conclusions are based only on the simulation of the behaviour of virtual students in VLE. The results of the experiment presented in this article are based on real data collected during the academic years 2017/2018 and 2018/2019 on a sample of students characterized in previous chapters. One of the most commonly used LMS for the realization of personalised learning is Moodle, which after the careful analysis was chosen in this case for experimental purposes too (Mudrák, 2018). For this reason, there was an effort to select the publications dealing with this issue those that also work with a physical sample of students in the Moodle environment.

The experiment conducted by Mironova et al. (2015) included 300 students of economics, social and technical sciences participating in e-courses in computer science. Students were divided according to the results of the entrance test into 3 groups - beginners, intermediates, and experts. The results were compared between a control and an experimental group of 150 students. Students of the experimental group were tested for their preferences of learning styles by the ILS questionnaire and based on the results they were recommended study material. This approach was found to have a positive impact on the experimental group and their acquisition of new knowledge showed by better test results.

Karagiannis and Satratzemi (2018) created 2 programming courses with the same content for their experiment, but an adaptive approach and progress bar was used for the experimental sample of the students. The analysis presented by the authors aimed to find out via attitude questionnaire whether their developed methodology helped students to improve their learning results, to learn more easily, and whether the motivation of students to study was increased. In their first feedback, they found out that implementing adaptive techniques did not affect the usability of the system. Secondly in the latter case, they found a statistically

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significant difference between the experimental and control group in terms of study motivation. According to the results, the experimental group was more motivated to study and also assessed the use of adaptive techniques as helpful in gaining new knowledge.

Kuchárik and Balogh (2019) used *Book* and *Quiz* activities in their experiment. In the end, however, they did not achieve such an improvement in the final assessment of students as they expected. A solution that could contribute to more improvement in learning outcomes could be the use of the *Quizzes* with personalized feedback (Mudrák, Turčáni and Burianová, 2018).

The results obtained from the research activities of the authors of the article are relevant for the monitored area from the point of view of comparing the results of foreign authors.

From the measurements, it is evident that the hypothesis H(1b) has been rejected. CON group students had better average scores than EXP group students from the pre-test. The observed difference in initial knowledge was probably due to the fact that current students of computer science, who were involved in research activities, attended secondary schools with various specializations. That was confirmed, when a statistically significant difference in initial knowledge was found also in groups divided according to a secondary school. There the EXP_TS group achieved on average better results than the EXP_OS group. These findings conclude that the initial knowledge of LSC students is not at the same level and hypothesis H(1a) has been rejected. It also shows that students coming from technical secondary schools have better predispositions for studying the subject of LSC. Based on the analysis of the results obtained by the research methods of the mentioned students it can be concluded that this fact should be taken into account when choosing the composition of individual research groups. From these findings, it can be answered in Q1. New students have a different level of initial knowledge. Based on the results presented in Table 3, H(2) has not been rejected. It was found that differences between EXP_TS and EXP_OS groups of students, who studied by using the personalized e-course were balanced in the post-test. Both groups have improved. It follows that the attended secondary school has no impact on the output knowledge if the students studied through the personalized e-course.

From the results of the post-test of the EXP_TS and EXP_OS groups, it was found that the secondary school attended does not affect the output knowledge of students studying through a personalized e-course (answer on the Q2).

The entry questionnaire revealed that new students have different levels of motivation. Based on the results of the evaluation questionnaire, students declared the positive impact of a personalized e-course on their motivation to study (answer on the Q3).

An interesting finding was that H(3), which was formulated as an alternative hypothesis, has not been rejected. A positive correlation was found between the wanted grade from LSC subject before and the real grade from the final exam. Therefore, we believe that this is a factor reflecting the motivation of students to study a given subject. This finding should be considered when evaluating results in the future.

The results also show that the created personalised e-course has a significant impact on the efficiency of students' knowledge acquisition as a classical (non-personalised) e-course. It is highly likely that the better results of the EXP group in the post-test, as opposed to the CON group, are the result of the personalised e-course application. Hypothesis H(4) has been rejected. From the calculated values, it is concluded that the EXP group students showed better post-test results compared to the CON group. By testing H(2) and H(4), the Q4 was answered. It was found that the use of personalized e-course has a positive effect on the level of students' output knowledge.

From the ILS questionnaire results, it was found that students have different learning styles. But we cannot answer Q5 with absolute certainty. We conducted this survey repeatedly over the years on several samples of students. It was found that students in all surveys have a stronger tendency to prefer the same learning styles: Active, Sensing, Visual, and Sequential.

The proposed methodology described in this article was also verified by comparing the activity based on student logs in Moodle for the last 3 years. Based on the obtained data, we could answer on the Q6 that the use of Moodle adaptive tools in a personalised e-course had a positive effect on student activity.

Data obtained from questionnaires, pre-tests, post-tests were processed and evaluated to improve education in the AI. These findings represent a good direction in the area of the quality of achieved results in computer science subjects for students studying via the described methodology.

CONCLUSION

The main goal of the article was to present the methodology we created and verify its impact on students' learning outcomes as well as the overall effectiveness of studies. Based on the research questions and the above results, we consider the main goal to be fully met.

During teaching activities in the educational process, we constantly encounter insufficient personalisation of education for students who come to university education with different quality and quantity of knowledge in the field of study they have chosen. Based on this knowledge it is necessary to devote more attention to the analysis of the student's condition, the level of his or her knowledge in the given subject as well as the procedures of the educational process. For this purpose, e-courses were created for selected subjects on DI at UKF, which were subjected to thorough analysis to identify and remove all the shortcomings affecting the quality of personalised content of provided e-courses. Using the methodology described in this article, there was an opportunity to compare the impact of two different approaches and procedures on the effectiveness and level of students' knowledge.

This article is an extended version of the conference paper by Mudrák, Turčáni and Burianová (2019). The main points of the extension are:

- more detailed analysis of the issue
- the extended methodology of the personalized e-course with a specific model
- more detailed research methodology with new results

The creation of the personalised e-course methodology and its application proved to be an important activity, which had the most significant impact on the students' output knowledge and activity during the term. We assume that this fact was reflected in the students' achievements in the post-test. However, it should be stressed that the output educational effect could be influenced by the personality of the teacher/tutor, as it was a form of blended learning.

Unpreparedness or not enough will of teachers to implement personalisation into e-education can be one of the threats. This appeared in the research by Caputi and Garrido (2015), where teachers preferred their own concept of e-course planning to the suggested methodology of personalised e-course.

In the future, we will try to evaluate and continuously update all findings regarding education through a personalised e-course. The decisive factor will be the use of Moodle's adaptive options and the use of an appropriate e-course structure using personalisation options. Applying the proposed concept is expected to increase not only the effectiveness of the educational process but also to improve the results in terms of knowledge gained by studying via the proposed e-course.

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SCHOOL STAFF-CENTERED SCHOOL DEVELOPMENT BY COMMUNICATIVE ACTION: WORKING METHODS FOR CREATING COLLECTIVE RESPONSIBILITY - FROM THE IDEA TO ACTION

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ABSTRACT

School development is often seen as a concerted (re-)action to educational policies, curriculum development, and change in education laws or regulations, and sometimes, as stakeholders' reactions to low school performance. Generally, school development incorporates organizational, managerial, and educational activities and measures. This is done to adapt to the new situation to achieve the desired changes and goals initiated by a given curriculum reform. In contrast, this paper focuses on school staff–driven development: It describes how teachers together with paraprofessionals contribute to school-development. Using collective responsibility creating working methods of communication, the enactment of staff's self-chosen measures will be possible. This school staff–driven school development approach makes use of the Dialogue Café and the Reflection Cycle. The combined use of these working methods is seen as appropriate support for school staff–centered development of the School-In project based on the idea of collective responsibility. The paper presents by the application of a qualitative content and visualization analysis, how the communicative action according Habermas took place. This is the process from the individual participant's ideas, through individual and group reflections to finally formulated measures that result in the school's staff joint actions.

KEYWORDS

Collective responsibility, democratic method, dialogue café, reflection cycle, school development, working methods

HOW TO CITE

Highlights

- *Collective responsibility as an important driver for school development.*
- *Combined working methods for school development – a qualitative graphically visualized analysis to make the change process visible.*
- *Democratic participation for school staff–driven school development.*

INTRODUCTION

School reforms intend to foster school development and improvement, but reforms take often different effect (OECD 2015; Cuban, 1990, 2020). Classrooms, schools, and districts do change but they incorporate just some reforms to remain stable (Cuban 2020: 670). Research has shown that participative school development contributes to collective capacity building (Hargreaves 2019; Harris 2011) which is important for professional learning communities (PLCs). Even if participative school development supported by the paradigm of PLCs has become popular, little research (Korthagen and Vasalos, 2008, 2005; Korthagen, Greene and Kim, 2013) is

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conducted on *democratic* working methods. Besides, starting school development by generating appropriate ideas, activities and measures one final tipping point is its implementation. For instance, the enactment of specific developed and useful measures needs continuous guidance, tracing, and support as a final stage. In Korthagen, Greene and Kim (2013: 115) the 'within-in' approach stresses as one implementation characteristic this kind of 'transfer enhancement'. Therefore, this paper will contribute to fill this research gap and report on the whole working process of staff-driven school development. In specific, the paper analyzes and presents how school staff contributed to school development by using working methods of dialogue and mixed group discussions, and by enacting school staff's self-chosen measures (School-In Consortium, 2016; Hillen, in preparation; Dalehefte and Hillen, in preparation). The study makes use of the constant comparative method and its graphically visualized qualitative analysis conducted by using NVivo (Glaser and Strauss, 1967).

The paper applies the concept of school staff instead of teachers because all employees and school-associated members create the school and the school's culture, respectively. This includes paraprofessionals, such as assistant teachers, academic counselors, school psychological and social workers, etc. Generally, paraprofessionals are educated or trained and certified persons who assist and support the professionals' work, in our case the teachers. Focusing on teachers only would create an intra-professional platform for collaboration, whereas including paraprofessionals creates interprofessional groups for school development.

Concerning the working methods, the Dialogue Café method ("world café"; according to Brown and Issacs, 1995) and the Reflection Cycle method (Dalehefte and Kobarg, 2014) are used. These methods were further developed by the project team (Dalehefte and Hillen, in preparation) to support the school staff–driven school development. Specifically, the combined use of the working methods is seen as extraordinary support for school staff–driven development. This is based on the idea of creating collective responsibility (see Ingebrigtsvold Sæbø and Midtsundstad, 2018), which refers to student learning, students' social and moral development, and teachers' expectations.

THEORETICAL FRAMEWORK

The theoretical platform spans from Habermas' (1984) communicative action, Hargreaves (1995a, 1995b, 2014) and Fullan's (2010a) collegiality and collaboration concepts; capacity building, collective responsibility by Kruse, Louis and Bryk (1995) and Whalan (2012) to professional learning communities (Bolam et al, 2005; Kansteiner et al, 2020) for school staff–centered school development. These approaches can be seen from a historical research perspective, but they also mutually build a platform for each other's arguments. These are interwoven and well-known concepts used in the context of school development studies.

Collective responsibility for school development

Collective responsibility (CR) seems to be crucial for school development, but CR must be established first (Whalan, 2012). Collective responsibility is seen as a set of school norms that reflect teachers' willingness to take responsibility for their students' learning (Lee and Smith, 1996: 110, 114). Lee and Smith emphasize that if school staff believe that their contribution *is important* for student learning, which means they feel highly collectively responsible, then the staff's effort will be increased as well as student achievement.

Lee and Smith's (1996) research confirm statistically significantly that collective responsibility is positively related to student achievement. Moreover, the study showed that if the school staff have collective responsibility *for all students* independent of their students' previous performances or their students' social background, this learning was likely to create more equity among all students. 'These results indicate that schools, where teachers take collective responsibility for their students' learning, are not only more effective but also more equalizing environments for students' learning, …' (Lee and Smith, 1996: 128). A later empirical study conducted by LoGerfo and Goddard (2008) reveals as well that collective responsibility is positively and statistically significantly related to mathematics achievement independent of the students' social background.

To summarize the phenomenon of collective responsibility, it appears to be a decisive, valuable, and necessary element for school development in general, and specifically, for the development of an inclusive, equalizing school learning culture. Because of little research on CR, Whalan (2012: 46) uses survey and interview data in multiple case studies to examine the phenomenon of CR. First, she identified with a factor analysis of survey data seven independent variables for collective responsibility (Whalan, 2012: 66):

1. teachers' satisfaction with professional learning on quality teaching
2. impact of professional learning on teaching practice
3. consistency of professional development focus on the school's goals
4. shared commitment to the quality of teaching
5. commitment to the school's shared goals
6. teachers' collective responsibility for student learning
7. teacher-to-teacher trust.

Second, her further analysis of the survey data confirmed research conducted by Louis, Marks and Kruse (1996) on CR, as well as work by Bryk and Schneider (2002) on the importance of trust related to CR. Whalan (2012: 87) study reports in detail that the survey data suggest teacher-to-teacher trust and teachers' shared understanding and commitment to a school's shared goals as elements of a professional learning community, and that they correlate positively with collective responsibility for student learning.

Communicative action and collegiality

Before diving deeper into the search for appropriate methods for school development, there is a need to emphasize the nature of collective responsibility which is related to teachers' shared understanding and trust. Bryk and Schneider (2002: 8) show that relational trust is dependent on shared commitment. For this, the paper introduces Habermas' (1984) paradigm of "communicative action" which is an understanding-oriented approach. His approach implies social action as a prerequisite for consensual collaboration based on free will. The concept assumes that people coordinate their interaction through linguistic communication. This communication provides people with the opportunity to resolve conflicts, but also to live together peacefully on reason and justice (Aakvaag, 2011: 189). Habermas' theory (1999b: 138) includes both non-social or social actions, and non-linguistic or linguistic actions of human beings.

	Reaching success/results	Reaching understanding
Non-social action	Instrumental action	
Social action	Strategic action	Communicative action

Table 1: Types of actions: Social and non-social action (sources: Habermas, 1984: 285, 1996a; Pedersen, 2010: 149).

Non-social action and social action

Non-social actions are described as instrumental actions. This implies that people do not need to interact with others to realize their action plans. In contrast, social actions are characterized by people's dependence on others to realize their action plans (Aakvaag, 2011: 190). Habermas (1999b: 153) also distinguishes between two main types of social actions: strategic action and communicative action. Table 1 illustrates these types of actions.

Strategic action

A strategic action is a result-oriented action (Habermas, 1999b: 139). Through this type of social interaction, the actors try to influence each other through positive or negative sanctions, such as a reward or punishment (Aakvaag, 2011: 189). In other words, this is a goal-oriented communication in which the actors try to reach an objective by influencing each other in a certain direction; there is an intention behind the action. Through a strategic action, understanding and consensus are only a means of achieving a goal (Habermas, 1999a: 16). The actors adopt a result-oriented and rational attitude (Habermas, 1999b: 154). In this case, the participants can approach each other only as objects. Thus, language is used only as a medium for transmitting information (Habermas, 1999b: 140-142).

Communicative action

Language is used as a source of social integration (Habermas, 1999b: 142-143). This means that the listener of free will *is motivated* to discuss and recognizes the matter being discussed (Habermas, 1999b: 140). This creates a prerequisite for productive, dialogue-based group work. School development has been criticized by researchers to pressure teachers (Hargreaves, 2014). This is not in line with Habermas claimed free will participation and is counterproductive for mutual understanding. Habermas points out that agreement cannot be imposed on one party by the other, but it must come from within. This understanding builds the platform for the actors' actions. This is a prerequisite for collaboration on agreed objectives. Schaefer et al (2013: 1) summarize it as 'communicative action is oriented towards mutual conflict resolution through compromise. Actors here do not primarily aim at accomplishing their own success but want to *harmonize their plans of actions* with the other participants.'

Collaboration and collegiality

Hargreaves (1995a) distinguishes collaboration from collegiality. He argues that collegiality is far from being a synonym for collaboration. An institutional structure is needed for collegiality: the collegium, or an organized society of persons performing certain common functions (Hargreaves, 1995a). The school staff's collaboration understood as collegial collaboration (Hargreaves, 1995a, 1995b) can become a communicative action where the actors jointly try to create a mutual understanding and by this a reflected, unsolicited, negotiated agreement. Hargreaves (1995a) points out the need for a *structure* for collaboration. 'Collaboration does not necessarily involve an institutional base to its structure but refers to a disposition towards, or the enactment of, a style of relationship which may take place in a very wide range of structural conditions' (1995a: 31).

Fullan (2010a) also states that collaboration if purposefully organized is an opportunity to ensure that there is coherence inside the targeted reform process. 'The right drivers – capacity building, group work, instruction, and systemic solutions – are effective because they work directly on changing the culture of school systems (values, norms, skills, practices, relationships)' (Fullan, 2011: 5). Interestingly, Fullan uses collaboration concepts of "within school" or "intraschool collaboration." He mentions its importance for facilitating professional learning to be based on teacher needs and to ensure consistency of practice within and across grades (Fullan, 2010b: 19). Fullan mentions as one key inhibiting factor in the grammar of schooling is the egg-crate classroom led by individual teachers (2020: 654). Practice within and across grades prevents the "privatization practice" of teaching and instruction. In contrast, it creates coherence for school development activities (Fullan, 2020). 'Within-school (or intraschool) collaboration, when it is focused, produces powerful results on an on-going basis' (Fullan, 2010b: 36). It is important to annotate how different school staff act and react to top-down and self-made contribution to school change. An unsurprising finding by Hargreaves (2019: 608) was that teachers were overwhelmingly positive about changes they had initiated themselves, but they were equally critical of changes that had been imposed from the district or the government above.

In the paper of Hargreaves in 2019, he summarizes 30 years of research on teachers' collaboration. The research results reported there showed that collaboration can increase student achievement and reduce teacher conservatism towards change as well (2019: 618).

The collaborative working methods of the project (School-In, 2016) presented here, also focus on within-school or

intraschool collaboration. Even if this kind of collaboration is a genuine collective or joint approach, it does not neglect individual needs or ideas. The individuals' voices must be heard to create the collective (see working methods chapter; Hillen, 2019). Interestingly, in a school where professional interdependencies are strong, which means strong collegial relationships, the school staff focus not only on the overall collective (performance) of the school but also on their own efficacy (Louis, Marks and Kruse, 1996: 764).

Capacity building and professional learning communities

Collective responsibility is seen as a prerequisite for school staff's capacity building. Capacity building by school staff is a major aim, a process as well as a result of school development. It is necessary to increase the ability to cope with the school's needs and the school's desired (future) goals. The crucial concept is "mutuality" and commitment, that is, where professionals work together to improve practice through mutual support, mutual accountability, and mutual challenge (Harris, 2011: 627). Fullan (2010a: 57) highlights that "capacity building concerns competencies, resources and motivation. Individuals and groups are high in capacity if they possess and continue to develop the knowledge and skills (…) if they are committed to putting the energy to get important things done collectively and continuously." Capacity building can focus on the individual teacher, but organizational capacity building "of a school to improve students' learning and equity outcomes is influenced by the extent to which collective responsibility is a feature of the school's culture" (Whalan, 2012: 4). Thus, there is a need for communicative action to enable capacity building at the individual and organizational levels for school development by creating collective responsibility. Lee and Smith (1996) state that collective responsibility is essential for school reforms and is a characteristic of professional (learning) communities (Bolam et al, 2005).

Professional learning communities, interprofessionality, and collective responsibility

Professional learning communities as a concept has undergone multifaceted discussions and developments (Kansteiner et al, 2020). Despite this variety, one overarching aspect is unambiguously the collective in these diverse approaches (Vescio, 2020). Research has shown that PLC's have a positive impact on both teaching practice and student achievement (Vescio, Ross and Adams, 2008: 86). As Resnick notes already in (2010: 183) in her model of pedagogy and content routine (PCR), collaborative routines among teachers are important for student learning. These collaborative routines have been described in various ways but are best described as "professional learning communities" (Harris, 2011: 628, Kansteiner et al, 2020). One of the main characteristics is not the improvement of individual teachers' competence and teaching quality presumably induced by specific teacher further education courses but collective improvement.

'The most powerful strategy for improving both teaching and learning, however, is not by micromanaging instruction but by creating the collaborative culture and collective responsibility

of a professional learning community (PLC)' (DuFour and Mattos, 2013: 37). Regarding PLCs, one needs to ask, who are the professionals to be addressed? Stoll and Louis (2007: 225) distinguish among PLCs only for teachers, all employees of a school, and those who do work at a school plus all those who are related to all kinds of school's activities.

Reducing the focus of school development only to teachers as the professional target group would hinder addressing the school's potential coherent development. Johnson et al (2020: 45) review-study on interprofessional partnerships reported for instance on school and community joint work trying to best serve students with special needs. They mentioned that collaboration is the key. The study stressed that the students' needs can be addressed differently through the capacity created by interprofessional partnerships. In contrast, the School-In project created interprofessional workgroups. Wackerhausen (2009) describes that sometimes profession(al)s are trapped in their own knowledge-building community. Wackerhausen terms it as not overcoming the profession's immune system. The professionals maintain their attitudes, traditions, and habits which lead to only first-order reflection when looking at issues. To climb over this "self-created wall," *all* professionals participating in school tasks and routines must be questioned and heard. This type of interprofessional group structure contributes as well to second-order reflection. Second-order thinking overcomes reflective activities that are predetermined to just stabilize the already stabilized tradition (Barr (2013: 5) discusses in general interprofessional education (IPE) and refers to Wackerhausen (2009) and Dahlgren (2009). He points out that working just in your own professional community will support first-order reflections that are based on own personal and professional views. It is self-affirmative; it is within your professional surroundings. Whereas second-order reflections are transformative reflections were the professionals step back to become aware of their own frames of reference. You "de-centre" the learning by considering points of views other than your own. Korthagen, Greene and Kim (2013: 128) refer as well to reflections by *teams* and *on school level* including pre-service teachers, remedial teachers, and school principals to discuss their educational identity and mission of the school. Hence, Wackerhausen's (2009) second-order reflection is decisive for restructuring established professionals' attitudes, behaviors, and values. Therefore, this paper includes Wackerhausen even if it is used here from an organizational perspective, as a structural prerequisite for interprofessional learning communities. This is close to Fullan's (2010b) idea of within-school collaboration. These approaches influence the construction of processes and groups of the working methods developed (see working methods chapter).

How to address school staff for school development? Working methods for school staff–driven development by communicative action and collective responsibility - working interprofessional from within

Consequently, the question emerges of how to address school staff to participate in school development activities. Moreover, how to foster them to take initiative, and how to make them

collectively responsible. These challenges introduced and prepared the creation of the main research question for this paper: "How to initiate, support, and develop collaborative responsibility through communicative action?"

Sub-research questions which specify the analysis are as follows: What kind of working methods are needed for school staff–driven school development, and what are their characteristics? How can the developed working methods and its combination contribute to support these desired different processes that span from the individual idea to collective action?

One approach is democratic participation which means to actively include the school staff in decision making for their *own* school development objectives (Dalehefte, Kristiansen and Midtsundstad, 2018). It seems to be a trigger for sustainable collective responsibility to use a participation and meaning-making school development approach. Geijsel and Meijers (2005: 426) point out that educational change is supported by collective meaning-giving and personal sense-making. One could conclude that the less meaning one sees in school change-related activities, the lower one's engagement will be. Korthagen, Greene and Kim (2013: 5) mentioned that a 'within'- development is decisive for transforming education by taken the inner life of teachers seriously. 'Evoking and nourishing the inner life of teachers can provide them to revisit their commitment to and the passion for teaching because it re-connects them with their core qualities.' This will affect the quality of teaching. Zwart, Korthagen and Attema-Noordewier (2015: 580) asked for instance, how one can create working environments for teachers and students where they can thrive and flourish, and where teachers believe they can make a difference to the academic performance of their students. Korthagen and Vasalos (2008) were inspired by these kind of questions and develop a professional development approach the 'Quality from Within' [QfW] approach, focusing on growth, starting from, and building on the inner potential of teachers and students.

In contrast to Korthagen, Greene and Kim (2013) where the focus was more on the instructional side, our approach included the individual (I), the group level (G) and the school level

learning reflection process (P) in *one but stepwise* working approach by using the so-called IGP stages of the 'Mental Mapping Response' (MMR) working method. This democratic, reflective approach of the Mental Mapping Response-method will enable the staff to participate in decisions about the overall school development area (main objective) which should *initiate* the responsibility-creating process. The MMR method is not discussed further here (Hillen, in preparation). It is one of the project's working methods applied in the innovation (Table 2). Concerning Korthagen, Greene and Kim (2013: 128) the importance of a learning process on the school level including teachers, school principals remedial teachers and preservice-teachers as well close to the interprofessional group learning approach mentioned as decisive for second-order reflection (Wackerhausen, 2009). This idea of a "within" school development approach by Korthagen, Greene and Kim (2013) can be found in all our democratic teacher-driven school development working methods, MMR, DC, and RC.

The combined working methods use the democratic communicative action paradigm which serves and continues the process for creating collective responsibility that begun previously with the MMR method.

MATERIALS AND METHODS

The intervention processes and the working methods

To initiate, support, and develop collaborative responsibility through communicative action, *appropriate participative* working methods for school staff are needed. The whole intervention approach of the School-In project is divided, into six different working days and activities (Dalehefte and Midtsundstad, 2019). We call these working days together with the school staff "innovation days". On these days, the school staff worked partly in groups guided by the project team. These groups consisted of school staff members from different divisions, grades, and subjects they teach. This was done in line with the intra- and interprofessional group composition paradigm for coherent school development.

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Introduction	Discussion of Research findings		Feedback on the measures implemented by the feedback- protocol	Feedback on the measures implemented by the feedback-protocol	Feedback on the measures implemented by the feedback protocol
		Knowledge input 1 The school as the heart of the region - to be proud of the school/ (region)	Knowledge input 2 The local environment of the school and its relational meaning	Knowledge input 3 Engaging and non-engaging teaching approaches	
Focus Group Interviews	Mental Mapping Response -method	Dialogue Café (T1)	Dialogue Café (T2)	Focus Group Interviews	Collective discussion on the second research findings
Individual Questionnaires	Collective Decision for the schools' Development area	Reflection Cycle (T1) with final defined measures	Reflection Cycle (T2) with final defined measures	Individual Questionnaires	Overall summary

Table 2: The innovation days of School-In and its working methods for school development (source: own presentation)

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On day 2, the combined use of the Dialogue Café (DC) and the Reflection Cycle (RC) started. The DC should support communication, ideas, reflection, and understanding connected with the Reflection Cycle to make a collective decision about the objectives and measures to be enacted across the school. In addition, the working method of the Reflection Cycle included staff-suggested indicators to prove that their measures had taken effect.

The rationale behind the combination of the working methods and its cyclic use is to create room and time through an easy-to-apply procedure. School staff communication and reflections led to the measures to be jointly taken. To enable intra-professional discussion, the group included teachers from different grades, subjects, and divisions. This is similar to what Fullan (2010a) calls "'with-in' school collaboration." Moreover, paraprofessionals participated across all groups which created opportunities for inter-professional discussion and reflection. To use Wackerhausen's (2009: 468) term, this should contribute to jeopardize and to overcome the profession's "immune system" to enable reflective growth from the first to the second order. The combination of the working methods and the mixed group approach intended to contribute to de-stabilizing the stabilized professionals' identity (Wackerhausen, 2009: 466f). This effect (the second-order reflection) was analyzed in the research project using focus group interviews (Ingebrigtsvold Sæbø and Midtsundstad, in review) which is not further described.

Method

Working Methods – Dialogue-Café and Reflection Cycle

During the innovation days, the school staff worked in mixed groups after the main issues for the school and its development had been discussed and chosen with the MMR method on innovation day 2 (see Table 2). Dialogue and reflection are core elements of the working methods. In addition to Korthagen's (2017: 392) reflection model 'ALACT' where the model helps teachers in developing their own personal theories about teaching and learning, the reflections during the Dialogue-Café and Reflection Cycle are focusing as well on the entire school activities, the school's context, expectations, and its culture asked in the end for the enactment of new, alternative or changed staff behavior.

The Dialogue Café and the following Reflection Cycle method are applied as a communication platform for reflective talks based on free will (Habermas, 1996). The whole school staff had the opportunity to communicate in interprofessional mixed and changing groups. That is, the school staff included paraprofessionals, for example, assistant teachers. Even if a huge group was meeting (Lagrosen, 2017), the dialogue café method allowed to let everyone work together with someone else by dividing all participants into smaller groups and by changing the group composition at the round tables. First, the school staff was introduced to the Dialogue Café method (Ingebrigtsvold Sæbø, in preparation). Each round table was provided

a thematic question for discussion. One scribe (host) stayed at one table to support the discussion process and to summarize the discussion verbally. The other table-mates changed each time when they joined another table. In general, the Dialogue Café is an approach to create mixed intra-professional groups. By including paraprofessionals, we enabled them to work as inter-professional groups, too, to enhance the opportunity for second-order reflection (Wackerhausen, 2009) over time. After the school staff had discussed and reflected on the critical issues in the Dialogue Café, with the questions given, they summarized it on a poster or paper. Then, the Reflection Cycle followed (Figure 1) as a group working method. The Reflection Cycle is an approach that follows the general problem-solving process. It has a cyclic structure (see Figure 1; Trepke, 2014: 35). In step 1 of the Reflection Cycle, the objectives were selected, based, and derived from ideas developed from the Dialogue Café results. The last step of the work with the Reflection Cycle (Dalehefte and Hillen, in preparation) was that the school staff groups decided and defined the measures to be enacted in their own school. The objectives were operationalized by the formulation of the measures. The group planned how to put these measures into action until the next innovation day. The groups received a Reflection Cycle form, as paper-and-pencil work, to fill out the different steps 1 through 6. In step 3, they needed to write down beside the measures, appropriate indicators.
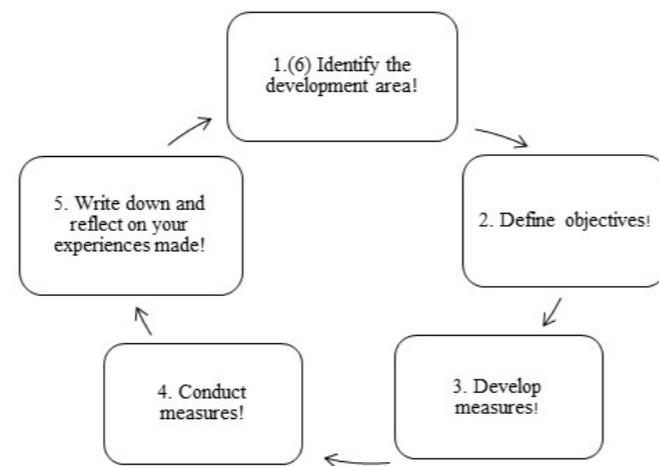

Figure 1: Reflection Cycle (source: adapted from Trepke, 2014: 35)

The intention was to be able to see how the measures took place and how they showed an effect. A spokesperson, chosen by the group, was responsible for summarizing the results, sending a feedback protocol, and being the contact person for the group and the research team.

Dataset and data analysis process

Fourteen schools were included in the project. Seven were reference schools, and seven innovation schools. Innovation schools were those schools actively participating in the school development process.

To become an innovation school, schools had to apply for taking part in the project. The intension was to gain

acceptance and motivation of these schools. The reference schools were those schools, not actively participating in the innovation process that is, not having used the developed working methods of School-In, but having contributed with questionnaires of the staff to serve with reference data about the school in the same district. This is done because one knows that school development is context-dependent. This context perspective helps to consider the given contextual situation for a reference school as well as it helps to validate the quantitative data collected but not discussed here in detail. For the analysis, one innovation school called 'Beeland' for anonymization reasons was chosen with a two-time analysis of the combined working methods Dialogue Café (DC) and Reflection Cycle (RC).

This school was selected because a full data set was available. During the research project, the project team not only developed but also improved the working method. In this case, we added feedback protocols to offer better bidirectional communication and support. The school staff comprised ($n = 35$) participants, 40% of whom were paraprofessionals. Both working methods were conducted together two times, that is, following two innovation days of the innovation phase. Table 3 presents the teacher and paraprofessional groups (G2/G5) and the time points (T1 and T2) of the innovation day's activities when the DC and the RC were applied. For instance, *DC21* represents the recorded discussions during the *Dialogue Café* of Group *2* on innovation day T*1*.

Innovation days T1/2 Mixed Groups of teachers and paraprofessionals (G 2/ G5)	T(1): Dialogue-Café Q2, Q5	T(1): Reflection Cycle	T(2) Dialogue-Café Q2	T(2) Reflection Cycle
Group 2	DC21	RC21	DC22	RC22
Group 5	DC51	RC52		

Table 3: Data set for two innovation days, T1 and T2, at one school (source: own presentation)

To conduct the Dialogue Café, questions for each table had to be developed. The questions were created by the research team to enable and foster discussion and reflection. Although the questions for each Dialogue Café table were created by the project team, they were derived from the school staff's self-chosen area of development (Table 4).

Beeland had decided to work on "Local community and parents used as resources for the school" as a development area. Additionally, the school staff had received short presentations from the project team, as knowledge input

(Table 2) related to the development area and as follow-up to the measures conducted to deepen the school staff knowledge and understanding of the related pedagogical content knowledge.

The conversations in response to the questions (Table 4) were recorded. Later, the discussions were transcribed digitally and analyzed with a constant comparative method with open coding (Glaser and Strauss, 1967). In addition, the feedback protocols written by the school staff were collected as additional data to show how the planned measures were actually enacted (Table 5 and Table 6).

Area of development: "Local community and parents used as resources for the school"	
Dialogue Café: Innovation day (T1) DC 21/DC51 Question:	Dialogue Café: Innovation day (T2) DC 22 Question:
Q2 What in the local community can engage students, and how to take advantage of this? Q5 How can parents contribute to teaching without showing up at school?	Q2 How can one make use of people who are familiar with the local environment to engage the students in instruction?

Table 4: Question used during Dialogue Café for T1 and T2 (source: own presentation)

The different school staff groups developed measures that they reported on the following innovation day during a plenary session. The intention of the plenary session was twofold: to make visible what the different groups had initiated and conducted thus far and to inform and distribute the activities and measures further across the whole school. This was also

structurally laid down and implicitly implemented by the fact that the group members belonged to different divisions and taught different grades and subjects. This distribution approach made the measures easier to share. The school, the school district, and the local environment are named "Beeland".

Group/T1	Objective	Measure	Indicator
G2 worked with Q2	Students should become well acquainted with natural areas in 'Beeland'	Outdoor tours (excursions) as a competition. Hang up mailboxes/using own tour books (for nature)	Students' participation in out-door competition. Letters in the mailboxes when pupils have visited the place in nature
G5 worked with Q5	Parents share ideas, resources, experiences	Gather information via transponder for a given theme	Feedback from parents

Table 5: Results of the Reflection Cycle documented in feedback protocols of Group 2 and Group 5 on Innovation day (T1)

Group/T2	Objective	Measure	Indicator
G2 worked with Q2	The students will become acquainted with the minerals of the local environment in Beeland	We need to find out what kind of geological equipment/resources/ material we have at our disposal. We need to analyze what kind of teaching plan we (will) have for outdoor education	Indicator: Students can recognize/ name/differentiate the minerals

Table 6: Results for the Reflection Cycle Group 2, Innovation day (T2), documented in the feedback protocol (source: own presentation)

RESULTS

Verbal and graphical analysis of the combined working method process and accompanying questionnaire results

This subchapter, show and explain the innovation, the working method's process, and its results. The working method approach is a procedural and combined one. Therefore, the qualitative process presented and analyzed here is to be seen as a formative research result itself. As well as this kind of qualitative, hermeneutic study describes and highlights the processes and stages necessary to be conducted *with* the interprofessional staff. For reasons of triangulation, the dataset was accompanied by quantitative data (see Table 7) which were collected at the end of the innovation phase. The scale spans from 0-5. (0 = I do not agree at all; 5 = I totally

agree). The quantitative analysis is not discussed here further. These descriptive findings do support by its triangulation the qualitative study results and its interpretation. That is, that innovation and school development by creating and enacting the measures has taken place using these working methods. For instance (see Table 7), there was an increased reflection on the school activities (5.1), more initiatives and processes towards school development were perceived (5.2), and more collaboration and participation of the staff was mentioned after the innovation phase of half a schooling year. Desimone (2009: 184) highlights that professional school development or change are less likely by short or one-time interventions. Duration is needed, frequency as well as the timespan is decisive that professional development can take place and show effect.

Descriptive Statistics					
Combined Items of the post-questionnaire	5.1 Increased reflection on school activities (5 Items)	5.2 Increased initiatives and processes for change in school (4 Items)	5.3 Increased awareness of the local environment and the role of parents (3 Items)	5.4 A clearer picture of the expectations of the students (2 Items)	5.5 Collaboration and Participation (2 Items)
N Valid	31	31	32	31	29
Missing	10	10	9	10	12
Mean	2.9113	3.8226	3.5677	2.6129	2.9655
Median	3.2000	3.7500	3.6667	2.5000	3.0000
Mode	3.2000	3.7500	4.0000	2.5000[a]	2.5000
Std. Deviation	1.1618	0.7336	0.9827	1.1526	1.3156

a) Multiple modes exist. The smallest value is shown

Table 7: Staff experiences after the innovation phase (source: own presentation)

Using NVivo, specifically, the graphical approach contributed to visualize the qualitative analysis of what had been discussed applying the different working methods. At a glance (Figure 3), one can compare graphically, in addition to the textual overlapping references (ratio %, Figure 2), what topics were discussed during the different working methods (DC, RC). Open coding was applied (Glaser

and Strauss, 1967) to understand the socially constructed meaning by avoiding reduction with pre-structured concepts or labels of a codebook (Creswell and Poth, 2017). The open coding process resulted in the definition of the nodes. The coded compared nodes showed what kind of topics were taken up in the discussion during the DC and in the RC or what was discussed only in the RC. The

screenshot of the NVivo application (Figure 2) reveals that, for example, "cooperation with parents" (in Norwegian, *Foreldresamarbeid*) is named 5 times, and 26 references can be found to the "natural environment" (in Norwegian,

Naturområde) in both group work methods. The same nodes are found in both files (Figure 2). One file (file 1) relates to the transcription and coding of the Dialogue Café talks and one to the file of the Reflection Cycle (file 2) talks.
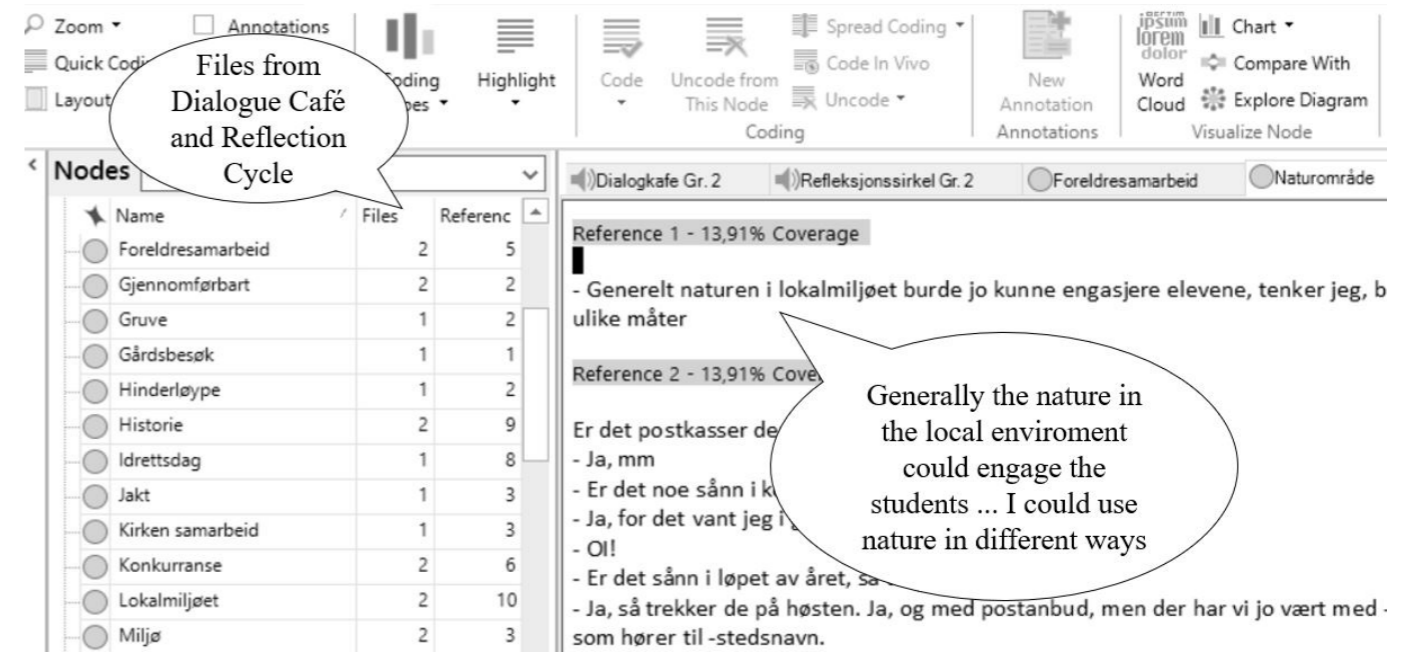

Figure 2: Analysis by transcription and coding of Group G2 (Innovation day T1; source: own presentation)

The following quotations are examples (1–4) from the full transcript of Group 2 and Group 5 during the DC and the RC of the first innovation day (T1).

Dialogue Café Example 1

Discussion in the DC, Group 2, Innovation day T1:
Coded Node: "Natural environment (*Naturområde*)"
Group 2 reads question Q2: What in the local community can engage students, and how to take advantage of this?
P 1: Generally, the nature in the local environment could engage the students, I think,… could use nature in different ways…
P2: Are there "outdoor mailboxes" in our district? (guestbooks to write your name in)…
P3: …our school could have our own tour-book to write one's name inside to engage the students in their leisure time to get them out into nature…

Summary Example 1

The core content in the Dialogue Café's discussion and the objective of the activity described were to motivate the students to experience and become engaged with nature.

Reflection Cycle Example 2

Talks during the follow-up of the RC, Group 2 on the same Innovation day (T1):
Coded node "measure (*tiltak*)" (see Figure 3)
Person 1: The class can do outdoor activities, excursions…
Person 3: …teaching outside of the classroom and the like?

Person 1: Classes go out [into nature], and we teach outside?
Person 2: Yes, then we can write this [in the Reflection Cycle document], that we are outside and teach, can we do this when we are out?
Person 4: Yes, outdoor school this could become a specific-measure!?
Person 3: Ya, that is completely right!
Person 2: Yes, outdoor teaching is specific
Person 1: Yes, this is a little different to just go out for an excursion or that you have outdoor teaching!
Person 4: …use the local environment
Person 1: …that is to use nature [for education]!

Summery RC Example 2

The core content of the discussion and the objective (Example 2) for the activity described, formulated as a *measure to implement in the future*, was to use excursions not only for walks and to be outside but specifically to connect them to the intended teaching purposes. Coming back to Habermas communicative action, one can realize that in these dialogues often the participants, either repeated what was said before or asked for further explanation, *seeking to understands the other's utterances. This is a prerequisite for communicative action by trying to recognize and to understand the matter being discussed.*

Dialogue Café Example 3

Talks during the DC, Group 5, Innovation day T1 was as follows:
Coded node "talking positively about the school (*framsnakke*)"

Person 1: (Reads the dialogue café question) How can parents contribute to teaching without showing up?
Person 2: Without showing up, it's really a bit risky here.
Person 3: Eh…mm, show that they care about what the kids are doing.
Person 1: It's not just about the school, it's about the teaching hours as well.
Person 3: After all, they [the parents] *contribute to teaching if they can motivate and push the kids like that, I think. Not directly, but in this way…*
Person 2: Yeah, that's the best thing.
Person 1: Hmm, [parents] *in teaching without being here.*

Summary DC Example 3

The core content of this Dialogue Café talk (example 3) was to possibly let parents indirectly contribute to the school's teaching. One participant stated it could be risky to let parents participate. The challenge was to find the key for how to let them in the school's teaching. During the discussion, the group found out that parents could motivate their children for schooling and make them more interested.

Reflection Cycle Example 4

Talks in the follow-up RC of group 5 of the same Innovation day (T1):
Coded node "*talking positively about the school'*
Person 1: Parents talk positively about the school, students, and staff and the parent association.
Person 2: One can notice this on the students like they… how they generally talk at home.…
Person 3: Although you can often hear if it stems from 'adult talk' when they [the students] *comment on it*
Person 4: Why? [should we have this as an objective]
Person 3: Engagement… Parents are engaged in school life, why?
Person 4: Should we justify it?
Person 2: Why they [the parents] *should be* [engaged]*?*
Person 3: Ya [they should]*!*
Person 1: Then we get an easier daily school life
Person 3: I think it shows… It helps the kids themselves to be[come] *interested. Doesn't it? Every school day!…….*
Person 2: But you can although pull yourself up because I heard at a parent meeting that someone said the "damn" parents. And you can't say that. So, we have to think about how we are talking to ourselves.
Person 3: Yes, because I think something like that, dialogue café, or a 'sit-in' in small groups at a parent meeting for example. What's good for? To sit for yourself, what is good about it?
Person 2: Then we can have a specific **measure** *to reach the* **objective** *because then we can just make such a dialogue café,… it is a concrete measure!*

Summary RC Example 4

The objective of the Reflection Cycle discussion (Example 4) was how to get parents actually involved. There was a shift in the discussion. Firstly, when they were reflecting to take

the school staff *own's* attitude into account that would make a difference in parents' motivation to participate, they became aware they should not continue talking negatively about the parents themselves. Secondly, the staff decided as a future *measure* to conduct a dialogue café with the parents to get them involved.

Graphical analysis

Figure 3 shows the discussion process in the different group working methods using the DC and the RC (examples 1 and 2). On the left side of Figure 3 are coded nodes referring to the Dialogue-Café. The arrows point to the symbol loudspeaker of the DC. In the middle of Figure 3, the bubbles represent topics that were discussed in both group working methods (the DC and the RC), and on the right side are topics discussed only in the RC. The graphical comparison shows that not all topics were taken up again in the Reflection Cycle, and that new or additional topics (nodes) appeared in the discussion. If one opens the node "Measure (*tiltak*)," one finds the topics "nature and teaching purpose". The content of the talks transcribed in the node "Measure" is shown above in Example 2.
Summarizing the different processes and results, one can see the working methods combined steps for school development as follows:

Mental Mapping Response
(1) See Table 2:
The staff chose the core development area for the whole school: "Use the local environment and the parents as a resource for the school."

Dialogue Café:
(2) See Example 1:
Discussion on how to use the environment to motivate students to make them interested in and become acquainted with nature.

Reflection Cycle**:**
(3) See Example 2:
Discussion about whether outdoor activities can be used as outdoor school or for teaching purposes and developed a measure to conduct outdoor teaching.

Feedback protocol:
(4) See Table 2:
The group reported what they had enacted as a measure for outdoor teaching.

The working methods process produced results in such a way that measures were formulated by the school staff in line with the overall formulated goal for their own school development. Out of this goal, the development area "to use the parents and the local environment as a resource," they discussed and reflected on the use of nature (26 references). This topic was taken up again in the Reflection Cycle where outdoor activities were planned to use *now* as a relevant topic for teaching. Communicative action took place among the school staff.
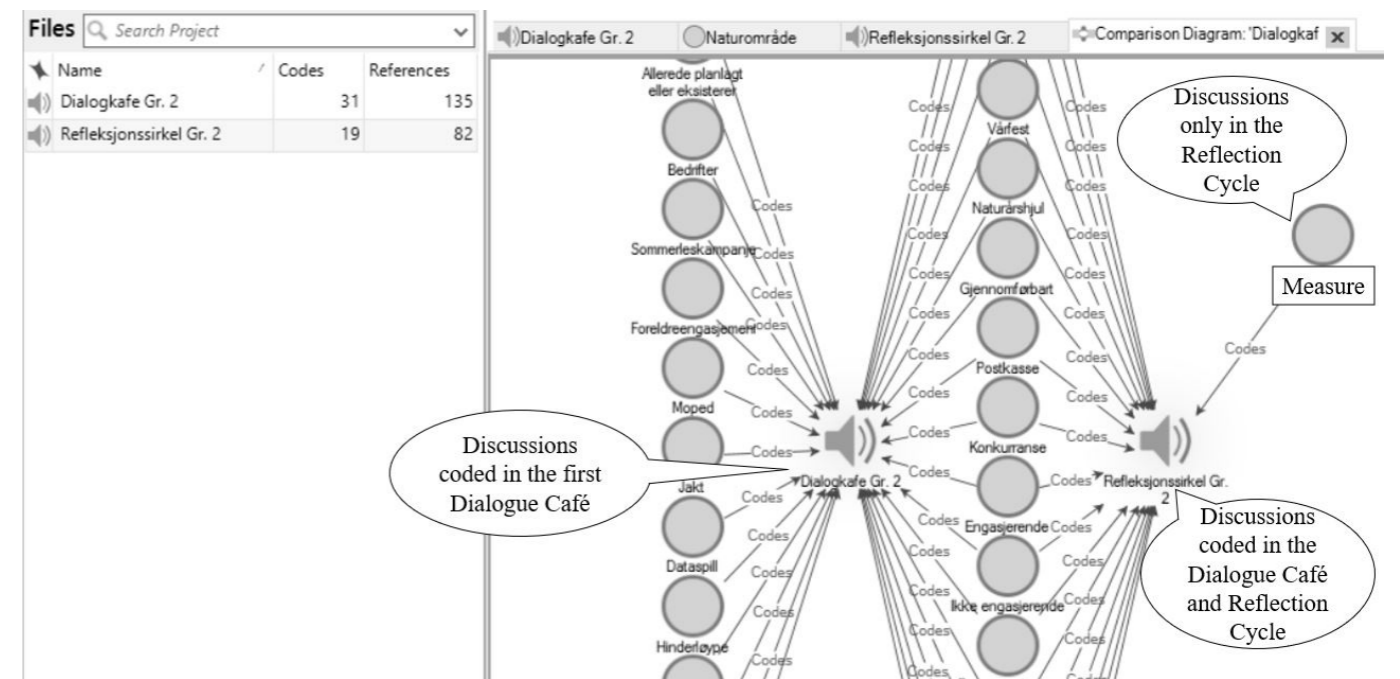Interestingly, by analyzing the raw data similar kinds of

Figure 3: From the Dialogue Café and the Reflection Cycle to measures for collective school development (Innovation day 1, Group 2; source: own presentation)

outdoor activities had been done before but were *not* used for teaching purposes. The reflection led to a *new perspective* on the same school activity. Specifically, the need to *formulate and specify* what the group would conduct, by using the RC form, which they needed to fill out, and the later feedback, functioning as a reminder, supported the enactment of the measures.
The results of the NVivo analysis and discussions related to the school staff's reflection and decision process qualitatively analyzed and visualized showed that the method could help support the formulation and implementation of measures for the whole school and its development.
The analysis shows that the combined methods lead to support communicative action, which can also be procedurally proved by the measures, objectives, and indicators formulated and defined by the staff themselves during the discussions. The group work was open for each participant's contribution based on free will. One of the challenges was that the school staff had difficulties distinguishing the concepts measure, objective, and indicator. This difficulty became obvious in some of the transcriptions but was solved by the support of the project team facilitating the working group methods.
Besides the main findings, one obvious result was that those measures were preferably enacted which needed less preparation but could, therefore, become included in an almost daily routine. Unexpectedly, some of the school staff felt less satisfied with measures they enacted themselves if the measures seemed smaller than colleagues' measures. Anyhow, the project team tried to emphasize the importance that small changes can make a difference in school development. One explanation lies in the fact that these smaller measures can be applied with less effort and easily every day. Presumably, the preparation time was less, and the measure, therefore, quickly became a routine in the new school culture.

DISCUSSION

The paper's focus is on school development by communicative action, which is implicitly based on a democratic understanding and its support for collective responsibility. The school staff-driven development approach is used based on the paradigm of PLC's (Viscio, 2020; Viscio 2008) but extended with the characteristics of interprofessional group work (Barr, 2013; Wackerhausen, 2009; Johnson et al, 2020). The analysis and discussion were divided into two sub-research questions: "What kind of working methods are needed for school staff–driven school development, and what are their characteristics?"
The first sub-research question addressed the *characteristics* of the working methods. The intention with the DC and RC was to enable support for participative democratic school development by working methods fostering collegial collaboration and collective responsibility. Using the presented theoretical framework above, one can contend that:

(1a) school-wide participation with within-*school* collaboration (Fullan, 2010b),
(1b) or more specifically, *interprofessional participation* (Wackerhausen, 2009, Barr 2013),
(2) by using a democratic, *free will–based, participative, and collective* approach as communicative action (Habermas, 1984, Hargreaves 2019: 617),
(3) through an explicit or implicit *organized society* for *performing certain common functions (Hargreaves, 1995a)* is needed.

These *participative characteristics* (1a,b) and (2) as well as (3) *certain functions of an organized society, which presumably* enabling collegial collaboration (Hargreaves, 1995b) and creating collective responsibility, are recognizable features of

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the working methods used in the School-In project for teacher-centered school development.

The open (1b) *interprofessional dialogue* (Barr, 2013) and mutual understanding process (2), as a genuine communicative action (Habermas, 1995) was served especially by the DC opportunity, of continuously mixing the composition of the groups of teachers with paraprofessionals. Specifically, the opportunity to create mutual understanding expanded by the interprofessional views (Johnson et al, 2020) through discussion and reflection on questions related to school issues is provided. The discussed questions were also rooted in the school staff's chosen developmental area. This can create responsibility for future activities to intentionally involve school staff by *free will* (Habermas, 1999a).

Repeating Hargreaves (2019), teachers' self-made contributions to school change showed that teachers were overwhelmingly positive about changes they had initiated themselves.

As well, the *specific group approach's function* (3) as a kind of structural condition (Hargreaves, 1995a: 31) was provided. For instance, every single group has had a host person (DC) as well as a contact person (RC) to report, to survey, and to distribute the results. This supports *purposeful* and *directed* collaborative work as Hargreaves emphasizes.

Collaboration understood as collegial collaboration needs an institutional structure or an organized society. This organized society of *persons performing certain function*s is needed, and one can find these implicitly not only by the group compositions but also by the group process structured DC and RC activities. Hargreaves (1995a: 40f) states that collaboration is wasteful and pointless if it lacks *purpose and direction*.

How can the developed working methods and its combination contribute to support these desired different processes which span from the idea to action?

The second sub-research question addresses the potential support of the whole process from the idea to final action, the enactment of the measures for school development by combining the DC and the RC. The *direction* of the school staff's work, based on the former jointly defined development area, is encompassed by applying the RC. The RC follows a general problem-solving (Betsch, Funke and Plessner, 2011; Borko, 2004), development (see Trepke, 2014: 37), or innovation process (Midtsundstad, in preparation). This process ends in the implementation of the innovation or more specifically, in the enactment of the measure.

One important part Midtsundstad (in preparation) states is the formulation of objectives or goals. Researchers have shown that goals are less explicitly addressed in innovation processes outside the private sector (DeVries, Bekkers and Tummers, 2016). This neglect makes innovation projects in the public sector, which school development belongs to, less effective (DeVries, Bekkers and Tummers, 2016). In this case, the RC addresses explicitly the formulation of a goal, of course, on a micro-level. Moreover, it includes the description of its enactment, the measure itself. Thus, the RC takes up the formulation of how-to, that is, the measure itself, and the goal (what) to be accomplished. Even more, the paper-and-

pencil form applied for the RC activities requires filling in indicators (see Trepke, 2014: 37) as well. Later, the school staff themselves can trace if their measure has taken effect. The Reflection Cycle in step 6 has closed now and can restart. Innovations are seldom linear and require several efforts to take effect. The paper-and-pencil documentation by the RC form and the follow-up by the project team and the contact person and his or her later plenum's talk serve as safeguards as well. One needs to keep in mind that the measures, and the objectives were negotiated and decided within the groups themselves, that is, to follow the idea of 'within' democratic staff-driven school development.

Combining the working methods, specific structural conditions are created which are needed for collaboration as Hargreaves (1995a: 31) points out. Referring to the combined processes, one activity (e.g., talk on a school issue) is to be initialized for discussion and reflection processes across both methods. Example 1 and Example 2 show discussions and reflection in each working method, but both are needed to reach finally the insight for the enactment of a measure. The DC (Example 1) showed that outdoor activity can be used to engage students with nature, but during the RC talks (Example 2), the school staff concluded that it could be used for educational purposes as well. The DC and the RC (examples 3 and 4) showed that the focus of the persons' talks about the goal to better involve parents changed by the reflection on the second-order (Wackerhausen, 2009). The school staff detected on their own the need to change their *own* attitude toward parents to get them actively involved (Example 4).

These communicative actions (examples 1, 2, 3, and 4) were fostered to become more coherent by the mixed and interprofessional group process approach ended in a measure documented in the RC and in the feedback protocols. The measures were reported as enacted by the contact person in the plenum of the school staff meeting during the following innovation days.

CONCLUSION

Returning to the main research question, "How to initiate, support, and develop collaborative responsibility through communicative action (sensu Habermas)?," one needs to take another critical look at the examples and the school's context again. Coming back to Habermas' communicative action, one can see in the dialogue examples (1-4) that the participants, either repeated often what was said before or asked for further explanations, *seeking to understand the other's utterances* to later harmonize their plans of actions, which are the measures. This is one *prerequisite for communicative action by trying to recognize and to understand the matter being discussed.*

Even if the analysis of the data, specifically, the examples, show a clear picture, one can critically ask if this has been communicative action by free will and if collaborative responsibility has had developed. How to guarantee that the discussion and final measures made were performed without an strategic intention? One cannot control that a school development situation is not perceived and experienced as forced. There is no guarantee that individuals will not have

been working strategically using these methods or even just act instrumental to get the work done. The *setting* a school offers for applying these methods, for instance, time and room (Hargreaves and O'Connor 2017), will influence the productive effect on the working methods, as well as every single participant and the school leadership's *attitude* toward school development and the methods used, respectively.

This is in line with Park, Lee and Cooc (2018: 769) quantitative study which concludes that principals should give more attention to exerting supportive and egalitarian leadership. The study from Park showed as well an indirect effect of principal support on student achievement *through* shaping professional learning community, collective responsibility, and collective teacher expectations rather than directive or restrictive leadership. That contrasts with a democratic participative understanding. Generally, Park and Byun (2020) mentioned that transforming a school into a PLC generates many positive effects for both teachers and students.

Nonetheless, the project team created working methods that enable and foster communication and reflection processes. These collaboration approaches can support the development of collaborative responsibility by opening up for communicative action. To open up is for instance if teachers are asked to bring in their own ideas. This is a clear signal for being important for the school and to e.g. value their teaching, respectively. This is in line with Lee and Smith when they mentioned that if school staff believe that their contribution *is important for student learning – it creates responsibility.* Revisiting Hargreaves' (2019: 608) 30 years of research experience on teachers' self-made contributions to school change it showed that teachers were overwhelmingly positive about changes they had initiated themselves compared to top-down experienced changes.

Coming back to leadership and direction, the direction is driven by the school staff themselves. This supports free will participation. Also, the DC and the RC are tools for starting and following these directions and bring it to an end, that is, joint action. The framework, the described processes, for instance, the intra- and interprofessional professional group working process across the school, can serve as one safeguard for a democratic, social situation for school development. The

same is due to collective responsibility. It is a social process that cannot be forced but encompassed with these working methods.

The analysis of the use of the combined working methods approach showed that school staff was able not only to work collaborate collegially but also to enact measures based on their initiative and engagement to participate in school development. This study is also important as it shows that and how collective responsibility as one driver for coherent school development can be created by school staff–centered working methods. The approach, the combined working methods themselves, tried to create a framework that offers the opportunity for social actions, framed by a democratic, communicative process such that school staff–driven school development can take place.

OUTLOOK

Language is a decisive factor for the 'collective approach' because it is a source of social integration (Habermas, 1999b). One might keep in mind that different professional groups make use of language in different ways. For instance, there is a variety in the professional understanding of concepts. Hence, language can separate and invite as well. Lagrosen (2017: 1518) stresses that Team learning implies that every member needs to see the full picture and speak the same language. One might propose this challenge as a future research desideratum that is to analyze the meaning and its effect on the use of language in interprofessional workgroups. Korthagen, Greene and Kim (2013: 128) mentioned that "The development of a common language was essential in this process, a language that supported the teams' discussions on the relationship among theory, vision, and practice at the school level, and it also deepened individual reflections". Hence, the conscious use of language is decisive for interprofessional working methods and the development of collaborative responsibility, respectively.

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MATHEMATICAL CALCULATIONS WITHIN PHYSICS LESSONS AND THEIR POPULARITY AMONG LEARNERS

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ABSTRACT

Mathematics is an important nature exploration tool used by all natural sciences. So it is usual that mathematical calculations are part of school science education. But how are these calculations perceived by the learners themselves? What are their attitudes to this part of the teaching process? The answer´to this question is important for any teacher who seeks to improve her/his teaching experience. The paper deals with the research of learners´ attitudes towards using mathematical calculations within physics lessons. Semantic differential for the sample of 230 primary and secondary school pupils was used in order to determine their attitudes towards this aspect and investigate the influence of grade and gender on the attitudes. The analysis of acquired data shows slightly negative learners´attitude to the mathematical calculations and some particular differences between grades and genders.

Highlights

- *The students' attitudes towards mathematical calculations in physics lessons were found to be generally negative.*
- *The differences between the students' attitudes with respect to age and gender were described.*
- *The attitudes of Czech and Slovak students were compared.*

INTRODUCTION

The school education system should respond to the current intensive development of technology by developing and innovating the technical education of secondary school students, not just technical schools and universities. Physics can be considered as the basis of technical education. Physics in the school system is naturally classified as a natural science subject. In many researches devoted to the perception of natural science subjects in primary and secondary schools, physics and interest in physics were perceived as the least negative (Osborne, Simon and Collins, 2003). Students' interest in physics as a challenging and little interesting subject was also confirmed by a number of researches focused directly on students' attitude to physics (Angell et al., 2004; Stefan and Ciomos, 2010). These findings led to follow-up research to identify factors that significantly affect students' attitudes towards physics. One surprising finding was that the more frequent use of experiments in physics teaching had a statistically insignificant impact on the change in the student's negative attitude to physics (Yesilyurt, 2004).

Another factor influencing students' attitudes towards physics could be mathematics, used as a basic communication language in physics. Lehavi et al. (2017) pointed out that the topic of physics-mathematics interrelations has been the focus of attention in physics education research. Also, the present research is aimed at identifying one of the possible factors that could influence students' attitude to physics. This factor is mathematics, which is the basic tool for calculations and derivation of physical formulas.

According to Boaler (2016), the general disgust and disappointment of mathematics currently prevail among students. Thus, mathematics and mathematics teaching are associated with negative emotions among students. According to Bandura (1977), students avoid things or situations that are associated with aversive experiences. The present research is based on the assumption that students transmit their negative attitudes towards mathematics and physics, as much of the physics teaching is devoted to problem solving. As physics students learn the culture of physics and grow from novice to expert, many have trouble bridging what they learn in mathematics and how we use mathematics in physics. As instructors, many of us are distressed and confused when our students succeed in mathematics classes but fail to use those same tools effectively in physics (Redish, 2017). There are also studies focused on the perception of mathematics in physics by teachers. For example, according to the findings of Pospiech et al. (2019), physics teachers perceive the role of mathematics in teaching physics differently. Some of them see it only as an "auxiliary science", others claim that physics can only be mastered with the help of mathematics. Threfore, the aim of this research is to find out students' attitudes to mathematical calculations in physics lessons.

Measurement of attitudes

As a hypothetical psychological construct, an attitude cannot be observed directly, but it can be inferred indirectly from observable answers expressing consent or disagreement (Eagly and Chaiken, 1998). Attitudes can be measured as positive or negative (Fishbein and Ajzen, 1975) and can be changed during time (Rubinstein, 1986). The authors generally regard the notion of attitude as a disposition of an individual to respond positively or negatively to some situation.

The research assumes the existence of three different components of attitude (cognitive, affective and behavioural) (Eagly and Chaiken, 1993; Maio and Haddock, 2010). The cognitive component includes opinions, ideas and information about the considered object. The affective component contains emotions related to the attitude object. Finally, the behavioural component includes willingness to act which is connected to the attitude. Learners´ attitudes towards various aspects of the teaching process can be positive or negative. The knowledge of students' attitude may give new look into how these attitudes can make the teaching process more difficult or easy.

The attitude measurement methodology is quite complicated and various methodological approaches exist. The main problem is that an attitude, as a hypothetical construct, cannot be measured directly. Only indirect measurement by inference is possible. Data collecting for this inference is realized by various methods. Measurement scales are often used methods (Thurstone, 1928; Likert, 1931). On the other hand, semantic differential (Osgood, 1952) represents not very often used method.

Semantic differential was developed by Osgood in 1952, as a means for measurement of the psychological meanings of the words or attitudes towards some aspects (Kerlinger, 1972). The results of Osgood´s research have shown that people understand the meaning of words and concepts along three main dimensions (evaluative, potency and activity dimension). The subjective rating of respondents is displayed on special scales created as bipolar adjective pairs. The simple tool is especially suitable for measuring emotional and behavioural aspects of the attitude (Hewstone and Stroebe, 2006). The method has been created to discover the connotative meaning of the words that can be depicted as points of so-called semantic space. Using factor analysis the relevant dimensions of the space and the three most important factors (evaluative, potency and activity)

can be determined. Each scale is meaningfully saturated with one factor. An indisputable advantage of the method is its relatively easy administration, fast data processing and relatively high reliability and validity (Svoboda, 1992).

MATERIALS AND METHODS

Participants

The research sample contained 230 learners from Czech ($n = 20$) and Slovak ($n = 110$) primary, grammar and secondary vocational schools. The pupils of 9th grade of primary schools ($n = 94$), 1st grade of grammar schools ($n = 91$) and 2nd grade of secondary vocational schools ($n = 45$) were included into the research. The respondents´ age was in the interval 15-19 years ($x = 17.87$, SD = 1.92). These age groups were included in the research in order to monitor the development of students' attitudes during the critical period of adolescence. By comparing students at 9th grade (primary school) and secondary vocational school, we wanted to find out how students' relationship to physics develops when they have more mathematics in physics lessons at high school. There were 94 girls (40.87%) and 136 boys (59.13%) in the sample. Given that the gender gap in learning so called STEM subjects (Wang and Degol, 2017) is a widely discussed topic, we consider the division of respondents into boys and girls in the analysis of research results to be natural.

Research Instrument

Twenty bipolar adjective pairs created as seven points scales (Table 2, in Appendix) are a major component of the questionnaire for semantic differential. The reliability of the instrument was determined using the value of Cronbach's alpha (Cronbach, 1951). The value for the whole research tool was $\alpha = 0.91$, the values for the particular factors were as follows: difficulty - $\alpha = 0.86$, usability - $\alpha = 0.87$, benefit - $\alpha = 0.66$ and perception - $\alpha = 0.82$. These values indicate the required reliability of the questionnaire. The measured data were transformed into a numerical data in such a way that the score 7 related to the most positive values and the score 1 to the most negative values. Learners´ attitude towards mathematical calculations within physics lessons can be inferred from the average score. The average value in range [3.5, 4.5] corresponds to a neutral attitude, the value above 4.5 related to a positive perception and the value below 3.5 means a negative attitude.

Data Analysis

Factor analysis with varimax rotation was realized with recoded numerical data. The standard tests of factor analysis justification for the obtain data were done before the analysis. The result of Kaiser-Meyer-Olkin (KMO) test was 0.87 and Bartlett´s test of sphericity was statistically significant ($\chi^2 = 728.51$, $p < 0.001$). The values of the tests are favorable for the use of the factor analysis.

According to the factor analysis, the items of the questionnaire were divided into 4 groups (factors) (Table 1): 1. Difficulty factor (6 items), 2. Usability factor (4 items), 3. Benefit factor (4 items), and 4. Perception factor (6 items). The factor score limit was 0.40.

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		α	dim. 1	dim. 2	dim. 3	dim. 4
1. Difficulty		**0.86**				
1 easy	difficult		**0.74**	0.31	0.03	0.09
4 simple	complicated		**0.84**	0.09	0.07	0.22
5 clear	confusing		**0.68**	0.16	0.25	0.16
8 causing pleasure	horrifying horror		**0.67**	0.09	0.05	0.38
14 funny	laborious		**0.71**	-0.10	-0.03	0.37
20 easy to underst.	difficult to under.		**0.63**	0.14	0.25	0.09
2. Usability		**0.87**				
2 useful	insignificant		0.04	**0.82**	0.12	0.16
6 good	bad		0.23	**0.82**	0.12	0.17
7 acceptable	unacceptable		0.35	**0.74**	0.17	0.13
13 valuable	unneccesary		0.05	**0.79**	0.19	0.18
3. Benefit		**0.66**				
15 organized	chaotic		0.19	0.25	**0.42**	0.21
16 harmless	dangerous		0.20	0.33	**0.67**	-0.08
18 safe	risky		-0.07	0.00	**0.85**	0.15
19 understandable	inconceivable		0.36	0.18	**0.49**	0.23
4. Perception		**0.82**				
3 exciting	boring		0.37	0.22	-0.07	**0.71**
9 friendly	unfriendly		0.36	0.32	0.33	**0.48**
10 interesting	dull		-0.06	0.37	0.09	**0.62**
11 attractive	disgusting		0.31	0.17	0.20	**0.65**
12 comfortable	inconvenient		0.35	0.18	0.24	**0.56**
17 relaxed	tense		0.32	0.12	0.23	**0.49**
Eigenvalues of factors			7.72	2.27	1.34	1.02
Percentage of variance			38.62	11.38	6.7	5.11

Table 1: Results of factor analysis, 2019 (source: own calculation)

RESULTS

Overall average score obtained from the questionnaire was $x = 3.73$ (SD = 1.61), corresponding to relatively neutral attitude to the mathematical counting within physics lessons which is near to the negative one. As regards the individual dimensions, learners achieved the highest score within the dimension called "usability" ($x = 3.90$, SD = 1.63), the lowest score was found within the dimension "difficulty" ($x = 3.47$, SD = 1.59). The distribution of the score is consistent with the total score and the score of the individual dimensions can be considered as neutral attitudes, with the "difficulty" score being slightly below the limit of negative perception. The score distribution for each dimension is depicted in Figure 1.
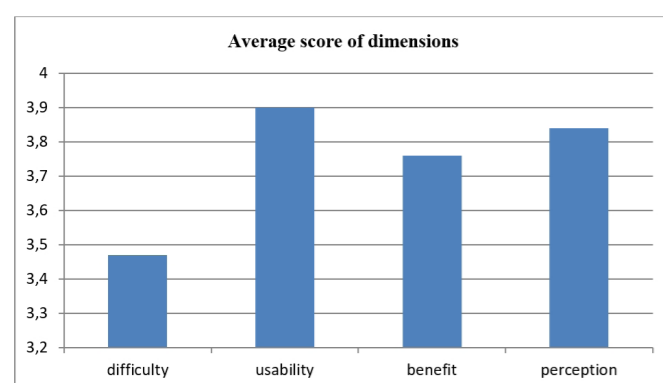

Figure 1: Average score of dimensions, 2019 (source: own calculation)

Due to the fact that parametric test (t-test, ANOVA) were to be used in the data analysis, the normality test of the basic set distribution was performed first. The values $W = 0.827$ and $p = 0.235$ of Shapiro-Wilk normality test obtained using the software Statistica, version 13.4.0.14 confirmed the normality assumption. Using statistical t-test of significance there was found out a statitically significant difference between boys´ ($x = 3.86$, SD = 1.56) and girls´ ($x = 3.52$, SD = 1.67) overall average score. The boys´ attitudes towards mathematical calculations within physics lessons is therefore more positive than the girls´ ones, but in both cases their perception can be considered as a neutral close to the negative. Investigating scores for gender-specific dimensions using statistical ANOVA test, statistically significant difference ($p < 0.05$) with more positive boys´ attitudes was found out. Relative to the dimension "difficulty", the boys reached the score of $x = 3.63$ (SD = 1.52) and girls $x = 3.24$ (SD = 1.67). For the factor called "usability", the boys achieved score $x = 4.0$ (SD = 1.64) and girls $x = 3.77$ (SD = 1.63), corresponding to slightly more positive perception of boys. Evaluating the "benefit" dimension, there were found the avarage values $x = 3.48$ (SD = 1.77) for the girls and $x = 3.95$ (SD = 1.64) for the boys. For the "perception" dimension, boys reached $x = 3.93$ (SD = 1.47) and girls $x = 3.72$ (SD = 1.58) (Figure 2). According to the Tukey post-hoc test, statistically significant differences between boys´ and girls´ scores are within the dimensions "difficulty" and "benefit".
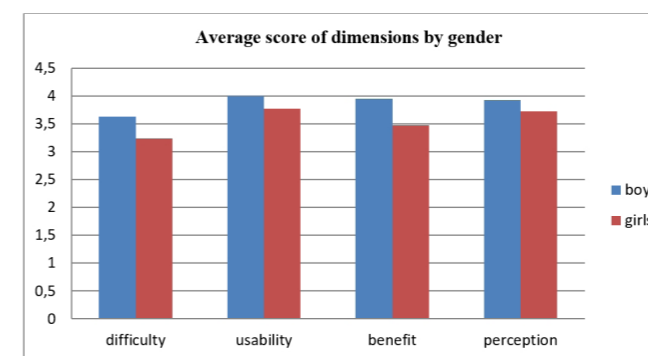

Figure 2: Average score of dimensions by gender, 2019 (source: own calculation)

In terms of the overall grade-specific average score, the value for 9th grade of primary schools was $x = 3.52$ (SD = 1.54), corresponding to almost negative relationship of this age category to the mathematical calculations within physics lessons. There is only a very small difference between the 1st grade ($x = 3.89$, SD = 1.69) and 2nd year of secondary vocational school pupils ($x = 3.85$, SD = 1.59) (Figure 3). The statistical ANOVA test confirmed the existence of statistically significant differences between the average scores of the individual age categories ($p < 0.001$). The follow-up Tukey post-hoc test revealed statistically significant differences between the 9th grade and the 1st grade ($p < 0.001$), between the 9th grade and the 2nd grade of the secondary school ($p < 0.001$).

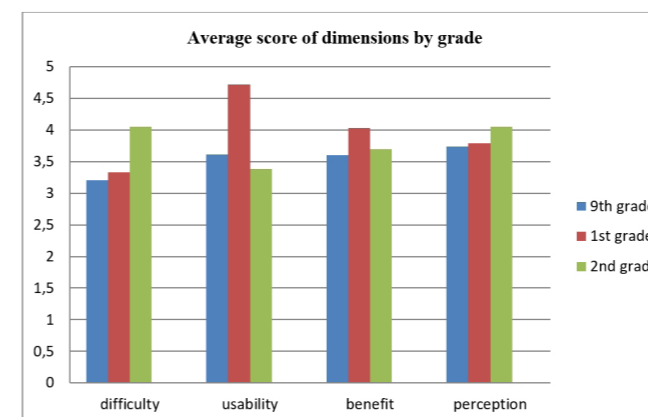Figure 3: Average score with respect to grade, 2019 (source: own calculation)

Figure 4: Average score of dimension by grade, 2019 (source: own calculation)

Evaluating the score for each factor in term of the attended grade, within the factor "difficulty" the pupils of the 9th grade reached the score $x = 3.20$; SD = 1.43, the pupils of the 1st grade achieved score $x = 3.33$; SD = 1.61 and for the 2nd grade of the secondary school $x = 4.05$; SD =1.66 (Figure 4). The statistical ANOVA test showed an existence of statistically significant difference ($p = 0.021$) and subsequent Tukey post-hoc test acknowledged statistically significant differences between the 9th grade and the 1st grade ($p = 0.031$) and between the 9th grade and the 2nd grade ($p = 0.035$). For the "usability" factor, the following values were found out: 9th grade – $x = 3.61$; SD =1.47, 1st grade – $x = 4.72$ (positive attitude); SD = 1.61; 2nd grade – $x = 3.38$; SD = 1.54. The p-value 0.016 of ANOVA test indicates that there exist significant differences for this dimension and Tukey post-hoc test showed the differences between the 9th grade and the 1st grade ($p < 0.001$) and between the 1st grade and the 2nd grade ($p < 0.001$).

Avarage values for the factor „benefit" were the following: 9th grade – $x = 3.60$; SD = 1.83; 1st grade – $x = 4.03$; SD =1.62; 2nd grade – $x = 3.69$; SD = 1.58. The ANOVA test revealed statistically significant differences ($p < 0.001$) and Tukey post-hoc test confirmed the differences between the 9th grade and the 1st grade ($p < 0.001$) and between the 1st grade and the 2nd grade ($p = 0.009$). For the factor „perception", ANOVA test indicated statistically insignificant differences between the grade categories ($p = 0.120$): 9th grade – $x = 3.74$; SD = 1.45; 1st grade – $x = 3.79$; SD = 1.63; 2nd grade – $x = 4.05$; SD = 1.47. Comparing the results of Czech and Slovak students, we find that there is no statistically significant difference between their average score (Czech students – $x = 3.74$, SD = 1.82; Slovak students – $x = 3.71$, SD = 1.42). However, gender difference can be observed in this case. While there was not find any statistically significant difference between Slovak boys and girls (Slovak boys – $x = 3.70$, SD = 1.39; Slovak girls – $x = 3.74$, SD = 1.39), in the case of the Czech pupils it was (Czech boys – $x = 3.99$, SD = 1.67; Czech girls – $x = 3.30$, SD = 1.92). The average scores of the Czech pupils depending on the grade are quite different. The value for 9th grade of primary schools comes out $x = 3.39$ (SD = 2.17), indicating negative relationship of this age category to the mathematical calculations. There is only a very small difference between the 1st grade ($x = 3.89$, SD = 1.69) and 2nd year of secondary school students ($x = 3.63$, SD = 1.52). The countries under comparisom formed for many years one state with one school system. After the division into two states, various reforms of the education system took place. We wanted to find out if the system for teaching mathematics and physics is better set up in any of the countries.

DISCUSSION

The analysis of acquired data shows the overall negative attitude of students to mathematical calculations in physics. According to the findings of Kaya and Böyük (2011), students' attitude to physics is neutral and, according to the research conducted by Ornek, Robinson and Haugan (2008), one of the factors affecting physics is the lack of a link between the theoretical part of physics and solved tasks in physics teaching. In view of

the above studies, it can be concluded from the present research that mathematical calculations have a significant negative impact on the physics perception of students. If we compare the method of teaching physics at primary and secondary school, we will find the following. In primary school, physics is taught by learning about the physical rules of the outside world. At secondary school, the use of physics knowledge in practical life prevails, and this is done predominantly through a mathematical problem solvings.

Changing the way of teaching mathematics and physics may not automatically change students' attitudes. According to the results of the research (Stejskalová et al., 2019), students are not inclined to change the way of teaching and learning. Other research on the development of the learning style (e.g. Vermetten, Vermunt, and Lodewijks 1999, Vermunt and Minaert, 2003) confirms the change in student's learning style when changing the way of teaching. Therefore, we recommend freqeuent including conceptual tasks that require students to create their own problem solving (Schneider, Grabner, and Paetsch, 2009). For example:

Peter Sagan has a 15 minute lead in a solo escape on the 24.3 km long rise to Passo dello Stelvio when the peloton arrives at the foot of the hill. The pursuers move in the rise at an average speed of 16 km.h⁻¹. Will Sagan win if he moves at an average speed of 14 km.h⁻¹?

The given task is from real life and its solving requires the identification of mathematics and the creation of a mathematical model, which are the basic elements of mathematical literacy (OECD, 2016). Tasks from everyday life require flexibility of procedural knowledge these are closely connected with conceptual knowledge (Rittle-Johnson and Star, 2011).

The change in students' attitudes towards the use of mathematics in the teaching of physics consists in teaching focused on balanced building of the conceptual and procedural knowledge (Hecht and Vagi, 2012). Verschaffel (2002) described the need to bring reality to the mathematics class, to create opportunities for learning and practice various aspects of applied problem solving. This would replace algorithms drilling and emphasize the creativity and independence of students in finding a solution. To increase the activity of students in the solving problems, it is appropriate to use the heuristic method, where students are actively looking for a way to solve a given task. Placing mathematical solvings in physics into semantic space allows the division of individual questionnaire items by factor analysis into individual dimensions. Based on the average score ($x = 3.47$) of the first dimension (difficulty), the mathematical solvings have a slightly negative impact on the physics' difficulty. Apparently, students who achieve weaker mathematics results also have problems in physics, in the case that mathematical solvings and the interpretation of their results form a significant part of physics teaching. This finding also corresponds to the results of other researches (Uz and Eryilmaz, 1999).

The already mentioned frequent use of real-life word problems in mathematics lessons could lead to an increase of student's success in solving physical problems. Word problems in mathematics lessons (as well as physics problems in physics lessons) require mathematization of the given task (creation of a mathematical model) and after finding a solution of the model, its interpretation in the conditions of the given problem. According to Boaler (2016), students do not see the importance of teaching mathematics, they see no links to real life. Physics is considered to be a part of science that uses the most of mathematical knowledge. However, based on the average score ($x = 3.90$) of the second dimension (usability), mathematical solvings are perceived significantly negatively. The mathematical solvings are considered to be of little use in physics. It can be concluded that the need for mathematical solvings in physics teaching is not sufficiently evident to students. Teaching mathematics often takes the form of practicing numerical algorithms (Boaler, 2016). Students believe that they learn mathematics in order to be able to solve equations and inequalities. However, there is lack of knowledge that each equation is essentially a mathematical model of some real situation.

The solution of this situation could be the use of project teaching already at primary school. In general, project-based teaching is a dynamic approach in which students explore real-life issues and challenges. This active and engaged way of learning inspires students to gain a deeper knowledge of the subjects they are studying (Dym et al., 2005; Mills and Treagust, 2003; Prince, 2004). If more emphasis were placed in project teaching at schools, students would be more aware of the mathematics usefulness in solving the problems of everyday life. An important aspect of teaching mathematics is the correct understanding of the context in the form of word problems (Chapman, 2006). Students also negatively perceive the contribution of mathematical solvings to understanding physical knowledge (benefit dimension, $x = 3.76$). It follows from the obtained data that the implementation of mathematical solvings rather increase the difficulty of learning physical knowledge. The average score ($x = 3.84$) of the fourth dimension (perception) is consistent with the findings within the previous dimensions.

In the present research, a statistically significant shift from a slightly negative attitude towards mathematical solvings in the physics of primary school students to a significantly negative attitude of secondary school students (Figure 3) was recorded. This shift is probably due to the fact that mathematical solvings are gradually becoming the core of physics teaching. And, unfortunately, similarly to the teaching of mathematics, drilling solutions to a given type of problems is also preferred in the teaching of physics.

From a methodological point of view, it is debatable whether we are entitled to use the parametric *t*-test and ANOVA test in the case of detecting statistically significant diferences between average scores obtained from the scales. This issue has been under discussion for almost 80 years. Some researchers recommend the use of a non-parametric (e.g. Wilcoxon) tests because they are free of the normality assumption and the assumption of interval data (Doane and Seward, 2011). However, many authors consider the scaled data as the interval ones (Boone and Boone, 2012). Consequently, they argue that the parametric tests can be applied for the scaled data that are widely used in the social sciences (Meek, Ozgur and Dunning, 2007). So, we can use those statistical methods.

CONCLUSION

According to PISA (Programme for International Student Assessment) 2015, the number of students reaching the 5th and 6th levels of mathematical literacy is decreasing and a significant proportion of pupils (27.7%) are in the risk group (OECD, 2016). Student results in PISA do not change significantly, in some cases slightly decrease. This finding indicates a more fundamental change in teaching mathematics towards task solvings from practical life. Teaching mathematics still runs in isolation. Individual parts of mathematics are often taught in isolation and mathematics itself is presented as isolated from other disciplines within the education (Boaler, 2016). Students often learn mathematics as a set of rules and practices without the necessary understanding. According to the findings of Mazur (1997), students do not focus on understanding the physical nature of the solution in solving physical tasks, but focus on the operation of the objects in the solvings. Even on the basis of the presented research, it can be stated that students transfer their mathematics habits to physics learning, specifically to solve physical tasks. The results of this research confirm the fact that mathematics, that students do not understand, will not help them to understand incomprehensible physics. Applying mathematical skills in physics requires a higher level of mathematical literacy because these are basically the verbal tasks.

In verbal tasks, it is necessary to be able to identify the mathematical knowledge that needs to be used in the task solving. This is the reason why verbal tasks are the biggest problem for students (OECD, 2016). In secondary school mathematics, their share in teaching is very low, which is counterproductive, as the share of mathematics is increasing in secondary school physics. Another factor that negatively affects the perception of mathematics usability in physics lessons is the fact that physical formulas are in fact the equations with a parameter, and understanding the term parameter is also one of the demanding parts of mathematics teaching. Understanding mathematical and physical symbols is not easy for students (Spelke and Tsivkin, 2001). Proper acquisition of these symbols by students requires an increased level of teaching focused on conceptual cognition. It is appropriate for students as well as teachers to realize that understanding mathematical symbols and concepts is as important as manipulating them in calculations (Leung, 2014). To achieve this goal, it is necessary to ensure that the expertise of mathematics and physics teachers is closely related to didactic knowledge in the context of specific teaching situations.

Based on the findings of the present research, the content of mathematics teaching should be based on the needs of the science disciplines. The verbal tasks from different areas of life but also from physics, chemistry, biology, etc. should be the foundation of secondary school mathematics. This would bring school mathematics back to true mathematics and, in addition to its usefulness and need, pupils would rediscover its beauty and creativity in it. We consider the project-based teaching to be the most suitable form of teaching to achieve this goal. The great advantage of this form of teaching is especially the possibility of an interdisciplinary approach to solving of a given problem. It would also be appropriate in the framework of teaching of mathematics and science to give students the opportunity for independent discovery of a solution of the problem in the form of heuristic teaching. A positive attitude towards mathematics would be transferred to other areas of life where mathematics is used, including physics.

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APPENDIX

	1	2	3	4	5	6	7	
Easy								Difficult
Useful								Insignificant
Exciting								Boring
Simple								Complicated
Confusing								Clear
Good								Bad
Causing pleasure								Horrifying horror
Friendly								Unfriendly
Comfortable								Inconvenient
Valuable								Unnecessary
Laborious								Funny
Chaotic								Organized
Harmless								Dangerous
Risky								Safe
Understandable								Inconceivable
Easy to understand								Difficult to understand
Unacceptable								Acceptable
Interesting								Dull
Disgusting								Attractive
Relaxed								Tense

Table 2: Bipolar adjective pairs