

## Welcome

Our first English-language issue in 2022 will be published as part of a newer electronic version of the Open Journal System (OJS). Of course, the first ideas formulated in 2014 are still valid today: "... the existence and hoped-for development of our online digital periodical Opus et Education will be appreciated by the numbers and writings in the future," but the quality of services is becoming increasingly important in today's online world, reliability. To this end, we want Opus to meet the requirements required at the international level in the spirit of a conscious strategy. We hope that the new electronic interface, which provides more complex electronic services, will increasingly meet the expectations of our authors and readers. With new support for the editorial workflow, our authors can submit their article submissions to the Editorial Board in a more transparent and quality-friendly form.

Opus's structure has remained unchanged, and the thematic spectrum, in line with changes in the interconnected worlds of work and Education, is multidisciplinary, according to our original intentions. Like last year, we plan to publish two issues in English and two in Hungarian in 2022. Because of the increase in the number of authors, we would like to increase the number of scientifically qualified domestic and foreign colleagues who can be involved in proofreading articles, so in the coming weeks, we will seek to strengthen our proofreading background by recruiting professionals. I would also like to talk about the content features of this issue in this short introduction.

Although this issue is not thematic, the five communications in the **Studies** section address strategic issues. The paper of Péter Tóth and Kinga Horváth deals with the developmental issues of the ionic thinking of teachers in the 21st century. Tamás Kersánszky analyzes the STEM problem darkness in terms of integrated Education. Geoffrey Vaughan's study on Metacognition and Self-Regulated Learning is also a strategic thought. Katalin Kanczné Nagy's In the intersection of Art-Pedagogy-Psychology is also an important area, in which Agátha Csehova and Anita Tóth-Bakos's Art and Intercultural Education with Signs of Tolerance, Acceptance from the Perspective of Future Teachers is related. Renáta Marosi-Lengyel Language Learning with English Audio-visual Media Among the University Students of English Language and Literature at J. Selye University concludes the articles in the Studies section.

Our authors undertook to present new research results in our **Awareness** section. Judit Verecki's and András Benedek's review of the development of Institutional Leadership in the Hungarian Education System reviews the specific public education leadership training system that has developed in recent decades. Helena Manojlovic undertakes to analyze the application of a new and popular method in her work Escape room as a teaching method, illustrating international innovation efforts. Also, a complex analysis of an exciting topic was undertaken by Henrietta Muzsalyiné Molnár et al. Current trends and developments in the application of digital tools and implementation of environmental awareness and sustainability in PBL-based STEM education: a dual systematic literature review. Gives Insight into the Technological World of Far Eastern Universities I Wayan Eka Dian Rahmanu Study of Spherical Video-Based Virtual Reality (SVVR).

Thanks to Katarina Szarka, our readers can also get acquainted with a new project that reflects the aspirations of two countries: Exploring science, mathematics, and computer science education in high schools in selected regions of South Slovakia and Hungary. Finally, a review of a critical newly published note concludes the chapter, presenting to Teodóra Békefi the new volume of Didactics published by the University of Selyei, authored by Kinga Horváth and Péter Tóth.

Budapest, June 2022.

We wish our readers a pleasant summer and good reading

András Benedek  
editor-in-chief of Opus et Education

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Péter TÓTH, Kinga HORVÁTH

## The development level of pedagogical students' inductive thinking in the 21st century

### Introduction

Owing to the requirements of a knowledge-based economy, the role of higher education has been appreciated during the latest decades. Therefore, third and fourth-generation universities have become committed to developing those competencies of their students that make them able to meet the dynamically changing requirements of modern societies and work positions (Kozma & Pusztai, 2018; Gordon, 2003; Lukovics & Zuti, 2014). Moreover, competence development has been at the core of higher grade training besides teaching vocational knowledge.

According to several types of research, the labor market is expressing a solid demand so that career-starters should, in addition to their vocational knowledge, possess developed communication, organization, and problem-solving skills as well as analog and logical thinking, creativity, interpersonal skills, emotional intelligence and should be assertive and apt to be motivated. Professional literature calls these labor market key competencies (soft skills). However, the researchers also point to the fact that it is precisely these competencies in terms which career starter employees are unprepared when arriving from higher education to the labor market (Engler, 2019); companies often consider these competencies more critical than vocational preparedness (Veroszta & Nyüsti, 2015) and call the trainers to develop these skills (Kautz et al., 2014). According to a study by the Manpower Group (2015), 16 percent of the positions have remained unfilled owing to the lack of soft skills in Europe. The opinions about what competencies belong to soft skills are very diverse. Career-starters show the most deficiencies in intra- and interpersonal and some cognitive competencies and attitudes. Several studies refer to serious shortages in the so-called higher-level reasoning, including problem-solving, critical thinking, judging, and decision-making ability. At the same time, in the world of labor, these appear as demands in their organic relation system (Balcar, 2014; Carnevale, 2013; Eger & Grossmann, 2004; Cornalli, 2018).

In higher education, pedagogical and teacher training plays a unique and outstanding role in many respects. The training does not only aim to develop the students' specific labor market competencies but to make them ready and able to develop the labor market competencies of their students, as well. So in training programs, the competence requirements teacher students meet must also include the methodology of developing these competencies.

Higher education can fulfill this requirement in case educators working in teacher training (1) are aware of what the key competencies of the pedagogic profession are, (2) know the development level of the competencies of the future pedagogic professionals, (3) are aware of the competing demands of the schools, and (4) know how the competencies presented in point (1) can be diversely developed so that by the end of the training the difference between the expected and the current competence levels can be as trim as possible.

According to another point of view, these soft skills are vital competencies, and their attainment influences the quality of teaching in public education. Furthermore, this is a decisive factor in promoting effective learning (Tang, 2013). At the same time, teaching is also a complex activity that needs a comprehensive set of knowledge and skills, including hard and soft skills, so that the teacher can handle classroom needs and problems successfully (Tang et al., 2015b; Flores & Day, 2006).

Consequently, teacher trainers face the challenge of how future teachers can be prepared to meet the labor market requirements; the school, in this case, takes the students' age characteristics and personal endowments into consideration.

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It cannot be postponed any longer – developing soft skills must be given more significant stress in teacher training and in-service training programs, primarily in the methodologies.

In order to be able to meet the presented requirements, the trainers must be able to assess the development level of pedagogical students' competencies. Hence, not being reliable and valid measuring tools for each soft skill. Logical reasoning and its components, rule induction, and analog and diagrammatic reasoning do not belong to this group.

Thus, this research can be considered a kind of a "situation analysis" as it was aimed to get to know what development level the education students entering higher education are at in terms of logical thinking, which is one of the labor market's key competencies (soft skills), i.e., what is the initial competence level in this field.

## **Conceptual background**

### ***Concept of Soft Skills***

As presented above, in addition to professional successes, or instead as their preconditions, the so-called soft skills are getting increasingly important and play a significant role in employability and achieving wealth and personal objectives.

Some authors identify soft skills with other characteristics; for example, Verma (2013) draws a parallel between soft skills and emotional intelligence, saying that a person more developed than the average can positively manage other people's behavior and positively impact them. Others think that soft skills are synonyms for employability (Prasad & Nagendra 2017), which indicates that to improve the chances of getting employed, one must have, in addition to his/her technical competencies, these skills and competencies throughout his/her life. Carneiro et al. (2007) stress the social utilization of soft skills. Besides this, by putting the aspects of using info-communication tools into the foreground, Meacham et al. (2014) distinguish between old and new soft skills. Communication skills, the ability to react, and teamwork appear in the new category, as well but already in the context of application in the online space.

It has been proved that the critical competencies demanded by employers are of fundamental importance in successfully implementing work activities (Pachauri & Yadav, 2012; Orlando & Altomari, 2019). These include employee engagement, interpersonal competencies, practical communication skills, emotional self-control, and problem-solving (Carnochan et al., 2014). These inter- and intrapersonal competencies refer to personality, attitudes, and behavior (Moss & Tilly, 2001) as well as aims, motifs, and personal preferences (Heckman & Kautz, 2012). This personality-specific competency determines one's strengths as a leader, facilitator, or mediator (Robles, 2012; Pisoňová, 2017). Cognitive and metacognitive skills represent the dynamic combination of intellectual and practical competencies (Haselberger et al., 2012, Cinque, 2016) that keep developing throughout one's life (Knight & Page, 2007) and are inevitable in community existence and workplace successes (Kechagias, 2011).

### ***Teachers' Soft Skills***

Soft skills can be developed the most effectively during education, so teachers play a decisive role in this process.

It is important to emphasize that the teachers do not only have to adapt to the requirements of the pupils and their parents (Brewster & Railsback, 2001) and must provide the effectiveness of the teaching-learning process (Pellerey, 2017) but also have to meet social and labor market expectancies (Bauman, 2011). Therefore, the development of transversal competencies (Svecnik, 2008; Tang et al. 2015a; Orlando & Altomari, 2019), known as teacher competencies, is a prime target. The comparative research that was implemented in 2011 and 2018 with the involvement of first-grade teacher students

and that examined the attitudes toward teacher competencies, abilities, and skills as well as to other knowledge and forms of behavior found that some capabilities (professional behavior, the ability to perform high-quality work, the ability to defend and protect, health consciousness, environmental consciousness, and moral competence) were judged significantly more critical by correspondence students than by full-time students.

According to Hattie (2003), teachers with developed soft skills exert direct influence on their pupils' interest, engagement, and the evolution of their future capacities (Salleh et al., 2010), and their role is vital in improving self-evaluation, self-knowledge, and other personal characteristics (Tang et al. 2015a; Csehiová & Kanczné, 2019; Csehiová, Kanczné Nagy & Tóth-Bakos, 2020; Baka, L. P., 2021).

Soft skills play an outstandingly important role in interpreting and understanding complex situations; therefore, they must be paid attention to when compiling the teacher training program. Many studies dealing with the soft skills needed for effective and successful teaching (Tang, 2018; Rashidi et al., 2018; Orlando & Altomari, 2019) distinguish between five components: communication, leadership and direction, teamwork, life-long learning, and problem-solving. Other authors mention specific moral characteristics, professional knowledge, and entrepreneurial competence (Pachauri & Yadav, 2012; Tang, et al., 2015b). Tang et al. (2015c) found that the five soft skills (teamwork, communication, leadership skills, critical thinking, and problem-solving) are significantly connected to the restfulness of teaching.

Using developed problem-solving skills, teachers' thinking may become critical, creative, innovative, and analyzing, which is of outstanding importance since, by way of these, they can offer their students new ideas and alternative solution possibilities (Orlando & Altomari, 2019). In cognitive pedagogy and psychology, the development of cognitive competencies has long been one of the essential education objectives (Resnick, 1987), as they include the ability to reason and explain, abstract notions, apply rules and draw conclusions (Holmes, 2002) as well as to gain and utilize new knowledge or use existing knowledge during the solution of new problems (Molnár et al. 2013).

Thinking is the base for all cognitive activities or processes characterizing humankind (Wu, 2011) and is the highest level of acquiring knowledge. The changes in individual thinking that appear in various contexts originate from the actual mutual effect of the cognitive system and the available environmental structure (Plumert, 2008). The personal ability to think in a disciplined way or to build one's thoughts on facts and proofs is known as the skill of logical Thinking (Wu, 2011). The ability to think logically means that logic is built into the thinking process when a problem is analyzed to find a solution. Logical thinking means that one sets reasonable goals, implements adequate operations according to the goals and hypotheses, and, considering the available proofs, comes to conclusions that prove or confuse one's hypotheses (Stanovich et al., 2008). The capability of analytic and logical thinking makes it possible to comprehend complex interrelations, transplant the gained information into a new structure quickly, and interpret it to solve the new problem.

### ***Role of Inductive Reasoning in Problem Solving***

Carroll (1993) mentioned inductive and deductive cognition as the "sub-skills" of the capacity of logical cognition. Inductive thinking is needed primarily when observations and experiences can be used in totally new (problem-solving of productive nature) or partly new, similar situations (problem-solving of reproductive nature). The new knowledge gained during such a process always bears the possibility of uncertainty and mistake. The main aim of inductive reasoning is to recognize regularities and generalizations (Mousa, 2017). According to Klauer (1999), the process of comparing is one of the essential characteristics of inductive reasoning. During this process, it is defined in the first step as the characteristics of the elements of reality and the relations between the specific elements, then similarities and differences are observed using which rules are recognized. Finally, generalizations and predictions can be formulated based on the rules identified while analyzing the observed cases; in this phase, inductive conclusions can be drawn.

Inductive thinking or reasoning plays an outstanding role in the cognition processes; it is understood as a general cognition capability (Pellegrino & Glaser, 1984; Molnár et al., 2013) that is connected to almost each higher-level cognition skill (Csapó, 1997; Molnár et al., 2013; Schubert et al., 2012; Alrawili et al., 2020), like for example, general intelligence (Klauer & Phye, 2008), the skills of gaining and applying knowledge (Hamers et al., 2000), abstract thinking (Goswami, 1991) or problem-solving.

Inductive reasoning is also referred to as the means of gaining new knowledge and the indicator of the learning potential and is also assigned an essential role in the transferability of knowledge (Resing, 1993). Research aimed at the exploration of general intelligence keeps count of it as one of the decisive factors in the effectiveness of the various operational processes of cognition (Carroll, 1993; Demetriou et al., 2011). The empiric research conducted with students starting their university studies and focused on inductive reasoning made it clear (Pásztor, 2019) that a quarter of the students were likely to face learning difficulties during their university years.

### ***Research Aim and Research Questions***

As presented above, inductive thinking is vital in teacher training as a soft skill. It is an essential key competence of the training, which must be developed – for two reasons. First, it plays an essential role in gaining knowledge, and so successful learning, for each teacher-student, and on the other hand, if highly developed, it will allow future teachers to improve their pupils' inductive thinking effectively.

In order that teacher training can fulfill its tasks effectively, educators must know and be able to examine the teacher candidates' key competencies, particularly their inductive thinking. This double aim makes this research especially timely.

Taking all this into consideration, the aim of this research was to

- describe the development level of first-grade teacher students' inductive reasoning,
- analyze the time spent on solving the tasks and task items,
- explore the relationship between the time consumed and the performance achieved in the inductive test.

### **Methodology of Research**

#### ***General Background***

From the time used for task solution, the speed of thinking can be concluded, allowing the determination of specific performance.

Specific performance indicates restfulness and can be described as the fraction of the consumed time and the achieved score.

According to Carroll (1993), those possessing more developed thinking skills can solve mathematical problems faster than people with weaker capacities, so there is a correlation between the development level and the pace of cognition (cited by: Sternberg & Ben-Zeev, 1996). Some query this standpoint (Winch, 1990). According to Sternberg and Pellegrino (cited by: Sternberg, 1985), the time used to choose a correct answer can predict the performance more precisely than the skill level itself.

Other researches were aimed at whether it was possible to conclude the item's difficulty level from the solution time. For example, Jacobs and Vandeventer (1968) said that the difficulty level of the items did have a correlation with the number of characteristics to be compared or remembered simultaneously; i.e., those achieving better results were able to keep several issues in mind at one time, but this could also mean that they dedicated more time to solve the given item (Georgiev, 2008). On the other hand, Vodegel Matzen et al. (1994) refer to Home and Habon's work which found that no conclusion can be drawn concerning the difficulty level of the items based on time consumption.

In this research, the tests developed by Psychometric Success WikiJob Ltd. (UK, London) were applied, paying particular attention to labor market demands (Newton & Bristol, n.s.). When developing the test, the experts based their measurement tools on one- and multifactor intelligence tests (Sternberg, 1985). The sample tasks of the test are available here: <https://psychometric-success.com/>.

According to Spearman (1927), the persons achieving good results in specific skill tests achieve good results in other performance tests, like mathematical tests or a worksheet measuring spatial skills; similarly, those producing weaker results in the given skill test will perform more weakly. Therefore, he thought one or more common factors concerning solving all intellectual tasks were the clues to success (Mackintosh, 1998).

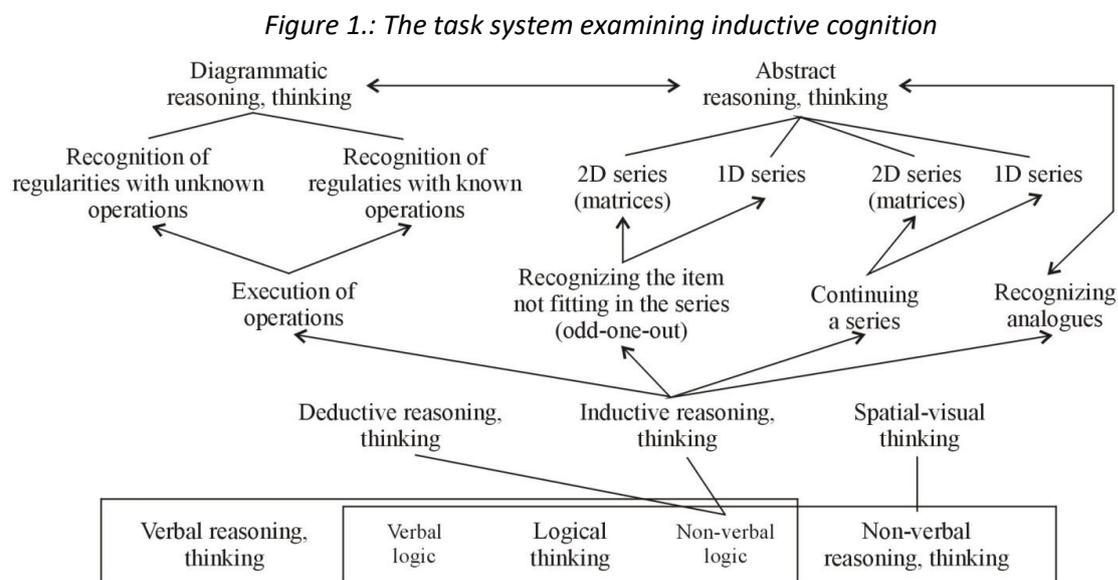
Spearman (1927) divided the g-factor into two parts: (1) implicative logical (eductive) skills and (2) reproductive skills connecting to the storage and recall of information. For example, the Raven or the test applied in this research (Newton, Bristol, n.s.) belongs to the former.

Eductive competencies refer to logical operations based on a conclusion through which new knowledge is created from the perceived information through recognizing and comprehending interconnections and considering the contextual content.

A holistic approach is needed to understand the whole of the problem, while its solution demands the ability to recognize the relations and interdependences between the parts. Understanding the problem is more than comprehensive pattern recognition (Gestalt); highlighting the essence and neglecting unimportant elements is also necessary. In most cases, these cannot be verbalized; therefore, the measuring tools mainly consist of geometrical figures (squares, polygons, circles, etc.). The perception of these geometrical forms, the recognition of their typical characteristics, and the comprehension of the relations between them are dependent on the existing knowledge on the one hand and specific cultural effects on the other (Kane & Brand, 2003). The previous one is in harmony with the inductive operations (Klauer & Phye, 2008). As for the latter, one of the main advantages of the test must be stressed: it is, to a certain extent, culture-independent.

### **Instrument**

To examine cognition based on inductive implications, Newton and Bristol (n.a.) elaborated on the skill structure presented in Figure 1.



In this research, an inductive reasoning test made of 30 items was applied, which consisted of the following task types:

- Task1: Continuation of one-dimension series (6 items);
- Task2: Recognition of the (' odd-one-out) elements not fitting in the one-dimension series (6 items);
- Task3: Recognizing an analog (6 items);
- Task4: Recognizing regularity – unknown operation (diagrammatic cognition) (6 items);
- Task5: Recognizing regularity – known operation (diagrammatic cognition) (6 items).

Online tests were applied during the research, which allowed to measure the time used for specific items. This was necessary for research objectives 2 and 3.

### **Data Analysis**

First, the outcomes of the online measurement were examined by descriptive statistical analysis. The characteristics and structure of the components of inductive reasoning were determined by the univariate analysis. The mean and the standard deviation of the certain variables and the quartile values were also given first by tasks, then according to the components of inductive reasoning (abstract, diagrammatic and analog reasoning) for the whole sample, and finally, in terms of the certain background variables (type of training, specialization, gender, place of stay during the studies), too. The variables' values also define the confidence interval by 95% probability. Since most of the variables were not of normal distribution, the Mann-Whitney test was applied to compare certain sub-samples to see whether they were significant differences.

Tasks also made a statistical analysis of time consumption in order to be able to observe the inner correlations of their difficulties. Online measurement also allowed for analysis of the sound and wrong answers.

To examine the relationship between time consumption and inductive reasoning, the concept of specific performance was introduced, using which the performance of the students with the best results was compared. In the inductive test, specific performance was understood as the time necessary to achieve a unit of the score, which was defined as the ratio of consumed time and the score achieved by items:  $\text{Timex/scores}$ , where Timex indicated the time spent on solving task x (6 items) by seconds, while scores represented the score reached during this time.

Regression analysis was used to define the relationship between the score achieved in the test and time consumption and to determine how many percent of the variance the model accounted for.

Based on time consumption and the achieved scores, homogenous groups were created by cluster analysis of the whole sample, and then, by using the background variables, we specified their characteristics. Finally, reliability was checked by the K-means test.

### **Participants**

The research, implemented in 2019 at the Faculty of Education at J. Selye University, Komarno, Slovakia, involved 204 first-grade teacher students. The demographical data of the participants are summarized below:

- Sex: 17.6% (N=36) male, 82.4% (N=168) female;
- Age: M=25.10 years, Modus: 20 years, SD=8.267 years, 76 persons (37.2%) between 19 and 20, while 49 persons (24.0%) between 21 and 22;
- Father's highest education level: primary school 9 persons (4.4%), trade school with no graduation exam 85 persons (41.7%), vocational secondary school 72 persons (35.3%), grammar school 18 persons (8.8%), higher education 20 persons (9.8%);
- Mother's highest education level: primary school 17 persons (8.3%), trade school with no graduation exam 47 persons (23.0%), vocational secondary school 85 persons (41.7%), grammar school 24 persons (11.8%), higher education 31 persons (18.2%);

- Place of living: city 92 persons (45.1%), other settlement 112 (54.9%); Country of secondary school graduation exam: Slovakia 120 persons (58.8%), Hungary 83 persons (40.7%);
- Type of the school of secondary school graduation: four-grade grammar school 70 persons (34.3%), eight-grade grammar school 9 persons (4.4%), vocational secondary school 113 persons (55.4%) and adult education 12 persons (5.9%). Rate of those having taken their secondary school graduation exams at Hungarian speaking vocational secondary schools in Slovakia: 60%, while this number is only 48.8% with those having taken their graduation exams in Hungary;
- Language of teaching at secondary school: Hungarian 182 persons (89.2%), Slovakian 12 persons (5.9%), bilingual 10 persons (4.9%);
- Specialization: teacher training 57 persons (27.9%), pre-school teacher education 127 persons (62.3%), pedagogy and public education 19 persons (9.3%);
- Training: full-time 145 persons (71.1%), correspondence 59 persons (28.9%);
- Place of stay during the studies: live at home 127 persons (62.3%), at dormitory 71 persons (34.8%), in lodgings 6 persons (2.9%);
- Family conditions: live with their families 160 persons (78.4%), with a life-partner or spouse 31 persons (15.2%), alone 7 persons (3.4%), with a friend 6 persons (2.9%).

According to the data presented above, most of the students had their secondary school leaving exams in Hungarian at vocational secondary schools, and the rate of those having applied for the full-time pre-school teacher training was high. A high proportion of the students took their exams in Hungary. It is important to remark that the J. Selye University is close to the Slovakian- Hungarian border, so students in Hungary can reach it easily. As for the parent's education level, the rate of those with vocational secondary education was high.

## Results of Research

### *The development level of inductive cognition*

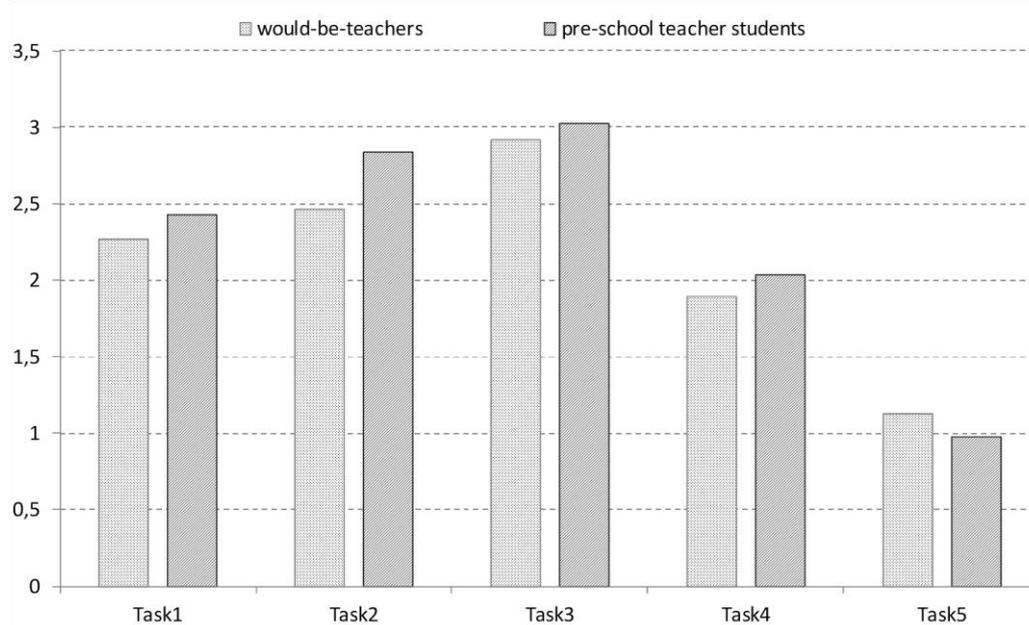
The descriptive statistical indicators of the whole sample are summarized in Table 1. The best results were born in recognition of the analog (Task3) and the odd-one-out (Task2), while the weakest ones in the task required the recognition of regularities containing known operations (Task5). Concerning the latter, the difficulty was probably caused by the high level of memory burden since the results of certain operations had to be stored in the short-term memory and then to be modified with new operations and choose the correct final result from the available list; sensual – perceptual shifts must have caused trouble to the students. On the other hand, the students did not have enough time left for the last task because they consumed plenty of time for solving the first task, so they mapped out their time improperly, and the novel nature of the last task-induced difficulties as well.

Table 1.: Descriptive statistical indicators by tasks

Descriptive statistical indicators		Task1	Task2	Task3	Task4	Task5	
Whole sample	N	186	184	179	179	179	
	M	2.39	2.73	2.97	1.96	0.98	
	SD	1.344	1.311	1.607	1.546	1.030	
	95% Conf. int.	Lower	2.20	2.53	2.73	1.73	0.83
		Upper	2.59	2.92	3.20	2.18	1.14
	Percentiles	25%	1	2	2	1	0
		50%	2	3	3	2	1
75%		3	4	4	3	2	

Sex	male (27 pers)	M	2.59	2.13	2.61	1.43	0.83
		SD	1.526	1.361	1.644	1.805	0.937
	female (159 pers)	M	2.36	2.82	3.02	2.03	1.01
		SD	1.313	1.283	1.600	1.496	1.044
Training	full-time (127 pers)	M	2.35	2.,54	2.80	1.82	1.05
		SD	1.847	1.334	1.618	1.460	1.078
	correspondence (59 pers)	M	2.49	3.14	3.32	2.25	0.84
		SD	1.318	1.167	1.539	1.698	0.910

Figure 2: Average results of the certain tasks in terms of the two examined specializations



The students' results were compared by the various sub-samples, as well.

Except for the first one, females achieved better results, and as for the odd-one-out (Task2: Mann-Whitney  $U= 1348.500$ ;  $p<0.05$ ) and the recognition of regularities containing unknown operations (Task4: Mann-Whitney  $U= 1265.000$ ;  $p<0.05$ ), they reached significantly better results than men.

Correspondence students achieved better results for each task, except for the last one, in recognition of the odd-one-out elements (Task2: Mann Whitney  $U= 2542.500$ ;  $p<0.05$ ) and the analog (Task3: Mann Whitney  $U= 2795.000$ ;  $p<0.05$ ), they achieved significantly better results than full-time students.

Regarding the parents' educational level, the type of settlement where they lived, and the type of secondary school (grammar or vocational), any significant differences were not found in the averages of specific tasks. The same applies to the student's specialization and the country of the secondary school leaving exam (Hungary, Slovakia). However, it must also be remarked that the pre-school teacher students achieved better results (Figure 2) than their would-be-teacher peers, and so did those having taken their exams in Hungary as compared to those finishing their secondary school studies in Slovakia. However, these results cannot be generalized.

The results of the inductive reasoning test were summarized according to Figure 1: abstract reasoning, analog thinking, and diagrammatic thinking. The descriptive statistical indicators of these have been summed up in Table 2. Concerning abstract reasoning and considering the background variables,

significant differences were found in terms of the student's specialization (Mann-Whitney  $U= 2598.500$ ;  $p<0.05$ ) and their place of stay during their studies (Mann-Whitney  $U= 2614.000$ ;  $p<0.05$ ). Correspondence students and those studying at home reached better results in each cognition component. In summary, it can be stated that the development level of the abstract and analog reasoning of these first-grade students was medium, while that of their diagrammatic thinking was weaker.

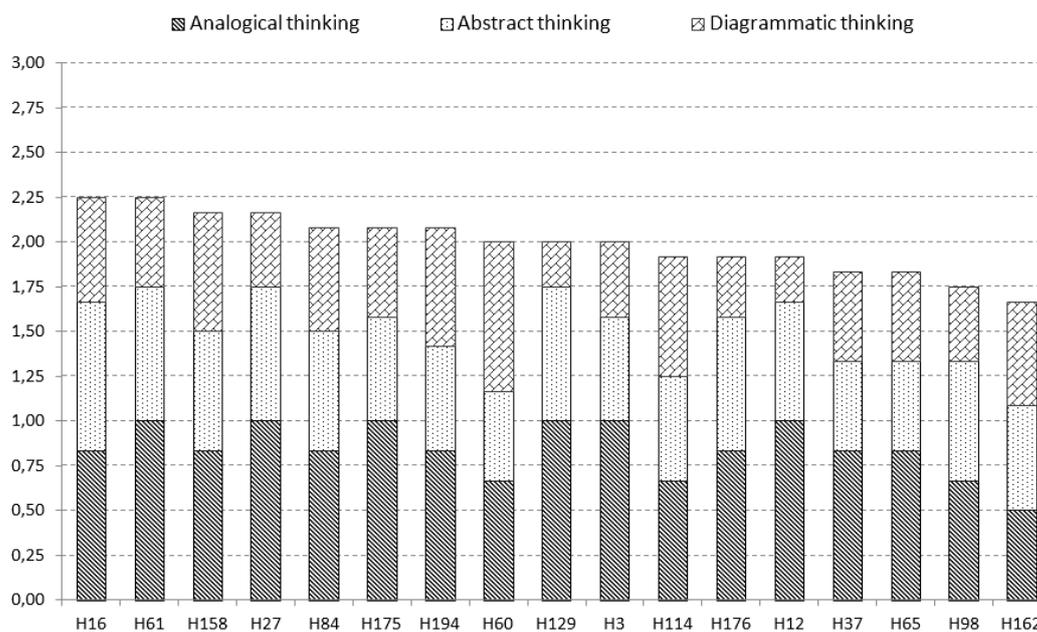
Table 2: Descriptive statistical indicators of inductive thinking and its components

Descriptive statistical indicators			Abstract cognition (12 items)	Diagrammatic cognition (12 items)	Analogue cognition (6 items)	Inductive cognition (30 items)
Whole sample	N		180	179	179	179
	M		5.17	2.94	2.97	11.08
	SD		2.065	1.917	1.607	3.862
	95% Conf. int.	Lower	4.86	2.66	2.73	10.51
		Upper	5.47	3.22	3.20	11.65
	Percentiles	25%	4	2	2	8
		50%	5	3	3	11
75%		7	4	4	13	
Training	full-time (124 pers)	M	4.90	2.87	2.80	10.59
		SD	2.097	1.864	1.618	3.944
	correspondence (56 pers)	M	5.75	3.09	3.32	12.16
		SD	1.881	2.039	1.539	3.468
Place of stay during studies	at home (116 pers)	M	5.44	2.95	3.07	11.46
		SD	1.979	2.012	1.548	5.282
	dormitory (58 pers)	M	4.72	2.79	2.63	10.16
		SD	2.118	1.612	1.676	3.877
Specialization	would-be-teacher (38 pers)	M	4.82	3.03	2.92	10.76
		SD	2.437	2.354	1.583	4.727
	pre-school teacher (124 pers)	M	5.32	3.00	3.02	11.35
		SD	1.957	1.808	1.585	3.658

Pre-school teachers achieved better results than would-be teachers in each cognition component; however, these differences are insignificant.

The results of the 10 percent of students (17 persons) who had achieved the best (more than 16 points) were also evaluated in the inductive test separately. The cumulate diagram of the relative values of the part components is presented in Figure 3. The relative values of each of the three components fall between 0 and 1, thus cumulating them; the values between 0 and 3 are shown on the vertical axle. Only three students (H60, H114, and H162) have diagrammatic thinking at least as developed as the other two components. On the other hand, 6 students achieved the maximum result in the analog reasoning test, and their weaker result in the diagrammatic test debased their total performance (H61, H27, H175, H129, H3, H12).

Figure 3.: Rates of the components of inductive cognition at the students with the best results



Relying on the analysis of the students' background variables with the best results, the following statements can be made. In this group of students, the proportion of

- those with a mother (29.4% vs. 15.2%) and father (23.5% vs. 9.8%) with a degree;
- women (94.1% vs. 82.4%);
- those living in a city (53.0% vs. 45.1%);
- having taken their school-leaving exams at grammar schools (47.1% vs. 38.7%) and
- taking their school-leaving exams in Hungary (52.9% vs. 40.7%) was higher.

However, no significant differences in specialization were found, the type of training, the place of stay during the studies, and the distance of the place of living from the university.

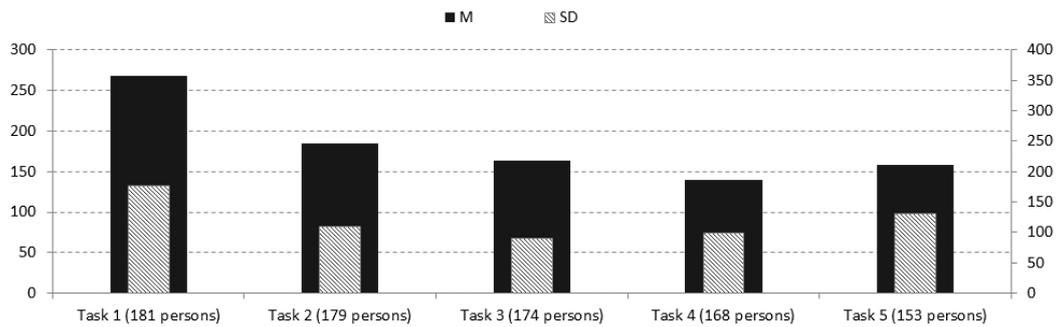
### ***Time used for task solution***

The second objective of this research was to analyze the time spent on solving the tasks and task items.

The students were given 1500 seconds to solve the tasks. Online measuring allowed to register the time spent on task solutions by items; thus, it became possible to analyze and compare them with the achieved results.

The first-grade would-be-teachers consumed the most time for solving the series continuation (Task1) and used the least time for the diagrammatic task containing unknown operations (Task4) (Figure 4). If these are compared to the data presented in Table 1, it can be stated that there is a correlation between the average results of certain task types and time consumption. However, high deviation rates imply considerable personal differences.

Figure 4.: Average and deviation of time spent on solving the certain task types

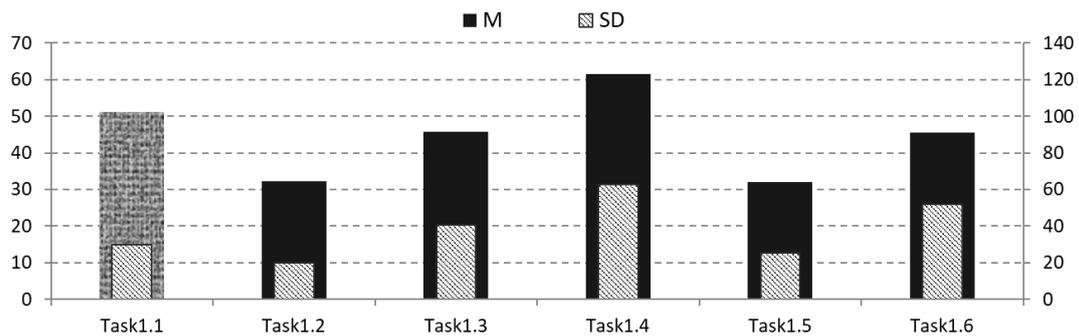


Remark: The left-hand vertical axle indicates the averages while the right one shows deviation.

If we focus on the first items, very diverse phenomena analyze the last task type, and the time consumption will also be found.

The items of the series continuation task (Task1) differed. However, the students understood the task relatively quickly, so time consumption reflects the difficulty level of the given item (Figure 5). It is also apparent that the more complex an item was (e.g., Task 1.4), the more significant personal differences could be observed, which is proved by high deviation values.

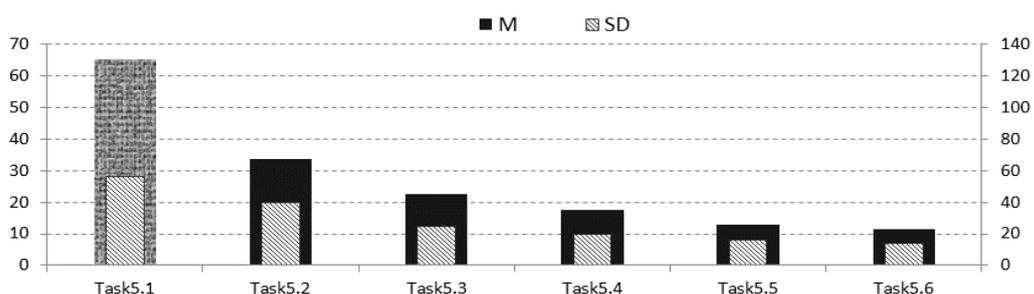
Figure 5: Average and deviation of the time spent on the series continuation items



Remark: The left-hand vertical axle indicates the averages, while the right one shows deviation

Another phenomenon can be noticed regarding the diagrammatic items using general operations (Task5). According to Figure 4, the average time consumption of this task type almost agrees with that of the analog task (Task3). However, it can be seen that the first item meant a real challenge for the students (Figure 6), i.e., at first, they faced problems with understanding. Later this decreased gradually. Personal differences were less typical here, reflected by much more common deviation values; thus, it was equally difficult to solve the items for everyone in this case. As a result, students tended to rely on guessing rather than thinking thoroughly.

Figure 6: Average and deviation of the time used to solve the diagrammatic items containing known operation



Remark: The left-hand vertical axle indicates the averages, and the right one shows deviation.

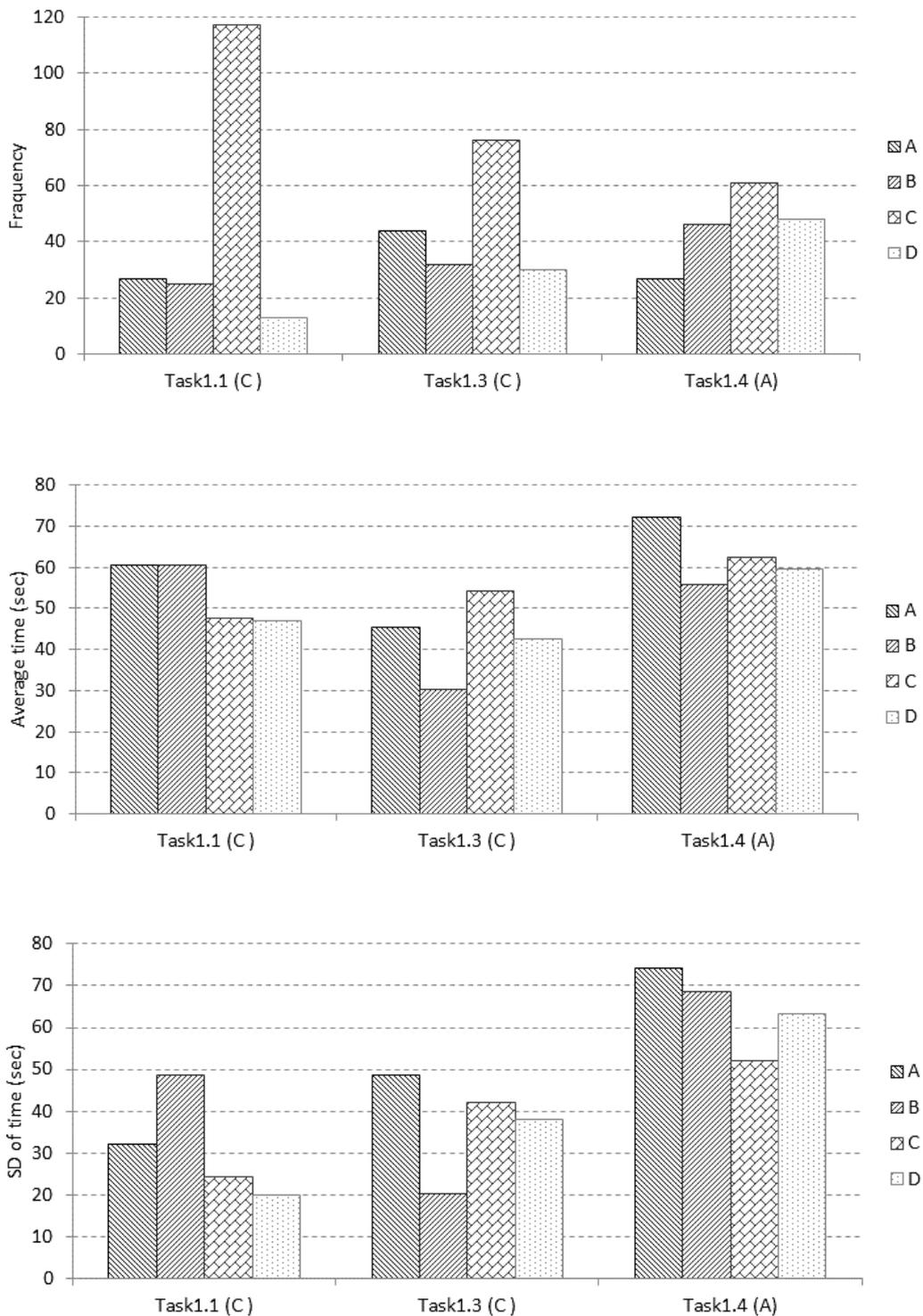
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Returning to Figure 5, the online framework system allowed the analysis of the students' solutions to specific items. Three kinds of solutions were found for the series continuation task type (Figure 7). Task 1.1 was easy, and many of the students were able to solve it. Those choosing the correct answer (C) found the solution fast. The few who chose a lousy answer had spent a long time thinking about the solution. The solution of Task 1.3 shows more considerable divergence. The false solution B was chosen by many students, after a short time of thinking and with low personal differences (the good solution was C). Task 1.4 proved to be rather tricky. Many chose false answers (B, C, D), with high time consumption and significant personal differences. The ones choosing the correct answer (A) used the most time for thinking, with considerable differences. The students giving the correct answer were also analyzed separately. 25 percent of the 27 students consumed less than 25 seconds to choose the correct answer, while 25 percent used more than 89 seconds. That someone solved this difficult task did not necessarily mean that he/she succeeded with the easier ones. There was only one student who managed to solve each of the 6 items without any mistakes. Most of them had 3 reasonable solutions for this task type. The descriptive statistical indicators of these students are significantly better than those presented in Table 1 ( $M= 3.44$ ;  $SD= 1.155$ ).

Time consumption in Task 2 and Task 3 was similar to that in Figure 5, while Task 4 resembled Figure 6.

Concerning the background variables, significant differences were found in terms of gender and the type of training. Women spent significantly more time on solving Task 2 (females:  $M= 169.85$ ;  $SD= 101.801$ ; males:  $M= 164.07$ ;  $SD= 105.657$ ; Mann-Whitney  $U=1348.500$ ;  $p<0.05$ ) and Task 4 (females:  $M= 135.51$ ;  $SD= 97.742$ ; males:  $M= 101.53$ ;  $SD= 79.097$ ; Mann-Whitney  $U= 1265.000$ ;  $p<0.05$ ) than men. Correspondence student spent significantly more time on solving Task 2 (correspondence students:  $M= 212.44$ ;  $SD= 112.63$ ; full-time students:  $M= 150.95$ ;  $SD= 91.453$ ; Mann-Whitney  $U= 2542.500$ ;  $p<0.05$ ) and Task 3 (correspondence students:  $M= 194.49$ ;  $SD= 70.356$ ; full-time students:  $M= 137.90$ ;  $SD= 90.079$ ; Mann-Whitney  $U= 2795.000$ ;  $p<0.05$ ) than full-time students.

Figure 7.: Frequency of the series continuation items and mean and standard deviation of time consumption by items



**Relation between the time used for task solution and inductive cognition**

To explore the relationship between the amount of time used for task solutions and inductive reasoning, it was first based on the results of the best 27 students.

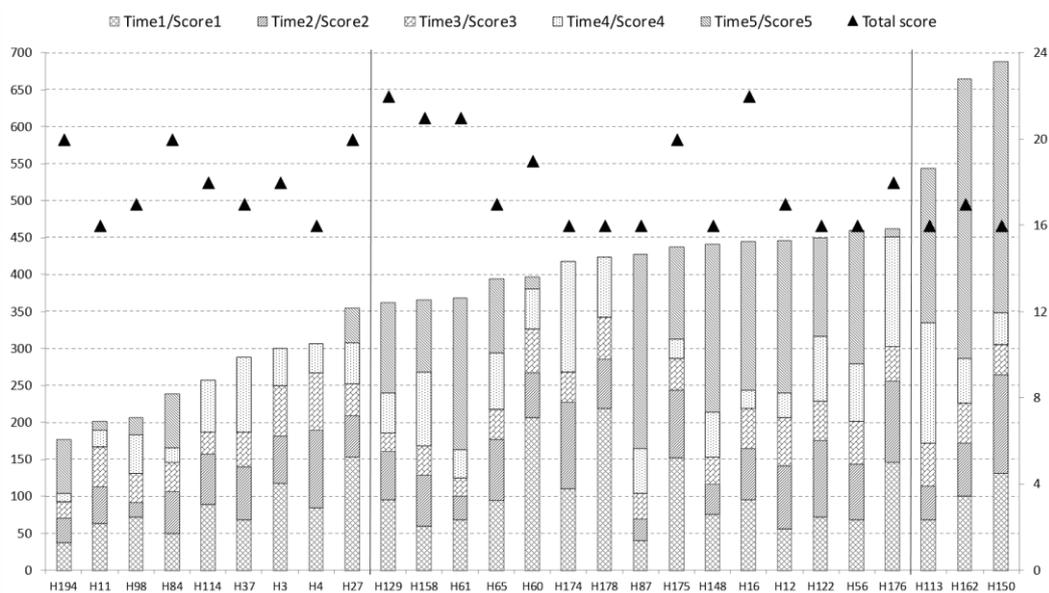
The students with the highest scores were ranked based on specific performance (Figure 8). 300 sec/point as the high specific performance was considered, which means that the students achieved a high number of points using little time. The values between 300 and 450 sec/point were assessed as

specific performance of medium level, while the values above were considered low specific performance, i.e., a high amount of time was used to reach one unit of points.

Figure 8 shows that in almost all cases (except for, e.g., H60, H11, or H176), the last task requiring diagrammatic thinking debased specific performance. However, there were also students who spent 4-5 minutes on this task, but they could solve any items from correctly (i.e. H37, H114, H4).

27 students were ranked according to the total scores gained in the five task types (Figure 9). It can be seen that the students, in most cases, utilized the whole time available; however, in each score category, there were one or two students who achieved results similar to the others' with little time consumption. For example, H11 or H87 in the 16-points group, H98 in the 17-points group, or H194 and H84 in the 20-points group.

Figure 8.: Specific performance of 27 students



Remark: The left-hand vertical axle indicates time and the right one shows the scores.

Figure 9.: Time consumption and total score of the 27 students

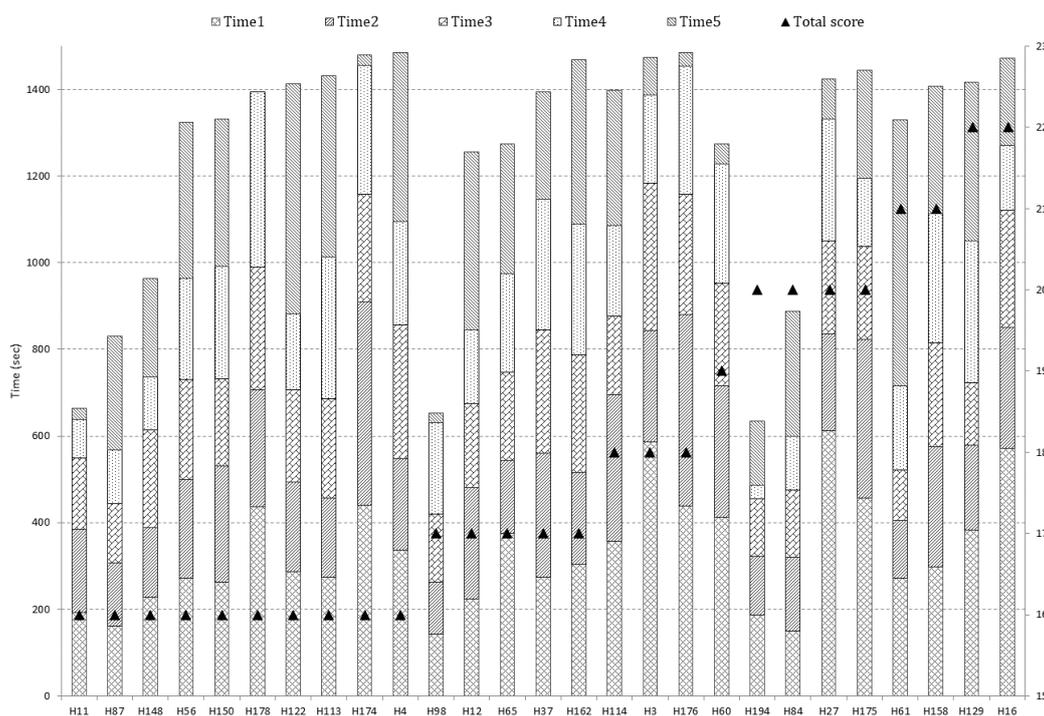


Figure 10.: Relation between time consumption and total score of the whole sample

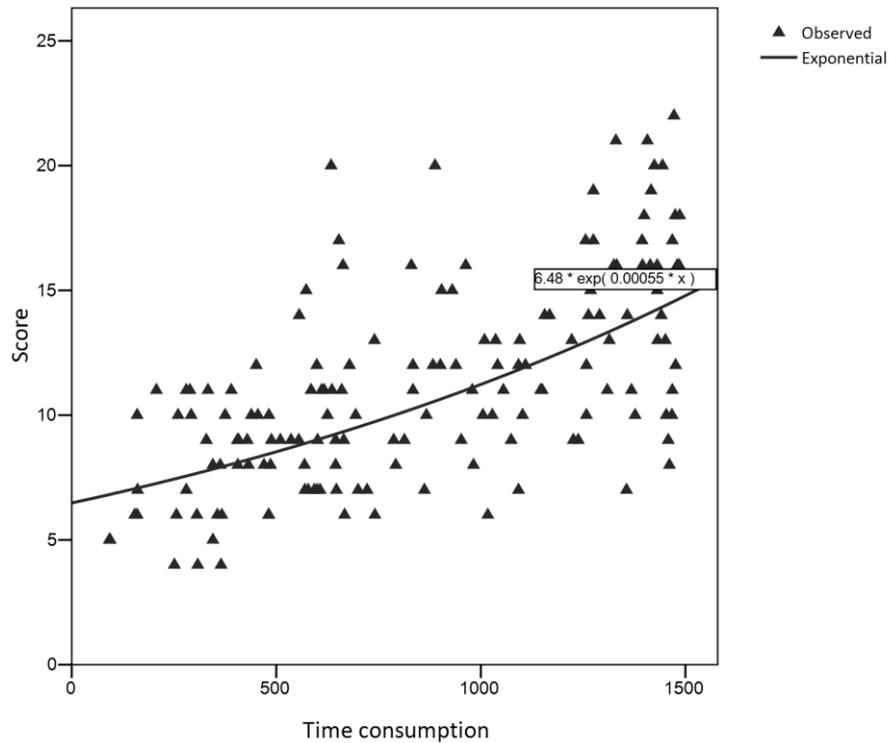
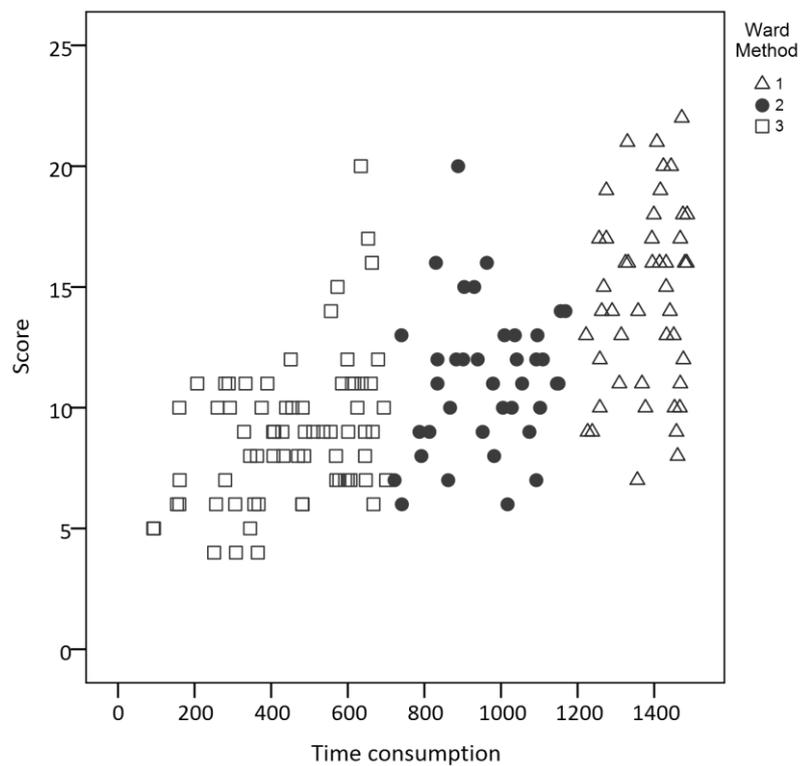


Figure 11.: Clusters composed in terms of the whole sample



It can be stated that the full utilization of the available time did not necessarily mean a high score; however, it is visible that each of the students, having reached more than 20 points, used almost entirely the 25 minutes available for the test.

The relation between time consumption and gained points was also examined in terms of the whole sample (Figure 10). The relation can be described sufficiently by an exponential function:

$$\text{Score} = 6.48 * \exp(0.00055 * \text{Time consumption})$$

The model accounts for 39.9% of all of the variances. The ANOVA test indicates a significant regressive relation ( $F=100.318$ ;  $p<0.05$ ).

Finally, a cluster analysis of the whole sample has been made. Clusters can be created according to the time used for the task solution. In this case, three groups can be created (Figure 11):

- "negligent "and superficial ones;
- considered but not persistent enough;
- persistent and diligent ones.

Each of the three groups contains students with low and high scores, as well; however, the tendency is what has been described by the regression analysis.

Reliability was checked by the K-means probe and was found satisfactory. The data of the cluster centroids are summarized in Table 3.

Background variables also examined the composition of the clusters in terms of the whole sample (Figure 12-13). A more significant rate of the full-time students belongs to Cluster3 while correspondence students belong to Cluster1. Most would-be teachers are part of Cluster3, the ones in the pedagogy and public education program to Cluster2, while preschool teacher students mainly belong to Cluster1 and Cluster3. It was proved by the Khi-square probe that there was a significant correlation between the type of training and belonging to a cluster ( $F= 18.473$ ;  $p<0.05$ ) and between the program attended and belonging to a cluster ( $F= 15.138$ ;  $p<0.05$ ). Summarizing these, Table 4 presents the explanation of the clusters.

Table 3.: Cluster centroids and deviation

Cluster		Score achieved in the test	Time used for task solution
1.	M	1378.36	14.51
	N	45	45
	SD	84.658	3.841
2.	M	961.000	11.21
	N	38	38
	SD	128.830	3.024
3.	M	455.79	8.93
	N	70	70
	SD	166.251	2.994
Total	M	852.61	11.14
	N	153	153
	SD	419.463	4.023

Figure 12.: Belonging to clusters by type of course

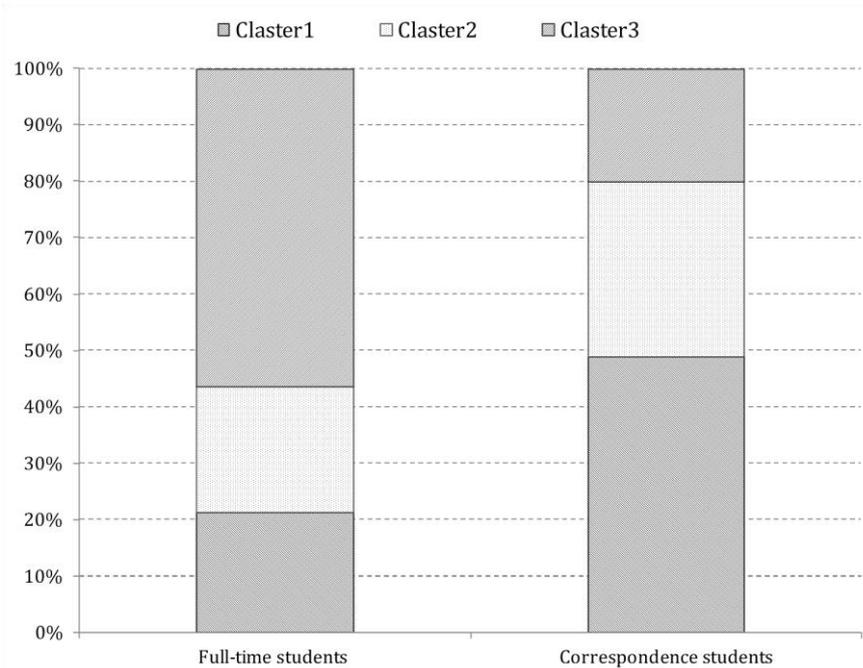


Figure 13.: Belonging to clusters by specialization

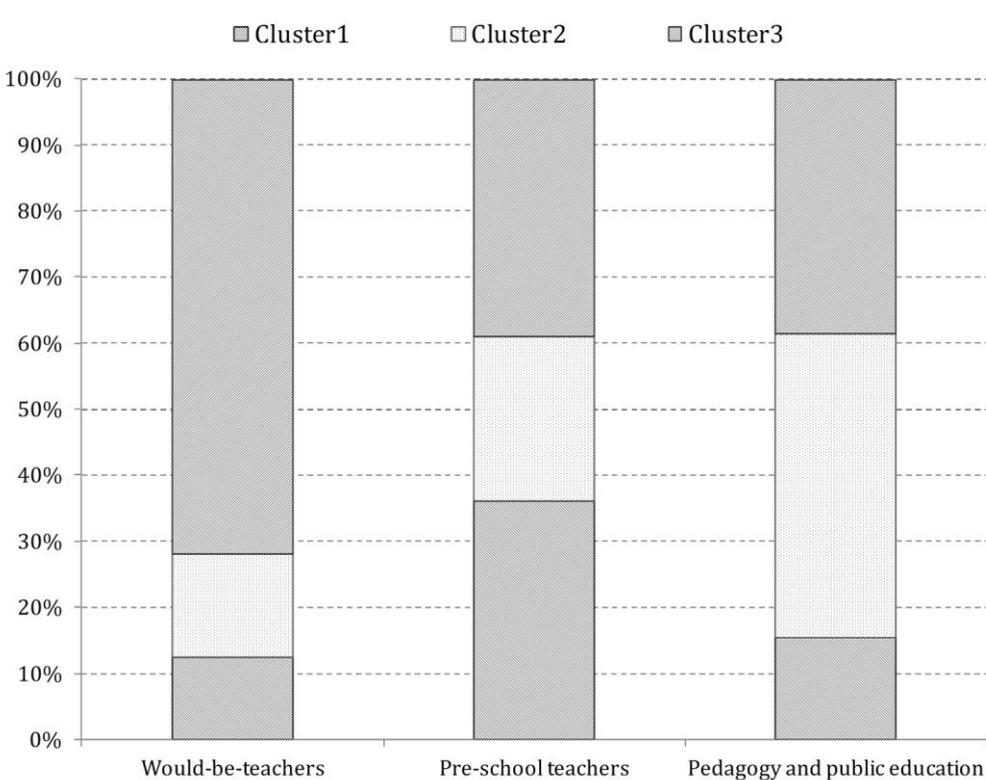


Table 4.: Explanation of clusters

Features	Cluster1	Cluster2	Cluster3
Time used for task solution	less	medium	more
Achieved result	5 – 20 points	6 – 20 points	7 – 22 points
Training	correspondence	full-time and correspondence	full-time
Specialization of students	pre-school teachers	pedagogy and public education	would-be-teachers, pre-school teachers

## Discussion

Competitiveness is an orienting notion that offers a pivot for the schools in preparing and developing their pupils. It reflects the strong demand for improving the economy and its impact that has extended competition to the world of education, making it clear that education is a direct competition factor. The competitive student is also successful in his/her school career and the labor market. I.e., he/she is someone who can find his/her place in a competitive world and can get on. Schools must provide the necessary bases for this. The question is what these bases are.

When responding to this question, one must return to one of the core problems of pedagogy: what is the relation between the school and the society like, and within that, the school and the economy? The answer seems evident: it is reasonable to describe competitiveness by the competencies in the cases of both the pupils and the teachers. Student competencies needed for labor market performance are primarily determined by economic aspects recently. This is reflected in the concepts and components of hard and soft skills. Thus the original question can be specified according to this: what should the learning material be, and how could the pupils' labor market key competencies be developed? This depends less on the concrete learning material and more on how the learning process is organized and what type of learning environment the pupil is surrounded by. So the primary stress is not put on WHAT to teach but HOW to. Moreover, this places teacher competencies in the limelight.

The educational methods applied during the lessons are affected by several factors, e.g., the characteristics of the subject, the type of the lesson (elaboration of new knowledge, practicing, summing up and systemizing or checking and evaluation of pupils' knowledge), the pupils' existing knowledge, their skills, age characteristics, etc. Solving this complex task system needs complex methodological competencies. For example, a would-be teacher should

- know the epistemological bases, cognition characteristics, logic, and terminology of the subject taught;
- know the inner characteristics of the subject as well as its cognition methods and the structure and inner logic of the educational material;
- be able to select and apply the methods and organizational forms developing the pupils' cognition, problem-solving, and cooperation skills;
- adapt the hubs, structure, and logic of transmission of the education material to the given student group and per the curricular rules and pedagogical objectives.

From the teacher's point of view, developing the pupils' soft skills needs hard methodological skills. Therefore, two preconditions of pupils' thinking, and within that inductive reasoning, should be mentioned here: the teacher's thinking should be as developed as possible, and (s)he should also possess the methodological competencies using the pupils' thinking and problem-solving skills can be developed.

For teacher training, this means a triple challenge. First, at the beginning of the training, it must be able to assess the development level of the students' cognition skills; their development must be given high priority during the training program; second and third, the teacher students must learn the methodology of developing pupils' cognition (Neubert & Binko, 1992; de Koning et al., 2002).

As for the structure of inductive cognition, there are five conceptions: 1) it is a general reasoning factor that bears several components both concerning its content (verbal, quantitative or numerical, figural-

spatial) and operation (inductive, deductive). 2) Inductive and deductive reasoning are interrelated, however, with no content factor. 3) Deductive and inductive cognition processes cannot be separated from each other, while the three factors of reasoning: verbal, quantitative/numerical, and figural-spatial, are related. 4) It is a general reasoning factor with embedded and orthogonal content factors like verbal and quantitative reasoning but no figural-spatial factor. 5) Inductive and deductive reasoning are interrelated, including orthogonal content factors like verbal and quantitative reasoning but no figural-spatial factors (Wilhelm, 2005).

In the high-order model of fluid intelligence, Wilhelm (2005) used the measuring tool presented in Table 5 to examine reasoning in the dimensions of content and operation. The value of the correlation between fluid intelligence and the specific content components was very high (0.83-1.00), so any of the tests, but most of all the figural-spatial ones, were suitable to measure the development of thinking capacities.

*Table 5.: High-order model of fluid intelligence (reasoning)*

<b>Contents / Operations</b>	<b>Deductive</b>	<b>Inductive</b>
Figural-spatial	Electric circuits Spatial relations	Figural classifications Matrices
Numerical, kvantitatív	Solving Equations Arithmetic reasoning	Number series Unfitting number
Verbal	Propositions Syllogisms	Verbal analogies Word meanings

To assess the inductive thinking of first-grade would-be-teacher students, the figural test is applied in labor market aptitude tests (Newton & Bristol, n.s.), the model indicated in Figure 1. Future research will be worth examining the relation system of the two complex tests.

In Carroll's (1993) cognitive skills structure, cognition speed appears as one of the components of fluid intelligence. Applying Raven's Advanced Progressive Matrices (APM) test and the Test for Attentional Performance (TAP), Frank Goldhammer and Rinke H. Klein Entink (2011) found that (1) reasoning speed is a one-dimension construction that shows significant personal differences and that (2) cognition speed and reasoning capacity are in negative correlation but can clearly be distinguished. Regarding reasoning speed and thinking capacities, perceptual and executive attention differ as reasoning speed is only explained by executive attention while thinking capacities are accounted for by both covariants.

In this research, cognition speed was measured directly; however, in the future, it will be reasonable to extend the research beyond the area of attention to the field of visual perception, visual memory, and visuo-construction capacities, as well (pl. Benton Visual Retention Test). By doing so, this model will be possible to be described more precisely.

### **Conclusions and Implications**

The research implemented at the Faculty of Education of the J. Selye University, Komarno, (Slovakia) involved 204 first-grade students. The research was aimed at the examination of the development level of the students' inductive thinking, and the following results can be made.

#### ***Development level of inductive cognition***

The students achieved the best results in the analogue task and were the weakest in the diagrammatic task. The reason for the latter was probably the significant burden put on short-time memory (they had to store four medium states of four operations) and the frequent sensual–perceptual shifts.

Females achieved significantly better results concerning the odd-one-out task and the recognition of regularities containing unknown operations than males. At the same time, in the odd-one-out and the analog task correspondence, students performed significantly better than full-time students.

The development level of these first-grade students' abstract and analog thinking is medium, while their diagrammatic thinking is weaker.

The 10 percent of the students with the best results are women with parents with a degree; they live in cities and take their secondary school leaving exams in grammar schools in Hungary.

### ***Time used for task solution***

The first grade pedagogy students consumed the most time solving the series continuation and the diagrammatic task containing known operations, while they used the least time for the diagrammatic task containing unknown operations. There is a correlation between the average results of the specific task types and the time consumed.

The five task types can be divided into two groups based on analyzing the time used for the task solution. Each item of the two diagrammatic tasks proved equally difficult; several students only guessed. The time used for the items following each other showed a significantly decreasing tendency. However, as for the first three tasks, there were more manageable tasks demanding less time and more complex tasks requiring more time.

Females spent significantly more time finding the odd-one-out and the diagrammatic task containing unknown operations than men. In addition, correspondence students spent significantly more time finding the odd-one-out and the analog task than their full-time peers.

### ***Relation between time consumption and inductive reasoning***

The concept of specific performance has been introduced to demonstrate success, which was defined as the ratio of consumed time and the achieved score. This fraction indicates the speed of thinking, as well.

Utilization of the available time frame did not necessarily result in a high score; however, it could be observed that each student, having gained more than 20 points, utilized the 25 minutes given for the test almost entirely.

The relation between time consumption and the achieved score can be defined by an exponential function:  $Score = 6.48 * exp(0.00055 * Time\ consumption)$ .

The cluster analysis was made in terms of the whole sample, and it was found that clusters could be created according to the time consumed for task solution: (a) "negligent" and superficial, (b) considered but not persistent enough, (c) persistent and diligent ones.

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## Opportunities for integrated education in STEM

### Introduction

In recent decades, several publications have attempted to define what integrated STEM education means (Barcelona, 2014; C. C. Johnson, 2013; C. C. Johnson et al., 2015; Kelley & Knowles, 2016; Stohlmann et al., 2012; Thibaut et al., 2018). However, there is a lack of research to demonstrate how conditions and good practices provide integrated STEM education within classrooms (Nadelson and Seifert, 2017; Stohlmann et al., 2012).

Over the past 25 years, the focus of STEM education has shifted from individual disciplines to a more integrated or multidisciplinary approach to teaching and learning. Recent worldwide education reforms highlight the vital role of STEM education (English, 2017). If we talk about integrated STEM education, it includes teaching science, mathematics, engineering, and the involvement of modern educational technology (Moore et al., 2014). Research shows that integrated STEM experiences in education can provide invaluable opportunities for learners, especially in activities that facilitate and enable the integration of individual STEM subjects. (Honey et al., 2012; Katehi et al., 2009).

Integrated STEM education is thus emerging as a new educational methodological approach in the 21st century. Acquired knowledge is acquired through formal and non-formal learning while developing transversal skills such as creativity, collaboration and critical thinking (Rotherham & Willingham, 2010; Holik - Sanda, 2020).

The use and integrated teaching of STEM subjects in framework curricula help students better understand the existence and relevance of professions and careers related to STEM. In addition, it significantly increases students' interest in STEM disciplines (Moore et al., 2020). The goal of integrated STEM education is to develop students' STEM knowledge and skills, that is, to identify, evaluate, use, and combine mathematical and scientific knowledge, concepts, and skills. They must understand and be able to solve complex problems and place and apply the skills and knowledge acquired in today's economic and social situations. Societal challenges characterize integrated STEM education as the combined use of science, technology, engineering, mathematics and related practical activities to create a learner-centred learning environment where students explore problems and develop evidence-based solutions based on real-life examples and problems (Zollman, 2012, Shernoff et al., 2017).

According to Thibaut et al., Five fundamental principles form the basis of integrated STEM education: (1) integration of STEM learning content, (2) problem-based learning, (3) collaborative exploratory learning, (4) research and design-based learning, and (5) models they are learning with the help. (Thibaut 2018) These critical principles of integrated STEM education require teaching methods and approaches that encourage students to self-regulate. In order to engage students in self-regulated learning for a more entrenched understanding, "classroom activities need to be designed around learning outcomes" (Prince, 2004, p. 226). The teacher should support the learning process of the student's inappropriate ways, continuously monitor and evaluate the completed tasks, and ensure flexibility in the individual learning paths of the students (de Meester, 2019).

Despite expanding knowledge about integrated STEM learning activities, planning and implementing learning activities that are the responsibility of teachers is not easy. According to teachers, the main obstacle to implementing STEM education in the classroom is the incomplete and necessary interdisciplinary approach in preparatory teacher training and in-service training programs (Shernoff et al., 2017).

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Integrated STEM education is a relatively new field in educational science. Therefore, there is a growing need for an integrated STEM framework to help teachers, educators, and curriculum developers meet the requirements of 21st century STEM education" (Boon Ng, 2019, 3).

### **The integrated STEM training framework**

The CISTEM2 project, a collaboration between four universities (KU Leuven University, University College of Northern Denmark, University of Cyprus and the University of Óbuda), aims to develop a framework for teacher education and educators to support and structure a process that prepares future teachers for integrated STEM for education.

As part of the CISTEM2 project, the project aims to develop and structure an educational process support framework for teacher education participants and educators that will prepare future teachers for integrated STEM education. Based on the fundamental principles of integrated STEM teaching, the developers identified five essential competencies for teachers who want to teach STEM subjects with an integrated approach. The higher education institutions participating in the project cover different areas in the education and training of teachers, lecturers and university lecturers. Therefore, the five key competencies will be developed for the target group based on individual strategies and needs in the four educational institutions. The development aims to integrate this new approach into the training system in the long term. During the project, it will be piloted in each subject to influence the development of the competencies of the teachers already in training. Thus, the fundamental principles of integrated STEM education will prevail in future classrooms.

### **Principles of integrated STEM education**

Thibaut et al. (2018) and De Meester (2019) suggest five fundamental principles that characterize integrated STEM education. The five key principles are outlined below. One of the critical skills is a problem-based learning skill. Based on the observations, the knowledge acquired with traditional learning methods is challenging to reproduce, and the connections are less visible to the students after learning. The real problem must be poorly structured and open, which means that the problem can consist of unstructured goals and constraints, multiple possible solutions, and solution strategies. (Jonassen, 1999)

In education, problem-based learning creates a learning environment where cooperative group work can occur, and students can deepen their prior knowledge with practical tasks and real-life problems. (Merrill, 2002)

To prepare students to solve real-world problems that are often multidisciplinary, students must integrate curricula from different STEM sciences. Integrating learning content from different disciplines makes solving problems in different subject areas possible. Moreover, their integration can take place in different ways.

According to Vasquez et al. (2013), the early framework for integration consists of a one-dimensional continuum of increasing levels of interconnections between STEM disciplines. The continuum begins with disciplinary approaches and moves towards multidisciplinary forms of integration – in which the concepts and skills of each discipline are linked separately but over a common theme. *Interdisciplinary learning* is an integration that combines knowledge and skills learned from two or more disciplines to deepen that knowledge and skills. Emphasis should be placed on transdisciplinary integration, which uses real problems to integrate the knowledge and skills of two or more disciplines.

Our development aims to integrate the STEM content of interdisciplinary and transdisciplinary disciplines into the project.

*Design-based learning* is a learning process that engages learners by making genuine connections through discovery and direct communication. (Holik - Sanda, 2022) This learning approach encourages

students to participate in problem-solving and experiential learning. Research is not just about experimentation; it also requires competencies related to setting up hypotheses, exploring, designing experiments, collecting data, organizing data, interpreting, modelling, and scientifically arguing (Pedaste et al., 2015). In interest-based learning, students are directly confronted with phenomena that question prior knowledge and assume a restructuring of their conceptual schemas to understand the phenomena (Gerber et al., 2001).

Engineering design is usually at the heart of design-based learning. Its concepts and problem-solving practices are critical components of technology, engineering, and science education. Planning is an effective tool for integrated pedagogical approaches (English, 2016). Design can include concept building, prioritization, decision making, modelling, design, prototyping, coding, and testing (Fortus et al., 2016; Guzey et al., 2016). One of the benefits of integrating design is facilitating the exploration of complex problems. Given that design is central to integrated STEM learning, a generally accepted framework will likely contribute to greater recognition of and focus on design-based learning experiences.

*Cooperative learning* is where learners work together in small groups to develop communication and teamwork skills (Guzey et al., 2016). To reap the benefits of cooperative learning, each group member must take responsibility for their learning and contribute to teamwork. All group members should be involved for an equal period, developing knowledge and solution strategies and encouraging feedback (Kagan & Kagan, 1994). Cooperative learning in small groups can lead to higher student performance, perseverance, practical reasoning, better attitudes to learning, better relationships with peers, and higher efficiency (Prince, 2004). A well-functioning group is more than the sum of its members.

*Conceptual learning* is a process in which learners acquire knowledge relevant to a given concept. Their skills and attitudes develop to form logical cognitive relationships that result in the assimilation, storage, retrieval, and transmission of concepts in familiar and unfamiliar situations. (Fletcher et al., 2019). Learners can categorize and systematize concepts by creating structures based on mental logic. The mental building blocks of the concepts are conceptual maps on which STEM knowledge is built and integrated. Conceptual learning aims to deepen students' thinking, pattern recognition, the need for practical outcomes and lifelong learning, and to develop critical skills related to outcomes (Giddens et al., 2012; S. D. Johnson, 1996). Conceptual learning can be described as "learning with understanding". Students have an in-depth understanding of concepts when they can build scientifically sound connections between what is already known and what is being learned and when they can consciously consider and examine new concepts and methods rather than schematically adopting a particular procedure (Carpenter & Lehrer, 1999). To improve their conceptual learning, learners should be encouraged to use their knowledge in a new context and to express their professional perception through different models and representations (i.e., speech, writing, drawings, diagrams, models, symbols, or other ways).

Key competencies have been identified during development based on the idea that teacher-education students can be equipped to develop STEM education with the fundamental principles mentioned above. The framework of competencies is formed by the definition of competence in the European Union (2019) as the knowledge, skills and attitudes required in a given context (European Union, 2019). Knowledge consists of concepts, facts and figures, ideas and theories that are already well-founded and support understanding a particular field or topic. Skills are the ability to execute processes and use existing knowledge to achieve results. Third, attitudes describe students' tendency and way of thinking to act or react to ideas, people, or situations. Second, competence is seen as someone's insightful ability to respond appropriately to all STEM-related challenges that apply to specific situations (Niss & Højgaard, 2019).

Below, we present the critical competencies identified by the developers and educators involved in the project as core competencies for prospective STEM teachers. It also demonstrates how they facilitate the implementation of fundamental principles of integrated STEM education. It assesses and embodies the nature and importance of *the first key competence*, integrated STEM education, for

which STEM teachers need to understand that almost all real problems are multidisciplinary and that the ability to recognize the connections between concepts from different STEM subjects is essential for 'future-proof' competence of learners.

In order to demonstrate the values behind STEM and its importance, teachers must continually review their STEM teaching work in light of today's societal challenges, evolving scientific and pedagogical knowledge, and the changing interests and generational characteristics of students. Based on this, STEM teachers need to be able to ask credible questions, that is, to present and solve interdisciplinary problems, developing their students' cognitive abilities to achieve learning goals related to different STEM subjects.

*The second critical competence is to focus classroom practices around real-world challenges that encourage students to learn and connect concepts and skills from different STEM subjects.* In order to make concepts from different STEM subjects tangible and relevant to students, STEM teachers need to provide STEM education that arouses students' interest and desire for further learning. Real problems are often multidisciplinary, requiring students to make cross-disciplinary connections between discipline-specific concepts. By focusing education on real-world problems, STEM teachers prepare students for future challenges. Real-world problems require constructive problem-solving, so STEM teachers need to incorporate problem-solving attitudes and techniques into lesson planning.

*A third critical competence* presupposes taking the initiative to reach colleagues in STEM disciplines to create value-based relationships between the learning objectives of different STEM subjects. It is far from certain that a teaching student who graduates as a math teacher has in-depth knowledge of physical, chemical, or biology subjects, so students must be able to reach out to colleagues in other disciplines to make connections between scientific concepts in different disciplines. In order to integrate and demonstrate the interdisciplinary relationships between everyday and scholarly concepts, STEM teachers should be able and willing to consult with their colleagues in other STEM disciplines.

Insight based on the expertise of others helps STEM teachers to plan learning activities that require students to work with their peers, and STEM teachers need to recognize and appreciate the fact that they cannot and do not need to "know everything".

*The fourth critical competence* is designed to encourage and support students in preparing and implementing scientific research and design. In order to provide STEM education with principles that reflect real-world STEM practice, STEM teachers need to involve their students in the research and design process. Such studies and the design required for cooperative work require students to collaborate and support their choices and decisions with scientific arguments during the research or design process. To do this, STEM teachers need to understand the different methodologies of the research and design processes and arouse students' interest and creativity through targeted motivation.

*The fifth key competence* is using models to deepen the learner's conceptual understanding and support interdisciplinary links in STEM subjects.

Models are ideal tools researchers and engineers use to help group and analyze data, so learners understand systems, processes, and phenomena. The models provide a mediating language for STEM interdisciplinary communication using discipline-specific concepts and principles in this role. Models can be mathematical expressions or graphs, scientific principles, or diagrams. By asking students to imagine their model, STEM teachers can encourage their students to present and explain what they have learned to their peers.

## Summary

Digitalization, technology-oriented developments, the capabilities of new generations, and the knowledge and transversal skills required by the market pose challenges to the education system and teacher education institutions. Integrated STEM education is a new approach to teaching STEM subjects that meets today's challenges. During the development, we identified five fundamental

principles of integrated STEM education. These key principles have an impact on the development of the competencies of 21st-century students, which has been confirmed in the literature. Based on these critical principles, five key competencies for teachers in integrated STEM education have been identified. An effective STEM teacher can confidently apply the fundamental principles of integrated STEM in the classroom.

In summary, to implement the integrated STEM key principles in the classroom, STEM teachers must be able to apply/practice the above principles themselves and evaluate and demonstrate the importance of STEM integration in real issues. They should consider research and design and support each other in research and design. To formulate these critical competencies for effective STEM teachers, we have developed a methodological proposal that can be used across different levels of STEM teacher education and national borders. These methodologies include collaboration in multidisciplinary teams, the design of integrated STEM learning units, and the development of digital literacy.

The integrated STEM developments will not only improve the methodological culture of teacher trainees in STEM education but will also increase the possibilities for using project-based methods, cooperative learning and other situational learning methods. Such elements include competence-developing teacher planning, the use of group work methods that increase student interaction (e.g. cooperation between groups of 3-6 students, project teams), and preparation for developing e-learning programmes. Integrating teaching-learning opportunities provided by modern IT applications and tools into education is increasingly essential, which is one of the main challenges for science education and modernization after COVID-19. Developing a culture of classroom assessment - teacher-student, student-student - will significantly improve the assessment competencies of participants, and spreading the concept and practice of developmental assessment will improve students' self- and peer-assessment skills by making it a routine in the classroom. Realistic self- and peer-assessment skills thus help them to cope in the world of work and to achieve individual and group results.

With these skills and the framework to be developed, students in the STEM field in Hungary will be able to more directly experienced, and methodological test innovations developed for teaching integrated STEM subjects and then apply them in school practice.

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Geoff VAUGHAN

## **Metacognition and Self-Regulated Learning – Recent Perspectives for an International Context**

### **Introduction**

The UK, more specifically England, has been going through a 'cognitive learning revolution' in school-based pedagogy over the past ten years. Increasingly, the knowledge from cognitive psychology and neuroscience is altering the landscape in the English classroom. Like in anthropology and linguistics dating back to the 1960s, pedagogy in England has experienced a cognitive turn. At the heart of this turn has been the growing implementation of a substantial body of research from cognitive psychology and neuroscience in the role of learning. One significant area is a growing understanding of the application in learning about the uses of theories of metacognition and self-regulated learning. Put briefly, learning how to learn.

Understanding the concepts of metacognition and self-regulated learning is vital for teachers. However, how implementing effective metacognitive and self-regulation strategies for learners in the classroom is just as important. In this paper, I set out some of the most important practical applications in this area based on research-based guidance from the UK and cognitive neuroscience findings on metacognition and self-regulated learning. Much of this research is now finding its way into the classroom in England, and it is hoped to be implemented globally as well.

### **What is metacognition and/or self-regulated learning?**

Often these two terms are seen as labels for the same thing, and definitions of both are incredibly similar. For example, both terms are often captured in the phrases 'learning to learn', 'thinking about thinking', and, sometimes, 'critical thinking'. This is not a modern phenomenon and goes right back to the earliest philosophers who tackled the complexities of thinking about thinking. However, it is important to delineate between the two, and the most common way that is used is to use self-regulated learning as the 'umbrella term' for these concepts of learning how to learn. As such, a definition is given in the EEF guidance report on metacognition, and self-regulated learning (SRL) states that it is essentially "about the learners' ability to monitor, direct and review their learning" (Introduction, p.4).

For further clarification, the EEF guidance report defines self-regulated learning as:

Self-regulation is about the extent to which learners ...are aware of their strengths and weaknesses and the strategies they use to learn. It describes how they (learners) can motivate themselves to engage in learning and develop strategies to enhance their learning and improve. It will look different for learners of different ages and tasks, but teachers will recognize these characteristics in their most effective learners (EEF Report, 2018, 8).

This umbrella term of SRL is broken down into three core categories in the guidance report.

- Cognition
- Metacognition
- Motivation

These three components interact in significant and complex ways during the learning process. For metacognition to happen, a learner must possess cognitive abilities and strategies and the motivation to tackle problems that will be faced in the learning process. It is a 3-way process, with cognition at the core.

In *How We Learn*, Stanislas Dehaene also focuses closely on the concept of metacognition in his exploration of how humans learn. He explains metacognition as:

cognition over cognition: the set of higher-order cognitive systems that monitor our mental processes. According to the gap theory of curiosity, metacognitive systems must constantly supervise our learning, evaluating what we know and do not know, whether we are wrong or not and whether we are fast or slow. So on and so forth – metacognition encompasses everything we know about our minds. (my italics) (Dehaene, 2019, 193).

These are the basic theoretical concepts involved in the theory of self-regulated learning. However, it is the application of this knowledge about SRL and metacognition that is most important for teachers, and it is to this application that I will now turn.

### **Application in the classroom**

The EEF Guidance Report outlines seven recommendations for implementing SRL in the classroom. The first sections of the guidance report clarified the understanding of the concept of metacognition. It is defined in the introduction of the guidance report as being "about the ways learners monitor and purposefully direct their learning" (EEF report, 2018, p.9). This is then illustrated by the use of a 'metacognitive cycle' diagram (p10), showing the dynamic links between planning, monitoring, and evaluation.

In the second section of the guidance report, the authors turn to the implementation of metacognitive strategies and propose a seven-step model for explicitly teaching metacognitive strategies, as illustrated below (EEF Guidance Report, 2018, 14):

- Activating prior knowledge
- Explicit strategy instruction
- Modelling of learned strategy
- Memorisation of strategy
- Guided practice
- Independent practice
- Structured reflection

At the end of the report's second section, there is an essential addition regarding a common misconception. Here the authors identify the misconception as "metacognition is a general skill that can be separated from subject knowledge" (EEF Report, 2018, 15). This is a crucial section of the report that is commonly overlooked or disregarded. The authors state in this section, "The clue is in the word: without cognition, there is no metacognition" (p.15, my italics).

The third section of the guidance report turns to the critical concept of modeling your thinking to help learners develop their metacognitive and cognitive skills. In this section, an instrumental concept is used to illustrate this approach, namely the idea of 'the master and the apprentice'. The authors state in the introduction to this section:

All teachers use modelling to some extent. The most effective teachers – like master artisans working with their novice apprentices – are aware of their expertise and how to reveal their skills to learners and assess whether their pupils have understood them; they are metacognitive about their teaching. (my italics, EEF Report, 2018, 16). In the 4th section, the concept of the challenge as key to developing self-regulation is detailed. The author's state:

A successful pupil will regularly engage in metacognitive reflection, asking self-reflective questions such as (EEF Report, 2018, 18):

- Knowledge of task questions
- Knowledge of self questions
- Knowledge of strategies questions

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This section then details the importance of motivation as one of the essential components of SRL. Recognition of self-efficacy and individual motivation is seen as essential when setting suitably challenging work as stated:

In motivating learners to persevere at challenging tasks, it is essential to reward effort rather than absolute levels of achievement, give feedback about personal progress, and avoid social comparison (EEF Report, 2018, p18).

This section then proceeds to address the critical link between self-regulation and cognitive load theory developed by John Sweller (1988). The report summarises Sweller's cognitive load theory as:

Cognitive Load Theory is the amount of information our working memory can hold at any time. Unfortunately, the capacity for working memory is limited. We can, however, support learners to maximize their working memory with a range of metacognitive strategies. (EEF Report, 2018, 19).

The final section of this overall section has some significant guidance about understanding the consequences of cognitive load on self-regulation and metacognition. Two consequences are highlighted:

Where we can draw on existing knowledge from the long-term memory, we increase (cognitive) capacity- this is one reason why knowledge matters and why learners need to be taught first to try and activate prior knowledge.

Second, we must ensure that learning activities do not overburden working memory. (EEF Report, 2018, 19).

In the fifth section, the report refers to research by Robin Alexander (2017) and his work on dialogic teaching, where the importance of 'learning talk' and 'teaching talk' is highlighted as the two most relevant repertoires for developing metacognitive skills.' (EEF Report, 2018, p21).

The sixth section focuses on the explicit teaching of pupils how to organize and manage their learning independently. Here the report refers to research by Zimmerman (2010) that looked at how "effective learners use a number of strategies to help them learn well independently." (Zimmerman, 2010, 23). They then detail these as including:

- Setting specific short-term goals
- Adopting powerful strategies for attaining the goals
- Monitoring performance for signs of progress
- Restructuring one's physical and social context to make it compatible with one's goals
- Managing time-use efficiently
- Self-evaluating one's methods

Attributing causation to results and adapting future methods (EEF Report, 2018, 23).

The final section of the guidance report looks at the more strategic level of how to support schools with how they can implement metacognition and self-regulated learning successfully. Four key recommendations are made (EEF Report, 2018, 26):

- Sufficient time...to train teachers and allow them to practice and embed new methods.
- High-quality professional development...with the particular challenge of integrating metacognition into subject-specific domains
- Teachers must be provided with high-quality tools (textbooks and resources) and support such as ongoing coaching and mentoring.
- Support from school senior leadership.

### **Active engagement – the findings of neuroscience**

Stanislas Dehaene in *How We Learn* is also profoundly concerned with the practical application of the research into metacognition with what can be transferred to the classroom. One of his central 'pillars of learning' is active engagement. At the heart of this notion of active engagement is the human capacity for curiosity. Dehaene links metacognition with curiosity. He states, "...in order for children to

be curious, they must be aware of what they do not yet know." (Dehaene, 2109, 193). He refers to the research of infants (aged one and even earlier) who understand that there are things that they do not know and comes to a conclusion that "this is the early manifestation of epistemic curiosity: the irresistible desire to know." (Dehaene, 2019, 193).

Dehaene applies this fundamental desire to know as having essential considerations in the classroom by proposing several vital hypotheses. His first hypothesis is that "children may lose their curiosity because they lack cognitive stimulation tailored to their needs." (Dehaene, 2019, 194). He explains that at both the upper and lower ends of the academic spectrum, "schools must continually provide children's supercomputing brains with stimulants that match their intelligence." (Dehaene, 2019, 194). He warns that advanced students often "lack stimulation: after a few months, their curiosity fades, and they no longer expect much from school, because their metacognition system has learned that, unfortunately, they are unlikely to learn much more." (Dehaene, 2019, 194). This is equally the case, he explains, for students at the other end of the intelligence spectrum. He states, "Metacognition remains the culprit: after a while they (lower attaining students) no longer have any reason to be curious, because they have learned...that they do not succeed in learning." (Dehaene, 2019, 194).

Dehaene's second hypothesis linked to metacognition is that "A child's appetite for discovery can be ruined by an overly rigid pedagogical strategy." (Dehaene, 2019, 195). He details the dangers of punishing any attempt at exploration by a student and concludes that "Repeated punishment leads to learned helplessness, a kind of physical and mental paralysis associated with stress and anxiety, which has been shown to inhibit learning in animals." (Dehaene, 2019, 195).

Dehaene's work on learning and metacognition is essential because he moves beyond theory to provide solutions for the classroom. For example, his solution to the problem of the loss of curiosity in learning is admirably clear and expressed:

The solution? Most teachers already know it. It is simply a matter of rewarding curiosity instead of punishing it: encouraging questions (however imperfect they may be), asking children to give presentations on subjects they love, and rewarding them for taking the initiative. (Dehaene, 2019, 195).

Dehaene warns that "there is a danger that this solution can fall into the older pedagogical methods of encouraging purely discovery-based learning." (Dehaene, 2019, 197). However, he is apparently in his concluding remarks about the link between metacognition and active engagement, stating that "The ideal scenario is to offer the guidance of a structured pedagogy while encouraging children's creativity by letting them know that there are still a thousand things to discover." (Dehaene, 2019, 197).

## Conclusions

There has been considerable research undertaken in the field of metacognition/self-regulated learning, as is shown clearly in the EEF report and through the work of Stanislas Dehaene outlined here. Moving the research into the application in the classroom is a challenge many teachers and schools currently undertake in England. It can be further shared and developed globally. Research findings appear favorable for the role of metacognition and self-regulated learning in improving learning. A critical point that is made explicit by Tom Sherrington, a leading figure in international education and pedagogy, in his discussion of the EEF guidance report, and with which I agree, is that "all of this (metacognition/SRL) is located in subject specific content. It is not generic at any stage. Metacognition is something you model while teaching maths, science, English, art or French." (Sherrington, 2017). This is hugely significant.

The whole area and concept of SRL can seem extremely overwhelming to already overworked teachers. However, learning about and starting to apply the findings of cognitive neuroscience, as detailed by cognitive neuroscientists such as Stanislas Dehaene, and research-informed guidance such as that published by the EEF, can only help in the pursuit of knowledge about how we learn.

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In appreciating these important core areas related to self-regulated learning and metacognition, and with adequately supported teacher development and resourcing, teachers across the globe and all pedagogic domains will have a more significant opportunity to develop successful approaches in this fundamental approach to learning. As L Rafael Reif, president of MIT stated so well, "If we don't know how we learn, how on earth do we know how to teach?" (March 23, 2017, in Dehaene, 2019, foreword).

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Katalin KANCZNÉ NAGY

## In the intersection of Art-Pedagogy-Psychology

### Introduction

The results of our international research (Twenge, 2017; Cretu, 2017; Hara – Kling, 2000) and our researches confirm in five Hungarian-language higher education institutions in the Carpathian Basin (Kanczné Nagy – Tóth 2018; Nagy – Szabóová – Horváth – Kanczné Nagy, Tóth-Bakos – Orsovcics – Strédl 2018; Tóth-Bakos – Tóth, 2018; Kanczné Nagy – Csehi 2018), support the fact that university students are pretty insecure in their abilities. They have huge expectations regarding how they will perform during their studies and what kind of educators they will become in their later careers. They are afraid that they will not be able to pass, fail the exams, or postpone them. They are afraid of loneliness and the feeling that they can not do anything well. Research has shown that they have a strong sense of anxiety and a depressive state that is a “block” in their actions and thinking. In addition, they struggle with a significant number of mental and spiritual problems.

First-year students significantly impact the beginning of their university careers, human relationships, and interpersonal factors. The personalities of their teachers are significant to them. The results of the questionnaire surveys allow us to conclude that the existence and quality of interpersonal relationships with lecturers are crucial for students. Empathy and consideration of the current state and abilities of the students appeared as an expectation.

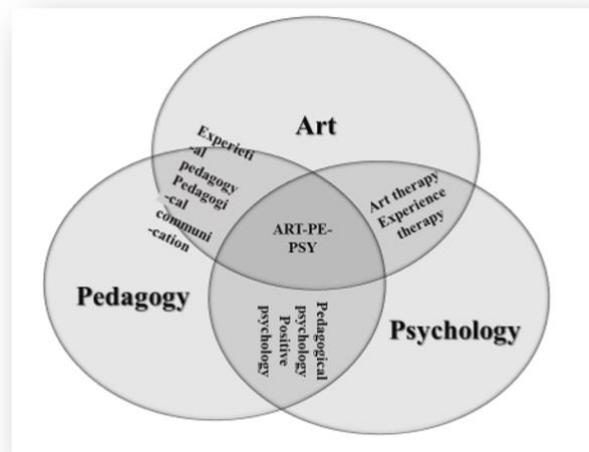
All this led to the conclusion that students need not only to acquire professional knowledge but also to strengthen some of their qualities and develop their personalities. As a result of this finding, we created a development course in the 2019/2020 academic year that sought to offer students a possible alternative to solve the abovementioned problems using three disciplines (art pedagogy, pedagogy, and psychology) (Csehiová – Kanczné Nagy, 2019). The course used developmental procedures capable of bringing about positive changes in students’ personalities. They can strengthen their self-confidence, increase the effectiveness of social cooperation, a positive outlook on life, conflict resolution and communication skills, self-efficacy, and time management efficiency (Csehiová-Kanczné Nagy 2019).

The course was classified as an optional subject in university education. The sessions were conducted using a co-teaching model, which allowed the teachers to exchange experiences more effectively, coordinate the educational strategy, and respond more closely to the needs of the students. The course is activity- and experience-oriented, which we first implemented in training kindergarten teacher students in the first half of the 2019/2020 academic year. The present study aims to explore the first experiences.

### In the intersections of the three disciplines

The name ART-PE-PSY was created by the playful use of the initials of three sciences (Art, PEdagoggy, and PSYchology) by the idea of university lecturers teaching the three disciplines. All three of us were actively involved in leading the course. The educational material of the semester, the dates, and the development of the topics were done together. For most of the semester, the classes were conducted together – all three or two by two – to implement process evaluation, share experiences, or just rethink specific plans. Another great result of the collaboration is that it has made it possible to effectively apply the disciplines that have been developed in the intersections of the three disciplines (Figure 1).

Figure 1.: Fields of science of the “ART-PE-PSY” development course



(source: own editing)

At the intersection of the arts and pedagogy (Tóth-Bakos – Csehiová, 2016), we worked with experiential pedagogy and pedagogical communication tools. Experiential pedagogy builds on the evolution of positive emotions. The communicative processing of the experiences helps the students to get to know several points of view through the evaluations of their own and their peers' experiences. Active exchange of experiences, case discussions, analysis of case studies, and outlining situations all contribute to students' more confident action, handling and resolving unexpected situations.

At the intersection of pedagogy and psychology are pedagogical psychology and positive psychology. With the help of the tools of these two disciplines, we wanted to influence the students' motivation. Motivation plays a vital role in the personality traits of teachers. This means, on the one hand, the educator's motivation and, on the other hand, how he or she can effectively motivate students. Therefore, arousing, continuously maintaining, nurturing, and strengthening motivation plays a crucial role in students' success, experiencing and processing their failures, and becoming a successful teachers.

The intersection of psychology and the arts includes art therapy and experiential therapy. The essence of art therapy is to help, heal, prevent and develop through some aspects of art. It draws from all directions of the arts (music, fine arts, literature, drama, dance) and applies them in active and passive forms, individually or in groups, in the way that best suits their needs. With the use of the arts, art trends, and their interdisciplinary nature, it is possible to educate and develop students more uniformly and effectively, which is proved by the results of more and more educational research (Csehiová, 2014). The key to experience therapy is the experience of success. It can be any new experience, experience, challenge, or activity outside the comfort zone.

As a result of combining the three sciences, the complex developmental effects on students' personalities and their transfer effects are broad (Figure 2).

Figure 2.: The transfer effects of the applied procedures and the transfer effects of the changes in the personality

Using tools from the following disciplines:	Available development effects:	Changes in Personality:
art therapy (passive and active elements)	experiencing experiences	→ healing effect
	gaining new experience	→ experience of success
experience therapy (passive and active elements)	experience of success	→ growing self-confidence
	tension relief	→ openness, courage
	joy of creation	→ creativity, taste formation
	development of artistic skills	→ self-confidence
	cooperation with others	→ social relations
		→ strengthening cognitive abilities
↕ ↕ ↕	↕ ↕ ↕	↕ ↕ ↕
experiential pedagogy	evoking positive emotions	→ positive attitude
	change in mindset	→
pedagogical communication	feeling of belonging to a group	→ positive self-image
	problem management	→
	conflict management	→ community attitude
	exercising understanding, attention	→ confidence
	empathy	→ social competences
	optimism	→ new knowledge
	motivation	→ tolerance
↕ ↕ ↕	↕ ↕ ↕	↕ ↕ ↕
pedagogical psychology	pleasure seeking	→ self-esteem
	experiencing positive experiences	→ self-realization
positive psychology	learning positive teaching techniques	→ expansion of pedagogical methodology
	new knowledge	→ professional efficiency
	arousing curiosity	→ motivation
	stress relief	→ stress management
	progressivity	→ innovation

(source: own editing)

The aim of the course is, on the one hand, to strengthen the students' personality traits and, on the other hand, to master the applied experience-based pedagogical principles and modern and progressive methods so that they can apply them effectively in their future teaching careers.

### **Topics of the sessions**

- Creating motivational tasks motivational calendar;
- Case discussions, developmental evaluation;
- Teaching styles, teacher personality;
- Happiness Class Program Classes:
  - exercise optimism,
  - gratitude and good deeds,
  - setting and achieving goals,
  - practice coping,
  - exercising social relations;
- Personality, self-image, self-confidence development sessions;
- Team building, community building;
- IQ, EQ, Creativity, and Thinking;
- Motivation and learning motivation in practice, development of internal, intrinsic motivation;
- Learning anxiety-relieving techniques;
- Active and passive relaxation exercises;
- Communication channels and tools: development of verbal, non-verbal communication, and metacommunication;
- Passive art therapy elements: theatre, concert, museum, exhibition, library visits;
- Active art therapy elements: art therapy (music therapy, art therapy, drama therapy, movement therapy) tasks, joint visual or auditory productions chosen and compiled by the students;
- Controlled processing of experiences: processing, analyzing, and illustrating experience reports, experiences, and information - freely chosen e.g., in the form of a presentation, whiteboard, experience diary, experience map);
- Discussing and evaluating experiences and pleasures.

### **First experiences of development sessions**

The following are some of the seminars whose documentation has already been partially processed.

#### ***Creating a motivational calendar***

The participants were tasked with preparing the motivational calendar in the first lesson. They had time to work on it until the end of the semester. In the last lesson, everyone presented their work. Students were encouraged to make their calendars so that they could include thoughts and pictures that had a motivating effect on them. The completed works were documented by photography and then subjected to content analysis. In our first study, we established the following categories:

- Thoughts on coping, perseverance
  - "Human Law: To endure everything and always go on, Even if there are no more hopes and wonders in you."*
  - "There is a problem that cannot be solved. But you can start with something: you can grow up. I may not have to start something with the problem, maybe with me."*
  - "Don't let everyday hardships take away your dreams, so take one step forward every day."*
  - "Two things can happen: I'll either succeed or I'll start over."*
  - "Stop complaining, act!"*
- Thoughts on building self-confidence
  - "You know you're going to the right direction, you don't look back anymore."*
  - "You are just as unique and special as ice crystals. Don't believe anyone who claims otherwise!"*
  - "A forest begins with a tree, a friendship begins with a smile, a helping hand can lift the soul, a candle extinguishes the darkness, a life can make a difference in the world. Be the one!"*
  - "Treat yourself!"*
  - "Be the reason someone thinks it's still worth believing in people!"*
  - "Forgive someone, especially yourself!"*

- Thoughts about the accomplishment  
*"What the human mind can believe, it can realize."*  
*"Learn something new!"*  
*"We are as good as our worst habits. If we not only focus on learning useful habits, but also get rid of our restraining habits, we can achieve orders of magnitude greater results."*  
*"Take a step towards your goal!"*
- d) Thoughts on cheerfulness, optimism  
*"When the winds of change blow, skeptics pull up walls and optimists sail."*  
*"If you started today without smiling, start practicing tomorrow!"*  
*"Believe me, in the end everything will be fine. Everything is moving in the right direction! If everything is not right in your life, it means you still have a way to go."*  
*"Smile today at everyone you meet today!"*  
*"Surround yourself with positive people!"*  
*"Which is just a small thing for you, it can make someone else's whole day happy."*

### **Making a thanksgiving tree**

Making the Thanksgiving tree was a group task. During the creation, there was an opportunity for a conversation, the central theme of which was gratitude:

- What do you mean by gratitude? – personal interpretation of gratitude per student;
- Who, in what situations do you feel grateful? – discussing situations;
- What effect (s) does gratitude have? – individual opinions;
- How do we express our gratitude? – case studies;
- Why would we give thanks? – putting grateful thoughts on the finished Thanksgiving tree (Figure 3).

Figure 4.: Gratitude Tree made by students



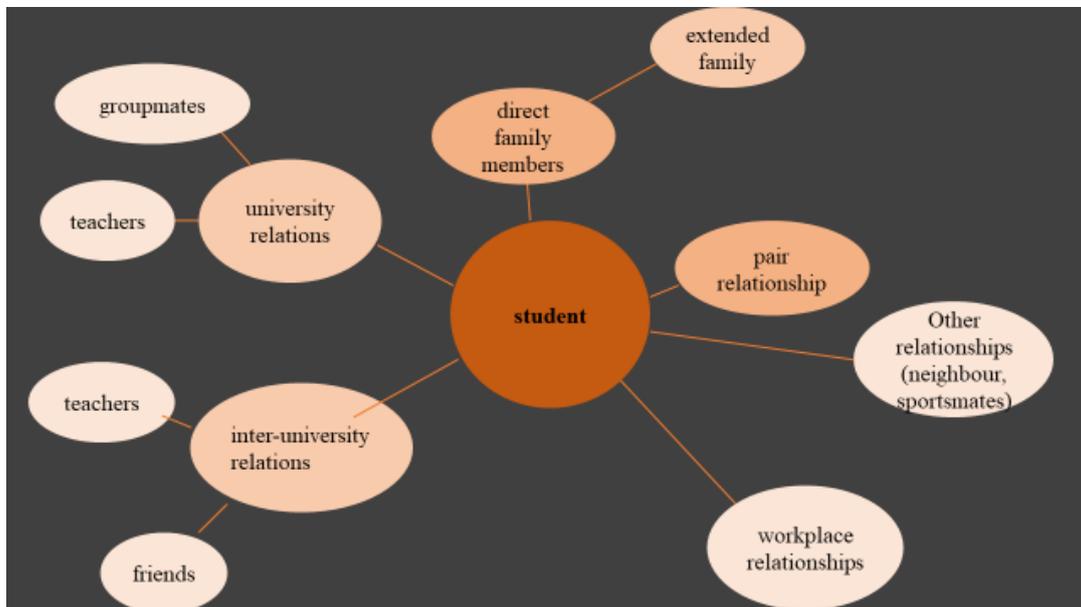
(source: own editing)

### **Making a network of contacts**

In the session, they had to draw their social network for their current stage of life. The session aimed to raise awareness of the relationship system and recognize the inherent retaining power in human

relationships. After the document analysis of the completed contact networks, we summarized the displayed persons, and based on the frequency, the aggregated result of the students' social relationships could be plotted (Figure 5).

Figure 5: Summary of contact networks drawn by students



(source: own editing)

### ***What do I take with me from the course...?***

For the last time, after the presentation of the motivational calendars, we asked the students to visualize what the ART-PEP-PSY course gave them? During the creation, a spontaneous conversation took place, the topics of which were as follows:

- How does positive thinking help to overcome everyday difficulties?
- What is a good smile for?
- Why is it important that the joy of life flows from the teacher?
- What techniques did they try at home on their mate?
- What are they consciously paying attention to as a result of ART-PE-PSZI?
- How do you plan to deal with their current difficulties (exam period, dissertation preparation, moving)?
- What do you want to deal with in the future?
- What kind of teachers do you want to become?
- How can they help each other with the tasks at the end of the semester?
- What positive sentences influenced them the most?
- What were the sweetest experiences of the semester?
- What were the most memorable tasks at ART-PE-PSZI?
- What topics could be included in the future?
- Why is it good not to have a lesson in more than just a formal setting?

The completed montages depict the positive thoughts of the students (Figure 6).

Figure 6.: Montage by students entitled: What do I take with me from the course?



(source: own editing)

### Summary of results

The categories set up during the first content analysis of motivational calendars show that students collected and formulated their thoughts on the topics in which they are most vulnerable based on our research results: 1. coping, perseverance, 2. self-confidence, 3. performance, 4. cheerfulness, optimism. Further qualitative analysis of the collected motivational thoughts is currently underway, but the first analysis points out that the quotations contain suggestions for solutions, alternatives for action, and encouragement for self-reflection.

During the conversation, while we were making the Thanksgiving tree, we observed many reactions that confirmed each other's thoughts and opinions - verbal and metacommunicative signals. Our students agreed on the importance of gratitude and the energizing quality of the personality - by continuously strengthening each other. The honest sharing of individual stories intensified the social connections with one another, and at the end of the lesson, we observed the content of cooperation in the spontaneous conversations between students of different grades, which suggested that they helped them study.

The analysis of relationship networks supported the finding of our preliminary research that interpersonal relationships are of paramount importance to students (Kanczné Nagy, 2019). On the drawn contact networks, it could be read that the "closest circle" includes direct family members. More distant, though, but with great frequency, teachers - university lecturers and educators from their former school - also appear. We also have measured results among the students about the importance of the teachers' personality and personality. Our previous research also points out that a significant proportion of our students work in addition to learning.

Furthermore, this is typical not only for students in the correspondence department but also for full-time students. When they draw their social network, they also display their workplace relationships. Overall, it can be said that our students have an extensive network of contacts. The reason for their fears about social relationships, we assume, lies in the quality and quantity of how relationships work. Exploring this requires further investigation.

Positive thoughts are reflected in student reflections on the semester course. Their oral statements support their beliefs about the importance of an optimistic attitude. The lasting manifestation of changes in behavior can only be measured later. Our further objective is to compare the results of the students participating in the course with the results of the other students in the framework of the longitudinal research carried out by the Ratio research group in our faculty using eleven measurement tools.

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Agáta CSEHIOVÁ – Anita TÓTH-Bakos

## **Art and Intercultural Education With Signs Of Tolerance, Acceptance From The Perspective Of Future Teachers**

### **The place and role of art education in education, in the education system, and its forms**

Art is a human-forming force that affects the whole personality. It makes us sensitive to the reception of beauty, forms, taste, and human behavior. It directly evokes emotions and affects the development of cognitive and emotional competencies and physical and mental health, so it takes part in personality development. It significantly affects the balance of intellectual and emotional forces, the higher level of strengths, and the harmony of the personality. Art and its branches – e.g., music, fine arts, and dance – can help achieve spiritual harmony and well-being, preserve and nurture health, relieve stress, and rehabilitate. Therefore, it is a tool in education, personality development, therapy, and prevention (Falus 2016). It has a beneficial effect on the physical-mental-emotional world of the individual. Therefore, it can be an integral part of teaching and education. “Art education is essentially nothing more than the development of specific influences that enrich the personality” (Foghtúy 1993: 1).

Arts education appears at all levels of education, from the pre-school level, through the primary and secondary levels to the university level, and can be even included in the LLL-Lifelong Learning education approach. These are regulated by the laws on public education and are realized based on official documents.

In Slovakia, the State Education Program (*Štátny vzdelávací program* in Slovak) represents a crucial document on education, which defines the principles, goals, requirements, and areas of education, content, and critical competencies. In addition, all the elements of art education are also defined in this document.

According to the State Education Program, art-oriented subjects are included in the field of Arts and Culture as well, as their organically related sub-areas and subject systems are operated at each level of education (ISCED).<sup>1</sup>

The State Education Program defines the content of **preschool education**<sup>2</sup> in seven educational fields<sup>3</sup> of which art education is the sixth field called *Art and Culture*. The field of Art and Culture is divided into two parts: music education and fine arts education, through which it provides the development of musical and visual skills of preschool children.

According to the State Education Program, **the operation of schools** in Slovakia is determined by eight developmental and educational areas and by the system of subjects organically connected to them, which also provide space for the application of interdisciplinary relations.<sup>4</sup>

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<sup>1</sup> ISCED – International Standards Classification of education: Its levels: ISCED 0 – preschool and elementary education; ISCED 1 – primary education, grades 1 to 4; ISCED 2 – Primary education, grades 5 to 9; ISCED 3 – secondary education.

<sup>2</sup> In 2008, the Slovak National Council accepted the Law on Public Education 245/2008 (which entered into force on 1 September 2008 and has been in force until today with several modifications), according to which kindergartens have become part of public education and in which pre-school education is provided. According to this, the task of the kindergarten is to develop the child's personality physically, intellectually, emotionally, socially, aesthetically, morally, as well as to create the necessary conditions for further learning and to prepare them for life, taking into account individual characteristics (Szabóová, In: Orsovics et al. 2018).

<sup>3</sup> The seven fields are: 1. Language and Communication, 2. Mathematics and Information management, 3. Human and Nature, 4. Human and Society, 5. Human and the World of Work, 6. Art and Culture, 7. Health and Movement

<sup>4</sup> The eight developmental and educational areas and subjects are: 1. Language and Communication – Slovak Language and Literature, Minority Language and Literature, 2. Mathematics and Information Management – Mathematics and Informatics, 3. Human and Nature: Environmental Education, 4. Human and Society – Environmental Education, Geography, 5. Human

Art education is the seventh field of **primary level education**, named *Art and Culture*; it provides an opportunity to understand the importance of arts and culture from the point of view of both humans and society. It also contributes to the foundation of general education and helps to perceive, interpret and understand the values of the arts, culture, national traditions, and cultural heritage. Its task is to develop students' skills to express themselves and their opinions and artistic experiences by tools of arts. The main goal of the field of arts and cultural literacy is to develop students' skills and abilities continuously, stimulate their playful, spontaneous expressions, and emphasize the importance of artistic activities and the diversity of knowledge about pieces of art. At the elementary level, two subjects are organically connected to the field of Arts and Culture. Music Education and Fine Arts Education. They aim to enable the student to interpret the arts, the importance of aesthetic and artistic activities, acquire knowledge about works of art, be able to articulate his artistic experiences, be aware of his own cultural identity, and accept the values of the culture of others (Orsovcics, In Orsovcics et al. 2018).

The institutional art education is followed by the next, **second level of primary education**. However, according to the State Education Program, art education of this level still belongs to the seventh field, *Art and Culture*, similar to the primary level.

The essence and goal of the Arts and Culture Literacy Area are for students to understand and comprehend the arts, acquire information and knowledge about works of art, become aware of their own cultural identity, and accept the values of other cultures. It is an important task to learn about and nurture one's own national culture, but also to educate respect for 'otherness,' other cultures, traditions, arts, identities, aesthetic values, and differences in values. In addition, there is a need to develop intercultural competencies, including the perspective of successful communication with representatives of other cultures. The field of Arts and Culture is also represented at this level by the subjects Music Education and Fine Arts Education, continuously developing the students' musical competencies, abilities, and skills. Particular attention is paid to developing the manifestations of students' abilities and skills through creative means of expression, through the worlds of fine arts, music, architecture, cinema, and modern media. Subjects called Music Education and Fine Arts Education, continuously developing students' art and musical competencies and skills, represent Art and Culture literacy.

The field of art and culture has become part of the **lifelong learning** (lifelong education) process. It includes all educational activities, learning processes, and the process of gaining experiences from preschool age to university studies and for the whole life. It covers the entire life cycle of the individual, from early socialization and preschool education to the period of active and productive working age. It aims to develop and acquire critical competencies and essential skills and abilities, in addition to acquiring and developing the skills of cooperation.

The European Union recommends that EU governments make the teaching and learning of critical competencies part of lifelong learning strategies. The Recommendation sets out eight essential competencies for all individuals in a knowledge-based society.<sup>5</sup> Among the eight essential competencies, the topic of art and culture was ranked last; that is, in the eighth area. It is an area of Cultural Awareness and Expression Competency. Its task is to creatively express ideas, experiences, and feelings, to recognize their importance in different branches of art – thus, taking into account both multicultural and intercultural aspects in music, literature, fine arts, and performing arts.<sup>6</sup>

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and Values: Ethics, Religion Education, 6. Human and the World of Work: Work Education, 7. Art and Culture: Music Education, Fine Arts Education, 8. Health and Movement: Physical Education.

<sup>5</sup> Eight key competencies of LLL are: 1. *Communication in the mother tongue*; 2. *Communication in a foreign language*; 3. *Mathematical, scientific and technical competences*; 4. *Digital competence*; 5. *Acquisition of learning*; 6. *Social and citizenship competences*; 7. *Initiative and entrepreneurial competence*; 8. *Cultural awareness and expression*.

<sup>6</sup> <https://www.minedu.sk/celozivotne-vzdelavanie/>  
<https://ofi.oh.gov.hu/tudastar/nemzetkozi-kitekintes/egeszes-eleten-at-tarto>

### Art education and teacher training in the spirit of tolerance and acceptance

Considering that art education at the preschool and school level is a segment of education, it naturally forms an integral part of teacher education. It includes preschool and primary education, teacher training, and study programs related to teacher training.

Therefore, art education, specifically music and fine art education, as well as essential elements of aesthetic and cultural education, include cooperation, acceptance, tolerance, and not forgetting the signs of interculturality.<sup>7</sup> The justification for tolerance can be defined in three ways: a requirement of prudence, a requirement of reasonableness, and a requirement of morality. Tolerance recognizes the individual's right to manage his or her own life as he or she sees fit, but also to respect the ideas of others about the right and meaningful life (Mendus 1987, qt. Strédl 2015). In this spirit, respect for "otherness" other cultures, traditions, arts, identities, aesthetic values, tastes, and differences in values all appear in art-oriented subjects. All this is present (should be presented) at all levels of the teacher-education process and, last but not least, in the training of future teachers. It is essential because the teacher plays a vital role in shaping the thinking, education, life philosophy, and attitude of the representatives of the next generations. As it is put in a recent study on tolerance and education on tolerance.

The opinion of future teachers is an essential social factor because, as opinion formers, they are present in the lives of future generations. Therefore, the formation of prejudices is often based on the experiences and attitudes of previous generations. If other types of information and experiences can accompany this, the young person has the opportunity to re-evaluate his/her previous opinion. Therefore, it is necessary to deal regularly with tolerance and cooperation, as skill acquired through learning is essential for social competence (Nagy – Strédl – Szarka – Zahatňanská – Poráčková, 2019: 302-303).<sup>8</sup>

Tolerance – an indispensable element of culture, peace, democracy, and human rights (Latham 1995, qt. Kusý – Stredlová 2003) – is gaining increasing importance and emphasis in the 21st century. In education, its accurate interpretation and reinterpretation are (also) critical. Tolerance should not be applied in the sense of "passive" understanding (indifference, ignoring others), nor in the sense of "laissez faire, laissez passer" (not coexistence, living side by side, with the slogan "live and let live"), but rather it should be applied in an 'active' form (Kusý – Stredlová 2003). In this sense, it means to try to understand the other, to consider its otherness, values, affiliation, customs, traditions, and culture.

At J. Selye University, mutual acceptance, understanding, and tolerance principles receive special attention. Of course, it happens not simply randomly but, among other things, by keeping in mind the specific mission, milieu, and significance of minority university education. It is also the purpose of the subjects that encourage, motivate and inspire the students to get to know and master the principles above and apply them in practice. At the Faculty of Education of J. Selye University, students study *Intercultural Education, Social Psychology, Pedagogical Communication, Minority Pedagogy, and Cultural Anthropology of Education* within the framework of compulsory and compulsory elective subjects, they can get acquainted with the principles of education for tolerance, the means of tolerant communication, and with the current literature related to it.<sup>9</sup>

Subjects of art education are realized with the inclusion of the elements of tolerance, acceptance, and cooperation, which are part of the study program of Teacher Training and Pedagogical Sciences. They are also part of the Preschool and Elementary Education study program for bachelor's degree, the Teacher Training for Primary Education study program for master's degree (taught at the Department of Preschool and Primary Education at Faculty of Education at J. Selye University), as well as the Pedagogy and Public Education study program and teacher training study programs in bachelor's

<sup>7</sup> Interculturalism: respecting differences, authority, mutual acceptance in the spirit of tolerance and understanding.

<sup>8</sup> All the translations are ours.

<sup>9</sup> See also for example: Nagy – Strédl – Szarka 2018; Nagy – Strédl – Szarka – Zahatňanská – Poráčková 2019; Kusý – Strédl 2013; Liszka 1990, 2009; Horváth – Szókö 2016; Horváth – Tóth 2018.

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degree (taught at the Department of Education Sciences at Faculty of Education of J. Selye University).<sup>10</sup>

An essential feature of art education for teacher training is that art and the branches and trends of art are mainly subjective. However, due to their richness of content, diversity of art history, color in style, and emotional impact, they enable the active cultivator and the recipient – i.e., the observer and the student - to choose, percept, and accept.

### **The aim, method, and realization of the survey conducted among future teachers**

The facts summarized above inspired the implementation of this study, in which students of the Faculty of Education at J. Selye University participated. The outlined aspects, i.e., the connection points between art education and tolerance in minority tertiary education in Slovakia, made it necessary to assess and examine the students' opinions, views, and experiences in this respect and then draw the necessary conclusions and lessons to strengthen the students' university attachment and to strengthen and nurture their interpersonal relations.

The target group was students of the Faculty of Education at J. Selye University. They came from different regions of Slovakia and Hungary to the only minority higher education institution in Slovakia to complete their university studies and obtain a professional qualifications here. Because the composition of the groups consisted of students who came from ethnic minority (Hungarian) schools, Slovak schools, and schools in Hungary, different perceptions, opinions, thinking, emotions, and national affiliations can be pointed out in the result.

The present study presents a segment of a questionnaire survey, as well as the partial results obtained based on the analysis of the answers to the questions asked and the opinions expressed.

The survey was carried out in the summer semester of the 2020/2021 academic year and the winter semester of 2021/2022 with the Faculty of Education at J. Selye University students, using a questionnaire method. A total of 137 students were addressed to complete the questionnaires, and 113 were sent back completed. Students who have passed an art course(s) were asked to complete the questionnaire. The number of students participating in the courses is as follows:

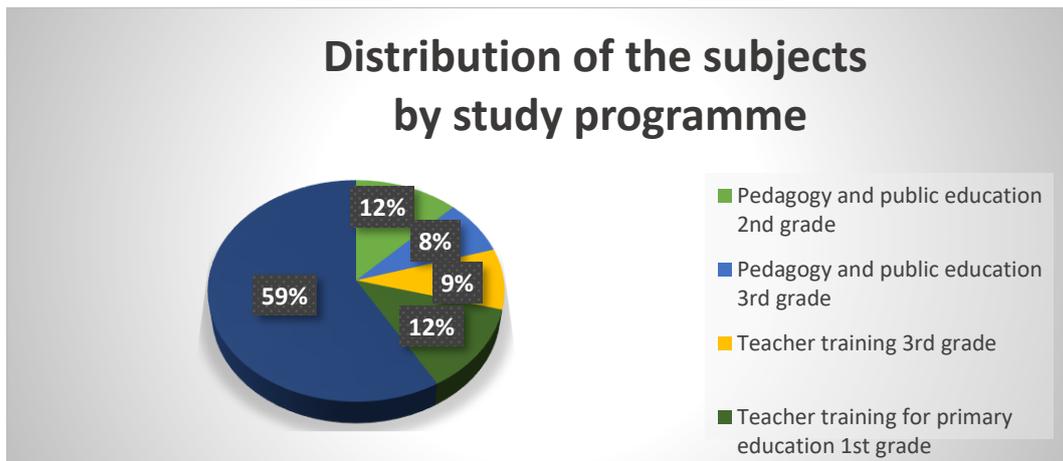
- *Thematic fields of education 4* (aesthetic education, art, culture) compulsory subject – with the participation of second-grade students of bachelor study program Pedagogy and Public Education. The questionnaire was completed by 14 students (out of 14 members of the group).
- *Thematic fields of education 4* (aesthetic education, art, culture) compulsory subject – with the participation of first-grade students of bachelor study program Pedagogy and Public Education. The questionnaire was completed by 9 students (out of 13 members of the group).
- *Art education* – compulsory elective subject in teacher training at bachelor level with the following majors: Hungarian language and literature, Slovak language and literature, English language and literature, German language and literature, History, Catechetic, Biology, Chemistry, Mathematics, Informatics. The questionnaire was completed by 10 third-grade students (out of 14 students signed up for the course).
- *Music literature for children and youth* compulsory elective subject – teacher training for primary education at master's level, first-grade. The questionnaire was completed by 14 students in this group (out of 17 students signed up for the course).
- *Basics of music education 1* compulsory subject – in the preschool and elementary education, at the bachelor's degree, in the first grade. The questionnaire was completed by 66 students in this group (out of 79 students signed up for the program).

Thus, 113 students actively participated in the survey, and they all studied on a daily form.

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<sup>10</sup> The training is carried out at all levels, taking into account and complying with the requirements of the current State Education Program.

Figure 1: Percentage distribution of students participating in the survey by the study program



Of the 113 students participating in the survey, 82 indicated Slovakia as their place of residence, and 31 students indicated Hungary. It follows that 73% of the respondents are students from Slovakia and 27% from Hungary.

Figure 2: Proportion of students in Slovakia and Hungary participating in the survey



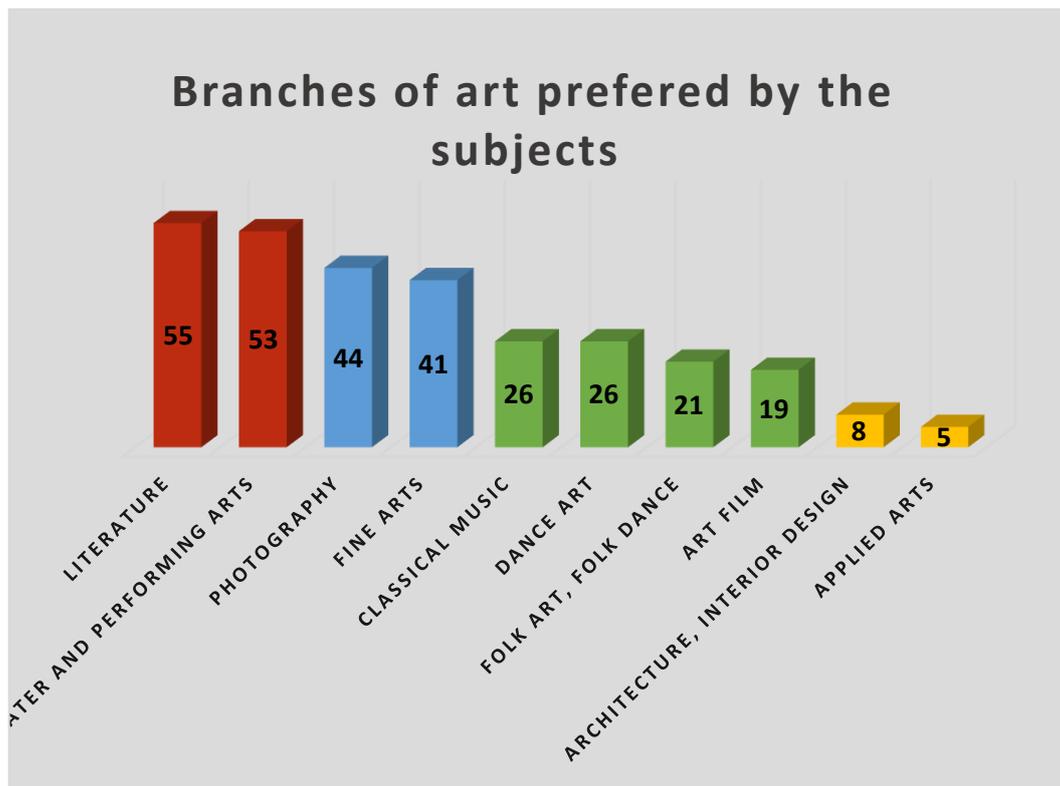
The information from the survey was obtained in written form. In written form, the students explained their answers and experiences to the questions/questionnaire items. Firstly, the questions were related to the content of art-oriented subjects. Secondly, they focused on the factors of heterogeneous groups (of ethnicity) such as acceptance, cooperation, tolerance, and positive influences. The students were not given any stipulations about the answers. They were free to express their opinions without any influence. With this, we tried to ensure the objectivity of the survey.

**Results and conclusions of the survey following** the essential questions of the study – i.e., the study program of the students, the field of study, majors and grades, and the students' residences (Slovakia or Hungary) – in *question 1* we intended to map the students' interest in the branches of art. Regarding that, the seminars include a wide range of arts, accompanied by a rich discussion and consultation, and students can choose the topic of their presentations on their own; they also present their multifaceted interest in the arts. These are also promoted to the other members of the group. Thus, at the seminars, they face and confront the differences in each other's tastes, interest in artistic values, and subjective attitudes, representing an essential practical segment of the expression of "likes and dislikes," and the principles of acceptance and tolerance.

This approach is provided by **Question 1**, in which students could select the one closest to them from 10 branches of art. Regarding the results obtained, it should be mentioned that most students (88) indicated more than one option, and the minor part (25) chose only one.

Based on the responses, the respondents' most preferred arts were literature (rated 55), theatre, and performing arts (53). It is followed by photography (44), fine arts (41), classical music (26), and dance (26) in equal proportions, followed by folk art and folk dance (21), art film (19), and significantly smaller than before, architecture and interior design (8) and applied arts (5). Quantitative data of the responses are shown in the following figure:

*Figure 3: Future Teachers' interest in the arts, in the light of accurate numeric data (Question 1 of the questionnaire)*

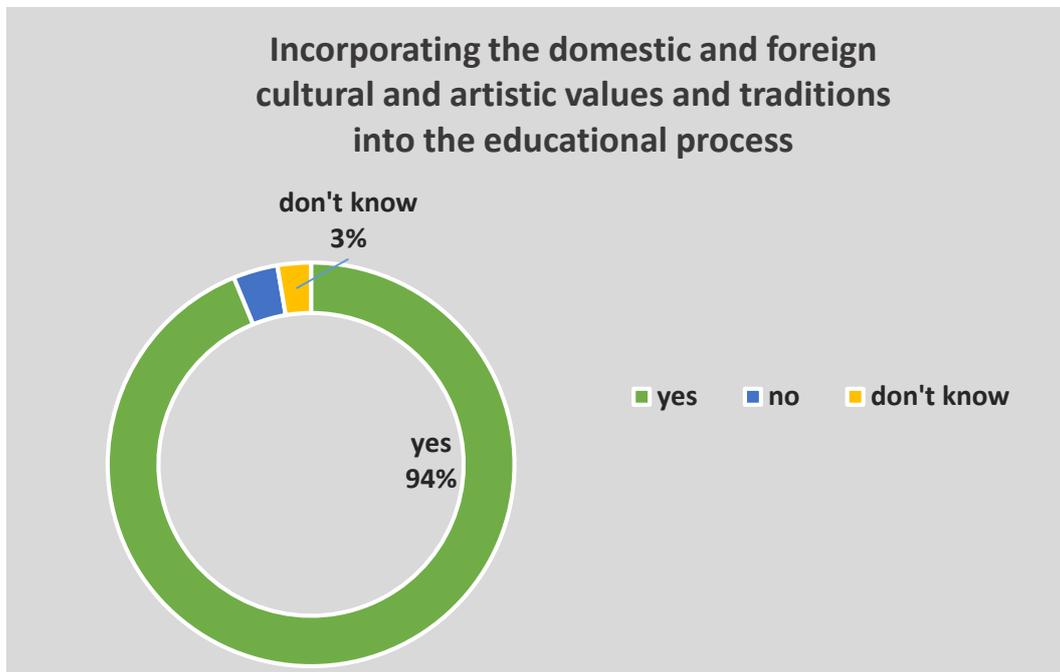


**Questions 2 and 3** are closely connected. With question 2 we were looking for the answer to whether the future teachers consider it essential to get to know the cultural, artistic values, customs, and traditions of other nations in addition to their own. It was further explained in question 3, i.e., whether it is essential to incorporate and adapt this knowledge into teacher practice. For both questions, respondents could choose from three options: yes, no, I do not know.

It is important to note that for **Question 2**, respondents produced a complete agreement. Namely, 113 students answered the question, and in 100 percent agreement, only the 'yes' option was marked. Positive feedback is crucial for the teaching profession to get to know, respect, and, in part, promote other cultures, artistic values, and traditions, thus practicing and applying the principles of acceptance and tolerance.

For **Question 3**, however, there was no complete agreement between the students' views. Here they used all the three options of choice, so "no" and "I do not know" choices were also marked. As for precise data, 106 students marked the answer "yes" to the following questions: "Do you consider it important to adapt and incorporate the cultural, artistic values and traditions of other peoples into the educational practice in addition to their own?" Finally, 4 students answered "no," and 3 voted for the "I don't know" option.

Figure 4: The answers of the future teachers (expressed in percentages) to the question “Do you consider it important to adapt and incorporate the cultural and artistic values and traditions of other peoples into the educational practice in addition to their own?” (Question 3 of the questionnaire)

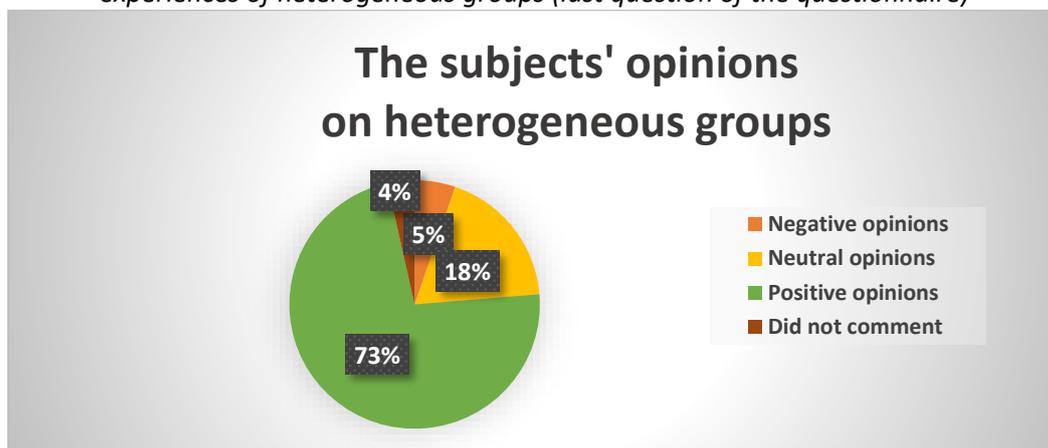


The most essential and relevant answers for the survey and study were obtained in the answers to the last question. The students had to express their opinion on how the “heterogenic” groups lived/are experiencing as UJS students in terms of affiliation. What legitimacy, positive value, negative experience, advantage, or disadvantage do they see in these circumstances?

Based on the quantitative analysis of the answers, it can be stated that 4 out of 113 respondents did not express their opinion, so they did not take a position on this issue at all.

The qualitative analysis of the answers, on the other hand, resulted in richer knowledge and conclusions. Student opinions, experiences, and resolutions can be divided into three groups: *negative opinions*, *neutral opinions*, and *positive opinions*. In total, only 6 student resolutions can be classified into the group of opposing opinions, 21 students took neutral positions, and the vast majority, precisely 83 students, i.e., 73 percent of the respondents, took a position in favor of positive opinions.

Figure 5: Expression of the future teachers’ opinions (expressed in percentages) based on the experiences of heterogeneous groups (last question of the questionnaire)



Based on a closer and consistent examination of the answers, we would highlight the opinions that support the reason for classifying students' views into three groups: *negative*, *positive*, and *neutral*.

Of the student opinions that reflect only 4 percent of **negative attitudes**, we highlight the following: *"Like everything in life, being a student at J. Selye University has its pros and cons. Also as"; "I often sensed exclusion. However, I would like to learn a little Slovak"; "Getting a task in Slovak is a disadvantage for me, although the teammates helped on request."*

A part of the teacher candidates, precisely 18 percent, took a **neutral position**: *"It is neutral to me if the students of J. Selye University form heterogeneous groups in terms of belonging."; "It does not mean anything to me."; "It was neither an advantage nor a disadvantage to me."; "It's not a disadvantage, it is not an advantage."; "The heterogeneous structure of the university means nothing to me. The difference is more pronounced at other universities."*

The answers and experiences of most students can be classified into a group of **positive opinions**. The beneficial effects were formulated from different perspectives, supported by subjective and objective reasons, highlighting:

- the impact of heterogeneous groups on study results, acquisition of new knowledge, comparison of their level of knowledge,
- in terms of getting to know other cultures,
- socialization, building "borderless" friendships in terms of cooperation.

The following selected students' thoughts support these.

**Experiences and views influencing university studies:** *"It's refreshing to learn about the experiences of others from another country, from another school system. We can better compare the functioning of the two school systems or just the teaching of writing in the two countries. This makes the lessons even more interesting."; "I can only evaluate mixed groups positively since we learned a lot from each other, everyone learned something new from each other."; "It is an advantage to me because in many ways it is different from us. Different words and phrases are used for certain objects and addresses. We laughed well at these as we got closer to each other, got to know each other's expressions, and learned new words."*

**Getting to know other's cultures:** *"When I found out that I would not only have fellow students from Slovakia, I was happy with the news. We had the opportunity to get to know each other's cultures."; "Working in heterogeneous groups is an advantage to me. It prepares for life after studies. I have also developed my cultural literacy."; "In my opinion, it is an advantage for everyone to come from a different community, as there is a lot to learn from others and what culture and customs there are in other communities."; "It means an advantage to me and gives a positive value. It gives you a chance to build international relationships. We have the opportunity to look into the educational programs of the two countries and compare Hungarian culture within Hungary and beyond."; "It was definitely an advantage; we were able to compare our different cultures, which was also coloured by the minority Hungarian identity. The difficulties of Hungarians living in minorities were also manifested in the study of contemporary Slovak literary works studied within the subject of Regional Education. As a Hungarian, I see a lot differently since I became a student of J. Selye University, and taking advantage of the mixed group, I became more immersed in studying the culture and everyday life of Hungarians across the border."*

**Cooperation within the group, social relations,** helping and supporting each other, understanding and tolerating differences, making new friendships "without borders": *"I experienced it as a positive experience that I became acquaintances and friends from Hungary. I started talking to one of them right during the Slovak class when I offered my help."; "I can say I am lucky. We accept and help each other unconditionally."; "It's a beautiful symbol for me. It helps to get to know Hungarians living abroad and the situation of Hungarians living abroad."; "During my studies, I was able to make new friendships with fellow students from other countries. I have had very positive experiences both with teachers and with fellow students. It has helped change my fears and prejudices."; "I'm glad they have become my*

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*Highland peers."; "Heterogeneous composition is a big advantage for me. Helping each other within the group is natural. I consider the 'Selye years' to be one of the greatest gifts of my life. I wish there wasn't a Covid there could be a lot more."*

We conclude the interesting, valuable, and instructive opinions and views of the teacher candidates with a series of thoughts in which the representatives of the countries, nations, and nationalities respect each other, getting to know and living them in the minority Hungarian-language University in Slovakia, at the Faculty of Education of J. Selye University in Komárno.

*"I am a student in Hungary, only with Slovak ancestors. The citizens of the two nations are able to live together in peace and side by side, staying away from the views of extremist groups. Although, I have not personally experienced a negative experience with my ethnic affiliation, both my groupmates and the university have provided me with an extremely inclusive and supportive environment for the past 3 years."*

### Summary

Summarizing the student views and the content of the answers, we would highlight the importance of intercultural and interpersonal relationships and their interaction, taking into account the signs of tolerance, acceptance, and understanding, preference for arts and art trends, and cooperation between heterogeneous groups.

The overall results suggest that a practical, *helpful, accepting, cooperative, cooperative, and tolerant attitude* within groups is paramount to students. In addition, interpersonal relationships play a crucial role in student opinions – within these, distinguishing between the spirit of collaboration between students and within groups and the importance of relationships between groupmates.

This position is reflected in the terms and concepts found in students' opinions, such as tolerance, patience, acceptance, understanding, and adaptation. Concluded in concrete thoughts: *"It must also be accepted among groupmates that everyone is different, so it is important to adapt to others and each other."; "It is important that we are patient and understanding with each other. We need to accept, tolerate and understand the differences."; "There is nothing impossible for a group if we understand and tolerate each other."*

According to the vast majority of student views, opinions, and experiences obtained from the study, heterogeneous groups of students in terms of ethnicity produced a positive impact on the community and were motivating. It can be said that communication and cooperation played a vital role within the groups. The feedback is mostly positive and inspiring to the students. It accurately reflects 73 percent of the responses of the students participating in the study, so the vast majority identified the nature and influence of heterogeneous groups as an advantage.

In art courses, seminars and classes, all this was enhanced by the experiences provided by art. It is because art transcends the boundaries of its content and material through experiential, diverse, interactive, and creative activities. As a result, it determines the formation, emotional and intellectual development of the whole personality (Csehiová – Kanczné Nagy 2018, Csehiová 2020). Last but not least, it positively affects the development of higher psychic functions.<sup>11</sup> In more detail, with regular and systematic use of art and art-based tasks, the teacher trainees' cognitive skills can develop, which they can activate in other valuable fields such as language learning (Marosi 2021: 40).

These facts can also be positively related to the presented survey, and based on the results, future teachers have a demand for the arts respectively for art education. There is a significant interest in

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<sup>11</sup> See also: Tóth-Bakos, A.: *Mozartov efekt - môže hudba zlepšiť inteligenciu a kognitívne schopnosti?* In: Zborník medzinárodnej vedeckej konferencie Univerzity J. Selyeho: "Inovácia a kreativita vo vzdelávaní a vede" - Sekcie pedagogických vied. Komárno: Univerzita J. Selyeho, 2015. CD-ROM, p. 163-172; Tóth-Bakos, A. – Csehiová, A.: *Music and Brain - Music Training Transfer*. INTED 2016 Proceedings: 10th International Technology, Education and Development Conference. Valencia. USB. WoS. 2016. P. 1726-1732

literature (55), theatre, and the performing arts (53), but they also have a significant interest and affinity in photography (44) and the fine arts (41). Last but not least, it is vital to get to know the arts, traditions, and values of other nations and cultures (100 percent) and incorporate and adapt them into the teaching practice (94 percent of the subjects).

Finally, the listed aspects – the interaction of art education and teacher training in the spirit of acceptance and tolerance – can significantly help Slovak and Hungarian university students to understand, help and support each other, and tolerate differences.

## Conclusion

Our study and survey, as described in the summary, provided a lot of instructive information and experience, which raises further questions and strategies. As a result, our intention is to plan and carry out further research and, in practice, to bring future teachers closer together with the help of art education. To nurture and build interpersonal and intercultural relations in all respects – national, ethnic, regional, cultural heritage, values, traditions – and to strengthen this view, this “philosophy of life” in the educators of future generations in the spirit of tolerance, acceptance and mutual respect. We conclude our study with Kodály’s thought-provoking and inspiring interpretation on the connection between science and art, which might further justify the place and value of art in tertiary education:

The root of science and art is one. Each reflects the world in its own way. Its basic condition is a sharp observation ability, accurate feedback, and elevation to a higher synthesis of the observed life, and the basis of scientific and artistic greatness is the same: the real man, *vir justus* (Kodály 1974: 454).

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Renáta Lengyel-MAROSI

## Language learning with English audio-visual media among the university students of English language and literature at J. Selye University

### Introduction

In our modern world, we are subject to mass information through the internet, visual media, and social media platforms. "Education as such reflects the present-day needs and requirements of the society and flexibly adapts to the changes happening worldwide" (Pauliková 1). So, besides using traditional methods such as teaching from books and with handouts, for (language) teachers, it is inevitable to keep up to date with new methods and use modern materials to help and encourage students – young as well as adult learners, and both beginners and advanced learners – and to develop their language proficiency (speaking, listening, writing, and reading skills) effectively and enjoyably.

There are multiple ways of developing students' listening skills. Students can listen to pedagogic (textbook) and authentic (TV, radio, songs, and podcasts) recordings; listen to the teacher's instructions and his/her talk; students can listen to their peers while cooperating, and they can listen to a guest lecturer. Of the methods and materials mentioned above, the one that students can do regularly and individually outside the classroom and without the teacher's presence is working with visual media in English. More precisely, they can listen to and watch films, sitcoms, and videos in this global language, which is dominant in most platforms where audio-visual media can be retrieved. Since English has thus become a part of the students' everyday lives, contemporary pedagogy has to consider it when designing listening tasks. It should recognize the values of authentic listening in the EFL classroom.

### Audio-visual Media in the Classroom

Technology with all its inventions should be a general part of modern education. "With the expansion that technology has had, visual and audio materials have become meaningful elements for teachers to keep in mind when planning their teaching lessons" (Vivalba and Cardona Osorio 2013: 1). Among the advantages of using audio-visual media in education are

- catching students' attention,
- helping them to grasp the meaning of complex concepts or clarify ideas,
- building rapport with learners,
- guiding beginners to be familiarized with authentic materials,
- decreasing anxiety in students,
- controlling their affective filter (Vivalba and Cardona Osorio 2013: 2).

Media can be applied in teaching in multiple ways as it has many forms. Generally, there are three kinds of media: audio, visual, and audio-visual. Firstly, audio media can be listened to (e.g., recording, tape-recording, multitrack recording, digital recording, and radio). For instance, audio media is commonly used in music education to develop students' emotional intelligence (Csehi-Tóth-Bakos 2016: 5). Secondly, visual media can be seen (e.g., realia, pictures, photos, sketches, charts, graphics, boards, posters, cartoons, maps, and globe). Visual media can develop students' visual memory, creativity, and imagination. Finally, media that involve the senses of sight and hearing are called audio-visual media, e.g., field trips, interactive whiteboards, video, videogames, film, tablets, smartphones, and television (Widiatmoko and Endarto 2018: 119; Puskás 2018: 56-57; Tubagus 2020: 58-59). Regarding this media, students can develop their personality and be educated in various ways, using and practicing the previously mentioned skills.

### Audio-Visual Media in the EFL Classroom

As Mathew and Alidmat (2013) put it, “[i]t has become a common phenomenon to integrate language textbooks with audio and video as additional or supplementary resources for classroom language learning activities” (86). It is because “language is no longer seen as an isolated phenomenon separate from visual/gestural codes” (Widiatmoko and Endarto 2018: 118). Moreover, since people converse by paying attention to gestures and facial expressions, it is necessary to include features of non-verbal modalities in the context of teaching and learning a foreign language (Widiatmoko and Endarto 2018: 116).

For the same reason, several studies emphasize attempts to combine the state-of-the-art pedagogy with state-of-the-art technology (e.g., Morales and Beltran 2006; Mathew and Alidmat; 2013; Vivalba and Cardona Osorio 2013; Rusmiati 2017; Tubagus 2020). As an example, like video game players’ listening skills can be engaged and improved throughout gaming, a popular audio-visual activity (Zolczer 2019: 233, 234), language learners’ listening skills can be effectively activated throughout listening to and watching films with or without subtitles, which is another attractive audio-visual activity. Finally, audio-visuals “attract the students’ attention and aid concentration,” and they “add variety and interest to a lesson” but also “help to make the associated language memorable” (Gower et al. 2005: 70-71).

All in all, by using audio-visual materials, students break with regular listening exercises to turn to something else that, although it requires their attention and concentration, also helps maintain their interest in the given curriculum and keep their attention and motivation.

### Listening skills in focus

In training future English language teachers, a great emphasis must be placed on language proficiency, and it is because, as Puskás (2020) claims, “only effective and highly proficient second language users can properly teach the language and well-prepared, motivated trainees can become teachers who can develop their expertise with experience” (53). Therefore, developing listening skills – one of the basic language skills – is a must, especially when considering that among the language skills, “listening is the first skill that the ELLs acquire initially” (Odilovna Djaborova 2020: 212).

Language learners are instructed to listen to audio and audio-visual recordings for many reasons, each closely connected to the types of listening activities. Among them are the following:

- Listening for gist, when the learner needs to know the general or central idea of what is being said, who is speaking to whom and why, and how successful they are in communicating their point.
- Listening for specific information means that the learner listens selectively for the specific information (e.g., hearing the news about something).
- Learners listen in detail when they need to find errors or determine differences between one passage and another. In this case, they cannot ignore anything because they do not know precisely what information will help them achieve their task.
- Inferential listening is when they wish to know how the speaker feels (Wilson 2008: 10).

The success of listening can be affected by numerous factors, such as characteristics of the message (e.g., simple mishearing, unknown words), characteristics of the delivery (e.g., the speakers ramble on, duration, number of speakers, accent, rhythm pattern of English speech, different ways of pronouncing the ‘same’ sound, changes in sounds when they occur in rapid, connected speech, and the weak relationship between English sounds and the way they are spelled in the written language), characteristics of the listener (e.g., lack of concentration, anxiety, tiredness, boredom or the listener having a cold (blocked organs), characteristics of the environment (e.g., the temperature of the room, background noise or defective equipment which affects the clarity of a recording), and the role of memory in listening (Wilson 2008: 10-15; Zerín 2009: 23, qt. Rixon 1986). In a word, listening “requires the ability to understand phonology, syntax, lexis and information content within real-time [and] Apart

from time pressure, there are also problems stemming from inexplicit information given by the speaker and environmental obstructions” (Zerin 2009: 22).

I support the use of authentic audio-visual materials in the EFL Classroom. I agree with Vivialba and Cardona Osorio (2013). They think language learners should be “exposed to audio-visual material from native speakers since they begin the language learning process to develop listening skills which help them to learn the language easily”(2). Although, I would add that it is necessary to set measurable goals in this respect: to work with audio-visual aids that satisfy the learners’ needs and age level and achieve goals that match the overall expectations of audio-visual resources; that is, “to improve the language proficiency of the students” (Mathew and Alidmat 2013: 87).

By definition, “any text is ‘authentic’ if it was produced in response to real-life communicative needs rather than as an imitation of real-life communicative needs. The term can be applied to any text, written or spoken, and concerning any kind of situation of language use” (Morales and Beltran 2006: 106; qt. Underwood 1990). The advantages of authentic listening are as follows: it allows sufficient access to environmental cues; listening segments come in short sounds; and listening requires reciprocity and frequent listener response” (Morales and Beltran 2006: 107).

It does not mean that pedagogic listening is not worth dealing with compared to authentic materials. However, it has some setbacks. Morals and Beltrán (2006) scrutinize it as follows:

“Most of the written texts are usually edited and not authentic. This means that a publishing house creates these texts in order to have students practice listening, but in many of them there does not exist real speed and pronunciation. Also, many of these listening texts are recorded by native speakers but involve the listeners in an unreal and almost perfect language use. Without any doubt, this material helps students to develop listening skills, but the exclusive use of this kind of text causes them to get used to listening to clear language without allowing for misunderstanding. This type of listening creates big problems when learners have to face communicative situations with native speakers because learners are not used to facing this sort of speech. The decodification process will take more time or, in some cases, they will not be able to decode at all” (106).

Additionally, when using audio material, language learners are only expected to use their ears, whereas audio-visual media aid in alleviating listening difficulties and provide a more comprehensible input by visualizing the message (Widiatmoko and Endarto 2018: 118; Brett 1995: 83).

## **Research Design and Methodology**

### ***Subjects***

One hundred students were asked to participate in the survey, but finally, the study was conducted with 44 undergraduate students at J. Selye University, Komárno. With an exception (whose native tongue is Spanish), all students are native Hungarians, and in addition to English language and literature, the students’ majors are Hungarian language and literature, Informatics, History, Math, Slovak, and Biology.

### ***Questionnaire***

A qualitative method was used to address and explore research questions. During the survey, the education was moved online due to the COVID 19 pandemic, so an online questionnaire (in the form of a Google sheet) was prepared for the subjects.

The questionnaire was designed to obtain information on the use of audio-visual media and its impact on the language learning process among university students of English Language and Literature. Students were told that their responses would be used for research purposes only.

The questionnaire (including 26 questions) had three main parts. The first part aimed at surveying the habits of watching English films and sitcoms. For instance, what dialect do they prefer and why? How often do they watch English films or sitcoms? The second part tried to point out the benefits of watching films and sitcoms in a foreign language, that is, the likely results of individual language improvement. Finally, the third part intended to find challenges and opportunities for language learning by listening in English.

The questionnaire had open-ended and closed-ended questions. Question No. 1, 3, 4, 7, 9, 10, 11, 14, 16, 17, 18, 19, 20, 21, 22, 24 were close-ended questions where students were expected to choose an option that is true for the them (e.g., yes/no questions). Question No. 2, 5, 6, 8, 12, 13, 15, 23, 25, 26 were open-ended questions. The subjects were expected to respond based on their observation, knowledge, and experience as tertiary students. It was felt that open-ended questions would give more insights by activating students' thought processes.

### Data analysis and Findings

The response of the students was calculated in a percentage. According to the results, 95,5% of the subjects watch films/sitcoms in English, and 59, 5% watch films/sitcoms every day (26,2%, once a week and 14,3%, once a month). 68,2% prefer American English when watching films and sitcoms. 27,3% like watching them in British English. 4,6% (two subjects) prefer Australian or other English. Those who chose American English justified their decision by writing that, compared to British English,

- it is easier to understand American English,
- it is more common,
- films in this dialect are easier to access on the internet,
- the speech sounds (pronunciation) seem more natural,
- the speech rate seems more natural,
- they have American friends.

Those who prefer British English explained it in the following way:

- they love hearing it,
- the speaker can sound a lot more intelligent and professional,
- it is fancy,
- this is the way they feel they can improve their language skills and pronunciation,
- they love British humor,
- it is more difficult to understand, and it is good to face challenges.

The remaining 4,5% of the participants that do not watch films/sitcoms in English explained their negative answers to the lack of time or interest.

The participants of the survey have been watching films and sitcoms in English for many years, more precisely from 2 to 20 years:

- 0,5% of the participants (2 students) have been watching them for more than 10 years.
- 23,8% of the subjects (10 students) have been watching films and sitcoms in English for ten years.
- 52,4% (22 students) have been watching films and sitcoms in English for 5-10 years.
- 14,2% of the students (6) have been actively watching films and sitcoms for less than 5 years.

As for the missing numbers, some students did not answer correctly (perhaps not understand the question) or did not answer.

33,3% of the subjects *often* (cc. 5 times out of 10) add subtitles to English films. 42,4% *always* add subtitles, and 24,2% *sometimes* (cc. 3 times out of 10) add subtitles. Most (92,5%) use English subtitles, and a significant number (42,5%) add Hungarian subtitles too. 11,4% do not add subtitles because they either understand everything clearly, or it distracts their attention from watching the film, and they like facing challenges.

54,5% of the participants usually watch English podcasts, news, and interviews related to the films/sitcoms they are interested in whereas 45,5% do not. The active users visit websites and service providers such as BBC News, CNN, YouTube, IGN, Spotify, Reddit, TikTok, and Instagram.

As to how can English listening skills develop through audio-visual media, the subjects' most common answers were the following:

- "Listening to what I enjoy makes my learning more effective. I can use the subtitle to check my understanding."
- "It helps me with everything, my ear getting used to the accents, the sentence construction, the slang, etc."
- "It can improve our vocabulary and pronunciation as well. Without any recognition, we store everything we see and hear. Even if we do not understand a word or a phrase, the context will help us to understand better."
- "This method can be also useful for those, who do not like to learn vocabulary from words to words, expressions to expressions."
- "We can learn how native speakers use the language."
- "You hear the same expressions a lot of times and you learn them. With listening, you also learn correct pronunciation."
- "Podcasts help us to visualise and understand without subtitles. Films/sitcoms help us to understand with subtitles and how the words are written and pronounced. The interviews are more real-life alike, it shares with us stories of everyday life. You can choose which interview you want to listen to, so you can learn about things in which are you interested in."
- "Perhaps with a lot of repetition. Watching and listening to the same film, etc. several times."
- "Improves vocabulary and pronunciation which makes us more confident while speaking, gives examples of the right usage of intonations and body language."

While watching a movie or listening to a podcast, the student is more engaged in learning the language and can feel more motivated by this type of learning process.

Practise makes perfect. You develop your listening skills over time. The key is consistency and will.

- "In many ways, since we don't have the opportunity to use the language in our environment, that's the best way to hear any English words. My English has improved because I started to watch everything in English, I have learned new words, my pronunciation became more natural, and also, subconsciously I picked up fixed forms, e.g. how to use prepositions – if I had to explain why we use certain prepositions before certain words, I'm not sure I would be able to, but I immediately hear if someone misuses them."
- "Quite easily, and it doesn't feel like learning at all, it is just fun. Even if the person is at a lower language level and doesn't understand some particular words, they can get the gist of what's been told based on the context or the scene."
- "Listeners focus on one topic at a time and learn the vocabulary of that topic, e.g. when watching cooking-related shows they learn ingredients, fruits, vegetables, etc. in English; when listening to crime and investigation shows or podcasts they learn the vocabulary of forensics."

In the subjects' opinion, with using audio-visual media, their listening skills (93,2% of them) and vocabulary (84,1%) have improved the most recognizably. They also feel that this media has had a positive impact on their speaking skills (75%) and language knowledge (50%). Developing reading (45,5%) and writing skills (22,7%) seem to be less likely for them in this respect.

They noticed their language improvement based on the following:

- "I understand the text better than before."
- "I think my speaking skills have improved because it gave me a brief introduction to how native speakers express themselves in their native language. The same applies to vocabulary."
- "I think my reading skills have improved because I noticed a notable difference in my reading speed from reading subtitles."

- "I think my writing and language skills have improved because I saw how the words were structured in the subs."
- "I think all my skills have improved with the help of listening, it is something which affects all skills positively."
- "I've noticed that after watching 3-4 movies a day I was able to speak fluently in English, and I also started to use expressions and phrases that I've never heard before."
- "I think I learned most from the serials (e.g. Criminal Minds, Bones, NCIS) – Sometimes I heard words that were unfamiliar to me, so I searched for them and learned new words. Which was really helpful, and sometimes I use those words... I read many articles, fanfictions, and books on the internet, and I noticed that when I read I can read faster, because I know how to pronounce each word, and my brain processes those information faster."
- "I think my listening skills have improved because I can understand speech better. And in reading, the subtitles help. And my vocabulary has improved because I need to use a dictionary to understand exactly what is happening."
- "I do not need subtitles, my pronunciation improved."
- "I have always had problems with my speaking skills but since I started watching movies with English dubbing or subtitles I have been able to remember useful slangs that are used in everyday life and that can be easily learned by only listening to the speakers."
- "My vocabulary has improved because I got familiar with the patterns in the language, the collocations, the phrasal verbs, and knowing about them and using them leads to native-like fluency."
- "I think my speaking skill has improved because my pronunciation improved as well, so I was braver to talk more in English..."
- "I think my speaking skills have improved because the more I watch films in English the more I can speak fluently."
- "I think all my skills improved because I was listening to English on daily basis, paying attention to people talking about certain topics. I also learnt the pronunciation, of new phrases and this even made reading easier because I encountered fewer and fewer unknown words. By the time my writing skills improved because I learnt new words and learnt to express myself more variably."
- "My listening skills improved because gradually I can understand more and more words and sentences without subtitles."
- I know how to use some idioms, words, or phrases.

54,5% of the participants did not work with audio-visual media in primary school, whereas 29,5% did. 15,9% cannot remember. However, students had more experience with this media in secondary school. 65,9% watched films in English lessons, but 29,5% did not. 4,5% cannot remember. Working with audio-visual media at J. Selye University showed the highest numbers: 79,5% of the subjects watched them in lessons, 15,5% of them did not, and 4,5% of the students could not remember. 86,8% of the students could recall that worksheets and tasks always accompanied these classes. These tasks mainly focused on listening (78,4% of 37 students) and vocabulary (62,2% of 37 students). Reading comprehension and language knowledge were also among the foci (according to 37,8% and 32,4% of 37 students). Speaking and writing exercises were less common (29,7%, and 18,9% of 37 students). 7,9% state that in lessons, they only passively watched the films without using any materials<sup>1</sup>.

45,4% of the participants think that a film-watching-based lesson requires special listening activities because they might help to comprehend the film and acquire the necessary vocabulary or knowledge of grammar. 43, 2% of the subjects believe that working with exercises is not always necessary when watching a film. Finally, 11,4% stated that simply watching a film is entirely sufficient for improving listening skills.

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<sup>1</sup> Several students did not answer these questions – hence the number: 37.

79,5% of the teacher trainees participants are convinced that it is necessary to bring films/sitcoms into the EFL classroom, and 18,2% think it can become an adequate but not an essential teaching method:

- "It would be more interesting. If something interests me, I will remember it better."
- "Most people watch videos online (Netflix, HBO GO). ....We will watch it for our entertainment while we were secretly learning, so why not put it into another context and watch them on the lesson, talk the show out, explain what happened with the characters, how the story went on, what was the main point where was the stress, some critical parts (e.g. Sheldon explain the famous Back to the future timeline - never had have hasn't.)."
- "I think that is the most interesting and entertaining way to teach a foreign language besides video games."
- "They are useful but not necessary, as a recommended self-improvement it should be fine."
- "It brings the real world into the classroom."
- "Most of the students are visual learners, and it's important to catch the learner's attention."
- "I think it is necessary because in these modern days, children are more interested in virtual life. So with these techniques, you can make your lessons more interesting. And of course, with films/sitcoms/interviews, you can show them the original dubbing, real-life conversations, situations."
- "It's necessary to watch films in English class, because not only does it help to teach the language, but it can also make students love English. Because they will see that if they know the language, they will have more opportunities to watch and understand films."
- "It's a ... fun and learning activity at the same time."
- "I think it's a good way of teaching the students because nowadays generations are more compatible learning from a film or video, than reading a whole book...."
- "For the authentic language exposition students need not only the audiotapes which come with their exercise books. You need to have as much "real, authentic" input as possible."
- "A sitcom is way more interesting for students than a random recording for the book that students use in the classroom. It's funny, there are sitcoms with easier language. Students will be more engaged and maybe they will start watching sitcoms, and other shows in English at home."
- "If the teacher or the school does not have access to such good quality teaching-focused material, the next best thing is to bring something from films/sitcoms. It can happen that the students have seen that film in Hungarian, and they can do all the exercises just by remembering, not by understanding English."
- "I think they make the learning process more fun and easier."

Finally, 2,3% (1 student) believe it is not essential to work with audio-visual media in the EFL classroom because such activities "take up too much time."

84,1% of the subjects support using a particular sitcom or film accompanied by exercises in their English lessons. In addition, 15,9% of them think that as future teachers, they may use audio-visual media in the EFL classroom. Among the English films and sitcoms that they would use are: Friends, The Big Bang Theory, Young Sheldon, Gilmore Girls, Legally Blonde, Extra English serial on and Learn English with TV series on YouTube, Peaky Blinders, Anne with an E, The Crown, The Office, Modern Family, Sherlock, Mr. Robot, Boondocks, BoJack Horseman, Peppa Pig, The Simpsons, Fawlty Towers, Keeping Up Appearances, Outnumbered, New Girl, The Good Place, Raven, Zack and Cody, The Core, Alexa and Katie, Doctor Who, How I Met Your Mother, Game of Thrones, The Middle, Black Mirror, The Lord of the Rings, Harry Potter films, To All the Boys I have Loved Before, Grease, Ferris Bueller's Day Off, Ready Player One, League of Extraordinary Gentlemen, and Back to the Future.

Students gave the following recommendations and pieces of advice about the ways of using audio-visual media in the English language classroom:

- to choose exciting topics,
- to give homework in connection with audio-visual media,
- to use subtitles,

- to watch a compulsory film and discuss it in class just like with compulsory readings,
- to prepare synonym finding tasks and listening tasks about it,
- music lyrics analysis would be welcome among students,
- to use short videos and to somehow make students part of the lesson,
- to write down all the new words after watching a film, to try to pronounce them, and then re-watch them,
- to have English subs turned on whenever possible since it helps students memorize how particular words/phrases should be pronounced,
- to choose films and sitcoms based on the students' genre of interest.

### **Conclusion and Recommendations**

Audio-visual media has become an essential and natural part of people's everyday lives in the 21st century. Very often, these contents are accessible in English. Therefore, EFL education has to adopt working with this type of media among its methods in order to motivate language learners and offer enjoyable classes and up-to-date materials. First and foremost, language learners must gradually develop their language proficiency: in speaking, reading, writing, and listening. Listening is the first skill that learners start practicing, so even from the beginning, a great emphasis should be placed on interactive and current listening exercises. For example, beginners can watch and listen to cartoons, whereas intermediate, upper-intermediate, and advanced students can work with tasks while watching popular films or sitcoms.

The present questionnaire aimed at surveying students' likely interest in audio-visual media and their personal opinion on the possible use of films and sitcoms in the EFL classroom. My thesis, according to which authentic listening should become an integral part of EFL education, has been justified by the opinions of the students of English language and literature at JSU.

Data analysis indicates that authentic recordings should be used in the EFL classroom in the following way:

- It is good to use a variety of English dialects, yet students prefer American, for it is easier to understand. Here I would remark that as European English language education prefers Received Pronunciation, the standard for British English, British sitcoms, and films should also be incorporated into the curriculum.
- Sitcoms that are available on currently trendy streaming services such as Netflix or HBO GO should be used.
- A preliminary discussion on the students' favorite series, sitcoms, and genres is recommended.
- Series are more preferably and advised than films (e.g., Friends, The Big Bang Theory, Young Sheldon, Gilmore Girls, Extra English serial on and Learn English with TV series on YouTube, Peaky Blinders, Anne with an E, The Crown, The Office, Modern Family, Sherlock, etc.)
- When it comes to teaching B1 and B2 students, teachers should consider working with sitcoms, for an episode is usually 20-25 minute-long.
- As they often watch films and series, compulsory listening assignments can be given to students (similar to reading assignments).
- These assignments are the most effective in terms of TEFL if they are accompanied by exercises (at home or in class).

A language learner whose needs and interests are heard and considered can be equal to a motivated, satisfied and successful language learner. Therefore, based on the active learners' experience and opinions, the paper and its results will hopefully motivate and draw the English language teachers' attention to the importance of bringing authentic listening materials into their EFL classrooms for more effective education.

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Judit VERECKEI – András BENEDEK

## Development of Institutional Leadership in the Hungarian Education System

### Introduction

The understanding and research of the phenomenon of leadership in human systems gained its place in the system of sciences about a century ago as an independent branch of social science. Beforehand, it was mainly birth privileges and property relations that determined who became a leader. For centuries, the collection and transmission of leadership experience and training were carried out in a narrow circle, only about specific, privileged individuals and social groups. The industrial revolution brought about a decisive change in this situation, as the development of the economy and technology transformed organizations and made their processes more complex. This also necessitated a review of managerial preparedness, which led, among other things, to the conclusion that an adequate theoretical basis was essential for leadership (Czuprák-Kovács, 2017; Dobák, 2006; Bakacsi, 1999; Taylor, 1911). In Hungary, research on leadership started in the middle of the last century. In the 1950s, management and organization studies were taught at the Technical University of Budapest, the University of Economics and then in Miskolc, and scientific associations were established (Management Science Committee, Organisation Science Committee). From the 1970s, management conferences were organized regularly, and in 1980 the Hungarian Academy of Sciences established the Management and Organisation Committee. The names of István Harsányi, János Susánszky, László Ladó, János Czabán and László Szabó are certainly noteworthy among the thinkers of the period who were concerned with management science (Farkas, 1997). The need to train managers also emerged at about the same time, first in the business sector and then in the public sector (Vereckei, 2022; Halász, 1996). Different forms of training are developed in different fields of the public sector; for public employees, the general picture is that the skills needed for management can be acquired not only as part of basic training but also in further training and higher education. These training prepare professionals to meet leadership responsibilities and, in most cases, are a precondition of being appointed to a management post. This form of higher education training is built directly on management practice developed in leadership training in 1993. Close connection to the leader activities also appeared in the fact that leaders' further training became a system element in public education institutions. After a decade, from 2002 on, completing a specialized training course in public education management became an advantage for candidates applying for institutional leader positions and became a prerequisite for reappointment in 2005 and already for a first appointment in 2013 (Vereckei, 2022). The present descriptive paper reviews this process, describing the evolution of the current leadership training system over the past three decades. It then goes on to describe the content and organizational characteristics of the training courses offering the qualification of the leader of an institution, showing how preparation and leadership are interrelated. In the final part of the study, the need for training elements following managers' preparation and current development trends are discussed.

### Evolution of the current system of leader training in education

The beginnings of the development of leadership training in the Hungarian education system can be traced back to the second half of the 1970s, and the reasons for its organization were related to the formation of the independent role of the director (Vereckei, 2021a). During this period, training still happened in the form of courses; then, in 1993, the Budapest University of Technology launched the current version of the training operating with a higher education institutional background, under the name of public education leadership training (Benedek, 2018; Halász, 1994). "No one disputed that leadership is an activity requiring independent skills and competences, but the realization that it should be acquired in higher education training providing professional qualification came from our University

in 1993", writes Márta Bosch, a participant in the launching and later the organization of the training (Bosch, 2014, 33). The fields of study and the requirements for the training of public school leaders, which were later adopted in the legislation on qualification requirements in the MKM Decree 8/1997 (18.II.), were developed in the Department of Technical Pedagogy of the University.

The training has been a specialized in-service training course, a vocational further training course since the beginning. In the international classification system, vocational training is assigned to ISCED 5 and classification levels 6 and 7 in the Hungarian Qualifications Framework (MKKR) as practice-oriented specialized pieces of training that deepen or broaden the professional knowledge certified by the primary degree (Loboda-Szlamka-Tót, 2017). Thus, according to both the previous and current legal provisions, in the framework of further vocational training, a new qualification, building on the existing level of qualification and corresponding to the specialization of the qualification acquired in the basic training, can be obtained; in our case, qualification as an institution leader (Act CCIV of 2011 on National Higher Education, § 15).

1998 was a milestone in the history of public school leader training as it was certified as a teacher specialized qualification and was included in the system of teachers' further training regulated by the Government Decree no. 277/1997 (XII. 22.). This had several advantages: on the one hand, under the government mentioned above decree, the seven-yearly teacher further training obligation can be fulfilled using a specialized examination, and once the teacher has passed it, he/she is also exempt from the obligation to undergo the next seven-year cycle of further training. (The original intention was to require a professional examination for all teaching posts after the tenth year following graduation (Gönczöl, 2011).) On the other hand, until 2011, the professional examination meant financial advantage, as well, as the concerned person was upgraded to one step higher on the civil service pay scale, and the employer could financially support his/her training as part of the system of in-service teacher training, i.e. reimbursement of costs (Vereckei, 2021b; Bosch, 2014). Although it no longer entails a higher salary grade, possessing a specialized teacher qualification is still a requirement for those working in the specialized pedagogical service. For other teaching posts, it is an advantage in terms of progression between the grades of the teacher career model and for reaching levels in a teacher's career, such as being an expert, subject adviser or chair of the examination committee.

### Introduction of the trainings offering institution leader qualification

Of the 78 higher education institutions in Hungary, there are 31 offering a teaching qualification, and more than two-thirds (22 institutions) have a licence to launch a university course offering specialized teacher qualification as a leader of an institution. Six of these courses are currently registered with the Education Office.

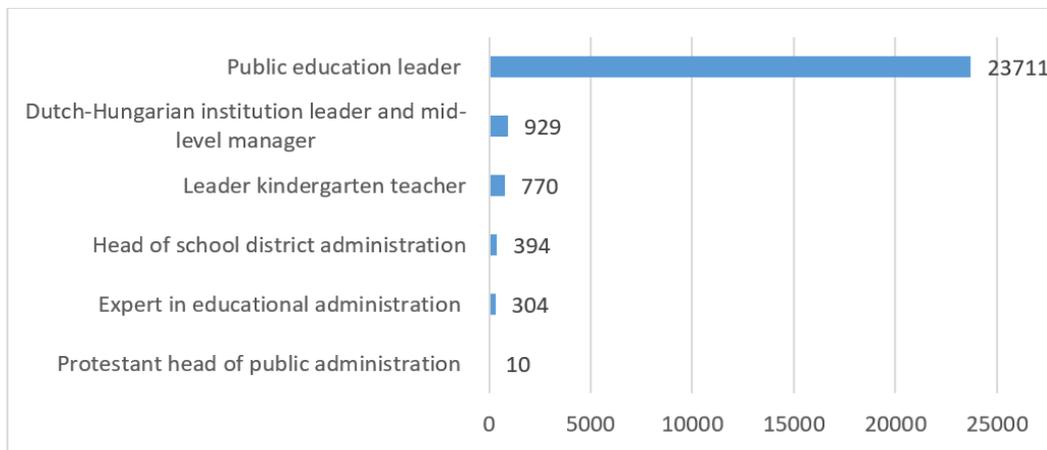
*Table 1.: Number of courses preparing for specialization exams giving institutional leader qualification and of institutions certified to launch a university course*

	<b>Name of the specialization</b>	<b>Start of the possibility to be announced</b>	<b>Number of institutions certified to launch a university course</b>	<b>Number of the institutions currently offering the training</b>
1.	Public education leader	1993	18	16
2.	Leader kindergarten teacher	1993	6	3
3.	Expert in educational administration	1993	3	1
4.	Dutch-Hungarian institution leader and mid-level manager	2009	3	2
5.	Head of school district administration	2013	5	0
6.	Protestant head of public administration	2021	1	1

*Source: own edition*

Based on the number of the institutions in the table, it can be assumed, and according to the statistics of the Education Office, it can be factually verified that most, precisely 90 per cent of the persons studying in further professional education offer some institutional leader qualification enrol to the public education leader training.

Figure 1.: Number of students between 2013 and 2021

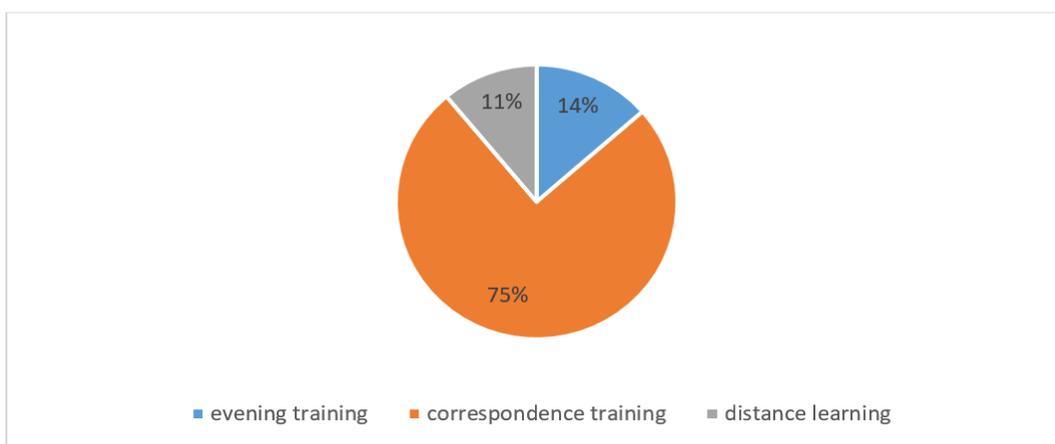


Source: own edition

The higher education institutions concerned generally offer courses at their headquarters, it is only one fifth of the institutions that offer a course in several locations. Among these, the Budapest University of Technology and Economics stands out as it has developed a distance learning model that includes several rural training sites outside the capital (Benedek, 2018), with 20 consultancy centres in operation in 2022.

In terms of the way it is organised, correspondence courses are the dominant form, accounting for three quarters of the courses, with the remaining quarter being almost equally divided between evening and distance learning.

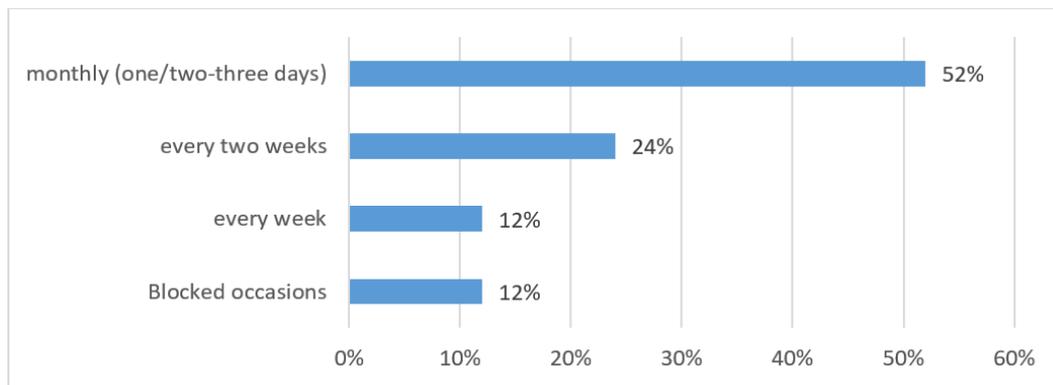
Figure 2.: Distribution of training forms



Source: own edition

In terms of attendance, once-a-month training is the dominant method. Less frequent in the case of block teaching and more frequent when weekly or fortnightly sessions are held.

Figure 3.: Frequency of presence



Source: own edition

All six training types are structured similarly: the 120-credit courses consist of 4 semesters and culminate in a diploma after writing and defending a thesis.

The 120 credits are divided into two large groups according to the implementing decree of the Law on National Higher Education (from now on referred to as The). 55 credits are compulsory courses preparing for the teacher qualification examination, and the other 55 credits are specific courses preparing for a management function, the so-called compulsory electives (The. 21/B. §). The table below lists the subjects prescribed by The, those included in the training and outcome requirements (TOR), and the most frequently encountered knowledge/subjects in the curricula drawn up by the institutions.

Table 2: Knowledge fields and subjects of trainings Source: own edition

Trainings	Compulsory knowledge field (Idhe/TOR)	Subject taught in the compulsory knowledge fields (curriculum)	Compulsory electives: knowledge field/subject (TOR/curriculum)
Public education leader	Management skills in public administration	Public administration, state administration	<b>Knowledge for leaders of educational institutions</b> School management Leadership theory Elective: Educational Governance, Vocational Education and Training Administration, Quality Management, Assessment and Measurement, Adult Education, Organisational Techniques, Curriculum Fundamentals, Advocacy Training Practice
Leader kindergarten teacher	Organisation of the institution	European union The educational system, Levels, responsibilities and authority of education management	
Educational administration expert	Environment of the institution	Law in education/education administration	
Dutch-Hungarian institution leader and mid-level manager	Efficiency of the institution	Operation and management of the institution Management theory	
Head of school-district administration	Teacher in the educational institution	Analysation, development and innovation at the organisational level	
	Issues of integration and segregation	Communication Conflict management	<b>Head Kindergarten Teacher/</b> General foundation subjects: leadership, leadership psychology, educational systems, alternative pedagogy,
	Use of specific pedagogical and	Cooperation within and among sectors, partnership relations	

Protestant head of public administration	psychological knowledge and methods	<p>measurement, evaluation and performance assessment</p> <p>Quality, quality assurance</p> <p>Equal chances, integration, segregation compensation of disadvantages, talent development</p> <p>Teacher roles, work activities, teachers' ethics</p> <p>Career and evaluation system</p> <p>Mental hygiene</p> <p>Children with specific education needs</p> <p>Health education and development</p> <p>National and ethnic minorities</p> <p>Life-long learning, adult education</p>	<p>personality development, family pedagogy</p> <p>Professional foundation subjects: application writing, professional management, kindergarten administration and management</p> <p>Practical training and skills development: measurement, evaluation, human resource development, communication, organisational development</p> <p><b>Expert knowledge in public education/</b></p> <p>Theoretical and methodological foundations of expertise</p> <p>Methodology of document analysis and expert analysis</p> <p>Curriculum and programme development</p> <p><b>Knowledge of educational management/</b></p> <p>Project management, school marketing</p> <p>Adaptive education, organisational development, quality development</p> <p>Pedagogical programme, local curriculum</p> <p>Measurement and evaluation, quality management</p> <p>Personal and social relations</p> <p>Competence development</p> <p>Leadership roles, conflict, self-development</p> <p>Pedagogical leadership, strategy development,</p>
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			management of human and material resources <b>Administrative management skills in school districts</b> System design and operation Maintainer's tasks Strategic management, project management Teachers' further training Leadership and decision psychology Professional supervision system, teacher career model Practice in public educational leadership <b>Protestant public education leadership skills</b> Legal knowledge (family, data management, employment, child protection) Budget and management of a church-run institution Applying for grants The essence of Christian leadership The raison d'être of Christian education Value-based leadership Leadership ethics in denominational education Balancing religious and financial issues Christian financial management Biblical approach to organisational development Godly excellence
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It follows from the above and from the legal requirements that the subjects and knowledge taught in the first group are roughly the same in the six courses, with the major differences being in the second credit group, since the subjects taught in this group prepare students for specific tasks that correspond to the name of the course - e.g., for expert tasks or for the management of a church-run institution or a kindergarten. A closer look at this specific credit group reveals common points though: on the one

hand, all courses contain practical and/or training elements, and there are key terms that can be found in the subjects of the chosen field of knowledge in almost all courses:

- leadership, leadership theory, organisational development, communication;
- quality, quality management, marketing;
- professional direction, administration, management (of material and human resources);
- curriculum;
- projects, tenders.

In addition to the 110 credits listed in the tables, each course also includes a 10-credit thesis, for which a preparatory course is also included in the subjects.

### **Consistency between preparation and leadership**

An analytical presentation of the training system for heads of institutions naturally includes an assessment of its adequacy, as it is essential whether it provides prospective heads with the practical knowledge to carry out their tasks. The tasks of leaders of institutions are detailed in paragraph (1) in Article 69 of Act CXC of 2011 on National Public Education. The most critical leadership activities to be assessed are listed in the section on leadership supervision in the Handbook on Supervision of Teaching, which is based on the Central5 framework of school leadership competencies developed in the framework of the International Co-operation for School Leadership project supported by the European Commission (Révai-Kirkham, 2013). Comparing the two documents, the following groups of leadership tasks and activities can be identified:

- I. Legal and legitimate management of the institution
  - drawing up and ensuring compliance with the institutional documents governing its operation;
  - taking decisions concerning the operation of the institution and the children and pupils;
  - ensuring the adequacy of the administration of educational management;
  - ensuring sound and cost-effective management of the institution.
- II. Ensuring staff and material conditions
  - ensuring, analyzing and making efficient use of institutional resources;
  - exercising special or other rights of employment;
  - the definition of decision-making powers and competences;
  - enforcing ethical standards for teachers;
  - ensuring material (and financial) conditions;
  - creating healthy and safe conditions for teaching and learning;
  - organizing regular health checks for children and pupils, accident prevention.
- III. Management of professional-pedagogical work/processes
  - preparing and implementing the pedagogical programme and the local curriculum, ensuring consistency with the management programme, the curricula and the in-service training programme;
  - organizing effective pedagogical work for student achievement (incorporation of assessment results, developmental assessment, differentiation, adaptiveness etc...);
  - management, effective information and involvement of the teaching staff in the institutional processes;
  - development of staff and their professional cooperation.
- IV. Quality improvement, organizational development, innovation
  - shaping the vision and strategic objectives of the institution, defining professional and institutional development directions and areas;
  - establishing the system of internal control;
  - setting up a system of self-evaluation;
  - managing institutional changes;

- developing a positive and supportive organizational culture;
- creating an environment open to innovation and learning.
- V. Representation of the institution, tasks related to its environment and partners
  - representing the institution;
  - ensuring the publicity of the institution's activities;
  - maintaining contacts with parents, advocacy groups, the student council, the maintainer of the institution and other partners;
  - liaising with the child protection referral system.

If the list is compared with the fields of knowledge set in the legal regulations for leadership training, it can clearly be matched with at least one or more of the leadership activity groups.

*Table 3.: Comparison of the knowledge fields and management activities*

<b>Knowledge field</b>	<b>Management activity group</b>
Public administration leadership knowledge	I. Legal and legitimate management of the institution
The organisation of the institution	III. Management of professional-pedagogical work/processes IV. Quality improvement, organisational development, innovation
Environment of the institution	V. Representation of the institution, tasks related to its environment and partners
Effectiveness of the institution	IV. Quality improvement, organisational development, innovation
Teacher in the educational institution	II. Ensuring staff and material conditions
Issues of integration and segregation	III. Management of professional-pedagogical work/processes
Use of specific pedagogical and psychological knowledge and methods	III. Management of professional-pedagogical work/processes IV. Quality improvement, organisational development, innovation

*Source: own edition*

The second set of credits focuses on different areas of management activity groups in the different courses. In this respect, the training of experts in educational administration should be treated separately, since the subjects to be covered prepare them more for the tasks of experts and less for those of heads of institutions.

### **Need for post-training elements, directions for improvement**

It has already been mentioned that in Hungary, completion of one of the management training courses described above is a compulsory condition for the appointment of a head of an institution in the public education system, regardless of the type of provider. At the same time, it is not possible to doubt without reference to legal provisions the legitimacy of the preparation of heads of institutions and the validity of the statement that the operation of a public education institution is fundamentally influenced by the activity and professional preparation of the head of the institution (Schratz et al, 2009, 2013; Johnson, 2008, Baráth, 2006; Kristóf, 2003; OECD, 2001; Halász, 1996). McKinsey's findings are also widely known: after examining the most successful national education systems, he included the training and further training of teachers among the factors determining the conditions for effectiveness (McKinsey, 2007).

The importance of training to prepare for the role of head of an institution is also increased by the fact that the selection of heads – with the exception of the conditions of education, professional

qualifications and professional experience – is not regulated by our public education system, there is no mandatory procedure to follow, so it is a matter of individual discretion how the appointing authority assesses the suitability of the candidate. Although the analytical presentation has established a clear correspondence between the managerial tasks to be performed and the knowledge content of the preparatory training, in addition to the identity of the scope of activities, the different perceptions of the managerial role in different models of maintenance (public and non-public) and the methodological approach to the challenges of the digital age must also be taken into account (Benedek, 2020). In addition to further examination of the preparatory training from this perspective, thinking must also shift in the direction of the need for development not only before but also after the start of the managerial work. In the system of in-service teacher training, there is no statutory continuation of training for heads of institutions during their career as a head. However, the handbook on supervision of teaching identifies the development of leadership competencies as a specific area to be monitored, with the following activities: monitoring the implementation of the leadership programme, identifying strengths and areas for improvement and improving leadership effectiveness.

Of the 1530 accredited teacher training programmes currently registered, 14, i.e. less than 1%, are designed to develop leaders, all in the form of courses and predominantly 30-hour courses. There is currently only one teacher qualification training for leadership development, the Master of Leadership training; the Budapest University of Technology and Economics had it authorized in 2014, and other higher education institutions have adopted it since then. This 2-semester course is open to leaders with an institutional leader qualification and at least 5 years of management experience. The training aims to optimize management activities, renew knowledge and deepen and develop management skills and abilities. It is structured in four main blocks: leadership identity, the coach approach to leadership, the life of public education institutions and digital media management (Kalicz, 2018).

To ensure that public education institutions are led by people who are competent, efficient and effective in leading an organization whose fundamental purpose is to educate and train the next generation, it is undoubtedly necessary that the three elements mentioned above – preparation for leadership, development throughout the leadership career and preparation for leadership monitoring (performance measurement) – are linked in a complex leadership development model. Furthermore, the fact that the training of heads of institutions is also a priority under the new public education strategy adopted in 2020 (Public Education Strategy 2020) should also be a hopeful sign for the future of such a model.

### Summary

In summary, there are currently six two-year specialized further education courses offered by higher education institutions, which serve the purpose of preparing future leaders of Hungarian public education for leadership tasks. The courses fulfil their role in content and form, provide knowledge that is in line with the activities of principals/heads of institutions, and are designed to meet the training needs of adults and the expectations of the workplace. Our study, which undertakes a professional overview, ends with the conclusion, which is also worthy of consideration by researchers, that there is a need to analyze the system of training of leaders further and to undertake comparative research in a broader, international context: firstly, from the point of view of whether the content on offer can be adapted more emphatically to the different perceptions of the managerial role in different providers, and secondly, from the point of view of whether the training of public education leaders can be made more multilevel. An exciting question is how and to what extent development elements can be integrated into the system (even at the level of legislation, e.g. by requiring the acquisition of a master manager qualification for the third and subsequent managerial mandate) and linked to the preparation for measuring managerial performance. To further explore this issue, our further research will focus on the synchronicity of the content and methodology of training and on the possibilities for ensuring continuity of training throughout the leadership career.

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**Helena MANOJLOVIC**

## **Escape room as a teaching method**

### **Introduction**

It is essential to recognize how students can be better connected to the classroom and make the curriculum and learning more attractive. In order to attract and maintain students' attention, increase motivation and make learning easier, teachers are constantly experimenting with new strategies and teaching methods (Kurian & Ross, 2021).

The European Higher Education Area (EHEA)<sup>1</sup> supports the use of active learning teaching methods that complement traditional methods and respond to the new socio-educational context (Magro et al., 2019).

The active learning methodology is one of the most exciting approaches to facilitating the involvement of learners in their learning processes (Grande-de-Prado et al., 2021). According to Piaget and Vygotsky, the role of play in cognitive development is emphasized. The game allows strategies, norms, and values to be incorporated into the process of personality formation (DeVries, 2000). Among the advantages offered by games, it is worth highlighting their didactic potential, which ranges from adapting to different learning styles, allowing mistakes, providing instant feedback, and developing creativity to increase the motivation and socialization of students. Disadvantages include the risk of possible excessive competitiveness and inadequate time management, which should be considered along with other specific aspects of each game (Cadavid & Corcho, 2018). This approach, as opposed to traditional education, opens the door to new concepts such as integrating curriculum into the game-based frameworks.

The games are highly inspiring, use different methods to engage the individual, and offer opportunities for fun and competition (Dicheva et al., 2015). This innovative play method reduces the risk of dropout or low achievement (Ahmed, 2013). In addition, the application of play in the educational environment increases motivation and engagement and facilitates learning while developing collaborative and communication skills (Borrego et al., 2017; Cain, 2019; Clapson et al., 2020; Edwards et al., 2019).

### **Learning through play**

In the 21st century, the concept of games has become very important due to the explosive development of technology, thanks to the digital revolution (Clarke et al., 2017). The use of games as a pedagogical method has gained momentum recently (Vlachopoulos & Makri, 2017). From an educational perspective, three important concepts are related to games: serious games, gamification, and game-based learning. True, the concepts are related to each other, but they still have different characteristics.

In fact, serious games are designed for development, not for playful purposes. The concept first appeared in 1970 thanks to American researcher Clark C. Abt. He calls serious games an approach or simulation based on a real situation that develops into a game with an educational purpose (Abt, 1970).

Gamification consists of using the elements and mechanics of the game in a non-game context (Bruder, 2014). Gamification became popular in education in the early 2010s (Kapp, 2012). It uses game-based mechanics, aesthetics, game and strategic thinking to engage participants, stimulate action, facilitate learning, and solve problems, implicitly focusing on its core strengths: engaging students, enhancing

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<sup>1</sup> The European Higher Education Area was launched in March 2010 as part of the Budapest-Vienna Ministerial Conference on the 10th anniversary of the Bologna Process. The European Higher Education Area is an association founded under the auspices of the Bologna Process, a European initiative whose members work together to renew higher education and facilitate the mobility of job-seekers and teachers in higher education. (European Higher Education Area and Bologna Process).

and improving learning, and motivating commitment (Makri et al., 2021). From an educational point of view, escape rooms are closely related to gamification methodology (Makri et al., 2021).

It is important to understand the differences between gamification and game-based learning. The main difference is that gamification adds a game component to the learning experience, while game-based learning involves the use of games in an educational context to achieve learning goals (Kapp, 2012; O'Brien & Pitera, 2019). Game-based learning aims to improve the quality of the learning process through interaction in a motivational environment (Cordova & Lepper, 1996).

By the way these methodologies, students are motivated to learn and master the curriculum while not even realizing they are learning. This approach makes learning playful, connects participants, and stimulates their curiosity in the educational environment (Looking at Learning Project, 2015). On the other hand, students can become key actors in their own learning process and interact with the available curriculum, because the presentation of new knowledge in the use of educational games differs from classical approaches.

The escape room is based on gamification and game-based learning. During this collaborative game, the task of the participants is to find different clues, solve puzzles, and complete various tasks within a limited time. The goal is usually to leave the room or find an object (Nicholson, 2015). Games developed for educational purposes are usually called educational escape room (game) or escape room (game) for educational purposes. The main theories of learning behind this method include active learning, which can be defined as "any instructional method that engages students in the learning process" (Prince, 2004: 1). One of the most representative characteristics of active learning is that students perform meaningful learning activities while thinking about the actions performed.

### **Educational escape room**

In recent years, commercial escape rooms have inspired teachers worldwide to use this fun activity for educational purposes (Veldkamp et al., 2020a). Escape room games are problem-based, limited playing time, and require active and cooperative participants. The first generation of escape rooms focused on tricky logical puzzles, which have now evolved into attractive environments with high-quality props and effects (Wiemker et al., 2015).

The escape rooms appeared in the educational area in 2017 and drew the attention of educators (López-Pernas et al., 2021). Since then, escape rooms have been used in various educational settings, and the game has emerged at all levels of education. In addition, the possibility of providing learning activities has attracted the attention of many researchers, as evidenced by the exponential growth in the number of studies in recent years (Fotaris & Mastoras, 2019). Although rooms have been developed for educational purposes as a relatively new concept, their educational potential has been explored by several authors (Adams et al., 2018; Ang et al., 2020; Borrego et al., 2017; Clarke et al., 2017; Duggins, 2019).

Unlike commercial escape rooms puzzles in educational rooms need to be aligned with the curriculum, and students need subject knowledge and a range of soft skills to achieve planned learning goals (Cain, 2019; López-Pernas et al., 2019b). Therefore, the primary criteria for designing escape rooms for educational purposes include reconciling learning objectives and puzzles.

The educational escape room is a new game-based learning approach that combines team-based problem solving with a narrative and mysterious clues. In the game, all problem situations and challenges are called puzzles that ensure the activity of the participants (Nicholson, 2012). There are different categories of puzzles: (1) cognitive, (2) physical, and (3) meta-puzzles. Predominantly present logical, analytical and mathematical games in rooms requiring problem-solving and logical thinking. (Wiemker et al., 2015).

This game has proven to be an innovative pedagogical tool that increases learning efficiency. Educational escape rooms are perfect examples of active learning because students have to interact

with various elements and figure out how to solve different puzzles. The game's appeal lies in stimulating the players' minds and the variety of puzzles (Zaug et al., 2021). Escape rooms can transform any curriculum into an attractive learning environment (Neumann et al., 2020). One of its main advantages is to increase student engagement and motivation (Berthod et al., 2020; Grande-de-Prado et al., 2021; Kinio et al., 2019; Walsh & Spence, 2018). The puzzles test students' knowledge of the curriculum and actively develop their skills. In particular, by participating in the educational escape room, students strengthen their problem-solving skills by observing, identifying relationships and logical contexts while solving problems creatively (Huang et al., 2020).

Competences that can be developed through the game include developing problem-solving skills, encouraging collaborative work, learning to think, motivating and learning to learn, improving learning, developing imagination, fostering social interaction and communication, critical and lateral thinking, developing leadership behavior, etc. (e.g., Cruz, 2019; Friedrich et al., 2019; Karageorgiou et al., 2019). Furthermore, compared to other teaching and learning methods, the fact that students work together can be emphasized, making it possible to strengthen group cohesion. In addition, it provides an opportunity to simulate different lifelike situations (Brooks-Buza et al., 2011).

The majority of studies on educational escape rooms focus on teaching educational topics (Adams et al., 2018; Dietrich, 2018; Glavaš & Staščík, 2017; Jambhekar et al., 2020; López-Pernas et al., 2019a). However, it is possible to develop technical (complex) and social (soft) skills simultaneously. For example, some games focus on developing soft skills, such as team building and group leadership (Gordon et al., 2019a; Wu et al., 2018). However, it is impossible to draw a clear line between a game created solely for developing interpersonal skills and a game that serves to teach subject knowledge. In summary, escape room games are suitable for the development of both: cognitive and social competencies.

### **Game methodology and design**

Before developing a game, several aspects need to be considered: the target group, the length of time spent on the game, the equipment required, and the educational and competency development goals of the game (Clarke et al., 2017).

Designing escape games requires a thoughtful, well-defined process. There is very scarce literature about the methodological implementation of the game. Teachers must be helped with guidelines to apply a thoughtful, methodical, iterative process to ensure quality, educational capacity, and a positive learning experience (Eukel & Morrell, 2021). The game is designed through an iterative process. This process is through different approaches conducted by designers, researchers, and educators. There are theoretical frameworks for design and construction in the literature, some of which are specifically designed to meet educational goals: escapED (Clarke et al., 2017); SERF (Snyder, 2018); SEGAM (Guigon et al., 2018); StarModel (Botturi & Babazadeh, 2020). Each model contains steps for planning, experimenting, evaluating, redesigning, re-evaluating, and repeating the steps listed.

When designing escape rooms, teachers should consider educational goals, available resources, and the aims of the game. All puzzles must be carefully designed to meet the needs of education, teachers, and students.

In addition to teaching the curriculum, outcomes should also be considered, including developing a range of social skills. Systematic, flexible, and cyclical design can help make learning more effective, as the game is subject to constant change.

Four categories have been identified for the resources required to design and implement an escape room for educational purposes: physical resources, equipment, time, and money (Tercanli et al., 2021).

As our research has shown, a lack of physical resources can lead to several problems. Most educational escape room games consist of two separate rooms. While one room is set up as an actual educational escape room for players, game designers, moderators, and observers to watch participants from a

separate control room, which is mainly done via live video through a video camera (Berthod et al., 2020; Clarke et al., 2017). In addition, they can use microphones and speakers or computer chat windows to remotely give tips to participants if they encounter difficulties during the game (Clare, 2015). Most educational escape rooms are self-funded by educators, so the games contain simple puzzles and decorations.

In many cases, existing educational materials are used to design the rooms (Eukel et al., 2020; Nicholson, 2018). There are many templates on the World Wide Web, such as the BreakoutEDU sets. The time required for development depends on the complexity of the game. It can be a time interval from one day to several weeks, and sometimes it takes several months (Clare, 2015).

### Theoretical framework – SmarTeacheRoom

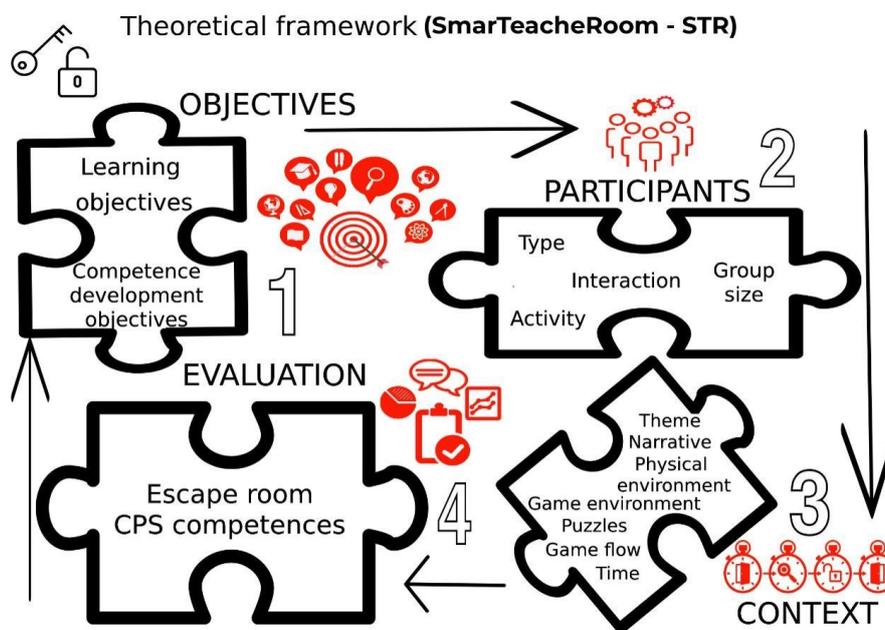
Several theoretical frameworks for designing escape rooms for educational purposes have been published that include step-by-step procedures for building a game (Clarke et al., 2017; Guigon et al., 2018; Snider, 2018). Frameworks provide guidelines for the design of physical rooms. However, some teachers prefer to develop more cost-effective, affordable, and accessible digital escape rooms, as several available digital tools can be used to create educational games in a hybrid or online environment (Kroski, 2020).

Based on theoretical frameworks describing the structure of existing escape rooms, we have developed our integrated model combining and complementing the different approaches.

We needed to create a model showing that problem-solving activities cannot always be accomplished without using social skills. Some activities move the group forward in the collaborative problem-solving process, which does not require the cognitive skills to solve them. In the model, the emphasis is on the directly observable activities since our observations are always related to the elements of behavior. Therefore, we can only assume the abilities and processes behind the activities.

The framework helps to find a way to structure and evaluate escape rooms for educational purposes, as well as direct observation of problem-solving groups to find out how individuals solve problems and how they work with their group peers. Incorporating elements such as objectives, participants, context, and evaluation allows for solving tasks as a game in an educational environment.

Figure 1: Theoretical framework (SmarTeacheRoom - STR)



(source: Own elaboration)

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Learning and competence development objectives are needed to create a meaningful educational game. Based on the model, it is advisable to start designing an escape room for educational purposes by defining aims. Developing goals at an early stage of the planning process ensures that the gaming experience is purposefully planned. Aligning other items with objectives is much easier than embedding objectives in an already planned game. The objectives of the game designer help to select the right participants, as well as to understand the structure and construction process. This step provides a basis on which the direction of development becomes clear and facilitates the subsequent development of the evaluation strategy (Snider, 2018).

As a second step, the designer should consider the participants and analyze who the target audience is. The target audience for the gaming experience must be selected before other content can be developed. Participants, often students, have different characteristics (demographic aspects, subject, and content aspects, attitudes towards play and learning, etc.).

The third step is for the designers to consider the general theme of the escape room. The context itself can increase the participants' motivation, and the game's narrative and content can provide an engaging gaming experience for the participants. The context gives meaning to the activity. Escape rooms usually have solid themes and narratives. Popular topics include investigation, escape from prison, hostage rescue, spyware games, and more. To increase the gaming experience's authenticity, designers use various decorations. A wide range of these props includes lighting, music, puzzles, riddles, and clues that follow the theme of the room. Finally, the designer should consider the space and equipment he will use to support the gaming experience. If e.g., the game design should be supported by technology, this step can help consider how participants will interact with technology and the steps to be taken if technology does not work as planned. The context is divided into seven areas the designer must consider during the design process.

The last point in the theoretical framework is evaluation. The designer must consider how to evaluate the gaming experience and the acquired knowledge, which is closely related to the first step of design: objectives. Here, methods for assessing desired goals and results come to the fore. Evaluation is a critical element of development. The overall efficiency of knowledge transfer in the escape room will be assessed, and the data collected by the evaluation may be helpful to improve the gaming experience further. It is possible to assess whether the escape room meets the objectives, which aspects contribute to or degrade the gaming experience, and how confusing elements could be corrected. In this step, we separate the evaluation of the escape room itself and the competencies we want to assess.

### **The role of the teacher**

In most educational escape rooms, teachers take over the roles of game designers, moderators, and observers (Berthod et al., 2020; Cain, 2019; Eukel et al., 2020). It is a great advantage if the teacher has previous experience in game development. A great advantage is the knowledge of design methods, creativity and entrepreneurial mindset, good time management, and flexibility. In addition, writing skills and knowledge of subject knowledge are essential. The teacher spends most of his time designing and planning the game.

Creating an educational escape room online platform to share and disseminate the tool and methodologies is critical. Such a platform could include blueprints, design schemes, and reproducible educational escape room modules. In addition, manuals and tutorials are needed to guide the teacher on how to modify and integrate this method into their courses. Such a platform could bring together teachers and escape room fans as a network node, creating new synergies and collaborations (Tercanli et al., 2021).

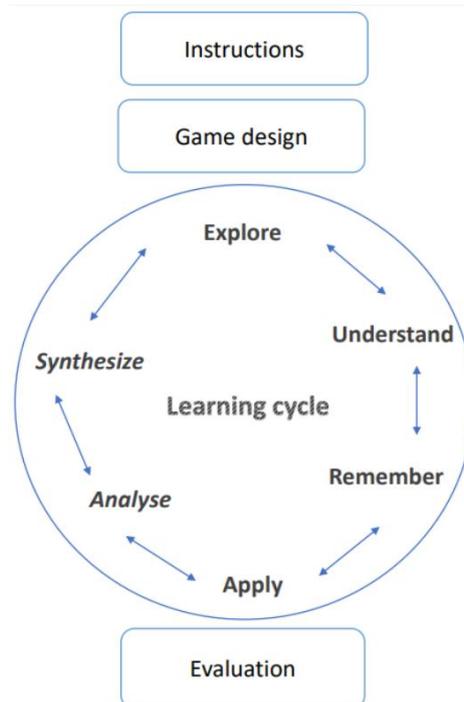
### Learning outcomes

In recent years, escape rooms for educational purposes have become an increasingly popular educational tool, with the ultimate goal of engaging students in the learning environment, encouraging collaboration, and practicing and developing 21st-century soft skills (Kinio et al., 2019). By using these tools for educational purposes, students move from passive knowledge recipients to active participants in the learning process. In an educational context, a problem-solving game that can simulate the real world provides an opportunity to practice different situations. Therefore, the criterion for a well-structured game is to ensure active participation.

The characteristics of many learning theories can be discovered during certain activities of the escape room game. Elements of constructionism and behaviorism are also recognizable (Ouariachi & Wim, 2020). Social constructivism is manifested in cooperation and constructive knowledge based on real-time experience (Zhang et al., 2018). This theory emphasizes the influence of those social circumstances that frame the social interactions between participants. Behaviorism is evident in the elements that reward positive behavior (Ouariachi & Wim, 2020; Zhang et al., 2018).

The student learning cycle follows specific characteristics during the activity (see Figure 2).

Figure 2: Student learning cycle in the escape room



Source: Reuter et al. (2020)

In the beginning, participants explore the tools available for the activity. Then they discover some clues and begin to understand the course of the game and the steps needed to solve the puzzle. Students need to remember certain contents and apply them in the game through attempts until they find a solution. In this process, participants need the ability to collaborate, communicate, and think critically to respond to challenges (Wiemker et al., 2015). Escape rooms are team-based activities and are great for active learning due to the pressure of the time frame and the number of puzzles that require a variety of mindsets (Menon, 2019).

Participants should have a range of skills to help them face challenges, such as good observation of details, clues to solving puzzles, logical thinking, memorizing a series of numbers or symbols, and good math skills, including solving anagrams and cryptograms. Successful teams work together, communicate and delegate challenges well, and analyze and synthesize possible solutions (Giang et al., 2020). A great feature of escape rooms is that they are suitable for all ages and are gender-

independent - in fact, teams composed of players with different backgrounds, abilities, and knowledge are the most successful (Gordon et al., 2019).

Creating an optimal flow is essential during the game. When experiencing the flow, participants are fully involved in the task and focus exclusively on it. If the challenge is too difficult, players become anxious and may become unmotivated to continue playing, while a too easy challenge leads to boredom (Wiemker et al., 2015). So, if the escape room is well designed, follows every step of the organization and creation accurately, and takes into account the needs of the students, the activity is more likely to get the students to the desired state of flow and the planned level of knowledge.

## Research

Our educational escape room game is designed to observe and measure collaborative problem-solving competencies. The game covers a wide range of escape room puzzles. Our target group was students of pedagogical practice. The sample consisted of students from:

- J. Selye University (Faculty of Education), Komarno, Slovakia;
- the Faculty of Economic and Social Sciences (BME), (Department of Technical Pedagogy), Budapest, Hungary;
- And UNS - University of Novi Sad Hungarian Language Teacher Training Faculty (Faculty of Teacher Education), Subotica, Serbia.

The sample consists of 101 students who participated in the research. The groups consisted of 3 to 5 participants. The progress of the game was monitored using a camera. The game was followed by focus group interviews and the completion of four questionnaires and a test:

- Scrambled Adaptive Matrices (SAM) (Fodor et al., 2018);
- Big Five (Caprara et al., 1993);
- Teamwork Skills Questionnaire (Marshall et al., 2005);
- Tóth-féle Kreativitás Becslő Skála (TKBS) (Tóth & Király, 2006);
- and background questionnaire.

Data collection began in September 2021 and ended in mid-December. The final results of the research are expected by the summer of 2022.

## Conclusion

Escape rooms have become one of the most significant leisure activities in the last few years (Lama, 2018). The advantages discovered in various studies of escape rooms are collaborative work, social competence, problem-solving, and motivation. In addition, existing experience and research results also support that the escape room for educational purposes can be a tool for any teaching area, as it is easy to apply, student-centered, and promotes research thinking, logical and critical thinking (Aubeux et al., 2020; Eukel et al., 2020).

Educational play provides a challenging activity for education that, in a well-designed way, can be very appealing to both students and teachers, promoting active and meaningful learning. With the right expertise and experience, teachers can cope with the challenges of escape rooms that maintain the flow between challenges and required skills, incorporating this activity into the curriculum and adapting it to organizational issues such as spaces, resources, schedules, and groups. True, there are several limitations that a teacher may face, such as limited resources. However, on the other hand, the benefits can enrich educational activities by facilitating the development of social relations and students' active involvement in the curriculum. Platforms like Breakout EDU or Genially can be very helpful in designing, as well as providing a variety of digital templates. Planning can be supported by one of the frameworks mentioned in the study, which can be a handy guide in different learning/teaching contexts.

In game-based learning, play is at the heart of the learning process. The acquisition of new knowledge and the realization of learning goals takes place in a playful environment, which provides additional motivation for students through the possibility of fun and competition. Moving beyond commercial use to education, the escape room is gaining importance in traditional and digital forms as a game-based learning tool.

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## Current trends and developments in the application of digital tools and implementation of environmental awareness and sustainability in PBL-based STEM education: a dual systematic literature review

### Introduction

Problem-Based Learning (PBL) is a part of meaningful, experiential learning, where students learn by solving problems and reflecting on their experiences (Barrows and Tamblyn, 1980). PBL can be used to help students become active learners by shifting learning to real-world problems and making students responsible for their learning. It places a dual emphasis on helping students develop strategies and construct knowledge (Collins et al., 1989; Hmelo and Ferrari, 1997; Kolodner et al., 1996). Cooperative learning methods are often used in problem-based learning (Hmelo-Silver, 2004).

STEM (Science Technology Engineering and Mathematics) in education is both a curriculum and a pedagogy. Moore et al. (2014) designated a framework that includes six important tenets for quality STEM education:

- the inclusion of math and science content,
- student-centered pedagogy,
- lessons are situated in an engaging and motivating context,
- inclusion of engineering design or redesign challenge,
- students learn from making mistakes,
- teamwork is emphasized.

However, Honey et al. (2014) argue that STEM education is not a well-defined concept.

The problem-based approach has been widely used in STEM education in recent years. PBL directly affected interest in a future STEM career (LaForce et al., 2017). PBL-STEM significantly increased students' problem-solving skills compared to the traditional class (Parno et al., 2019). Moreover, it was also found that STEM PBLs in schools helped lower-achieving students more and reduced achievement gaps (Han et al., 2015).

The combination of advances in technology, the digital literacy of Generation Z students, and online education due to the Covid-19 pandemic has meant that PBL STEM has very often been delivered in a digital environment in the recent past. For this reason, we considered it essential to examine how digitally-enhanced PBL in STEM education has been implemented in the last two years (from 2020 to 2022).

The most recent trends in the development of STEM curricula are implementing new, relevant topics, including environmental awareness (Nantsou and Tombras, 2022) and sustainability (Smith and Watson, 2019). Since these topics involve many fields of knowledge (Clark and Button, 2011), complex learning outcomes can be set and pursued (Rogers et al., 2015) – all the necessary vital competencies must be improved accordingly to critical thinking (Erikson and Erikson, 2019).

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## Methodology

### *Research questions*

Many recent publications which feature research on PBL-based STEM teaching and curricular development contain curricular elements and components of environmental education and sustainability. Therefore, we intended to analyze, classification, and assess the practical methods and tools along with the following criteria:

- **RQ1:** What methods and tools are used in problem-based STEM education that can raise environmental awareness and form the students' attitude concerning sustainability?
- **RQ2:** What key factors can we identify in successfully implementing such curricular content?
- **RQ3:** What types of digital devices are used in problem-based STEM education? What exactly is the role of digital tools in problem-based STEM learning?
- **RQ4:** What problems do students have to solve in problem-based STEM learning using a digital device?

### *Literature search process*

We chose the Web of Science (WoS) database as it is the gateway for all the Science Citation Indexed (SCI) and Social Science Citation Indexed (SSCI) journals. We queried the WoS database for the first time on the 1st of April 2022. The search string (*problem-based learning AND STEM*) was keyed into the advanced search option of the Web of Science database. We then specified the range of years from 2020 to 2022. Problem-based learning and STEM research areas have been very active over the years. However, we investigate only the most recent literature because technology evolves and rapidly changes. We, therefore, focused our research on considering studies from 2020 to 2022.

### *Eligibility criteria*

Inclusion and exclusion criteria were set to refine further the 377 results obtained. First, we read the 377 abstracts. We then looked at how these articles were grouped around broad themes. We found two particular groups:

- PBL in STEM education by using some digital device,
- PBL is related to environmental education or sustainability in STEM education.

Afterward, we narrowed our list to only articles on topics 1 or 2 above (126 articles). Of the studies with topics mentioned above, only the following were considered:

#### *PBL in STEM education by using some kind of digital device*

Of the studies with topics mentioned above, only the following were considered:

- Inclusion criteria: (a) empirical studies, (b) PBL in STEM education must be the central topic of the article, and (c) the study must focus on students and their PBL activities in STEM education.
- Exclusion criteria: (a) inadequate genre (theoretical study, literature, or systematic literature review), (b) the teachers are the main actors of the study (instead of students), (c) the study focuses on the digital tool that can be used to implement PBL in STEM education, (d) non-English articles, (e) articles in which the full text was not available.

After this procedure, we got 14 articles about problem-based learning in STEM education using a digital device.

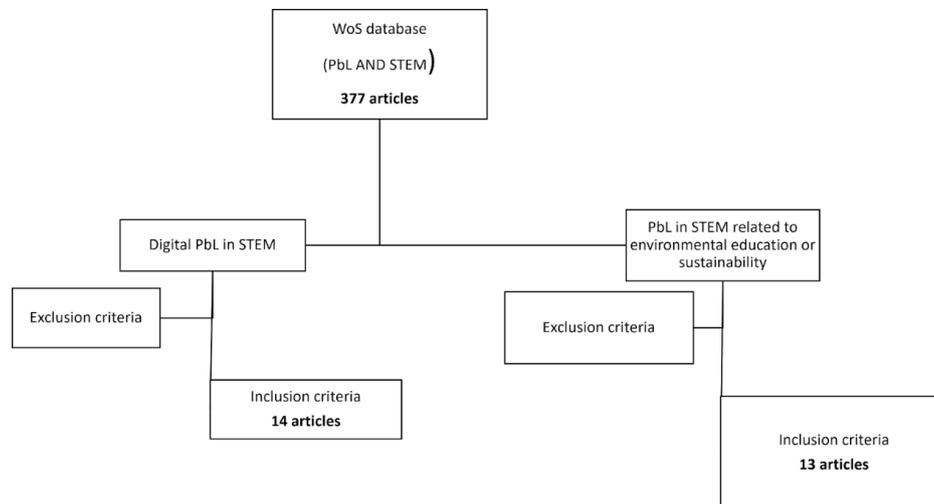
#### *PBL related to environmental education or sustainability in STEM education*

Out of the studies mentioned above, only the following ones were considered:

- Inclusion criteria: (a) empirical studies, (b) PBL in STEM education must be the main instrument to propagate environmental awareness towards the pupils, and (c) the study focuses at least partially on students and their PBL activities in STEM education.
- Exclusion criteria: (a) inadequate genre (theoretical study, literature, or systematic literature review), (b) non-English articles, and (c) articles in which the full text was not available.

After this procedure, we got 13 articles about problem-based learning in STEM education-related to either environmental education or sustainability. Out of the remaining articles, one was related to both of our chosen topics, so altogether, this article covers the systematic review of those 26 articles (Fig. 1).

Figure 1: An overview of the search protocol



## How PBL in STEM education contributes to environmental awareness and sustainability – and how it can be implemented successfully

### General characteristics of RQ1

A minority ( $n=3$ ) of the collected articles were based mainly on the development of a specific framework (Nawi et al., 2019) or model for (not necessarily only) environmental education, which put the focus of the entire learning process on the students, e.g., IGNITE (Dotson et al., 2020) or PRInK (Yahaya et al., 2021). However, since Nawi et al. tested their framework on a specific topic, we also classified their article as a case study. Therefore, this article and all the remaining publications ( $n=11$ ) were specific case studies in which the application of certain problem-based and other learning tools and methods were used during the learning process. The subjects of the studies varied from 3rd-grade pupils to university students and pre-service teachers (Rico et al., 2021; Maass et al., 2022).

### Educational methods for the frameworks

Since it is common practice to the couple (C)PBL and TEL (Technology-Enhanced Learning) (Nawi et al., 2019) or even its more advanced form of TEAL (Technology-Enabled Active Learning) (Shay et al., 2020), the most common component of these models was the technology as mentioned above *assisted learning* in many forms, especially Computer-Assisted Learning (Yahaya et al., 2021; Molan et al., 2022).

Other primary aspects were contextualizing the problem and the student's motivation. For this, the teachers and educators used the 5E (Engage, Explore, Explain, Elaborate, Evaluate) model (Bybee et al., 2006) for instruction in many cases ( $n=7$ ).

### Educational tools for the methods

As Table 1. shows, the educational tools used by the studies ranged from minor (Nawi et al., 2019) to no (Songer and Ibarrola Recalde, 2021; Talley et al., 2021) use of apps as a learning platform to partly (Rossano and Calvano, 2020) or immersive virtual environments (Molan et al., 2022).

The case studies can be divided into three categories based on the level of digitalization their methods and tools used based on the SAMR model (Hamilton et al., 2016):

- In some cases, there is no need to use technology further than to substitute or augment the already existing research and education tools to make the learning tools and the process more compatible with the younger generations (Maass et al., 2022; Rico et al., 2021; Songer and Ibarrola Recalde, 2021; Snell-Rood et al., 2021). It also makes research and education activities more easily conducive for technologically less developed institutions and communities (Gallay et al., 2021; 2021; Talley et al., 2021).
- In the remaining cases, digital technology can modify or even wholly redefine certain parts of the learning process by providing a new feature (Araya and Collanqui, 2021; Nawi et al., 2019; Shay et al., 2021) or a completely new task (Molan et al., 2021; Rossano and Calvano, 2020).

*Table 1: Classification of the case studies by scientific topic, research subjects and main educational tool.*

Article	Scientific topic	Res. subjects	Ed. tool(s)
Araya and Collanqui, 2021	CO2 emission	cross-border 8th grade classes (Chile and Peru)	ConectaIdeas (cloud-based educational platform)
Gallay et al, 2021	social justice and STEM	6th to 12th grade students	problem based STEM projects
Maass et al, 2022	active citizenship	pre-service teachers in six European countries	problem-based prof. developm. (PD) courses
Molan et al, 2021	bushfire safety	4th to 6th grade students	immersive virtual environment (IVE)
Nawi et al, 2019	low carbon awareness	8-9th grade students	technology-enhanced cooperative projects
Rico et al, 2021	sustainable development	pre-service teachers	PBL-oriented teacher-learning sequence (TLS)
Rossano and Calvano, 2020	ocean literacy, water pollution	4th grade students	educational video + computer game
Shay et al, 2020	carbon assimilation	racial/ethnic minority students in local communities	problem-based TEAL projects
Snell-Rood et al, 2021	COVID-19	summer schools students	PBL-oriented case study + lesson plan
Songer and Ibarrola R., 2021	solving socio-scientific issues via eco-solutioning	3rd to 6th grade students	complex tests
Talley et al, 2021	pollution in urban watersheds	local communities	data tracking, surveys, individual assessments and interviews

*Education system*

The first group of such features is those that can be regulated and monitored by levels and members of the education system or systems, which serve as a stage for innovation. One of the most important contributing factors is the clarity of all involved education policies – whether the policymakers (and the teachers) know and accept the goals of the modernization.

Those goals are usually clearly set in the learning outcomes, which can be categorized in many ways - e.g., by the types (content, practice) of learning items (Songer and Ibarrola Recalde, 2021) or by the classical three-way partitioning of the outcomes (stores of learning, capabilities, and attitudes). The latter was done implicitly in some articles (e.g., Rico et al., 2021) and more explicitly in others. For example, Molan et al. (2021) classify even more precise outcomes (learning objectives) for each step of the virtual PBL-based learning tool they designed - the most poignant examples of that are the three articles that involve different, precisely designed frameworks (Nawi et al., 2019) or models of learning (Dotson et al., 2020; Yahaya et al., 2021).

Another important systematic component of implementational success can be the instruments for development - however, the impact of these tools depends strongly on the complexity of the learning tools utilized by the learners. This impact can vary within vast limits, from having very little weight in the development (Maass et al., 2022) to being the sole instrument of the learning process (Rossano and Calvano, 2020).

A final addition to the potential contributing factors is a capable assessment system which may be created by developments of specific components of the internal assessment system of the school to support the means and goals of the modernization (Yahaya et al., 2021) and by creating and operating an independent, external assessment system to provide a risk-based evaluation (Nawi et al., 2019), or both (Dotson et al., 2020).

*Role of the community (learners, teachers)*

Other than formal education, some (n=3) studies introduced community science (Talley et al., 2021) or civic science (Gallay et al., 2021; Snell-Rood et al., 2021), especially so to compensate for the underrepresentation of participants in specific ethnic (Hispanic minorities in the State of California (Talley et al., 2021; Shay et al., 2020)) or socio-economic status (urban (Gallay et al., 2021) and foster students (Songer and Ibarrola Recalde, 2021)) status. The most probable general idea behind applying this approach was to elevate the socio-scientific status of these communities.

Horizontal cooperation (another operational system through which the teachers can access pedagogical consultation opportunities, professional support (e.g., literature), or horizontal network cooperation) also has to be considered a contributing factor. It may happen between schools in the exact count(r)y (Gallay et al., 2021; Songer and Ibarrola Recalde, 2021; Talley et al., 2021) or at the same level of education but in different countries (Araya and Collanqui, 2021) and also between different levels of research and education (Dotson et al., 2020). The latter can largely contribute to a broader range of applications as education methods and tools used in multiple systems have to be up to many different standards - a good practice that has been developed that way is the already referenced 5E model, which was incorporated in many of the studies researched by us (n=7).

Perhaps the most crucial contributing factor belongs to the teachers as individuals: their lesson planning practice has to enable said development processes; otherwise, the necessary learning tools cannot be adequately utilized. It is incredibly decisive when it comes to complex ICT tools (Molan et al., 2021; Shay et al., 2020), new or uncommon methods and practices (Molan et al., 2021; Rossano and Calvano, 2020) - especially new frameworks (Nawi et al., 2019) or learning models (Dotson et al., 2020; Yahaya et al., 2021).

*Discussion of RQ1 and RQ2 via SWOT of the implementation of PBL*

After identifying the key factors necessary for implementational success, we can also analyze other features of PBL that may motivate and navigate the schools and teachers during the implementation process. To do that, instead of subjecting PBL to SWOT, we subject the implementation process itself to the analysis. As *Table 2.* suggests, these possible strengths, weaknesses, opportunities, and threats concerning the implementation of PBL can be divided into features that can be managed or altered by either the institutes or the educators themselves (and in some rare cases, both).

*Table 2: SWOT analysis for the implementation of PBL*

<b>Strengths</b>	<b>Weaknesses</b>
<p>By applying PBL in practice, the teachers become capable of</p> <ul style="list-style-type: none"> <li>• enhancing the activity of students and their self-regulated learning,</li> <li>• facilitating more cooperation and collaboration between the learners,</li> <li>• deepening the understanding of the topic by discussion,</li> <li>• providing realistic topics and real life environmental problems.</li> </ul> <p>Also the school curricula can meet the educational challenges of the 21st century:</p> <ul style="list-style-type: none"> <li>• Complex topics can have many evaluation aspects, thus making detailed and personalized evaluation possible.</li> <li>• Complex tasks may also activate many of the key competences simultaneously.</li> </ul>	<p>The teachers also have to take into account that</p> <ul style="list-style-type: none"> <li>• objective summative evaluation can be notoriously difficult if not impossible in some cases,</li> <li>• and that PBL-based learning can be extremely resource-consuming (time, tools, sources, management of the learning process).</li> </ul> <p>The schools also have to consider that</p> <ul style="list-style-type: none"> <li>• use of PBL is not a common practice in Hungary - both the literature and methodology need serious development,</li> <li>• which means serious horizontal cooperation (for the purposes of design and development) may have to be created and developed.</li> </ul>
<b>Opportunities</b>	<b>Threats</b>
<p>PBL itself can become and intensive developmental tool for schools and teachers concerning</p> <ul style="list-style-type: none"> <li>• soft skills,</li> <li>• metacognitive and</li> <li>• metaaffective functions.</li> </ul>	<p>The teachers</p> <ul style="list-style-type: none"> <li>• may not be able to regulate the learning process in its entirety,</li> <li>• may only be able to facilitate instead of regulating in some cases, which may result in the loss of intrinsic motivation of the students (which can temporarily or permanently stun the learning process)</li> </ul> <p>The schools and the tutoriates have to also consider that the application of</p> <ul style="list-style-type: none"> <li>• improper methods and</li> <li>• lesson designs</li> </ul> <p>may also decrease student motivation or create free riders.</p>

Unsurprisingly, the SWOT of the implementation is very similar to the SWOT of PBL itself (Azaceta et al., 2018; Patrick et al., 2020). however, the focus on specific areas is shifted towards the systematic

and human resources rather than the characteristics of the theoretical framework of (Collaborative) Problem Based Learning.

### Problem-based learning in STEM education by using some kind of digital device

#### *General characteristics of RQ3 (the types and role of digital devices)*

Two large groups of digital devices appear in the studies examined. First, robotics was most popular - it was used in half of the cases (n=7). Different kinds of programming were used in problem-based STEM education in three cases. In the remaining four studies, virtual reality, computer games, computer agents, and interactive online boards occurred only once. The summary of these results is shown in *Table 3*.

*Table 3: The types of digital devices used in problem-based STEM education*

Categories	Sub-categories	More information	Articles
Robotics	detectors and sensors communicate with computer	Raspberry Pi	Major et al, 2021
	board microcontrollers	Arduino	Cui et al, 2021 Wang et al, 2021
		Micro:bit	Shahin et al, 2021
	robots capable of movement	sensitive robotic arm, a two-finger parallel gripper	Wang et al, 2021
		sumo robot	Sisman et al, 2022
		aerial drone	Bhuyan et al, 2020
		programmable robot ball (Sphero SPRK+)	Kim et al, 2021
Programming	text-based	Python language	Lin, YT et al, 2020
	block-based	Scratch	Weng et al, 2022 Century et al, 2020
Virtual reality (VR)			Dayarathna et al, 2020
Computer agent			Lin, KY et al, 2020
Computer game			Juric et al, 2021
Interactive online whiteboard			Ng et al, 2020

It should be made clear that, although programming is also used in robotics, in our study, programming means that the task is performed in a programming environment only, without using any physical panels, robots, sensors, or detectors.

### *Robotics in problem-based STEM education*

Based on the studies reviewed, using robotics seems to provide an appropriate problem-based STEM learning environment for all ages. Robotic devices, like Arduino, Micro: bit, or Raspberry PI are based on more straightforward block-based programming; therefore, they are suitable for elementary or secondary school students (Weng et al., 2022; Cui et al., 2021) and beginners (Major et al., 2021; Wang et al., 2021). For high school students with programming backgrounds or university students, robotic tools based on a text-based programming language (like Python or C++) are more common. Robots supported by text programming exercises can do much more - for example, move their arms and grip something (Wang et al., 2021), play sumo (Sisman et al., 2022) or act as drones for reconnaissance (Bhuyan et al., 2020). Among the studies examined was only one in which a motion-capable device had to be coded using block-based programming (Kim et al., 2021).

### *Programming in problem-based STEM education*

In our review of the articles, we found three cases where students had to solve a STEM problem in a programming environment (it is important to note that we are discussing non-robotics cases in this chapter). In two of three cases, it was used Scratch, a block-based programming tool that solves problems like saving money and fractal drawing among middle school students (Weng et al., 2022) or social and ecological problems among elementary school students (Century et al., 2020). Python, a text-based programming tool, was used among university students to solve scientific problems.

### *Other types of digital devices used in problem-based STEM education*

Four other types of digital devices appeared in the articles reviewed. A computer game about operations with Roman numbers was used among elementary school students to detect students gifted in Mathematics (Juric et al., 2021).

A computer agent helped junior high school students with a web-based collaborative problem-solving system. A computer agent is a computer-simulated participant that can develop goals, perform tasks, communicate messages, respond to other participants' messages, react to the environment, adapt to changes in the environment, and learn concurrently (Lin, KY et al., 2020).

Active learning (via cooperative problem-based learning and peer assessment) was implemented using an interactive online whiteboard in a first-year calculus class (Ng et al., 2020).

An innovative virtual reality (VR) based approach was tried among engineering students to understand and simulate manufacturing concepts (Dayarathna, 2020).

### *Discussion on RQ3*

Automated tools are the most popular digital devices for problem-based STEM learning. It could be because robotics makes the results of programming immediately visible. For example, the "robot arm" moves where students code it (Wang et al., 2021), and the aerial drone flies and takes pictures where they program it (Bhuyan et al., 2020). On the other hand, the fact that the physical device is not working well (or at all) is immediate feedback of lousy coding. Students' motivation in the world of mobile robots can be enhanced through gamification, as seen in the sumo robot championship (Sisman et al., 2022) or the robot ball competition (Kim et al., 2021).

Robotic devices based on block-based programming, which is much simpler than text-based programming, are also standard. These allow younger students (primary and secondary school) or beginners in programming to succeed in robotics. We could see an example of this in Hooke's Law experiment (Major et al., 2021), in collecting and processing sensor data for robotics electronics integration (Wang et al., 2021), in building a room capacity detector and a thermometer (Cui et al., 2021), or in such a real-world problem, like helping hospitals prioritize patients (Shahin et al., 2021).

However, there are some cases where we cannot use robotics. On the one hand, robotics tools are pretty expensive; on the other hand, if a course is only delivered online (Weng et al., 2022), it is more appropriate to use programming alone. For beginners and young students, block-based programming is the best - Scratch is the most popular of these, based on the articles studied (Century et al., 2020; Weng et al., 2022). Nevertheless, for example, complex scientific phenomena can also be modeled by programming - usually using text-based programming languages, like Python (Lin, YT et al., 2020).

We saw some further examples of the use of digital tools in problem-based STEM learning. For example, a VR-based approach can be used to understand and learn engineering concepts regardless of gender (Dayarathna, 2020). However, the authors argue that a new type of cheaper virtual reality technology is needed because of its high price.

Digital tools such as an interactive online whiteboard (Ng et al., 2020) and a computer agent (Lin, KY et al., 2020) can significantly enhance student collaboration and help them understand subject content better. While in the former case, the device helps students work transparently and simultaneously between groups (Ng et al., 2020), in the latter case, it also supports learning (Lin, KY et al., 2020). Moreover, a digital tool can also be used to identify mathematical talent among primary school pupils based on a computer game (Juric et al., 2021).

In general, the role of digital tools in problem-based STEM learning is

a) it is a problem-solving tool (using the tool to solve the problem).

It is the case for all robotics projects, where the robot has to be "made" to do something (Major et al., 2021; Cui et al., 2021; Wang et al., 2021; Shahin et al., 2021; Sisman et al., 2022; Bhuyan et al., 2020; Kim et al., 2021). However, it also includes programming tasks (Weng et al., 2022; Century et al., 2020; Lin, YT et al., 2020), computer games (Juric et al., 2021), and virtual reality (Darayathna et al., 2020).

b) helps with collaboration

It is either achieved by having to solve the task together, for example, in robotics cases (Major et al., 2021; Cui et al., 2021; Wang et al., 2021; Shahin et al., 2021; Sisman et al., 2022; Bhuyan et al., 2020; Kim et al., 2021) and the science simulation programming task (Lin, YT et al., 2020). Or it can be implemented by making the simultaneous work transparent and assessable, as in the case of the interactive online whiteboard (Ng et al., 2020)

c) supports learning (provides an environment that helps understand the subject content)

We saw examples of this in the use of computer games (Juric et al., 2021), computer agents (Lin, KY et al., 2020), and virtual reality (Dayarathna et al., 2020).

### ***General characteristics of RQ4 (the type of problems)***

In this chapter of the study, we want to answer the question of what problems the students had to solve during the STEM education supported by PbL-based digital tools. We grouped the cases into three broad categories based on the problems found in the articles reviewed. These large groups were: real-world problems (15 problems in 7 articles), subject-specific problems (8 problems in 7 articles), and robot operations (3 problems in 3 articles). Within the categories, we also separated subcategories for clarity. In this way, we separated the socially relevant problems, building or designing problems, and financial management problems within real-world problems. Most of the subject-specific problems were related to mathematics. However, we also found one example that was related to biology and two that were related to physics. Two of the three robot operation problems were based on gamification, and one was embedded in project-based learning. A summary of the general characteristics of RQ4 is shown in *Table 4*.

Table 4: The types of problems appeared in Pbl STEM using by some kind of digital devices

Categories	Sub-categories	The specific examples	Articles
Real world problems	socially relevant problems	mapping the geographical landscape suitable for plant production	Bhuyan et al, 2020
		finding landfills in uninhabited areas	Bhuyan et al, 2020
		planning a safe route for the school bus after flooding	Bhuyan et al, 2020
		medical transport to the community in case of emergency	Bhuyan et al, 2020
		helping hospitals prioritize patients	Shahin et al, 2021
		helping people who have trouble communicating their food allergies when they travel overseas	Shahin et al, 2021
	building or designing problems	building shelves	Lin, KY et al, 2020
		making a thermometer	Cui et al, 2021
		making a room capacity detector	Cui et al, 2021
		designing a desktop tidy	Lin, KY et al, 2020
		creating a machine, that calculate a bank deposit	Cui et al, 2021
	financial management problems	buying a mobile phone	Lin, KY et al, 2020
		saving money	Weng et al, 2022
creating a machine, that calculate a bank deposit		Cui et al, 2021	
how business works		Century et al, 2020	
Subject-specific problems	mathematical problems	operating with Roman numbers	Juric et al, 2021
		solving calculus problems	Ng et al, 2020
		fractal drawing	Weng et al, 2022 Lin, YT et al, 2020
		prime and composite number detector	Cui et al, 2021
		queuing theory	Dayarathna et al, 2020
	biological problem	DNA string matching	Lin, YT et al, 2020
	physical problem	testing Hooke's law	Major et al, 2021
		one-dimensional kinematic problems	Lin, YT et al, 2020
Robot operation based on gamification	building a robotic arm	Wang et al, 2021	
	rolling a robot ball along a defined path	Kim et al, 2021	
	sumo robot championship	Sisman et al, 2022	

### Real-world problems

Real-world problems are prevalent in digital PBL-based STEM education. These include problems arising from everyday difficulties. For example, in a study by Bhuyan et al. (2020), students are looking for solutions to socially fundamental problems such as finding landfills or finding land suitable for growing crops. Moreover, this project involved students from minority, disadvantaged socio-economic

backgrounds. The students in Shahin et al.'s (2021) study had to approach it from a different perspective, also looking for solutions to socially significant problems. They took on an entrepreneurial role in trying to offer solutions to hospitals in prioritizing patients. Lin, KY et al. (2020) and Cui et al. (2021) write in their paper about several problems related to design and creation, like making a thermometer or designing a room capacity detector.

Responsible financial management is a real-world issue. Within this, we encountered problems such as saving money (Weng et al., 2022), bank deposits (Cui et al., 2021), responsible shopping (Lin, KY et al., 2020), or business working (Century et al., 2020).

#### *Subject-specific problems*

Here we included problems related to the learning of subject content. Most of them have a mathematical focus, like Roman numbers among elementary school students (Juric et al., 2021), fractal drawing (Weng et al., 2022), and prime and composite number detectors (Cui et al., 2021) among secondary school students. Furthermore, the students' digital STEM Pbl exercises were based on topics such as solving various calculus problems (Ng et al., 2020) and queuing theory (Dayarathna et al., 2020).

Technical high school students tested Hooke's law in Major et al. (2021) study. Lin et al. (2021) report on one-dimensional kinetic problem solving by science students. Also, the last paper reports on one-dimensional kinematic problem-solving.

#### *Robot operation problems*

First, we would like to clarify that studies, where robotics was merely a tool to achieve a goal were classified in one of the upper categories. In this section, we have only included studies where the ultimate goal of the problem-solving was a particular movement of the robot. Two of these three studies were based on gamification, such as the sumo robot tournament (Sisman et al., 2022) and robot ball path planning (Kim et al., 2021). Moreover, Wang et al. (2021) write about a robot design and construction project among undergraduate students.

#### *Discussion on RQ4*

Schools are often criticized for having little to do with everyday life. Nevertheless, exposing pupils to real-world problems is essential as early as possible. Reflecting on socially relevant problems can lead to a change in attitudes towards social engagement, as seen in Bhuyan et al. (2020) study. In addition, it is also imperative for students to understand how, for example, a socially relevant problem can be used to build an enterprise (Shahin et al., 2021). However, not only future entrepreneurs but also engineers and designers are now in school, so various creative tasks (Cui et al., 2021; Lin, KY et al., 2020) and design tasks (Lin, KY et al., 2020) are also of great importance.

Good money management is part of responsible living. Unfortunately, in Hungary, students in public education have little (if any) exposure to money management. However, the articles reviewed provide good examples of money management (Weng et al., 2022; Cui et al., 2021), prudent purchasing (Lin, KY et al., 2020), and the functioning of business (Century et al., 2020).

Based on the reviewed articles, mathematics subject-specific content seems the most difficult to embed in an integrated STEM problem. While all digital Pbl STEM studies on social, environmental, or even robotics have mathematics as a tool in the background, the learning of mathematical content is most often done through subject-specific mathematical problem solving (Ng et al., 2020; Cui et al., 2021; Weng et al., 2022). However, digital tools can help to provide a more pleasant user experience for this learning (Dayarathna et al., 2020).

Problem-solving on how to operate robots fosters collaboration between students. These situations also create a natural working environment by jointly operating the robot while solving various

problems and resolving conflicts (Wang et al., 2021). At the same time, robotics can be used to develop a deeper understanding of different subject content, as was the case with the topic of angle pairs, which was aided by designing the path of the robot ball (Kim et al., 2021). Furthermore, the competitive and gamification environment can motivate students to operate the robots more (Kim et al., 2021; Sisman et al., 2022).

A significant finding of Century et al.'s (2020) study on problem-based STEM education supported by digital tools. In a comprehensive, longitudinal study, the authors found that this type of learning performs as well as traditional learning in the subject content. In addition, they develop a range of skills, an integrated approach to science, learn about social problems and develop a different work ethic.

## Conclusion

This study presented a systematic literature review revealing the current trends and developments in applying digital tools and implementing environmental awareness and sustainability in PBL-based STEM education. We examined 377 studies published in PBL STEM education from 2020 to 2022. We focused on the types and roles of digital tools, the types of problems solved with digital tools, the types of tools and methods used for environmental awareness and sustainability, and the critical factors for successful implementations.

Our study showed that besides entirely empirical studies, in some particular cases, the general testing, development, and calibration of specific frameworks, methods, or tools can also largely contribute to the effectiveness of the implementation of new environmental awareness- or sustainability-related topics and problems. We found that the most critical factors to success were partly systematic (clearly set goals and policies, state-of-the-art tools and instruments for development, effective assessment system) and partly (inter)personal (role of communities and horizontal networks, lesson planning of the teachers). The results of the SWOT analysis of the implementation of PBL (based on the articles of this study) were consistent with previous ones concerning PBL itself. It also showed that PBL has immense opportunities to help the schools and teachers develop the learners' soft skills, metacognitive skills, and met practical functions.

In our research, we also concluded that problem-based STEM learning in the last two years is most often conducted in a digital environment or with the help of a digital tool. Robotics and programming are the most popular of these. We also found that PBL supported by digital tools is more effective in collaboration than the non-digital version. The digital environment is not only helpful in improving attitudes towards computers or in promoting computational thinking. Nevertheless, it is also a suitable environment for solving problems relevant to everyday life - be it a socially relevant problem, a design-creation task, or even money management. One of the key findings of our research is that digital problem-based STEM learning does not continuously improve students' subject-specific knowledge, but it does not make it worse. However, it does develop skills and abilities such as collaboration, work ethic, creativity, critical thinking, and communication.

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I Wayan Eka Dian Rahmanu – Lokman Altun

## **Spherical video-based virtual reality (svvr) study: 360°-video implementation in English learning materials at polytechnic education**

### **Introduction**

The combination of multimodal, including audio-visuals, text, and internet technology, is suitable for adult learners (Rahmanu et al., 2020). The specific type of audio-visual employed for education nowadays is 360°-degree video, and this tool is usually designed to improve learners' particular abilities. Dalgarno and Lee summarize five learning benefits (Dalgarno & Lee, 2010):

- Spatial knowledge representation involves the contents that require spatial understanding and can benefit from three-dimensional visualizations in the virtual learning environment (VLEs). This tool also leads the experiential learning, which means learning through experimenting with and experiencing 3D-VLEs provides a better understanding of the subject matter. Engagement is another benefit that includes learning tasks in 3D VLEs, which can foster intrinsic motivation and engagement with the learning content.
- Contextual learning follows a constructivist view, and learning is always situated within a broader context.
- Three-dimensional learning environments resemble real-life situations in which the learning contents can be applied.

The last advantage is collaborative learning, which provides environments where learning can happen through collaboration and social interaction.

With regards to the synchronous and asynchronous learning in teacher education, developing spherical video was another brilliant option to scaffold professional learning in teacher education. These virtual experiences are significant equipment to elevate the professional however the facilitator's support must assist it. The 360° video seems to us to be a tool to generate skills and comprehension in education (Roche & Rolland, 2020). Related to this area, to develop a full picture, future studies of VR goggles should consider investigating the perception of ESP students and the factors influencing their perception. Besides, with the lack of rich ESP virtual videos and difficulties finding some related to Psychology, Child development, and Counselling content, more ESP 3D videos and guidance are required to enhance the use of VR headsets. (Madini & Alshaikhi, 2017). Similarly, another ESP area that should be underpinned by this tool is the Polytechnic education system.

### **Literature Review**

#### ***English Learning Materials***

Learning materials are applied to assist the learners in gaining the knowledge given by the teachers. English learning materials should be prepared to underpin the process of transferring the comprehension to the students. This potentially escalates learners' English language skills, including writing, reading, listening, and speaking ability. The teachers must prepare the English learning tools to espouse the English language teaching in the classroom. The goal of English language teaching is to make students communicate using the target language, in this case, English (Sukarno, 2012). In other words, the learning media is essential for the teachers and learners to evoke the learning objective. The systematic and appropriate learning media can improve the students' ability to learn English.

### ***Video-360°***

Some experts indicated that this medium is applied for many different purposes. This tool is used for destinations and tourism businesses field, and the results show that 360° videos increased positive feelings and willingness to travel regardless of watching with a tablet or VR glasses (Pasanen et al., 2019). This means that the tool is aimed to urge people to organize the trip; the customer is provided with the visual environment using 360°-videos. Similarly, the benefits of spherical video utilization to end-users include seeing eye contact between all the interlocutors acting in the video clips and getting to know about professional mannerisms, including how to interrupt during formal discussions from looking at the whole situation in the meeting room. The students can comprehend the importance of bodily gestures and facial expressions during professional communication, leading to their ability to communicate more effectively and professionally in the workplace as the experience of watching 360° or spherical videos is similar to the actual situation (Adnan, Ahmad, Yusof, et al., 2019). The advantage of this strategy is that the students can significantly absorb essential knowledge of the business environment before facing a real situation. The 360° videos were immersed in the four-year medical program. This fulfills the project's main objective, verifying that the immersive experience facilitates the teaching-learning experience by effectively removing the barrier between the student, the lecturer, and the machine. Most students felt spatially present in the surgery room, thus perceiving the scene as if they were there at the moment of the surgical intervention (Guervós et al., 2019). Involving spherical video based on medical education, the learners have presented the virtual medical sphere, which will actively enhance learners' understanding. The spherical video-based technology was also employed in the construction field, aiming for mobile safety education. The researcher generated Virtual Field Trip System (VIFITS) system, which provided an interactive learning environment for bringing construction field trips to the classroom to improve students' practical experience and safety knowledge. Preliminary results reveal that VIFITS was a powerful pedagogical method for effectively providing students practical experience and safety knowledge and improving construction safety education (Pham et al., 2018). It can, therefore, be assumed that the virtual field trip system leads to a sophisticated impression for the users. A clear learning objective will certainly be gained by generating the learners' urge to learn the subject. Creating interactive educational content is paramount to grabbing the attention of today's learners, whose attention span is easily dissolved into thin air. If we keep forcing them to learn using the traditional style such as teacher-led 'chalk-and-talk', reading from dry textbooks, and keeping teachers as the center of the class, we are doing these undergraduates a disservice in the long run. Grabbing learners' attention will result in authentic learning and knowledge acquisition (Adnan, Ahmad, Mohd Kamal, et al., 2019). One of the interactive learning tools is 360°-video or spherical video-based virtual reality, which shifts students' behavior towards the face-to-face and remote learning system.

### ***Spherical Video-Based Virtual Reality (SVVR)***

VR is a new media technology that provides three-dimensional (3D) simulations of natural scenes or recordings of real environments. VR technology can create artificial sensory experiences, involving individuals at an emotional and attentional level and allowing real-time interaction (Jung & Dieck, 2018). Moreover, it has an interactive and spherical presentation that makes the experiencers feel as if they are in a natural scene (Wu et al., 2021) and (Chien et al., 2020). VR can be categorized into three parts based on previous research:

- desktop VR (low-immersive VR desktop environments), which creates use of computer 3D modeling to generate a 3D landscape, and which users can view and experience through a computer and smartphone;
- cave-based VR, which provides a panoramic sensory experience in a confined space;
- and the fully immersive VR system, which achieves immersion through VR equipment (Wu et al., 2021), (Chien et al., 2020), (Portman et al., 2015), and (Smith, 2015).

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The vast development of VR technology has also resulted in significant possibilities for classroom teaching.

The lack of technology immersion in the learning materials leads the learners unavailable to follow the lesson properly in the State Polytechnic of Bali. The tendency of the students nowadays is to have a different learning experience, and this can be discovered in many learning sources. In addition, the learning tools are still prepared for traditional techniques, such as PowerPoint, slides, and conventional video, potentially decreasing learners' eagerness to learn the lesson. Based on the gap discovered, this research concerns on Spherical Video-Based Virtual Reality (SVVR) study: 360°-Video Implementation in English Learning Materials at Polytechnic Education. This paper presents preliminary results of a case study in generating the 360°-degree video for the English learning material in the business education department.

- What is the students' perception of the use of Spherical Video-Based Virtual Reality (SVVR) used in the State Polytechnic of Bali?
- Is there any performance expectancy (PE) on the Spherical Video-Based Virtual Reality (SVVR) used in the State Polytechnic of Bali?
- Is there any effort expectancy (EE) on using Spherical Video-Based Virtual Reality (SVVR) in the State Polytechnic of Bali?

## **Method**

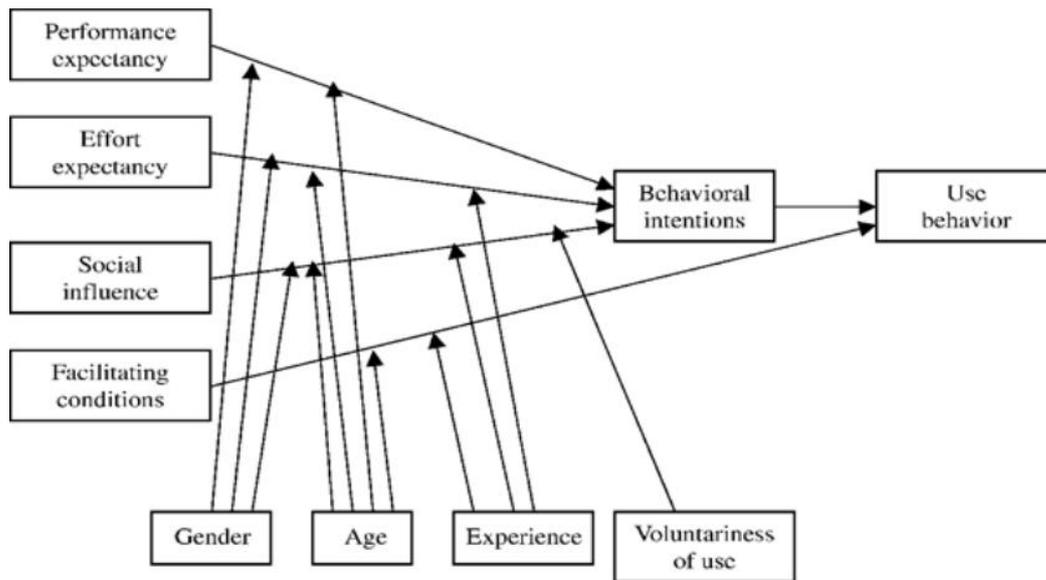
### ***Participants***

According to the study, 169 State Polytechnic of Bali adult learners who learned the English language in the Business Administration Department were involved in providing perception on the SVVR 360°-video. The age range of participants was from 18-20. They were in the second semester and obtained the English lesson at the State Polytechnic of Bali. The Indonesian language was the learners' first language; all of them had a smartphone for study. All participants had participated in the study voluntarily.

### ***Data Collection***

The concept of the unified theory of acceptance and use of technology (UTAUT) (Vankatesh, 2016) was applied to collect the data process. The use of UTAUT theory assists this research in evaluating the spherical video-based virtual reality benefit for the learners in the Business Administration program. The theory consists of performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), behavioral intension (BI), and use behavior (UB). Performance expectancy (PE) measures the properness and usefulness of the device. This also means the degree to which an individual believes that technology conduces learners or users to gain knowledge in the learning process, while effort expectancy (EE) evaluates the simplicity of technology use, stress-free interaction, and importance of use. Social influence (SI) involves the usefulness for the users whereas facilitating conditions, whereas facilitating conditions (FC) evaluate the availability of the system and knowledge to operate the system (Venkatesh et al., 2016). This study focused on measuring performance expectancy (PE) on the positive impact and the usefulness of the device and effort expectancy (EE) on ease of technology use and importance of use for Bali State Polytechnic students who learn English in the Business Administration department.

Figure 1. UTAUT (unified theory of acceptance and use of technology)



(Venkatesh, 2016)

For quantitative data, The digital questionnaire was deployed as the instrument to receive the participants' data based on 5-point Likert Scale, ranging from 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. The questionnaire items consisted of five topics concerned with the trend of multimodality in English instruction.

### Data Analysis

The researchers developed the questionnaire items based on the *unified theory of acceptance and use of technology* (UTAUT). After development, factor analysis was applied to this questionnaire by conducting a pilot study (Table 1).

Table 1.: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,909
Bartlett's Test of Sphericity	of Approx. Chi-Square	1151,725
	df	45
	Sig.	,000

Based on KMO and Bartlett's Test results, the questionnaire was found ready to analyze the data set, and a significant result was found. 2 factors specified in this research were clarified according to the total variance results (Table 2). The variance result was found as 71,875, which is highly acceptable.

*Table 2.: Total variance results*

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6,034	60,338	60,338	6,034	60,338	60,338	5,238	52,378	52,378
2	1,067	10,668	71,006	1,067	10,668	71,006	1,863	18,628	71,006
3	,623	6,232	77,238						
4	,512	5,116	82,354						
5	,493	4,926	87,280						
6	,328	3,278	90,558						
7	,316	3,163	93,721						
8	,270	2,705	96,426						
9	,206	2,055	98,481						
10	,152	1,519	100,000						

Extraction Method: Principal Component Analysis.

After that, the researchers clarified whether the items were analyzing these two factors or not by searching the matrix table after factor analysis. One item was excluded as it did not serve the target factor in the study (*Table 3*), and a total of 9 items were conducted for the target participants of this study.

*Table 3.: Component Matrix*

	Component	
	1	2
VAR00001	,849	-,175
VAR00002	,866	-,135
VAR00003	,826	-,172
VAR00004	,853	-,103
VAR00005	,573	,640
VAR00006	,804	-,038
VAR00007	,779	-,155
VAR00008	,810	-,117
VAR00009	,804	-,003
VAR00010	,519	,728

After the factor analysis process, the reliability of the final questionnaire was found (*Table 4*). Using SPSS, descriptive statistics of the questionnaire were calculated to answer the research questions.

*Table 4.: Reliability Statistics*

Cronbach's Alpha	N of Items
,925	9

## Procedures

The main scene of the video-360° was divided into 5 parts: introduction, audio-visual room, meeting room, office lab, and computer lab, which were explicitly elaborated. The speaker elucidated every part of the scene using the English language. The 360° camera was used to record the activities and was put 1,5 meters from the speaker. In addition, a tripod also was installed to put the camera properly. By setting the smartphone into the VR view, the picture will be split into two parts, but the extra tool was demanded to enjoy the environment virtually. In this research, the option of using VR was not chosen to simplify the process of English language instruction. Instead, this study applied Spherical Video-Based Virtual Reality (SVVR) to compact the classroom activities because the learners could use their hands to move the devices safely.

Figure 2.: Introduction



In the introduction scene, the presenter of the video introduced the departments available at the Polytechnic State of Bali, and the speaker explained the 6 departments, including Business Administration, Tourism, Engineering, Electro Engineering, Accountancy, and Civil Engineering. The text and logo of the Polytechnic State of Bali were added and placed beside the speaker. The setting was in front of the Administration building, close to the Tourism and Accountancy building departments. The research elaborated and explained the Business Administration Department building.

Figure 3.: Audio-visual room



In the audio-visual room, the viewers were referred to some green chairs, whiteboard projectors, a red floor, speakers, and a table. The speaker elaborated on the room generally to provide a chance for the learners to understand this scene. The camera is set approximately 2 meters from the speakers; as a result, the students saw the view widely. In the end session of this scene, the learners were allowed to analyze the room and provided 3 questions that should be responded to accurately. This occasion was beneficial for students to discuss and answer the questions with their classmates, enriching their idea, vocabulary, and understanding of the audio-visual room.

*Figure 4.: Meeting room*



The learners had a chance to see the meeting room's environment; specifically, this room's situation proposed learners' knowledge and vocabularies, especially in the business meeting room. The viewers noticed several tools related to the meeting room in this area, for example, cabinet, folder, chairs, long table, board, projector, speaker, and internet connection. In this part, the presenter explained the room's function and allowed the learners to observe the environment by moving the device or sweeping the smartphone screen. Subsequently, the questions (about what?) were displayed on the whiteboard to let the students answer and analyze a particular part of the area.

*Figure 5.: Office lab*



On the second floor of the building, the Business Department provides an office lab and can be applied by the lecturers to practice the business lesson. In the scene of this 360°-video, the viewers were

guided by the presenter to reach the room. Before entering the office lab, the learners would see the lecturers' office, department office, administration office, lobby, and server room. This room is situated near to computer lab and server room. The students could observe various office tools, for example, books, files, cabinets, computers, printers, copy machines, tables, telephones, and chairs. These types of equipment underpin learners' activity in practicing the administration responsible. The presenter must explain the room analysis because the students intended to answer and respond to the question provided at the end of the session.

Figure 6.: Computer lab



Another room on the second floor introduced by the speaker was the computer lab, and the students commonly use this area to conduct the keyboarding skill, media technology, digital business, and mailing system. In this part, the presenter opened the door and started explaining the computer lab's function. After that, the speaker provides several times for the students to analyze the room. A computer system, including monitors and CPU, is dominated, and the viewers must focus on these items because, in the last session, the questions about the total number of computers were deployed. At the end of the scene, the presenter provoked the learners to practice English through this application as this can be applied for General English lessons and English for specific purposes, especially in the Digital Business Program.

## Result

### A. The Students Perceptions on the SVVR 360°-video

To answer the first research question (RQ), frequency of students' responses was clarified and, it was believed that Spherical Video-Based Virtual Reality (SVVR) 360°-Video had a positive impact on the teaching and learning process in the classroom. From 169 responses, it was seen that the users tend to agree to utilize this tool in escalating the urge in learning English. The simplicity of this learning kit was another consideration for learners to use during the instruction.

*Table 5.: Students Perception on the SVVR 360°-Degree*

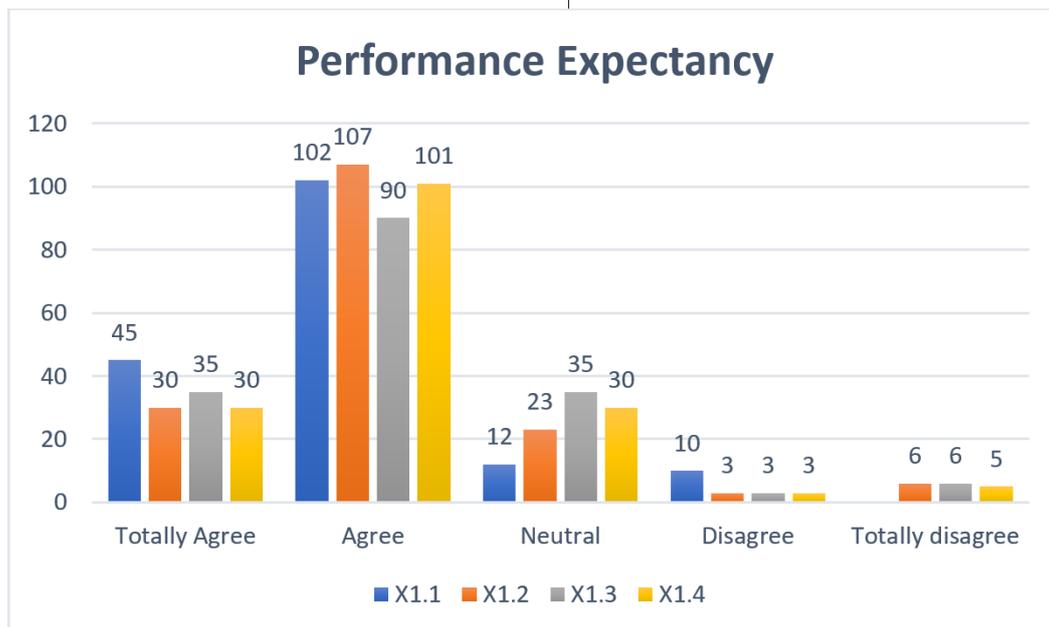
		X1.1	X1.2	X1.3	X1.4	X1.6	X1.7	X1.8	X1.9	X1.10	Total_X1
N	Valid	169	169	169	169	169	169	169	169	169	169
	Missing	0	0	0	0	0	0	0	0	0	0
	Mean	4.08	3.90	3.86	3.88	3.66	3.83	3.75	3.69	3.48	37.80
	Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	39.00
	Mode	4	4	4	4	4	4	4	4	3	40
	Std. Deviation	.756	.836	.888	.825	.793	.737	.772	.839	.839	6.280
	Sum	689	659	652	655	619	648	633	623	588	6389

According to the performance expectancy (PE), the data on X1.1 showed a positive experience using the SVVR. Based on the data, the mean = 4.08, median = 4.00, and mode = 4 indicated that the learners tended to agree that using SVVR in studying English provided a new experience. Item X1.2 represented the learners' arguments on the influence of SVVR in increasing the desire to learn English. The data mentioned the mean = 3.90, median = 4.00, and mode = 4; in other words, this medium evoked learners' urge to learn English. Similarly, item X1.3 explained the role of SVVR in assisting the students in learning English during the instruction. The mean = 3.86, median = 4.00, and mode = 4 implied the students' belief in the benefit of this contemporary medium in absorbing English knowledge. Finally, the item on X1.4 described a new learning method employing SVVR for the English lesson. The result of mean = 3.88, median = 4.00, and mode = 4 indicated the exciting video provided by SVVR through the teaching and learning process.

On the other hand, there were 5 questions based on the effort expectancy (EE) employed in this research. The question on X1.6 referred to the simplicity of SVVR use. based on table 1, the mean of this question was 3.66, while the median and mode were 4. The learners believed that this medium was conveniently applied through teaching and learning. Related to the data on X1.7, the question was about the compatibility of this tool with the learners' smartphones. The result of the data on the mean was 3.83, whereas the score of median and mode were 4. The tendency of students to use a smartphone during the teaching and learning process could be seen saliently. The learners agreed to employ smartphones specifically in operating the SVVR 360°-video. The data on X1.8 elaborated the easy access to the video for the English lesson. According to the data, the mean score was 3.75, while the result of median and mode were 4. It could be elaborated that most of the students agreed on the simplicity of SVVR video use. The students have a different experience as the device could be moved to watch the environment on the video. This was underpinned by the data on X1.9 that explain the chance of users to move the device or smartphone to watch the sphere. In the data, the mean score was 3.69, and the median and mode scores were similar at 4. It means the learners are assured that this medium brings a new impression to learning English. Based on the students' argument on the video quality, it is interesting for the writer to understand that the resolution of the video was not equitable when the learners faced a low internet connection. The result for the question on X1.10 represented the fear of the internet trouble when operating the SVVR video in the teaching and learning instruction. The recommendation to run the program smoothly was in the higher resolution, which is sometimes difficult for several students to organize.

**B. The performance expectancy (PE) on the Spherical Video-Based Virtual Reality (SVVR) used in the State Polytechnic of Bali**

Table 6.: Students perception on the Spherical Video-Based Virtual Reality (SVVR)

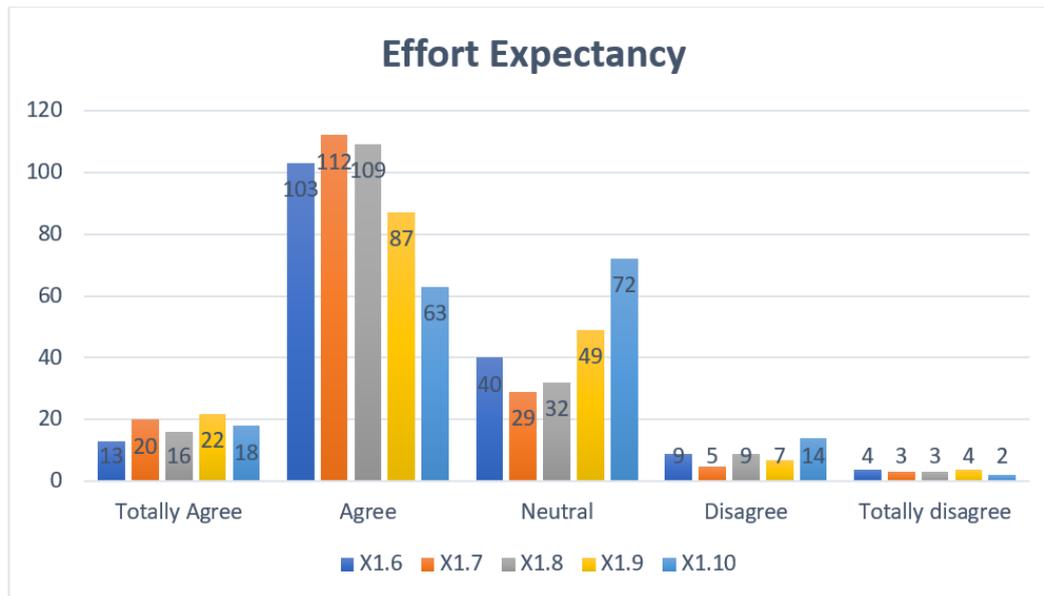


RQ2 aspires to the performance expectancy (PE) side of SVVR. In terms of the learners' opinion on the Spherical Video-based Virtual Reality (SVVR) use in the language instructional in the Polytechnic education system, the students believe that this medium positively impacts the learning process. This is in line with PE in UTAUT theory which measures the users' satisfaction. Offering a positive experience is the benefit of using this media as a learning kit. The lecturers can instruct the learners to watch the video directly using the smartphone or additional equipment, namely a VR tool. However, the users are recommended to wear the VR tool for the appropriate time, for example, 10-15 minutes, to avoid the inappropriate effect of the VR tool use. Unlike VR learning, this study selected a more accessible, more convenient SV-IVR and then expanded a landscape architecture SV-IVR learning system to assist the instructional in landscape architecture education (Wu et al., 2021). Both of these media are compatible with smartphones viewing the video. Using the smartphone as an instrument to run the spherical video-based virtual reality leads to simplicity during the classroom learning process.

Additionally, the SVVR evokes the learners' desire to learn the English language. Several media were introduced and employed by the lecturers to teach English, for example, Games, Kahoots, Quizzes, Google Classroom; these 'supplements' assist the teacher in running the lesson in the classroom. These applications contribute to the delivery of the lessons conducted by the lecturers in synchronous, asynchronous, face-to-face, and remote learning.

### C. The effort expectancy (EE) on the use of Spherical Video-Based Virtual Reality (SVVR) used in the State Polytechnic of Bali

Table 7.: Students perception on the Spherical Video-Based Virtual Reality (SVVR)



Lastly, RQ3 addressed the effort expectancy (EE) point of SVVR. In the EE aspect, the simplicity of the application exertion appeared during the 360°-video utilization. The learners were sent the link by the lecturer, which was directly connected to Youtube. To run the 360°-video appropriately, this application would work properly using Youtube as this application had a specific and compatible component for 360°-video. It led the learners to feel convenient in running the SVVR. Besides, in terms of employing an online learning platform, the learners thought it was effective since it saves effort (Cakrawati, 2017). Likewise, the spherical video utilization offered simplicity through exertion. The tendency to choose a smartphone to operate the application resulted in the students' keenness to learn English. The intelligent smaller device, smartphone offer handy, small, and compatible for any situation; for instance, the device was recommended to reduce the rigidity in operating the SVVR.

Furthermore, every learner had access to a mobile phone which brought simplicity to running the 360°-video. Another component that the teacher and learners must consider is the internet connection. These assist the classroom in implementing the SVVR during the English language instruction. Having mobile technology and internet facility in hand, English language learners these days are open to many learning resources (Hidayati & Diana, 2019). Concerning the see the sphere, the viewers encourage to have a visual environment. The students could move the device to analyze the surrounding that supports them in obtaining new experience.

### Discussion

The students understand and agree with the significance of contemporary kits nowadays for English language learning in the ESP classroom. This situation is underpinned by the fact that the young learners are familiar with the technology. The screenagers were born when the technology was developing, which means that they have been using it since they were early and were able to use technology meaningfully (Putra & Santosa, 2020). The positive side of this phenomenon is the avoidance of technology rigidity received by the millennials. This also may be dominantly influenced by the age of the users; the digital technology has been improved massively since a decade ago. Consequently, young generations do not feel strange about technology development as they engage

in it frequently. Similarly, education ought to immerse technology in the teaching and learning process in the classroom, but this argument must be evidenced by further research.

The previous study also believed that learners have a very positive perception of the use of Kahoot! in learning, and these results include a positive effect on attention, motivation, concentration, satisfaction, and confidence (Wang, & Tahir, 2020). Similarly, the role of SVVR as a tool provides an exciting impression in learning the English language. By engaging multimodal concept, which includes video, image, text, and audio as the learning material, students are keen to study the English language. This learning tool enhances language learning by providing immersive learning, improving motivation, creating interaction, and reducing learning anxiety (Huang et al., 2021). The presence of the visual, spatial, and gestures make the learners desire to get involved in the teaching and learning process. The 360°-video allows the learners to analyze and study English language skills involving speaking, writing and listening. The discussions are divided into 4 room which has a different environment. The students obtain a chance to explain the rooms using the English language by having a variety of spheres. The interaction will appear because the presenter on the video allows the viewers to analyze and answer the questions displayed in each room. The use of SVVR as the new English learning kit for Polytechnic education assign a specific understanding that this 360°-video is suitable for English lesson in the higher education system. On the other hand, playing the video from the Youtube program results in high demand on the internet band-witch. Receiving the high-quality 360°-video requires a high resolution that can be set from the smartphone.

Based on the SVVR video provided by the researcher, the scene started outside the Business Department building. From this area, the learners can see and analyze the environment by moving the smartphone or sweeping the device screen. Likewise, the learners could observe the object and environment in the audio-visual room, meeting room, office lab, and computer. Besides that, viewers are allowed to interact with other classmates to escalate their English language ability. On the other hand, to relish the 360°-video with better performance, the screen resolution should be escalated; the demand to set the smartphone screen resolution into high quality often complicates the learners. Moreover, the high quality requires high internet access to run the 360°-video. This circumstance inclines to debilitate the students who have a low internet connection.

## Conclusion

The performance expectancy (PE) involving the device's positive impact and usefulness can be attained by employing Spherical Video-Based Virtual Reality (SVVR) in the classroom. The usefulness of the SVVR leads the learners to study English more efficiently. Employing multimodal including (Spherical Video-Based Virtual Reality 360°-video, text, audio, and image) as learning tools potentially encourage learners to study more in absorbing the knowledge. This learning kit also underpins the learners' desire, especially in learning the target language. The tendency of the new medium, which offers different experiences, positively impacts the students learning objective.

Similarly, the students seem to support and favor the effort expectancy (EE), including the ease of technology use in this video. By having this learning tool, learners incline to be convenient to watch the 360°-video through the smartphone. The learners tap the link uploaded to Youtube by the lecturer and start to watch the video. The viewers can also move the smartphone to see the environment or spherical, leading to a new way to learn the materials. Engaging the Business Administration's building environment as the setting of this video assists the students in virtually understanding the campus sphere. This contributed to the learners' ability to explain the environment using English during the lesson activities. In line with that, the virtual building surrounding significantly encouraged the learners' study during remote learning. The compatibility of the learning medium for online learning will be beneficial for the remote learning system. Students can play the 360°-video from home using their smartphones.

This learning tool can be fruitful for the lecturers who teach General English and English for Specific Purposes in the Polytechnic education system. By providing and generating the new model of learning

tool, the lecturers can quickly deliver the knowledge to the students. The SVVR is a substantial learning kit for lecturers who desire to escalate learner eagerness and ability to engage in the English language. The combination of internet, video, audio, and text is known as multimodal and can be the criterion in creating the learning kits. The opportunity of generating the learning materials based on the multimodal concept can be the nutrition and supplementary for the learners in absorbing the English language learning. It means digital technology and multimodal are the fundamental concepts for building learning media during asynchronous, synchronous, face-to-face, and remote learning in the digital era. Immersing Spherical Video-based Virtual Reality is the new trend for classroom teaching and learning activities, which ought to be applied frequently by the lecturer and students in the English language lesson.

However, the shortcoming ought to be decreased to optimize the use of this medium in the classroom. One of the procedures is allowing the learners to select the average video quality during online or remote learning. Students who cannot access the video with high resolution are recommended to apply the medium quality; as a result, it can significantly reduce the barrier to watching the video during the lesson. As previous research points out, VR is not always shown to be the most effective way to impact perception, depending on the metric used (Lindquist et al., 2020). The shortcoming of this medium can be a barrier for the learners to use and apply it through the instructional. The expensive hardware and low internet access decrease the students' urge to experience this tool. It is vividly seen that lost and low internet access can be a massive barrier for the students to play the 360°-video that must be solved in the future. Another substantial focus is that this study was not exercising the social influence (SI) and facilitating conditions (FC) which are another part of UTAUT theory that can be explored in future research.

### **Conflict of interests**

The authors declare that they have no conflict of interest.

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**Katarina SZARKA**

## **Exploring science, mathematics, and computer science education in high schools in selected regions of South Slovakia and Hungary**

### **Introduction**

In this paper, we would like to present the research activities realized within project grant VEGA no. 1/0663/19 "*Analysis of science and mathematics education in secondary schools and innovation of the content of vocational didactics*".

### **The social and theoretical background of the project**

Education is an essential response to the urgent need to prepare young people with the ability to apply higher-order thought operations and deal productively with the global crises of the 21st century that affect the economy, the natural environment, and our diverse cultural heritage.

Economic and social development today is constrained by the fact that students' science competencies are not up to par. Science has a significant impact on personal life in global society as well as in its economy. Science has a significant impact on personal life in global society as well as in its economy. Scientific literacy is part of 21st-century skills (Djamahar, R., Ristanto, R. H., Sartono, N., Ichsan, I. Z., & Muhlisin, A., 2018). therefore, students have expected a good level of scientific literacy (Glynn, S. M., & Muth, K. D., 1994), which should be strengthened through nature education (Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F., 2018), (Jenisová, 2015).

Andreas Schleicher, director for education and skills and special adviser on education policy to the secretary-general at the OECD, points out that "the world economy no longer pays you for what you know; Google knows everything. The world economy pays you for what you can do with what you know. If you want to learn if someone can think scientifically or translate a real-world problem into a mathematical context, those things are harder to assess. However, they're also more important in today's world. We see a rapid decline in the demand for routine cognitive skills in our world, and the kinds of things that are easy to test and easy to teach are also the kinds of things that are easy to digitize, automate, and outsource" (Robinson, K. & Aronica, L., 2018).

This is why there is an increasing emphasis on 21st-century skills. In one of his reflections, Dylan Wiliam points out that the term '21st-century skills are misleading, as none of the skills commonly referred to in the term is new. On the contrary, they are skills that have always been important. However, the labor market tends to increase the demands on workers, which were previously required of a small number of workers at the top of the management hierarchy (Wiliam, 2013).

They include critical and creative thinking, digital and technological skills, communication skills, and the ability to acquire and apply knowledge to problems and real-life contexts. We often use and interpret numbers, data, and mathematical ideas in everyday life. We do it without noticing or realizing it. When solving everyday problems, we often need to translate the problem situation into a mathematical context. Nevertheless, that is not enough - we also need a mathematical apparatus that we can use purposefully.

We formulate a problem in mathematical terms to solve it using mathematical tools, then interpret solutions to mathematical problems using logic-based thought processes that explore and connect pieces of information in ways that allow us to draw meaningful conclusions.

Most of our everyday problems are linked to the requirement for science competence.

By science competence, we mean the knowledge, abilities, skills, and correct science aptitudes of students to interpret natural phenomena correctly and use the technical resources at our disposal consciously and correctly. Mathematical competence is an integral part of scientific competence; therefore, we have focused on this area in our research. Furthermore, given that the body of knowledge is constantly changing and expanding in the given scientific fields, it is essential to develop lifelong learning in secondary school students.

Despite the significant importance of STEM fields, the younger generation is not interested in these fields, which may lead to a significant shortage of human resources in these spheres. BusinessEurope already highlighted in its 2011 study – *Plugging the Skills Gap the Clock is Ticking* – that the share of graduates in STEM fields in the EU fell from 24.8% to 22.7% in 2005 compared to 1999 (BusinessEurope, 2011). This ratio has stabilized, although there are still significant differences between the EU Member States. Furthermore, it is a well-known finding that the proportion of women graduates in STEM is significantly lower (Caprile, M., Palmén, R., Sanz, P., & Dente, G., 2015).

Interest in pursuing higher education in STEM fields is decided in middle school. However, positive attitudes toward individual subjects are formed in elementary school and continue through high school. This idea inspired us to determine high school students' attitudes towards science, mathematics, and computer science. These were the close regions' grammar school pupils who can be potential applicants to study at our university. We were curious about the level of their logical-inductive-, scientific- and mathematical thinking. We would find out the factors influencing their thinking and attitude towards STEM subjects.

### **Description of the project**

Thanks to the submitted project material, in which we formulated our research interests and innovative intentions, and which was positively assessed within the VEGA grant and funded by the Ministry of Education, Science, Research and Sport of the Slovak Republic, we were able to start the scientific research activities of the project.

Within the project for the four-year project period (2019-2022), activities were planned that focused on meeting the following objectives:

- to examine the main attributes of natural scientific and mathematical thinking, understanding and problem solving;
- to examine the relationship among natural scientific and mathematical thinking and attitudes, socio-economic status of students, their career paths, and learning styles;
- to identify the factors influencing the students' relations to natural science and math subjects;
- to explore the teaching strategies used during the education of these subjects;
- to explore the teachers' view on the learning difficulties of these subjects;
- to formulate recommendations for the methodological renewal of these subjects.

We implemented the project with the formulated goals, which required the design of research activities. To meet the first two objectives mentioned above, we used the theoretical analysis method of domestic and foreign studies and other literature sources.

To meet objective no. 3, we conducted quantitative empirical research. The measurement tool of the research was an online available comprehensive system consisting of questionnaires and tests. The questionnaire survey focused on finding out the socio-economic background of the respondents, mapping the selected aspects influencing the science attitudes of the respondents, and mapping the learning style of the respondents through Kolb's questionnaire. In addition to the questionnaires, the integrated research instrument included a standardized test to map the logical and inductive reasoning of the students and a self-made non-standardized knowledge test consisting of the tasks requiring mathematical and scientific thinking.

The reliability and validity of the measurement tools were checked in pilot research. Subsequently, we redesigned and innovated the didactic test of STEM competencies and refined the investigated competencies. To meet the fourth and fifth goals, we used a questionnaire survey, which we addressed to high school teachers teaching science, mathematics, and computer science.

Our research sample was the age category of pupils in the 1st and 2nd year of grammar schools in Southern Slovakia and Hungary (Komárom-Esztergom and Győr-Moson-Sopron County).

### Project results

The pandemic situation due to the spread of the coronavirus had a significant impact on the progress of the project. We could only test pupils on a rolling basis at the start of the 2021/2022 school year. We originally planned to involve 3,600 students from 30 schools in the research. However, due to the short time (September-November 2022), we managed to involve only 1646 students from 25 schools. The processing and analysis of the data are currently underway, and the interpretation of the results of the analyses and their publication is expected soon.

Short time prevented us from conducting research among middle school STEM teachers, classroom lesson visits, and small group interviews with teachers within the defined project period. However, this does not mean our goals will not be met soon.

### Conclusions

We see the societal utility and added value of our empirical research in the comparison of results in neighboring regions of two states, which signalize similar societal phenomena related to the unpopularity of the STEM subjects and lack of interest in study programs requiring competency in STEM subjects.

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Teodóra BÉKEFI

### Péter Tóth – Kinga Horváth: Didactics

*Artificium omnia omnes docendi*. The art of teaching everyone everything – says the motto of Péter Tóth's and Kinga Horváth's recently published *Didactics*. The citation is taken from *Didactica Magna*, the grand opus of the seventeenth-century philosopher-pedagogue Comenius. A momentous sentence of actual work on the history of pedagogy, shedding light on the fact that the most critical dilemmas of pedagogy are constant – but in diverse contexts of different times, our answers cannot remain the same. An essential problem of (post)modern thinking is to pose the question: what is the definition of *everything* in the twenty-twenties if any? What do we know (or at least think) about knowledge? Pedagogy, especially Didactics, establishes the *how* (the "art of teaching") according to the *whom*. These three (*what*, *how*, and *whom*) are anchored aspects of the book expressed already by the preface, and all the eight chapters can be assigned to at least one.

The question of *how* it is in prevails in the book, which is not surprising if we consider its genre. The genre of *Didactics* is an interesting question (of this particular one and other works with a similar title), given that it is a mainly theoretical summary of inherently practical problems (the subtitle is *An Introduction to the Theory of Education*). The explicit target audience is Hungarian-speaking teachers of Slovakia and student teachers of J. Selye University; the aim is to help their professional learning and development. As the authors do not emphasize the socio-cultural aspects of education in the ethnic minority in Slovakia, the theoretical summaries are comprehensible and adaptable in other cultural contexts, such as Hungary.

The first of the eight chapters introduces the concept of didactics, considering the relation between didactics, pedagogy, and theory of education. The conceptual exposition is accompanied by a rich historical introduction, which remains a frame of reference as it enumerates the most important works that influenced nowadays' (including, of course, the authors') pedagogical mentality, from Comenius to John Dewey and Sándor Nagy, closing with Iván Falus, also mentioning the most important works of Czechoslovak and Slovak literature.

Returning to the focus of the book, we can see that practical considerations, induced by the characteristics of the target audience, organize the weight of the three main aspects of *what*, *how* and *whom* – from the 5th to the 8th chapters, almost the two-thirds (two hundred pages) of the book discuss the aspect of *how*. The 5th chapter describes education as an objective process, emphasizing that both are essential characteristics. As Figure 14 (p. 126) suggests, the (micro)process of education can be described with difficulty as many factors affect it. Chapter 5.3 enumerates the different levels of design and planning from the core curriculum to the lesson plan, demonstrating that many external aspects determine the process of education. 5.2 describes, on the other hand, the internal conditions of an educational process by listing the objectives of education and learning outcomes. This chapter establishes the complexity of the educational process, the components of which are described in the following three chapters.

Teaching strategies are classified according to the phases of the educational process (listed on p. 125): strategies of motivation (Ch. 6.1), obtaining knowledge (Ch. 6.2), applying knowledge (Ch. 6.3), systematizing knowledge (Ch. 6.4) and assessment (Ch. 6.5) are described. Practical and organizational aspects of education are detailed in Chapter 7. Apart from the types and the possibilities of organizing lessons and activities, the chapter emphasizes Internet-based learning, which is a very current topic not only because of the pandemic situation. The 8th chapter focuses on teaching methods and instruments, paying particular attention to digital and Internet-based possibilities, also considering the characteristics of Generation Z and Alpha. All three chapters approach the question of *how* from diverse aspects, according to the complex process-like characteristic of education, giving a broad but comprehensible description.

Chapters 2, 3, and 4 help better understand the question of *whom*. The second chapter discusses the epistemological aspects of education. Apart from the essential theories of epistemology, logic and reasoning are two central concepts of the concise summary (including heuristic research). This helps better understand the students' reasoning processes and allows the reader to reflect on their reasoning characteristics, which is fundamental for a (student) teacher. The third chapter describes the theories of learning from behaviorism to constructivism, and the models of teaching and learning, including the description of the educational context. Computer-based and virtual learning environments also have an essential role in this chapter, as does neuro-pedagogy as a new and modern aspect of educational research. These two chapters establish the theoretical base of Chapter 4, which details the characteristics of students. Besides the description of cognitive, reasoning, and moral developmental phases, motivation theories and the concepts of metacognition and learning styles give a wide range of helpful information about the possible learning characteristics and methodology. It is also important to mention the description of special educational needs, from disadvantaged to gifted students.

Specific problems of students and beginning teachers are two aspects that could have enriched the wide range of topics of the book. In addition, they would have given a few points of reference for the target audience of the problem. Reflectiveness is also a fundamental aspect of teaching that would have been interesting to read more about than in Chapter 6.6. Otherwise, it has to be said that *Didactics* is a very complex, detailed, and informative work and is advised to be used in teacher education and for promoting teachers' professional learning and development.