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THE PSYCHOSOCIAL AND COGNITIVE INFLUENCE OF ICT ON COMPETENCES OF STEM STUDENTS

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Abstract. *Information and communications technology (ICT) shapes life and work in every educational system. Where to place ICT in the pedagogical process and how it affects students' psychosocial and cognitive abilities are questions that do not have one definitive answer. The research addresses the intense introduction of ICT that accords with educational trends and the requirements of today's society, but sometimes neglects social competences and any potential psychosocial effects. A need for new and effective methods in upbringing and education to offer everyone, equal opportunities become more and more important in the "world of the 21st century". The research also proved that innovative didactic methods of teaching (4.0) using a transdisciplinary model and supported by state-of-the-art information and communications technology as well as cooperative learning, have a positive psychosocial effect on science, technology, engineering and mathematics (STEM) students. Students who experience innovative didactic teaching supported by ICT reach higher taxonomic, cognitive and social standards of competence and are thus better prepared for the challenges of future society.*

Keywords: *cognitive competences, education system, ICT, psychosocial influence, social competences.*

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Introduction

Every country's education system is its basis for progress and the groundwork for its future. Changes happen very slowly in education, since education systems are some of the largest and most complex systems in every society and are impossible to change overnight. One of the key reasons for an education system's success is its close connection to the history and development of a specific society. A common feature in successful education systems is the balance between tradition and the capacity to be flexible and able to adapt to current social trends. Every successful education system stems from a certain philosophy and is not the random outcome of current ideology or political ideas (Selwyn, 2013).

Today, the current opinion and understanding is that the knowledge that formed the basis of progress in the 19th and 20th centuries is insufficient in the modern world (the 21st century). It will be even less so in the future, when the fourth industrial revolution will be reached, called Industry 4.0 (World Economic Forum, 2017), designed with four basic principles in mind. These principles support the economy and determine the scenarios of their implementation. The principles are as follows:

- *Interoperability*: the ability of machines, devices, sensors and people to connect and communicate among each other and on the internet of things (IoT), as well as on other internet (global) connections.
- *Informational transparency*: the ability of information systems to create virtual copies of the physical world (various simplified, clear models) by connecting large databases and various sensor systems, which, for example, is done today in weather forecasting.
- *Technical support*: the first form is the technical support of support systems displaying a large amount of data in a clear, visual

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manner (for example, tables turned into appropriate graphic representations), which aids in fast and competent problem solving. The second form is the ability of cyber-physical systems (CPS) to support a person carrying out unpleasant, tiring or dangerous tasks, such as the use of robots in the search and disposal of mine fields.
- *Decentralised decision-making*: the capability of cyber-physical systems (CPS) to make decisions and carry out their given tasks as quickly as possible, and in an automated, independent manner. A person needs to intervene only if the CPS is not capable of independent decision-making.

Knowledge, SKILLS and Competences Needed in the Future

There is no doubt that Industry 4.0 is a reality. Since general opinion is that the education system at the primary level does follow social changes with a significant delay, which is realistically about 15 to 20 years, it becomes clear that, if society wishes to follow these changes brought on by Industry 4.0, it will need to adjust the education system as soon as possible. This is especially true in the area of Science, technology, engineering and mathematics (STEM), where changes happen more rapidly (Flogie & Aberšek, 2015). The knowledge of modern society as presented by Industry 4.0 should be as follows (World Economic Forum, 2017, Aberšek, Flogie, Kordigel Aberšek, & Šverc, 2017):

- *Competency-based development knowledge* in the area of CPS and IoT, connected to the internet of people. In short, a specialized engineering (STEM) knowledge, upgraded with digital literacy 4.0, is needed.
- Interoperability requires *communication competence 4.0*, which includes not only the skills of human-human communication, but also the skills of human-machine communication and the understanding of machine-machine communication.
- *The ability to develop systems* that support people when making decisions in complex situations by means of visualization and processing large amounts of data (data mining), as well as the *ability to resolve complex* problems in real time (critical judgement, critical decision-making).
- Decentralized decision-making means that most decisions will be made by machines with the help of various algorithms (such as Google filters). A person's role will be to make these decisions only in "critical, badly defined situations", when these algorithms fail.

The collaboration of various scientific branches is welcome, but it is no longer enough. The quality and value of the competences, skills and knowledge of an individual are the basis for creating their competitive advantage in the global world, and, consequently, increasing their prosperity as an individual and that of the entire society. Nair (2003) also thinks that the classical school paradigm is a relic and a remainder of the first industrial revolution. The education system established in the first half of the 20th century, which unfortunately is still the foundation of most educational processes, is outdated, since global economic policy has changed so significantly. On the other hand, the development of modern production technologies, information and communication technology, as well as findings in the field of cognitive science and neuroscience is the basis of modern methods of teaching. All of this changes the employment needs and potentials of tomorrow's society, that is, the education systems that must consider the needs of such a society. Recognizing that the education model of the 19th and early 20th century was based on the following needs in the field of employment:

- 20 % professionals,
- 30 % merchants and office workers,
- 50 % physical labourers,

one can say that a model catering to the employment needs of the 21st century would need to adapt to the following employment needs:

- a minority of unqualified, temporary and seasonal workers (approximately 1/8) and
- hardworking, self-educated workers with the initiative to manage their own work and time (approximately 7/8) (Dryden & Vos, 1999), which calls for the *development* and *achievement of higher taxonomic and cognitive levels of competency*.

A country's development and employment prospects are among the foundations for the development of society and its education system. Thus, the education system has an indirect impact on the prosperity and state of society as a whole. Research in the field of education policies shows that European education systems are falling behind those in other regions of the world (COM 654 final, 2013).

It is obviously necessary to connect the principles and concepts of various scientific branches in the field of the development of modern concepts (Okasha, 2002). The foundation for modern innovative education in the 21st century is now based on current knowledge of the brain and its processing of information and on the field of cognitive science (Aberšek, Borstner, & Bregant, 2014). More and more questions are arising similar to those asked by British scientist Tony Buzan:

> At school I spent thousands of hours studying mathematics, thousands of hours learning languages and literature, thousands of hours learning geography and history. Then I asked myself how much time I spent getting to know how my brain works. How much time did I spend learning about how my eyes work? How many hours did I spend learning about how to study? How much time did I spend learning about the functions of my head? How many hours did I spend learning about the mechanisms of thinking and how thoughts affect my body? Unfortunately, the answer is very simple - *none*! (Dryden & Vos, 2005, p. 73).

Boekaerts (Dumont, Istance, & Benavides, 2010) calls for a thorough reform of teacher education programs in order to provide them with a more comprehensive understanding of how cognition, motivation, teaching and learning relate to each other. It is also necessary to provide future teachers with training and experience in order to use their knowledge effectively in practice. Richard Mayer says (Dumont et al., 2010) that only a few of the many claims that the use of new technologies allows for a thorough reshaping of what we understand as learning are convincingly supported by research. The main reason for this is that these claims are all too often followed by "technology-oriented" rather than "learning and learner-oriented" teaching approaches (Dumont et al., 2010). A more compelling contribution to the theory of how people can learn using technology would be the following three important lessons: the existence of "double channels" (people process sound and visual images separately), "limited capacity" (people can only handle a small amount of information at one time - symbols, sounds or images) and "active processing" (meaningful learning is dependent on proper cognitive processing) (Dumont et al., 2010).

Certain researchers call attention to the negative consequences of using modern information and communication technology on adolescents, especially in terms of their brain development and psychosocial characteristics (Manfred, 2016). Others stress the "net generation's" addiction to technology and its negative impact on the quality of their knowledge (Carr, 2010; Rideout, Foehr, & Roberts, 2010). However, many authors (Dumont et al., 2010) emphasize the individual positive effects of the use of contemporary teaching/learning technology.

In the research presented, the focus was primarily on the influence of modern technologies on social competences and the psychosocial effects of technologies as the basis of competences for Industry 4.0 on an individual and societal level. It should be stressed that, if the aim is to create a society of equal opportunities, or if all young people need to be offered equal opportunities, new and effective approaches in education are required. So, the main research problem is to study what influence *innovative didactic teaching approaches* exert on students' psychosocial and cognitive abilities, and the main research questions are:

- Do innovative didactic teaching approaches supported by modern information and communication technology change the traditional form of teaching and the learning environment for students?
- Do they offer a large contribution to achieving higher psychosocial and higher cognitive competences?
- Are there statistically valid differences, according to students, between traditional (today's school) and innovative lessons (say, School 4.0)?

Research Methodology

General Background

The social aspect of a student's commitment to learning and school work is reflected in their willingness to work with others and their ability to function successfully at school. When an adolescent feels a sense of belonging, their commitment to school work is usually higher, whereas if they do not have this sense of belonging, they

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are often prone to problematic behavior (Juvonen, Espinoza & Knifsend, 2012). If these problems remain and their consequences are ignored by the family and the educational system, they can carry on into adulthood (Offord & Bennett, 1994). Inappropriate behavior, a lack of participation in school, and a negative attitude towards it are all too often connected with lower achievements in school as well as a lower level of emotional wellbeing, dropping out, adverse behavior and, last but not least, the use of prohibited substances (Baker & McGaw, 2007; Dumont et al., 2010).

The inclusion into the school curriculum of innovative teaching methods supported by modern information and communication technology represents a major challenge for the education system, both in Slovenia and elsewhere (Flogie & Aberšek, 2015). This issue is being addressed by all EU Member States as well as by the European Commission (Schleicher, 2016).

Based on the current study, new scientific findings and the specific outcomes of work at schools, the authors have established a multidimensional model„Innovative Pedagogy 1:1" (Aberšek et al., 2017; Aberšek & Flogie, 2015). The proposed model highlights the need for a comprehensive transdisciplinary approach to education based on the competences required for Industry 4.0. The role of school is to teach students to solve specific life problems and to offer them the experience of using a range of tools for different life situations. The model highlights the need for a holistic approach to education and emphasizes competence.

That is why the main aim of this research is to define and adapt these methods of innovative teaching, primarily at the paradigmatic and strategic levels, with an emphasis on the introduction of the world of modern ICT applications into 21st century schools (School 4.0). The results were obtained on the basis of longitudinal research form 2013 to 2016 and a three-year follow-up of intensive work in the classroom from 2014 to 2017 with various kinds of surveys, where the main scope was to verify whether a positive psychosocial and cognitive impact on students was detected, while using innovative didactic teaching approaches supported by modern information and communication technology (Aberšek, et al., 2017). The questionnaires for this study were prepared according to the activities form Table 1.

Participants and Sample Selection

The control group (CG) consisted of 1,356 students from all over Slovenia. The control group was formed indirectly by taking relevant questions from the international „Trends in International Mathematics and Science Study" (TIMSS study) (Mullis, Martin, Foy, & Hooper, 2016) used on a sample of the population of students from all over Slovenia who use classic work methods in class. The experimental group (EG) comprised the innovative classes of the 6 elementary schools participating in the project. The EG consisted of 86 students who correctly filled in the questionnaires for students of innovative classrooms and had used personalized devices (tablets), e-services and e-content for at least two school years, together with teachers who received intensive training as part of the project. For the EG a questionnaire was prepared for 100 students, which means that the survey questionnaire was correctly filled out by 86% of all participants.

Research Methods and Procedures

The foundation of this research and the entire empirical section is the finished project "Innovative Pedagogy 1:1 in the light of competences of the 21st century" (Aberšek et al., 2017), which was based on previously developed innovative methods of teaching, the use of modern information and communication technology, e-services and e-content, and their concrete use and improvement in the classroom. The project lasted from 1 January 2013 to 30 June 2015. All of the teachers involved studied the use of information communication technology, e-services and e-content throughout the project and were accurately guided and evaluated according to the 21 Steps methodology (Microsoft Partners in Learning, 2010) and in line with the multidimensional model of Innovative Pedagogy 1: 1 (Flogie & Aberšek, 2015). Selected teachers were invited from six innovative elementary schools from statistically deprivileged regions to participate in the study, since the aim was to eliminate any previously acquired knowledge and skills that students in urban schools would already have acquired at home. During the project, there was intense cooperation with the selected teachers from these elementary schools for two school years, wherein several evaluations were carried out, and the teachers became familiar with the methodologies and approaches. Within these schools, an experimental group (EG) was established, which was then compared to the control group (CG) representing all the students from the remaining Slovenian schools. The questionnaires were analysed using the IBM SPSS statistical data processing tool (Field, 2005). The hypothesis was tested with a T-test. The reliability of the questionnaire was calculated with the Cronbach alpha coefficient.

Data Analysis

Quantitative data from the experimental and control groups was collected, reviewed and rated by a group of experts in the field of educational science. Quantitative data collected in the experimental group was analyzed according to the following phases, or by encoding, defining and organizing the data and interpreting the results. Data from TIMSS research was collected, evaluated and statistically processed. Qualitative data from students was collected mostly via survey during specific training and with the help of assessment questionnaires. All the data was analysed with SPSS (Field, 2005). Descriptive statistics was used for each group, where the standard errors of the means and two versions of the independent sample *t*-test were used; the first is the usual form, based on assuming equal variances, and the second allows the variances to be different.

Research Results

Tables 1 and 2 show results from SPSS analyses. Table 1 begins with a number of descriptive statistics for each group, where the standard errors of the means are given. Table 2 gives the results of applying two versions of the independent sample *t*-test; the first is the usual form, based on assuming equal variances in the two groups (i.e., homogeneity of variance); the second allows the variances to be different.

Table 1. Group statistics comparing traditional and innovative lessons.

Categories	EG/CG	N	Mean	SD	SEM
A1: Creating text using text editing software.	EG	86	2.87	.89	.096
	CG	1356	2.68	1.05	.029
A2: Editing digital photos or other graphic images.	EG	86	2.86	.95	.102
	CG	1349	2.71	1.07	.029
A3: Online text editing with internal links and images.	EG	86	2.95	.87	.093
	CG	1335	2.71	1.03	.028
A4: Creating databases.	EG	86	2.38	.86	.092
	CG	1343	2.15	.99	.027
A5: Editing an online questionnaire.	EG	84	2.42	.87	.095
	CG	1330	2.11	1.04	.028
A6: Sending documents to other students or the teacher using an e-mail program.	EG	86	3.44	.86	.093
	CG	1334	2.64	1.13	.031
A7: Sorting electronic documents into folders and subfolders on a computer.	EG	86	3.07	.96	.103
	CG	1338	2.59	1.11	.030
A8: Using spreadsheet programs (Excel).	EG	85	2.78	.82	.089
	CG	1336	2.38	1.05	.029
A9: Creating presentations with animations (Prezi, PowerPoint).	EG	86	3.50	.78	.084
	CG	1328	2.54	1.09	.030
A10: Using social media and the accompanying tools.	EG	85	2.85	.93	.101
	CG	1325	2.38	1.12	.031
A11: Judging the reliability of information found on the internet.	EG	85	2.73	.85	.092
	CG	1335	2.46	1.05	.029
A12: Using the internet safely and protection against bullying.	EG	84	3.11	.80	.088
	CG	1336	2.83	1.09	.030

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Categories	EG/CG	N	Mean	SD	SEM
A13: Sending and reading e-mail.	EG	85	2.75	.89	.096
	CG	1385	2.42	1.08	.029
A14: Reading or watching the news online.	EG	84	2.65	.98	.106
	CG	1354	2.27	1.11	.030
A15: Using an online dictionary or encyclopedia (Wikipedia and others).	EG	85	2.68	.82	.089
	CG	1355	2.26	.84	.023
A16: Searching for practical information online (tickets for games/concerts, shopping, train schedules, health).	EG	82	2.62	.98	.108
	CG	1370	2.04	.95	.026
A17: Finding various online resources for information and becoming familiar with specific topics of interest.	EG	85	2.79	.85	.092
	CG	1365	2.40	.96	.026
A18: Learning through educational programs, games or quizzes.	EG	85	2.41	.85	.092
	CG	1365	1.90	.95	.026
A19: Cooperating in an online group discussion or forum.	EG	84	2.19	.91	.099
	CG	1358	1.62	.94	.026

The next research question is: are there statistically significant differences between these two groups? Thus, an independent sample *t*-test was implemented, the results of which are shown in Table 2.

Table 2. Statistically significant differences between EG and CG.

Categories		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig. (> .05)	t	df	Sig. (2-tailed) (< .05)	Mean Difference	SEM	95% Confidence Interval of the Difference Lower	Upper
A1	1*	15.365	.0001	1.667	1440	.096	.194	.116	-.034	.421
	2**			1.930	100.664	.056	.194	.100	-.005	.393
A2	1*	9.154	.003	1.293	1433	.196	.153	.118	-.079	.384
	2**			1.436	99.258	.154	.153	.106	-.058	.363
A3	1*	18.412	.0001	2.101	1419	.036	.239	.114	.016	.462
	2**			2.448	101.162	.016	.239	.098	.045	.432
A4	1*	2.252	.134	2.168	1427	.030	.236	.109	.022	.449
	2**			2.449	99.936	.016	.236	.096	.045	.426
A5	1*	4.050	.044	2.653	1412	.008	.306	.115	.080	.532
	2**			3.099	98.546	.003	.306	.099	.110	.502
A6	1*	27.175	.0001	6.451	1418	.000	.801	.124	.557	1.044
	2**			8.172	104.789	.000	.801	.098	.607	.995

Categories		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig. (> .05)	t	df	Sig. (2-tailed) (< .05)	Mean Difference	SEM	95% Confidence Interval of the Difference Lower	Upper
A7	1*	19.935	.0001	3.907	1422	.000	.479	.123	.239	.720
	2**			4.463	100.383	.000	.479	.107	.266	.692
A8	1*	20.907	.0001	3.383	1419	.001	.392	.116	.165	.620
	2**			4.190	102.254	.000	.392	.094	.207	.578
A9	1*	37.287	.0001	8.069	1412	.000	.962	.119	.728	1.195
	2**			10.795	107.717	.000	.962	.089	.785	1.138
	1*			.672	96.419	.503	.077	.115	-.150	.304
A10	1*	19.978	.0001	3.750	1408	.000	.467	.125	.223	.712
	2**			4.421	100.354	.000	.467	.106	.258	.677
A11	1*	16.912	.0001	2.310	1418	.021	.268	.116	.040	.496
	2**			2.774	100.946	.007	.268	.097	.076	.460
A12	1*	27.258	.0001	2.287	1418	.022	.276	.120	.039	.512
	2**			2.966	102.883	.004	.276	.093	.091	.460
A13	1*	15.605	.0001	2.771	1468	.006	.330	.119	.096	.563
	2**			3.290	99.854	.001	.330	.100	.131	.529
A14	1*	5.074	.024	3.110	1436	.002	.386	.124	.142	.629
	2**			3.488	96.857	.001	.386	.111	.166	.606
A15	1*	.034	.854	4.543	1438	.000	.426	.094	.242	.610
	2**			4.644	95.419	.000	.426	.092	.244	.608
A16	1*	2.438	.119	5.341	1450	.000	.578	.108	.366	.791
	2**			5.214	90.429	.000	.578	.111	.358	.798
A17	1*	5.786	.016	3.685	1448	.000	.392	.106	.183	.601
	2**			4.108	97.881	.000	.392	.095	.203	.581
A18	1*	.485	.486	4.857	1448	.000	.515	.106	.307	.723
	2**			5.384	97.694	.000	.515	.096	.325	.705
A19	1*	2.201	.138	5.381	1440	.000	.568	.106	.361	.775
	2**			5.534	94.276	.000	.568	.103	.364	.772
	1*			-.027	93.463	.978	-.003	.126	-.253	.246
	1*			-4.422	94.434	.000	-.479	.108	-.695	-.264
	1*			-1.712	96.532	.090	-.192	.112	-.415	.031

1 - Equal variances assumed*
*2** - Equal variances not assumed*

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When briefly summarizing the research results presented in Tables 1 and 2, it can be established that innovative teaching methods supported by modern information and communication technology have a positive effect on our way of teaching and learning.

Discussion

According to the results, of the 19 possible categories (A1-A19), there are only two for which there are no statistically significant differences between students from the innovative and traditional classes (although there are differences in the mean values of both groups for these two categories). For 17 of the categories, our assumption of the homogeneity of the variance can be confirmed. Because $p < .05$, one can conclude that there are statistically significant differences in 17 issues between students of the innovative and traditional classes. No statistically significant differences were found for the categories "Creating text using text editing software" and "Editing digital photos or other graphic images". Therefore, it can be assumed that students from both groups are equally skilled at these two activities. This is quite self-evident in the current information society, because these are basic skills that are well represented in schools and which can reasonably be assumed that all children have grasped.

There are differences in all of the other categories. Checks were done to establish whether there were any differences in Online text editing (A3) containing internet connections (hyperlinks) and images, and it was found that the assumption of the homogeneity of variance could be accepted. Since $p < .05$, it can also be said with great certainty that there are statistically significant differences between the EG and the CG. Students in the innovative classes are more skilled at editing online texts that contain internet connections and images.

Also, in the cases of Online text editing containing internet connections and images ($p < .05$), Creating databases (A4) ($p < .05$), Editing an online questionnaire (A5) ($p < .05$), Sending files to another student or teacher by using e-mail (A6) ($p < .05$), Sorting electronic documents into folders and subfolders on a computer (A7) ($p < .05$), Using spreadsheet programs (A8) ($p < .05$), and Creating presentations with animations (A9) ($p < .05$), it was found that there were statistically significant differences between the control and the expert groups. It can also reliably be claimed that students from the innovative classes (EG) are more proficient than those in CG (traditional departments) at these skills, and consequently achieve higher taxonomic levels of skill in these areas.

The next finding comes from the category of Social media (A10), the use of most of its tools, and Judging the reliability of information found on the internet (A11). In the context of these categories, the assumption of homogeneity of variance can be also accepted, and since, for all questions $p < .05$, the statistically significant differences between students in the EG and CG classes can also be claimed. The students in the innovative classes are more skilled in these areas than those in the traditional classes.

One can also confirm the hypothesis on the homogeneity of variances ($p < .05$) for the categories of Using the internet safely and protection against bullying (A12), Sending and reading e-mail (A13), and Reading or watching the news online (A14), and state that there are statistically significant differences between the two groups. Students in the innovative classes are more skilled (more competent) at these activities than those in regular classes.

The last set of categories is closely connected to the skills of obtaining information. It was established that for all activities (A15-A19) where $p < .05$, there are statistically significant differences between EG and CG. The students of innovative classes are more adept at using an online dictionary or encyclopaedia (Wikipedia, etc.), finding practical online information (e.g. tickets for a match / concert, shopping, timetables, health), finding various online resources for information and becoming familiar with specific topics of interest, learning through educational software, games or quizzes, and at participating in a web-based group discussion or a forum than students in traditional classes, that is, they are also more qualified to be part of future society, which they are studying for today.

If the focus is on the educational requirements of the future, such as interoperability, information transparency, technical support and decentralization of decision-making, which were evaluated mainly with categories (A4, A8, A9, A10, A11, A12, A18 and A19), it can be seen that an innovative didactic approach can achieve a fundamental shift in competences for Industry 4.0.

In comparison of these results with other similar research worldwide (Carr, 2010; COM 654 final, 2013; Dumont, et al., 2010; Halász &Michel, 2011; Malerba, Vonortas, Breschi & Lorenzo, 2006; Schleicher, 2016) and the author's (Dolenc, Aberšek, 2015, Kordigel Aberšek, Dolenc, Kovačič, 2015, Pešakovič, Flogie, Aberšek, 2014, Hus, Kordigel Aberšek, 2011), one can see that the results are similar or even slightly better. In the majority of international studies, the results were mostly reached under "laboratory" conditions, in newly built and well-equipped schools, where prepared and motivated teachers were chosen. Likewise, in the preceding pilot studies, the authors also worked with chosen teachers, properly trained and well-motivated.

It seems that in schools that continue to implement innovative pedagogy, there will soon come a shift in teacher training, from using tools, towards topics in pedagogy and didactics. This, of course, is a process that requires time and cannot be concluded in the duration of any project.

However, one must point out that on the one hand, there are pilot studies, where all parameters can be immediately adjusted, making it possible to achieve good results, and on the other, there are studies carried out under real-life conditions, in this case real learning environments in a real teaching situation as in the present study. Finally, it can be pointed out that innovative teaching methods supported by modern information and communication technology (School 4.0) are definitely changing ways of teaching and learning, as well as learning environments. And this is the right direction, according to the educational goals of Industry 4.0.

Conclusions

It was confirmed in this research that innovative didactic teaching approaches, supported by modern ICT, change traditional methods and the students' learning environment, and contribute greatly to achieving better taxonomic and cognitive competence levels than the use of traditional teaching methods. In the present study, it has been proven that an educational process that uses innovative teaching approaches supported by modern ICT keeps pace with the needs of today's, and especially tomorrow's, digital society 4.0 and the economy of Industry 4.0.

The students in the innovative classes achieve higher taxonomic levels of knowledge, have a positive psychosocial impact and are especially more skilled (more competent) in the areas of using the social media and internet safely and protection against bullying. They are quicker to find the information on the internet and more critical of this information. Consequently, they are also better qualified to fulfil future reguirements, such as interoperability, information transparency, technical support and decentralization of decision-making. It can be seen that, with innovative didactic approaches, a fundamental shift can be achieved in competences for Industry 4.0. However, the research presented constitutes only a first step in this long and exhausting process.

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