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Scientific Research on the Effects of the Project "e-Schools: Establishing a System for the Development of Digitally Mature Schools (Pilot Project)"

(151 selected schools)

Conclusions and recommendations

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Part of the document which provides recommendations is translated from Croatian to the English language and is equivalent to the Croatian version of recommendations given in the report *„Zaključci i preporuke*“.

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1. RECOMMENDATIONS

Within the pilot project "e-Schools: Establishment of the system for the development of digitally mature schools", the Center for Applied Psychology of the Faculty of Humanities and Social Sciences, University of Rijeka, conducted a scientific research aimed at systematic monitoring and evaluation of the effects of the pilot project on the following specific outcome variables:

- Affective and cognitive learning outcomes in students;
- Digital competences of students, educational and administrative staff;
- Attitudes of students, educational and administrative staff related to ICT;
- The level of digital maturity of schools.

All instruments are presented in details in the 4th chapter (Description of used measurements) in the final report *Conclusion and recommendations*.

Five general and several specific research objectives were defined, within which the impact of the basic elements of the pilot project was analysed: establishment of an adequate ICT infrastructure; establishment of upgraded business and teaching processes; application of the system of digitally mature schools; the use of ICT and digital educational content in the educational process; developing a community of practitioners and enhancing the digital competences of educational and administrative staff.

Based on the results of the research for each general goal, conclusions and recommendations were made depending on the effects of the analysed elements relevant to a particular goal.

In addition to recommendations referring to the general objectives of the research and the advancement of the Framework for the Digital Maturity of Schools, this Report also contains Recommendations for Educational Policy which are essential for further planning of the project, which will continue to introduce ICT to primary and secondary education in the Republic of Croatia.

1.1. 1st GOAL: The impact of the implementation of the e-School pilot project on general affective and specific cognitive learning outcomes of students

The first objective of the research was to examine the impact of e-School pilot project implementation on general affective and specific cognitive learning outcomes of students. Specific goals examine: the impact of school- and learning-related ICT activities on general affective and specific cognitive learning outcomes (SG1.1), verification of the effects of implementation of some of the applied digital educational content (DEC) and teaching scenarios on general affective and specific cognitive learning outcomes in students (SG1.2), verification of the interconnection of digital competences of the educational staff with the achievement of expected general affective and specific cognitive learning outcomes (SG1.3) and the verification of differences in achieving general affective and specific cognitive learning outcomes in the field of natural sciences and mathematics, considering the type of infrastructure which was used (presentational and interactive classrooms) (SG1.4)..

1.1.1. The impact of school- and learning-related ICT activities on general affective and specific cognitive learning outcomes

It was expected that school- and learning-related ICT activities would be statistically significantly positively associated with the general affective and specific cognitive learning outcomes of students.

- The results show that the levels of academic emotions, as well as the target orientations on learning, performance, and work avoidance tested at the beginning of the implementation of the e-School project have significantly determined how students will feel and how specific target orientations will be expressed at the end of project implementation regardless of their use ICT activities. So, the emotional experience of teaching is relatively stable. Positive and negative experiences of education are difficult to change; also, motivational patterns of students are relatively stable. The use of ICT activities is less important as a determinant than the learning outcomes of the learner's usual learning experience.
- The role of ICT activities depends on the context in which they are used. *The use of ICT in teaching activities* envisions general affective learning outcomes more than the *ICT activities associated with schooling and teaching in general*. More specifically, *ICT-based Teaching Activities* significantly stimulate *intrinsic orientation to learning* and to a lesser extent stimulate emotions of *pride and enjoyment* and reduce the emotions of *anxiety and anger*. On the other hand, as the teachers use *school- and learning-related ICT activities* more often,

but not in direct work with students, the students of that school have a less *intrinsic orientation to learning*.

- As far as specific cognitive learning outcomes are concerned, prior knowledge in different school subjects prior to teaching in the specific teaching situation have significantly determined how much have students learned during the teaching. Thus, the prior knowledge determines specific cognitive learning outcomes. On the other hand, the use of ICT activities in general, as well as in teaching, did not reflect on specific cognitive learning outcomes.

Recommendation:

- The use of ICT activities in teaching should be more frequent with the aim of encouraging students' intrinsic orientation to learning, and experiences of positive and reducing negative academic emotions. Using ICT activities to get realistic illustrations of some phenomena (e.g., simulations, videos, animations) and problem-solving makes the content of learning more meaningful and students can understand the objective of learning more clearly. Also, practising skills and broadening knowledge through the use of ICT activities helps students to perceive their own progress and experience the feelings of enjoyment in learning and pride in achieved progress.

1.1.2. The impact of the applied digital educational content (DEC) and teaching scenarios on general affective and specific cognitive learning outcomes in students

It was expected that the application of digital educational content and scenarios which encourage deeper learning would have a statistically significant positive effect on general affective and specific cognitive learning outcomes in students.

1.1.3. The effect of implementation of digital educational content (DEC) on general affective and specific cognitive learning outcomes in students

- The use of DECs has been established to be a negative predictor of the emotion of anger and orientation towards work avoidance. In other words, in schools in which more teachers used DECs, the students were less likely to feel the emotion of anger during the lessons and were

less orientated towards work avoidance. However, as was shown in the second testing that only about one-third of the teachers frequently use DECs, the effect would probably be more prominent if more teachers would use DECs more frequently.

- *The use of DECs* did not show an impact on specific cognitive learning outcomes. This result is not unusual given that the impact of ICT activities on specific learning outcomes was checked only in one teaching unit.

Recommendation:

- Teachers should be encouraged to apply digital educational content in teaching because of their positive effects on reducing anger and orientation towards work avoidance. They should also be supported in independent development and implementation of DECs, as well as through the development of new and more diverse DECs which would be readily available to them.

1.1.4. The effect of implementation of teaching scenarios on general affective and specific cognitive learning outcomes in students

Analyses of preparations and implementations of teaching units

- The basis for designing a teaching scenario is the idea of active participation of students in learning - through research and interaction with other students - with the objective to motivate students. In the scenarios, different activities are proposed along with the application of appropriate digital content and tools. However, preparations for teaching without the use of the ICT activities also included numerous research activities of the students and their mutual interaction. On the other hand, in the application of the teaching scenarios, the observed ICT activities were often just another way of implementing a part of the activities that did not necessarily encourage deep processing of the content. For example, after a demonstration or experiment in the class, the observed data was entered in the Excel spread sheet or the Google document instead of in the notebook. Thus, the two modes of teaching, with and without the teaching scenarios, were mostly not so different considering the level of the student's active participation in learning.
- Through analysis of the written preparation of lessons based on the teaching scenarios, it was found that the teachers planned to apply numerous elements and suggestions from the

teaching scenario as well as to use various ICT tools intended for the realisation of different teaching activities. However, the application of a larger number of different ICT tools has been planned and realized in the biology and mathematics classes than in the physics and chemistry classes.

- The type of most commonly used ICT tools and activities varied with respect to the subject (e.g. Internet search and working on the text available on the recommended web pages in biology classes; showing videos in physics and chemistry classes, or using GeoGebra app in maths). The planned use of ICT tools and activities has mostly been realized.
- In the notable number of teaching units, especially in biology and physics classes, difficulties in using ICT equipment were present, in most cases related to problems with connecting tablets to the network, logging into tablets, and shutting tablets down. In some teaching units, difficulties were caused by the lack of teachers' competence in the use of tools (e.g. data entry in Excel) or other reasons (e.g. absence of sound).
- The most frequently represented ICT activities of students varied according to the pedagogical specifics of a particular subject (e.g. obtaining a realistic representation of phenomena in chemistry or problem-solving tasks in maths). ICT activities are commonly used for students' group work in all subjects except chemistry. Practising skills and broadening knowledge through the use of ICT activities have been applied to the teaching of all subjects except physics. Keeping in mind all the subjects, the use of ICT for the purpose of submitting students' work in digital format was the least used. Also, using ICT for problem-solving was not used, except in maths classes. The use of ICT for obtaining a realistic representation of phenomena was used in chemistry and mathematics but was not used in biology and physics.
- In most cases, teachers used ICT activities and tools so as to incorporate them into activities aimed at achieving cognitive learning outcomes related to the level of understanding or even higher levels of cognitive outcomes, while ICTs were less used to achieve outcomes of the first level (of knowledge) that refer to outcomes such as to recognise, repeat, reproduce, list.
- Classes that were not based on teaching scenarios (control condition) in most cases predicted the same learning outcomes, had the same or similar course of the unit and, in most of these classes, students performed similar experiments or assignments as in experimental classes. Not one class was based solely on the frontal instruction of teachers (i.e. giving a lecture),

and some ICT tools which were not suggested in the teaching scenarios were used in a number of classes.

- Assessments of the observers indicate a greater involvement and interest of students in the classes in which the material was processed with the help of elements of the teaching scenarios, although this difference is absent when analysing the experimental and control classes given by the same teacher, which points to the importance of the teacher's role in performing the lesson.

General affective and specific cognitive learning outcomes

- In biology classes, students who were taught using ICT activities expressed a greater interest in teaching, a greater sense of involvement and less boredom, and estimated that they were more active than those taught without ICT activity. A similar pattern was not found when cognitive outcomes were analysed. In fact, in the initial application, the students in the group for teaching scenarios had better knowledge than the students in the control group, but the progress of the control-group students is higher, so after the teaching, there is no difference in knowledge between the two groups. Based on the analysis and comparison of the biology classes in experimental and control conditions, it can be concluded that in most cases there were very similar conceptions of lessons. The main difference was that the lessons based on the teaching scenarios used ICT tools and activities. It is possible that due to the biology's specific curricular content with a lot of theoretical data, the use of ICT tools and activities, such as searching images on the internet, working on texts and articles on online pages and solving online knowledge quizzes, additionally engages students and contributes to the dynamics of teaching, thus achieving favourable motivational and affective effects, but not necessarily changes in the level of cognitive outcomes.
- There was no difference in affective nor in cognitive outcomes among students in experimental and control conditions before or after lectures in chemistry classes. Progress is similar in both groups. If we consider the preparation and implementation of chemistry lessons with and without the teaching scenario, it can be seen that in both cases teachers use interactive teaching methods, conduct experiments, and in most control lessons, ICT was also included (presentation, quiz, video). Although teachers in the experimental condition use more diverse ICT tools and activities, there were no essential differences in organizing the lesson.

- In physics class, students taught without the use of ICT-based teaching scenarios, before teaching estimated the content to be more valuable and predict that they would enjoy lessons more than students taught using the teaching scenario. These initial differences also reflect on final assessments. Students taught without the use of learning scenarios, assessed lessons as more valuable, show greater interest in teaching, less boredom, a greater sense of self-efficacy, and greater effort. The difference in the knowledge of the students in the two groups was not gained before teaching, but the greater advancement in knowledge was achieved by the students in the control condition, so after the teaching they had better knowledge than the students in the experimental group. Given the initial differences in emotions and motivation, students who were taught without applying the teaching scenarios were more motivated to acquire knowledge. Similar to chemistry classes, the students were active, performed experiments and discussed in physics classes too.
- In maths classes, students in the experimental group show more favourable affective outcomes, as they report a higher level of enjoyment and self-efficacy; they evaluate the content as more valuable, show greater interest, are more involved and less bored than the students taught without the learning scenarios. However, students taught with the learning scenarios achieve better results both before and after teaching, but, similar to chemistry classes, the level of progress is similar in both groups. The beneficial effects of the application of teaching scenarios on affective outcomes in teaching mathematics are not surprising given that students generally have difficulties in understanding relatively abstract mathematical contents. Here ICT tools can give meaning to mathematical expressions through examples and students can have a higher experience of self-efficacy and show greater interest. Through analysis of preparation and implementation of teaching lessons based on the teaching scenarios, it was established that the use of ICT for the purpose of problem-solving was planned and implemented in all classes. Also, the use of ICT tools and activities that enabled students to obtain a realistic representation of phenomena (e.g. interactive research of graphs and functions in GeoGebra app) and group work on the task were more common. However, as the problem tasks were mostly abstract, they did not significantly improve students' understanding of the problem and their more successful solving than the approach to teaching with no ICT activity.
- Based on the comparison of the affective outcomes of the students in classes where the elements of the teaching scenario were used and without the use of the teaching scenarios, the positive effect of applying the teaching scenarios can be noticed. This effect is particularly

visible in subjects that are abundant with facts and it is more difficult to conduct a demonstration or experiment (biology and mathematics) in teaching, so ICT tools are a useful tool for it and contribute to the meaningful content, dynamics and interest in teaching. In subjects where experiments are used in teaching, the contribution of ICT tools to affective outcomes is not noticeable.

- As far as cognitive learning outcomes are concerned, it is not possible to make unambiguous conclusions on the effects. Generally, there is no significant direct impact of teaching with the help of the learning scenarios on the students' cognitive outcomes, or on their new knowledge. As was expected, the students have better knowledge after the lesson than they had before the lesson, regardless of the condition. It can be noticed that in both conditions, with and without teaching scenarios, teachers used assignments that actively involved students in learning and were focused on achieving higher-level cognitive outcomes. In addition, ICT activities that encourage the deepest processing of content (e.g. problem tasks) were the least used in all subjects except in math classes where problem tasks were used by teachers in both conditions. It may be expected that longer-lasting repetitive application of teaching scenarios, but lessons oriented to problem-solving, could have a greater impact on cognitive learning outcomes.

Recommendations:

- To ensure the effective use of ICT-based teaching scenarios, it is necessary to ensure the functionality of equipment and applications as well as provide teachers with fast and effective technical support to increase the number of teachers who will be willing to use the teaching scenarios.
- To ensure a more efficient use of ICT equipment before the implementation of the teaching scenarios, students should be trained in the use of tablets (turning on, logging in, launching applications etc.)
- It is recommended to further develop teaching scenarios which require different levels of digital competence of teachers, i.e. to develop more scenarios with simpler ICT activities which could be used by teachers with lower level digital competence.
- It is recommended to develop ICT activities appropriate to the various levels of students' prior knowledge so that teachers can individualise the teaching.

- It is necessary to continue with the activities of encouraging the development of digital competence of teachers so that they can effectively apply the teaching scenarios and independently solve the possible difficulties of using ICT.
- Due to the positive affective impacts of using ICT activities within the teaching scenarios framework, it is recommended to further develop different ICT activities, especially those which enable students to work together on the task. It is also recommended to draw up more detailed instructions for teachers to help them select appropriate ICT activities with regard to students' initial knowledge and expected learning outcomes, and planning the duration of each activity in order to achieve outcomes. The choice of ICT activities appropriate to the level of their knowledge would encourage students to actively participate, to achieve a sense of self-efficacy in the performance of the assignment, and, consequently, to have a positive experience and motivation for learning.
- In order to achieve the greater result from using ICT activities on cognitive learning outcomes, it is advised to carefully design ICT activities for problem-solving tasks which should be authentic, i.e. everyday and situational problems. They would be more meaningful and easier to understand to students than the abstract problems which are mainly suggested in existing teaching scenarios. The use of ICT can facilitate student's individual progress in solving tasks, as well as the exchange of ideas among students and mutual explaining how to solve problems. Also, it is recommended to use quizzes more frequently at the beginning of the lesson so students can check their prior knowledge, as well as at the end of the lesson so that they can get feedback on their own progress.
- It is recommended to plan two consecutive school periods for teaching with the use of ICT activities so that students have enough time to work on solving different problem tasks and consolidating the learned. On the other hand, teachers would have a greater chance of resolving any possible technical difficulties and realisation of planned ICT activities if they had more time.
- It is recommended systematical and long-term application of teaching scenarios and monitoring of the effects which can only be observed after the longer and multiple use of this teaching method, especially for the impact on the level of transfer of the acquired competences to the next level of education.

1.1.5. Interconnection of digital competences of the educational staff with the achievement of expected general affective and specific cognitive learning outcomes of the students

It was expected that the digital competences of the educational staff would have a positive effect on the general affective and specific cognitive outcomes of learning in students.

- Of the general digital competences of teachers, only two, and to a lesser extent, have predicted the affective outcomes of the students in the final testing. When the competence *Information and data literacy of teachers* was self-estimated as lower, it was associated with a higher sense of pride of students in the final testing, while teachers' higher *Troubleshooting* competency is associated with students' higher intrinsic orientation to learning. On the other hand, the competences *Communication and cooperation*, *Creating Content* and *Safety* did not affect the affective outcomes of students. It is possible that the teachers that perceive themselves as less competent in information and digital content searching, would more often assign this task to the students, who, because they demonstrate their own competence in those tasks, are more proud of themselves. Additionally, teachers who perceive that they are solving the problems they encounter in using ICT by themselves, can be models for students to develop their own competences, i.e. to be more focused on learning.
- Specific digital competence of teachers are somewhat better predictors of affective learning outcomes. Higher self-estimated specific competence of teachers *Teaching and Learning Using Digital Technology* is associated with students' higher sense of pride and enjoyment and greater intrinsic orientation to learning. Higher self-assessed competences *Professional education and Lifelong learning* of teachers is associated with a higher sense of anger and lower achievement of specific cognitive learning outcomes in students. This result can be partly explained through the relationship between professional teacher training and their use of ICT in teaching activities, which shows that teachers who are attending professional educations do not necessarily often use ICT in teaching.
- Self-assessed general digital competence of teachers, nor their specific digital competencies, other than *Professional education and Lifelong learning*, did not predict specific cognitive learning outcomes for students.
- Digital competences of teachers which were measured through assignments, with control of initial emotions and goal orientations, were not related to the general affective outcomes of learning in students, that is, with students' academic emotions and goal orientations.

- Digital competences of teachers which were measured through assignments, with control of students' prior knowledge on teaching content, have a low negative correlation with the specific cognitive outcomes of learning of students. Therefore, students of teachers with higher general digital competencies have achieved less number of specific cognitive learning outcomes in teaching specific content of four subjects. Given that higher general digital competences have teachers with less teaching experience, and more experienced teachers have more competence in teaching a specific subject, this finding could lead to this connection. Namely, teachers with higher digital competencies but less teaching experience are less successful in achieving cognitive outcomes, despite their digital competencies.
- Of general digital competence of expert associates, the only significant predictor of affective outcomes in students is *Safety* competence. When the competence *Safety* was self-assessed as higher by the expert associates of a school, students experience more boredom, less pride and enjoyment, and are more oriented towards work avoidance. It is possible that insisting on the protection of personal data and privacy by expert associates in relation to students through lectures about e.g. activities to protect themselves and others from the threats in the digital environment are perceived by students as boring.

Recommendations:

- It is recommended to further encourage teachers to develop digital competences for teaching with the help of digital technology, as it is associated with positive affective outcomes and motivation of students, and according to teachers' estimates, they have not yet reached the medium level of this digital competence.
- Organization of professional educations should be continued with the aim of developing digital competences for teaching with the help of digital technology.
- It is recommended that teachers who have improved their knowledge of ICT in teaching should use that gained knowledge more often in an appropriate manner in working with students to achieve learning outcomes.
- At the school level, there should be professional support in the application of ICT.
- Teachers who apply ICT activities in teaching should be stimulated in a variety of ways (e.g., rewards, paid professional educations, exchanges, etc.).

- It is recommended to use child-friendly methods (e.g. using computer games) while teaching about threats in the digital environment to avoid students' experience of boredom during the usual teaching methods.

1.1.6. Differences in achieving general affective and specific cognitive learning outcomes in the field of natural sciences and mathematics, considering the type of infrastructure which was used

It was expected that the use of an interactive classroom would have a statistically more significant positive effect on the general affective and specific cognitive learning outcomes of students relative to the use of the presentation classroom.

- In line with the hypothesis, the results show that the use of an *interactive classroom* has a greater positive impact on the general affective learning outcomes than using the *presentation classroom*. More specifically, the more frequent use of *interactive classrooms* reduces the experience of *boredom* and students' *orientation towards work avoidance*, and increases their sense of *pride* and *intrinsic and extrinsic orientation to learning*. In other words, in a school in which more teachers used an *interactive classroom*, the students were less likely to feel the emotion of *boredom*, and more often felt the emotion of *pride*. Also, the students of this school were *less oriented towards work avoidance*, and had a higher *intrinsic and extrinsic orientation to learning*.
- The use of a *presentation* or *interactive classroom* has not shown impact on specific cognitive learning outcomes. Cognitive learning outcomes depend primarily on the types of ICT activities used in the interactive classroom, or to what extent these activities encourage deeper learning.

Recommendations:

- It is recommended to use the interactive classroom more often because work in such a setting is stimulating to students. Also, when using a presentation classroom, the active involvement of students in learning can increase their motivation.
- In the interactive classroom, it is recommended to use ICT activities that encourage deeper learning to achieve cognitive learning outcomes through favourable motivational effects.

1.2. 2nd GOAL: The impact of the implementation of the e-School pilot project on the development of digital competences of students and their attitudes and experiences related to ICT

The second aim of the research was to determine the impact of the implementation of the e-School pilot project on the development of digital competences of students and their attitudes and experiences related to ICT. Within this general objective, six subgoals are defined: the impact of applied school- and learning-related ICT activities on the digital competences of students, their attitudes and experiences related to ICT (SG2.1); the impact of some of the applied digital educational content (DEC) and teaching scenarios on general affective and specific cognitive learning outcomes in students (SG2.2); correlation between improvement of the digital competence of educational staff and digital competences of students, their attitudes and experiences related to ICT (SG2.3); the impact of certain teaching processes which will be developed during the e-School pilot project on the digital competences of students, their attitudes and experiences related to ICT (SG2.4); a correlation between the frequency of use of a specific infrastructure with the digital competences of students, their attitudes and experiences related to ICT (SG2.5). The last specific goal examines the impact of the e-School pilot project implementation on the development of digital competences of students with developmental disabilities and their attitudes and experiences related to ICT (SG2.6).

- Digital competences of students were measured by self-assessments and assignments to test digital competences. There was a low correlation between these two measures, indicating the insufficient reliability of students' self-assessment. It should be kept in mind that it was not possible to check all aspects of digital competences through the assignments.
- According to the students' self-assessment during the e-School project, there was a significant increase in all areas of digital competence, although this effect is small[1]. At the beginning of the project, information and data literacy was best evaluated, which was on average on a middle level, but remained at that level in the final exam, and so did all the other digital competences.

[1] It is important to distinguish the statistical significance of an effect and the effect size. Statistical significance test refers to the likelihood that the obtained effect is declared significant, although the effect does not exist in the population. In other words, tests for statistical significance are used to estimate the probability that a relationship observed in the data occurred only by chance. The effect size is a quantitative measure of the magnitude of a phenomenon. In this example, there is a statistically significant difference between measures of students' digital competences taken on two occasions. That means that the probability that this result was obtained only by chance is very small (smaller than 5%). But, although the difference is statistically significant, the effect size is small, meaning that there is a change in the students' digital competencies, but that change is small.

- Digital competence measured through assignments did not change during project implementation.

1.2.1. The correlation between school- and learning-related ICT activities and the digital competences of students and change in their attitudes and experiences related to ICT

It was expected that school- and learning-related ICT activities of teachers would be statistically correlated with the development of students' digital competences and a positive shift in their attitudes and ICT-related experiences.

- The initial level of self-estimated digital competences of students, as well as the initial attitudes and experiences related to ICT, have significantly predicted the same variables in the final testing. This indicates relative stability of these characteristics in the period between the two tests.
- *ICT-based Teaching Activities* have proved to be a better predictor of digital competences of students and their attitudes and ICT-related experiences than the *School- and learning-related ICT activities*. More accurately, the more frequent use of *ICT-based Teaching Activities* is linked with higher self-assessed digital competences such as *Information and Data Literacy*, *Content Creation* and *Safety*, as well as a positive attitude on the *advantages of using ICT in teaching*.

Recommendation:

- Use of ICT activities in teaching should be more frequent with the aim of encouraging the development of digital competences of students and recognizing the advantages of using ICT in teaching.

1.2.2. The correlation between the application of digital educational content (DEC) and teaching scenarios with the students' digital competences and the change in their attitudes and experiences related to ICT

It was expected that the application of digital educational content and teaching scenarios would be statistically significantly correlated with the development of students' digital competences and a positive shift in their ICT-related attitudes and experiences.

- It was seen that the *use of DECs* during the project does not predict self-estimated digital competences of students nor digital competences measured through tasks. Also, the use of DECs does not predict students' ICT-related attitudes and experiences. However, as in the second testing only about one-third of teachers frequently uses DECs , this is a possible reason for the lack of the impact of the DECs.
- *The use of teaching scenarios* was not related to the digital competences of students in the final testing. The participation of students in teaching with the use of teaching scenarios was very rare considering that only 30% of teachers used the teaching scenarios in more than two units. This is not enough experience and cannot result in the advancement of students' digital competences.
- *The use of teaching scenarios* positively predicts students' *Perceived advantages and disadvantages of using ICT in everyday life*. In other words, in schools in which more teachers *used teaching scenarios*, the students more easily perceive the *many advantages and disadvantages of using ICT in their daily lives*.

Recommendation:

- It is recommended to encourage teachers to apply teaching scenarios so that it would reflect on the development of students' digital competences and further develop students' critical thinking in perceiving the role of ICT in everyday life.

1.2.3. The correlation between improvement of the digital competence of educational staff and digital competences of students and change in their attitudes and experiences related to ICT

It was expected that the improvement of the digital competences of the educational staff would be positively correlated with the development of students' digital competences and a positive change in their attitudes and experiences related to ICT.

- *The number of educations attended* by teachers did not correlate with the development of self-estimated students' digital competences nor those measured through tasks. This can be explained by the low correlation between the number of education in which teachers have participated and the frequency of using ICT activities in teaching, although this correlation has increased during the e-School project implementation.
- *The number of educations attended by expert associates* is positively correlated with the students' digital competences measured through tasks. This effect is probably mediated through the role of expert associates in encouraging teachers to use ICT in learning and teaching and in providing support to teachers.
- *The number of educations attended by expert associates* is significantly positively predicted by *Perceived advantages and disadvantages of using ICT in students' everyday life*. In other words, as the expert associates of a school attended more education, the students of this school *perceived more disadvantages when using ICT in their everyday lives*. It is possible that expert associates who have attended more educations have sensitized students more to the possible disadvantages of using ICT in their daily lives with the aim of better self-protection or lessening the risk of using ICT without supervision in their everyday lives.

Recommendations:

- Teachers who have participated in education on the possibilities of using ICT in teaching should be encouraged in different ways to apply the learned in their work and to strengthen that through mutual support, e.g. through the development of a community of practitioners.
- Educated expert associates play a particularly important role in encouraging teachers to use ICT in learning and teaching, which is why it is important to provide them with continuous professional education in the use of ICT.

1.2.4. The correlation between the application of new teaching processes with the development of students' digital competences and the shift in their attitudes and experiences related to ICT

It was expected that the application of new teaching processes, which will be developed during the e-School pilot project, will be statistically significantly correlated with the development of students' digital competences and a positive shift in their attitudes and experiences related to ICT.

- During the project, a large number of teachers are introduced to the role of *repositories of educational material*, and in the final testing only one-fifth of teachers are using the *repositories of educational material*.
- *The use of repositories of educational material* is correlated with the increase of students' self-estimated digital competences in *Information and Data Literacy* as well as *Communication and collaboration* and reduction in *Perceived disadvantages of using ICT in teaching*. In other words, in schools where a higher proportion of teachers use the *repository of educational materials*, the students of this school have more developed digital competencies in *Information and Data Literacy* as well as *Communication and collaboration*, and perceive *fewer disadvantages of using ICT in teaching*.
- *The use of repositories of educational material* was not related to the digital competences of students measured tasks.

Recommendation:

- Teachers should be encouraged to use the educational materials available in the repository, and the repository itself should be continuously enriched with new educational materials to encourage the development of digital competences of students.

1.2.5. The correlation between the use of a specific infrastructure with the development of students' digital competences and the shift in their attitudes and experiences related to ICT

It was expected that the frequency of using a specific infrastructure would be statistically significantly correlated with the development of students' digital competences and the shift in their attitudes and experiences related to ICT.

- There is no correlation between using a *presentation* or an *interactive classroom* with virtually all digital competences of students, regardless of how they are tested.
- *The use of a presentation classroom* is negatively correlated with *the flow while using ICT*, while the *use of interactive classrooms* is positively correlated with the students' self-assessed digital competence related to *Safety*. In other words, in a school where a higher proportion of teachers *use the presentation classroom*, the students of that school experience less *flow while using ICT*. Thus, the use of ICT without the active involvement of students in stimulating and challenging activity can not result in the flow as an indicator of authentic intrinsic motivation. Also, in a school where there is a higher proportion of teachers *using an interactive classroom*, the students have a more developed digital competence related to *Safety* in using ICT. This is a possible result of the teachers' instructions on how to use ICT during the students' activity in the interactive classroom.

Recommendation:

- It is recommended to use the interactive classroom more intensively in order to encourage the development of digital competences of students related to the safe use of ICT.

1.2.6. The correlation between the implementation of the e-School pilot project and the development of digital competences of students with developmental disabilities and the shift in their attitudes and experiences related to ICT

It was expected that the implementation of the e-School pilot project would be statistically significantly correlated with the development of digital competences of students with developmental disabilities and a positive shift in their attitudes and experiences related to ICT. The target group of this part of the research is a specialised primary school, Center for education Krapinske Toplice.

- The teachers have assessed both in the initial and final testing that desktop computers and access to the Internet (for more than 90% of students) at school are the most accessible to students. In the final testing, the availability of tablet computers increased, making them available for 50% of students. However, teachers state that the obtained tablets are rarely or not at all used by both teachers and students with developmental disabilities.

- Students are rarely involved with ICT activities at school, and the most frequent activity in the initial testing is searching for and using entertaining content and playing games (several times a month on average). In addition to these activities, the most frequent activity in the final testing is learning with the help of educational programs, games and quizzes. However, there is no statistically significant difference in ICT activities at school and at home between the initial and final testing.
- According to teachers' and parents' estimates, students do not have positive attitudes towards using ICT in the initial nor in the final testing. There was no statistically significant difference in attitudes towards the use of ICT in both teachers' and parents' estimates between initial and final testing.
- As far as **experience with new equipment/tools** is concerned, despite the fact that they were just introduced, the participants emphasise a great satisfaction with the smart boards, which they consider to be very useful. They are satisfied with the speed of the Internet connection and the obtained hybrid computers. However, they are not satisfied with the obtained tablets and keyboards because of their poor quality and slowness. In addition, due to their motor and visual impairment, the tablets are too small and strenuous for children with disabilities.
- With regard to **specialised equipment**, both in the final and the initial testing, the participants emphasise the need for a sufficient number of specialised keyboards and mice, ICT devices and equipment (e.g. *LCD projectors, smart boards, touch technologies and large screens*), specialized programs and applications (such as *voice interface, text-reading apps, and converting plain text into easy-to-read texts*) and communicators. Participants point out the need to protect equipment from possible damage. They state the need to design digital textbooks for children with disabilities.
- Parents and teachers evaluate the digital competence of children differently - parents are more inclined than the teachers to estimate that their child has a certain digital competence. From a group of digital competences related to Information and Data Literacy, both and parents and teachers estimate for more than 50% of students in both initial and final assessment that they are able to activate and deactivate the ICT device by themselves and also launch an application. By teachers' estimates, a percentage of students who can do this is higher in the final testing. According to both and parents' and teachers' estimate, a smaller number of students has competence Communication and cooperation. From a group of digital competences related to *Creating Content*, parents estimate that more than 40% of

children know that they should not use various content on the Internet, even though they can access them. Teachers' assessments show an increase in the number of children with this competence in the final testing. As far as *Safety* is concerned, teachers in the initial testing and both teachers and parents in the final testing estimate that the most prominent competence is related to the recognition of the positive side of the technology, which is also considered more represented in the final testing. With regard to digital competence *Troubleshooting*, both teachers and parents consistently evaluate the high level of competence related to motivation for acquiring new knowledge and skills. For that competence teachers' estimates are higher in the final testing compared to the initial one. It should be noted that it was a short period of time between the initial and the final testing, and the introduction of ICT within the Project and the related education took place only a few months before the final testing, so it is possible that the effects would be even higher if the period of application was longer.

Recommendations:

- As far as ICT equipment in schools is concerned, the specifics of children with disabilities should be taken into account. The tablets are too small and strenuous for them due to motor and visual impairment. It is recommended to introduce smart boards into classes that are attended by students with developmental disabilities.
- Specialised equipment (*specialised keyboards and mice, communicators, etc.*) and specialised programs and applications (e.g. *voice interface, text-reading applications, and plain text in read-only texts*) need to be provided. The equipment must be further protected from damage. In selecting the most suitable equipment, it would be of great help to demonstrate the specialized equipment/tools through e.g. workshops and play dates, through which users would familiarise themselves with the possibilities of the equipment. Namely, although teachers are well aware of the potential and interests of the children they work with, they are often not sufficiently familiar with ICT innovations in this area.
- As teachers and educational staff point to a lack of appropriate educational content for children with disabilities, it is necessary to focus on their development and to encourage publishers to issue specialised digital textbooks. This problem is particularly evident in working with children in the educational groups.

- It is necessary to regularly organise educations for teachers/educational staff on working with ICT equipment/tools and specialised equipment and programs, so that they would be in line with the changes and to successfully implement their new knowledge into everyday work. In addition, it is important to provide regular support for the use of ICT at the school's level.

- Considering the many advantages of using ICT in working with students with developmental disabilities (e.g. *higher motivation of students, availability of diverse content, an easier adaptation of materials and content, visualization and clarity of content, etc.*), it is recommended to introduce ICT in work with students with developmental disabilities. However, the use of ICT should be tailored to a particular student in view of his or her difficulties, abilities and needs. This is particularly important when considering the fact that the prevalence of disability has increased, including children with extreme and multiple disabilities. Many of the potential disadvantages of using ICT can be prevented by adequate teachers' methods, as most of them are under their control (e.g. a small number of children in special programs classes means that they would be provided with closer supervision regarding content, excessive exposure to ICT, scattered attention and ignoring other skills and abilities).

1.3. 3rd GOAL: The effects of the implementation of the e-School pilot project on the improvement of the digital competences of the educational staff through the use of ICT activities, as well as their attitudes and experiences related to ICT

The third aim of the research is to determine the effects of the implementation of the e-School pilot project on the improvement of the digital competences of the educational staff through the use of ICT activities, as well as their attitudes and experiences related to ICT.

The specific objectives examine: the impact of the implemented school- and learning-related ICT activities (SG3.1); the impact of some applied digital educational content (DEC) and teaching scenarios (SG3.2); the effect of education (for the advancement of digital competences) of teaching staff (SG3.3); the impact of development of the community of practitioners (SG3.4); the impact of individual teaching processes which will be developed during the project (SG3.5); correlation between the use of the specific infrastructure (SG3.6) and the impact of certain components of the System of Digitally Mature Schools (SG3.7) on the digital competence of the educational staff, their attitudes and experiences related to ICT.

- The digital competences of teachers and students are measured through self-assessments and assignments to test digital competences. There is a moderate correlation between these two measures for general digital competence, which suggests a slightly better validity and reliability of teachers' self-assessment than students'.
- Digital competences related to learning and teaching skills initially had a lower correlation with the achievement of digital competence testing tasks with the relation to general competences. However, in the final testing, these correlations were similar. This means that there was a more accurate teachers' self-assessment of specific competences in the final compared to the initial testing. Namely, at the end of the project, teachers had a better insight into their own specific digital competences related to learning and teaching, which was likely the effect of teachers' experience gained on workshops and ICT application in the school environment.

1.3.1. The effect of the implementation of the school- and learning-related ICT activities on the improvement of the digital competences of the educational staff, their attitudes and experiences related to ICT

It was expected that school- and learning-related ICT activities would be statistically significantly correlated with the development of digital competences of educational staff (teachers and expert associates) and a positive shift in their ICT-related attitudes and experiences.

- As compared to the initial examination, in the final examination teachers generally say that desktop computers are less commonly used, and laptops and tablet computers are more commonly used. A significant change is seen in the more frequent use of a smart board and interactive displays, although in the final testing 52% of teachers never use a smart board, which is not surprising because every school has received only one smart board.
- Additionally, teachers who are more involved in different activities involving ICT, and are related to work in school and teaching, are more likely to use ICT for specific teaching needs.
- As compared to initial testing, expert associates are more likely to use a laptop and most often use a desktop computer, like at the beginning of the e-School project. They use school- and learning-related ICT activities somewhat more often at the end of the project compared to the initial testing.

Correlation between applied school- and learning-related ICT activities and the digital competences of teachers

It was found that the teachers who apply school- and learning-related ICT activities during the project implementation show a higher level of digital competences measured through both self-assessments and assignments. The most correlations are found between *teaching activities in which ICT is used* and changes in their self-estimated specific digital competence related to *teaching and learning*, as well as changes in digital competence related to *work in the school environment*. Also, it was found that teachers who *use ICT for specific needs in teaching* more frequently had a greater change in digital competences.

The results also show a moderate correlation between the frequency of *use of ICT for specific teaching needs* and the change in teachers' digital competence measured through the assignments. In other words, teachers who have more often used ICT for specific teaching needs, have a greater change in

digital competences (measured through tasks). It can generally be concluded that the main prerequisite for improving the digital competence of teachers is the use of ICT tools in teaching.

Correlation between applied school- and learning-related ICT activities and the teachers' attitudes and experiences related to ICT

- In general, teachers are more moderate in their attitudes towards using ICT in the final testing. Namely, they identify fewer advantages and disadvantages of using ICT in the final testing compared to the initial testing.
- The inclusion of teachers in school- and learning-related ICT activities, as well as the frequency of *ICT use for specific teaching needs*, is positively correlated with the change in their attitude towards ICT, apart from the perceived disadvantages of students' using ICT in everyday life. For teachers who are more involved in school- and learning-related ICT activities, as well as teachers who have more often used ICT for specific needs in teaching, there is a greater change in positive attitude towards ICT. They have a greater increase in perceptions of the advantages of students' use of ICT in everyday life, the perception of the advantages of using ICT in learning and the perception of the advantages of using ICT in administrative jobs. Also, they had a significant decline in perceptions of the disadvantages of using ICT in teaching. In general, it can be concluded that teachers who have been using school- and learning-related ICT activities during the e-School project have changed their attitude towards using ICT in a positive direction.

Correlation between applied school- and learning-related ICT activities of the expert associates and their digital competences

- Involvement of expert associates in school- and learning-related ICT activities during the implementation of the e-School project is correlated with the improvement in self-assessed general digital competences. It should be emphasized that most of the correlations are low. A moderate correlation was achieved only between the use of *school- and learning-related ICT activities* and *Change in problem-solving*.

Correlation between applied school- and learning-related ICT activities of expert associates and their attitudes and experiences related to ICT

- The results point to a significant correlation between *the school- and learning-related ICT activities* of expert associates only in the change in the perceived *advantages of using ICT in administrative jobs*. The correlation is low and shows that the expert associates who more frequently used school- and learning-related ICT activities show a higher level of perception of the advantages of using ICT in administrative jobs. The inclusion of expert associates in school- and learning-related ICT activities is not related to change in their attitude towards students' use of ICT in everyday life.

Recommendations:

- With the aim of further enhancing the digital competence of teachers, it is recommended to continuously encourage teachers to use ICT activities, since the frequency of use of ICT after final testing is still low, i.e. only several times a month. The more frequent use of ICT activities results in teachers' more positive attitudes.
- Forms of encouraging teachers to implement ICT activities should become an integral part of a school's development plans, with elaborated support mechanisms for teachers.
- Teachers should be informed about the effects of the implementation of ICT activities on the development of digital competences in order to enhance the attitudes of the teachers who still do not recognize the advantages of ICT. More positive attitudes are associated with the more frequent use of ICT.
- Although in the initial testing the expert associates have reported using the ICT more frequently than the teachers, during the e-School project they have also improved digital competences and attitudes towards ICT, and it is therefore recommended to encourage expert associates to continue using ICT activities related to their specific jobs.

1.3.2. The effect of the implementation of certain digital educational content (DEC) and teaching scenarios on the improvement of the digital competences of the educational staff, their attitudes and experiences related to ICT

It was expected that more frequent implementation of digital educational content and teaching scenarios would be associated with the development of digital competence of teachers and a positive shift in their attitudes and experiences related to ICT.

Correlation between implementation of the digital educational content (DEC) and teaching scenarios and the digital competences of the teachers

- About 50% of teachers believe that *e-School digital educational contents* have helped them to use contemporary teaching methods and procedures (problem-solving, enquiry-based learning, project-based learning, etc.). ICT in teaching during the project implementation did not use about 18% of teachers.
- The obtained results indicate a significant difference between teachers who use *e-School digital educational contents* and those teachers who did not use them, in all self-assessed general and specific digital competences in the final testing, with the control of digital competences from initial testing. In other words, teachers who use an *e-School digital educational contents* estimate that they show a higher level of general and specific digital competences in final testing than those teachers who did not use *e-School digital educational contents*. However, it should be noted that this is a small to medium effect.
- Teachers who did not use *e-School digital educational contents* are not significantly different in digital competences from those teachers who used them, when they were measured through assignments.
- Results from a sample of teachers using teaching scenarios (48% of teacher sample) indicate a significant correlation between the frequency of use of the teaching scenarios and the level of self-assessed general and specific digital competence of teachers in the final testing. Teachers who have more often used the learning scenarios estimate their digital competence to be higher in the final testing. However, it should be emphasized that the obtained correlations are extremely low.
- When digital competences are measured through tasks, the use of teaching scenarios is not statistically significantly correlated with the development of digital competences.

- Since 52% of teachers indicated that they did not use teaching scenarios at all, we checked whether they also have developed digital competences. They too have self-estimated general and specific digital competences in the final testing as slightly higher than in the initial testing. Digital competences are a complex construct and involve many different abilities. Other activities of the e-School project (along with the use of teaching scenarios) also could have had effects on the development of digital competences, which would lead to their development regardless of (not)using the specific teaching scenarios in teaching.

Correlation between implementation of the digital educational content (DEC) and teaching scenarios and the teachers' attitudes and experiences related to ICT

- Teachers who used e-*School digital educational contents (DEC)* in the final testing have a more positive attitude towards ICT than teachers who did not use them. Those teachers who used DECs in the final testing perceived more advantages of using ICT in teaching and administrative jobs and fewer disadvantages of using ICT in teaching compared to teachers who did not use DECs. However, it should be emphasized that the obtained effects are small.
- Somewhat less than 50% of the tested teachers have used the teaching scenarios in their lessons and found the scenarios moderately useful.
- Teachers who had a more positive attitude towards ICT in the initial testing, who perceived more advantages of using ICT in teaching and administrative jobs and fewer disadvantages of using ICT, were more likely to use learning scenarios throughout the academic year. It is important to note that this correlation is extremely low for the perceived advantages of using ICT in administrative jobs, which was expected because the advantages in administrative jobs are not so important to the teaching scenarios, as the advantages (and disadvantages) of using ICT in teaching are. Although statistically significant, these correlations are very low.
- Teachers who have used multiple teaching scenarios throughout the academic year, in the final testing perceive fewer disadvantages of using ICT in teaching than those who used fewer teaching scenarios. Although significant, the resulting correlation is exceptionally low.
- Teachers who used the teaching scenarios during the academic year, in the final testing have a slightly better attitude towards ICT than the teachers who did not use the teaching scenarios in their work. Those teachers who used the learning scenarios in the final testing perceived more advantages of using ICT in teaching and administrative jobs, and fewer

disadvantages of using ICT in teaching than those who did not use teaching scenarios not once during the academic year. However, it is very important to emphasize that the differences and effects obtained are extremely small.

Recommendations:

- Considering that even with the low application of digital educational contents and learning scenarios during the implementation of the project a positive impact on the development of digital competence of teachers was obtained, it is recommended to encourage teachers in a more frequent use of digital educational contents and teaching scenarios in order to enhance digital competences more significantly.
- Since teachers' attitudes towards ICT in teaching determine the frequency of use of teaching scenarios, it is recommended to find various ways of encouraging teachers in the exchange of experiences with the teachers who apply scenarios, so as to help them to recognize the advantages of using the teaching scenarios and to start using them themselves.

1.3.3. The effect of education (for the improvement of digital competences) of teaching staff on their digital competences, attitudes and experiences related to ICT

Participation in educations for the improvement of the digital competence of teachers was expected to be correlated with the development of digital competences and a positive shift in ICT attitudes and experiences.

Participation in educations

- Unlike in the initial testing, when the highest percentage of teachers have stated that in the previous two years they have been independently educating themselves about the ICT during their free time, during the e-school project nearly all teachers have participated in some form of professional education (98%). Majority of teachers reported that they were educated about the use of specific equipment.
- The highest percentage of elementary- and secondary-school teachers (39%) participated in professional education for more than 10 days.

- Teachers have attended approximately 8 to 9 professional education on average and generally consider educations useful for their work at school.
- In the final testing, the highest percentage of teachers (67% in elementary school and 57% in secondary school) responded that they use the acquired knowledge and skills.

Correlation between participation in educations and digital competences of teachers

- The number of educations attended by teachers has significant, but low correlation with the change in self-assessments of digital competences. For teachers who participated in multiple educations, there was a greater positive change in digital competences.
- Digital competences measured through tasks are also significantly correlated with the frequency of participation in educations. Teachers who have participated in more educations, in the final testing are achieving better results in tasks for testing digital competences than those who have participated in a fewer number of educations (after controlling digital competences from the initial testing).

Correlation between participation in educations and teachers' attitudes

- Teachers who participated in educations have a somewhat more positive attitude towards ICT in the sense of perceiving fewer disadvantages in using ICT in teaching, however, obtained correlations are extremely low.

Evaluation of education - the effect of educations on teachers' knowledge

- After attending education *The use of tools for the development of digital educational content*, teachers show considerably higher, although still limited knowledge of digital educational contents than before attending education.
- In the first part of the education *The use of tools for the development of digital educational content*, by following the instructions, participants have successfully developed a digital teaching material (practical part of the education). Their digital books contained most or all of the required elements.
- In the case of individual work in the second part of education *The use of tools for the development of digital educational content*, a third of the teachers did not publish any digital

educational content in the Libar tool, and the content which was published was mostly of low quality. As the evaluators were not present in the educations, one can only guess on a possible reason for the low quality of their work. It is possible that the participants did not have enough time to focus on the content quality and were more focused on practising the technical performance, primarily inserting the various elements of digital educational content. Also, given that the education was five hours long, it is possible that the motivation of the participants was low at the end of the workshop, which affected the quality of the work.

- After attending education *The application of learning scenarios, digital tools and educational trends*, teachers demonstrate a significantly higher knowledge on teaching scenarios and educational trends than before attending education (after education they achieved about 77% of the maximum score).
- The use of teaching scenarios in preparation of the lesson plans in most cases was not successfully realised. Most of the plans did not emphasise the learning outcomes. Lessons had some of the ideas from the teaching scenarios, mostly those related to using video in education, as well as some ideas related to the performance of experiments or demonstrations, but were often not related to the use of ICT.
- After attending education *The basics of using tablets and hybrid computers*, teachers show significantly higher knowledge than before attending education, but the knowledge on using tablets and hybrid computers is still limited.
- In conclusion, it can be said that the evaluated educations have achieved their goals partially. Participants achieved comprehensive advances in knowledge, but the level of knowledge remained relatively low, especially in the case of educations which were primarily aimed at acquiring practical skills, after which teachers achieved only about 50% of points (*The use of tools for the development of digital educational content* and *The basics of using tablets and hybrid computers*). Since the tasks were mostly theoretical, a somewhat lower teachers' score is not surprising.
- With regard to the evaluation of teachers' independent practical assignments which were formulated during educations, it can generally be concluded that their quality is relatively low. It is possible that the participants did not have enough time to focus on the quality of the content and were more focused on practising the technical performance and, given the

duration of the education, that the motivation of the participants was low at the end of the workshop, which affected the quality of the work.

- Insights into the longer-term effects of education *The use of tools for the development of digital educational content* showed that after the education (February and March 2017) and until the end of the academic year 2016/2017, not one teacher has published additional digital educational content. It can be assumed that most teachers would need additional encouragement and support for the use of tools since a one-time attendance of education did not encourage them to use the tools for the development of digital educational content.

Recommendations:

- It is recommended to introduce a continuing professional education of teachers to use ICT teaching activities with a goal to enhance their digital competences and develop positive attitudes towards ICT.
- Under the framework of the professional education of teachers, it is recommended to adapt the structure of workshops so that their aim is a greater impact on the application of ICT skills in teaching. This implies a less content and more time for the activities of developing digital contents.
- It is recommended to apply subject-specific educations in which teachers would have actual examples of the application of ICT to their subjects.
- It is recommended to formalise participation in education and to recognise educations as a professional education of teachers. Additionally, educations should include a demonstration of the lessons learned in their own teaching, which would be supervised and evaluated by experts.
- Most teachers need additional encouragement and support for the continuing implementation of knowledge and skills acquired during their education in their work.

1.3.4. To test the impact of the development of the community of practitioners on the improvement of the digital competences of the educational staff (especially in the field of natural sciences and mathematics), their attitudes and experiences related to ICT

It was expected that the inclusion in the community of practitioners, developed within the e-School project, would be statistically significantly correlated with the development of digital competence of teachers and a positive shift in their ICT-related attitudes and experiences.

- Although most of the teachers were introduced to the community of practitioners during the course of the project, 40% did not join the network not once.
- Approximately 40% of the surveyed teachers use the Yammer network for cooperation and exchange of experience and materials with other teachers; they have accessed the Network several times during the academic year and consider it moderately useful.

Correlation between development of the community of practitioners and the improvement of the digital competences of the teachers

- There was no significant correlation between the frequency of accessing a community of practitioners and the level of general and almost all specific digital competences of teachers in the final testing. Only for specific competence *Professional education* there was a significant correlation, where teachers who have more frequently accessed the Yammer network during the academic year report on the higher digital competences in the final testing (after control of the digital competence from the initial testing). However, it should be emphasized that the resulting correlation is exceptionally low. This finding is expected, as the purpose of the Yammer network is to exchange teachers' experiences in using ICT, which can be considered as a form of professional education.
- The use of the Yammer network is statistically significantly associated with the development of digital competences measured through tasks, which suggests that teachers who accessed a community of practitioners more often have more developed digital competences measured through the tasks in the final testing (with control of the results of the initial test). However, it should be noted that the correlation is low.
- Correlation between the data collected from Yammer analytics (number of messages, groups and users at school, number of messages per month and number of messages per user) and teachers' self-assessed general and specific digital competences of the initial testing was not determined. However, in the final testing, there was a significant correlation between the

number of Yammer users in the school and the following digital competences of teachers: *Communication and Collaboration*, *Teaching and Learning* and *Working in the School Environment*. Schools that have a larger number of Yammer users also have teachers with more developed general and specific digital competences. However, it should be emphasized that the correlation is low. On the other hand, there is no significant correlation between the teachers' digital competences measured through tasks and the data collected by Yammer analytics. It is important to note that data from Yammer analytics is collected at the school level, not at the level of individual teachers.

Correlation between development of the community of practitioners and the teachers' attitudes and experiences related to ICT

- Teachers who have a more positive attitude towards ICT in the initial testing, who perceive the advantages of using ICT in teaching and administrative jobs and fewer disadvantages in using ICT, are more likely to access a community of practitioners throughout the academic year. Although statistically significant, these correlations are very low, especially for the perceived disadvantages of using ICT in teaching.
- Teachers who more frequently accessed the community of practitioners during the academic year, perceive more advantages of using ICT in administrative jobs in the final testing. However, the obtained correlation is extremely low.
- Teachers who joined the community of practitioners throughout the academic year have a slightly better attitude towards ICT in the final testing than the teachers who have never joined the Yammer network. A better attitude is reflected in the perception of somewhat more advantages of using ICT in teaching and administrative jobs, and fewer disadvantages of using ICT in teaching than the teachers who did not access the Yammer network not once during the academic year. However, it is very important to emphasize that the obtained differences and effects are extremely small.
- There is no significant correlation between data collected from Yammer analytics and teachers' attitudes in the initial testing. In the final testing, two significant but low correlations have been obtained, which suggests that slightly higher negative attitude towards using ICT have teachers in schools in which more messages were sent on the Yammer network in a month. It is possible that messages were often sent by teachers who had faced difficulties in using ICT, thus asking for help from their colleagues.

Recommendation:

- It is recommended to further encourage the development of community practitioners because, despite the increase, less than half of teachers are actively involved in the community of practitioners. This would stimulate the development of digital competences of teachers and strengthen their positive attitudes towards ICT. Cooperation between practitioners is an important form of support for teachers in the use of ICT teaching activities, and it would lead to an increase in the frequency of ICT use and enable teachers to independently develop quality digital contents.

1.3.5. To test the impact of individual teaching processes which will be developed during the project on the improvement of the digital competences of the teachers, their attitudes and experiences related to ICT

It was expected that the application of new teaching processes would be statistically significantly correlated with the development of digital competences and a positive shift in the attitudes and experiences of teachers.

- It was found that the repository of educational material was used by 20% of teachers during the implementation of the project. However, about 50% of teachers state that, although they did not use the repository, they support its development for learning and teaching purposes.

Correlation between new teaching processes, developed within the project and the teachers' digital competences

- Teachers who have used the repository of educational materials have more developed (self-assessed) general and specific digital competences in the final testing in comparison with those who did not use them. However, it should be noted that this is a small to medium effect. Teachers who did not use the repository of educational materials do not differ significantly in the digital competences measured through tasks from those teachers who used the repository.

Correlation between new teaching processes, developed within the e-School project and the teachers' attitudes and experiences related to ICT

- Teachers who used the repository of educational materials had a more positive attitude towards ICT in the final testing than the teachers who did not use the repository. Those teachers who used the repository of educational materials in the final testing perceived more advantages of using ICT in teaching and administrative jobs and fewer disadvantages of using ICT in teaching compared to teachers who did not use the repository of educational materials, although the obtained effects are small to medium.

Recommendation:

- A continuing enrichment of the repository of educational materials and encouragement of teachers to use repositories is recommended to promote a positive attitude towards ICT and to develop digital competences through the use of these materials.

1.3.6. To test the correlation between the use of the specific infrastructure and digital competences of the educational staff, their attitudes and experiences related to ICT

It was expected that the use of the specific infrastructure will be statistically significantly correlated with the development of digital competences of the educational staff and a positive shift in their attitudes and experiences related to ICT.

- In the initial testing, about 40% of teachers said they use a laptop every day. It can be noticed that the number of teachers who use tablets and laptops daily (17% more teachers use a laptop, and 7% more teachers use a tablet than in the initial testing) has increased in the final testing.
- In the final testing, 49% of teachers state that they use the equipment (tablet or hybrid computer) which they personally have received for use within the e-School project, while 12% of teachers state that they never used this equipment.
- During the project, more teachers used the presentation classroom (62%) than the interactive (53%) classroom, while about 7% of teachers reported that the classrooms were unavailable. About 23% of teachers realize 25% of their classes in the presentation classroom, while 33% of teachers realize 50% and more of their teaching in that classroom. About 25%

of teachers realize 25% of their classes in an interactive classroom, while 21% of teachers realize 50% and more of their teaching in that classroom.

Correlation between the use of the specific infrastructure and digital competences of the teachers

- Significant positive, but low correlation between the use of specialized classrooms and all general and specific digital competences of teachers has been established, where teachers who are using interactive and presentation classrooms more frequently in the final testing evaluate that they have more developed digital competences. This correlation is probably two-way. Namely, teachers who initially evaluated their digital competences as higher will be more willing to use specialized classrooms, and the use of classrooms alone contributes to the development of digital competences.
- Significant positive, but low correlation between the use of tablet or hybrid computers and all general and specific digital competence of teachers has been established, where teachers who are using tablet or hybrid computers more frequently in the final testing evaluate that they have more developed digital competences.
- Unlike self-assessed digital competences, no significant correlation has been achieved between the teachers' digital competences measured through tasks and the use of specific infrastructure.
- Significant positive, though low correlation between the use of laptop and digital competences of expert associates has been identified, where expert associates who use laptop more frequently in the final testing evaluate that they have more developed digital competences.

Correlation between the use of the specific infrastructure and attitudes and experiences related to ICT of the educational staff

- Teachers who used the equipment obtained through the pilot project (interactive and presentation classroom and tablet / hybrid computer) more frequently, perceive more advantages and fewer disadvantages of using ICT in teaching in the final testing. Although significant, the obtained correlations are low.

- There is no significant correlation between the frequency of use of laptops obtained within the project and the perceived advantages of using ICT in administrative jobs in expert associates.

Recommendation:

- Due to the positive correlation between the use of a specific infrastructure and the digital competences, attitudes and experiences, it is recommended to continue to equip the schools with the ICT equipment, so as to be available to more teachers.

1.3.7. To test the impact of certain components of the System of Digitally Mature Schools on the digital competences of the educational staff, their attitudes and experiences related to ICT

It is expected that the implementation of the elements of the System of Digitally Mature Schools will be statistically correlated with the development of digital competences of the educational staff, and their ICT-related attitudes and experiences.

The difference between the initial and final testing in the teachers' digital competences, their attitudes and experiences related to ICT

School- and learning-related ICT activities

- In the final testing, there is a higher average frequency of ICT use in activities related to working in school and teaching than in the initial testing. However, although a high effect has been obtained, average results of the final, as well as of the initial testing, show that teachers use different school- and learning-related ICT activities on average several times a month.

ICT-based teaching activities

- In the final testing, teachers reported on the more frequent use of ICT for specific needs in teaching than in the initial testing. However average results of the final, as well as of the initial testing, show that teachers use ICT for specific needs in the classroom on average several times a month.

Digital competences

- In the final testing, teachers have assessed all their general digital competences to be significantly higher than in the initial testing. This may indicate that participation in the e-School project has resulted in the development of general digital competences of teachers. Although the magnitude of the gained effects is medium to high, in the areas of competences: *Information and Data Literacy*, *Communication and Cooperation*, *Safety* and *Troubleshooting*, teachers are on average at the middle level, both in the initial and in the final testing. Their result in the final testing is higher than in the initial, but the change is not big enough to move to the advanced level.
- Teachers also evaluate all of their specific digital competences as significantly higher in the final testing than in the initial testing. In other words, during the implementation of the project there has been an improvement in the specific digital competences of teachers. In the field of competence *Teaching and learning with the application of digital technology* teachers are on average at the beginner level both in the initial and in the final testing. Despite a higher result in the final testing, the change is not big enough to shift to the intermediate level. In the areas of competences *Work in the School Environment* and *Professional education and Lifelong learning*, in the initial testing, the teachers were at the top of the beginner level of digital maturity, and they were on average at the beginning of the intermediate level of digital maturity in the final testing.
- However, there are no significant changes in the digital competences of teachers when they are measured through tasks.

Attitude towards students' use of ICT in everyday life

- The teacher's attitude towards the perceived advantages of students' use of ICT in everyday life did not differ in the initial and final testing. In both testings, on average they agree that there are advantages of students' using ICT. Their perception of disadvantages of students' using ICT in everyday life was somewhat lower in the final testing than in the initial testing. However, it should be emphasized that this is a small effect and that teachers in both testings agree on average that there are disadvantages of use of ICT in students.

Teachers' attitude towards the use of ICT in teaching and administrative jobs

- Teachers' attitude towards the perceived advantages and disadvantages of using ICT in teaching did not differ in the initial and final testing. Both testings had a moderate perception of the advantages of using ICT in teaching. Their perception of the advantages of using ICT in

administrative jobs was significantly higher in the final than in the initial testing, which suggests their more positive attitude in the final testing. Both testings have a moderately positive attitude of the advantages of using ICT in administrative jobs. The perception of the disadvantages of the use of ICT in teaching was slightly lower for teachers in the final testing than in the initial testing, which indicates a more negative attitude in the initial testing than in the final. Both testings have a moderate perception of the disadvantages of using ICT in teaching. It should be noted that the effect is small for both obtained differences.

The difference between the initial and final testing in the digital competences, attitudes and experiences related to ICT in expert associates

School- and learning-related ICT activities

- The expert associates report on the increased frequency of school- and learning-related ICT activities in the final testing than in the initial testing. However, although a medium effect has been obtained, average results of the final, as well as of the initial testing, show that expert associates use different school- and learning-related ICT activities on average several times a month.

Self- assessment of digital competences

- Based on the self-assessment of expert associates, it can be concluded that during the implementation of the project they made a significant improvement in all general digital competences, obtaining intermediate effects (for Information and data literacy) and large (for the remaining subscales). In the areas of competences *Information and Data Literacy*, *Communication and coordination*, *Safety* and *Troubleshooting*, expert associates are on average on the medium level both in the initial and in the final testing. Their result in the final testing is higher than in the initial, but the change is not big enough to move to the advanced level. In the *Creating content* area, expert associates were at the top of the beginner level of digital competence in the initial testing, and in the final testing, they are on average at the beginning of the intermediate level of digital competences.

Expert associates' attitude towards students' use of ICT in everyday life

- The expert associates' attitude towards students' use of ICT in everyday life has not changed in the final testing compared to the initial testing. Their attitude towards students' use of ICT in everyday life in both testings was moderately positive. Also, in both testings, they somehow agree that the students' use of ICT in everyday life has some disadvantages.

Perceived advantages and disadvantages of using ICT in administrative jobs

- There has been no significant change in the attitude of expert associates towards the use of ICT in administrative jobs. In the initial and the final testing, the expert associates on average agree that the use of ICT in administrative jobs has its advantages.

Recommendations:

- Considering that the use of ICT infrastructure within the implementation of the e-School project has resulted in the improvement, albeit small, of the digital competences of teachers in a relatively short period of time, it is recommended to continue use of the acquired infrastructure as well as additionally equipping schools, so that more teachers could use ICT equipment.
- With the aim of improvement in the teachers' specific digital competence of *teaching and learning with the use of digital technology* from the beginner level, it is recommended to encourage teachers to apply ICT activities in teaching, further exchange of examples of good practice and to provide support to teachers in these endeavours.
- Due to the moderate perception of the advantages of using ICT in teaching, teachers are still applying these activities infrequently, so every incentive that would lead to the increased implementation could facilitate the recognition of the advantages of ICT and its continued use in teaching. This would create a virtuous circle of increased implementation and satisfaction with ICT activities in teaching.
- Considering that expert associates have estimated that during e-School project implementation they have improved their digital competences, especially the competence of *creating content*, it is recommended to create a community of practitioners for expert associates as well, in order to exchange examples of good practice and provide mutual support for the use of ICT in their daily work.

1.4. 4th GOAL: The effect of the implementation of the e-School pilot project on the improvement of the digital competences of the administrative staff through the use of ICT activities, as well as their attitudes and experiences related to ICT

The fourth goal of the research is to determine the effects of the implementation of the e-School pilot project on the improvement of the digital competences of the administrative staff through the use of ICT activities, as well as their attitudes and experiences related to ICT.

Specific goals relate to testing the relationship between the use of specific infrastructure (SG4.1), business processes (SG4.2) and education for the enhancement of digital competences (SG4.3) with digital competences, attitudes and experiences of the administrative staff related to ICT.

1.4.1. The relationship between the use of specific infrastructure and administrative staff's digital competences, attitudes and experiences related to ICT

At the beginning of the implementation of the e-School project, it was expected that the use of specific infrastructure would be statistically significantly correlated with the digital competences of administrative staff and headmasters, and their ICT-related attitudes and experiences.

Due to objective circumstances during the e-School project implementation, before the final testing, only one-fifth of the administrative staff in the schools received the equipment envisaged by the project, so the effects of using the infrastructure cannot be expected.

Here are the conclusions of the relationship between initial and final testing regardless of the introduction of the infrastructure.

Administrative staff

- Administrative staff uses the ICT equipment almost equally often both in the initial and final testing. There is no difference in the average frequency of use of programs and systems with the administrative staff.
- The use of ICT in activities related to the work and business of the school is more frequent in the final testing than in the initial testing.

- Administrative staff equally perceives the advantages of using ICT in administrative jobs in the initial and final testing.
- In the final testing, the administrative staff reports on a higher level of general digital competences for *Communication and cooperation, Creating content* and *Safety*.
- Administrative staff who uses the ICT infrastructure more often evaluates their digital competences as more developed. The digital competences of the administrative staff in the final testing are also positively correlated with their digital competences from the initial testing.
- For the relationship between the use of a specific infrastructure and attitudes of administrative staff towards ICT in the final testing, the obtained results show that in the final testing more advantages of ICT use are perceived by the administrative staff who initially reported on a more positive perception of ICT use and who used ICT more in school, as well as computer programs and information systems in the final testing.
- Those employees who initially reported on the more frequent use of ICT for different activities and use ICT more at home and in school and more frequently use computer programs and IT systems in the final testing, use ICT more frequently for various activities related to the work and business of the school in the final testing.

Headmasters

- In the final testing, headmasters report that they use ICT more frequently in the school than the initial testing.
- The headmasters are satisfied with the technical equipment received within the project, and they are somewhat less satisfied with the received technical support.
- The headmasters use ICT more frequently in activities related to the work and business of the school in the final testing than in the initial testing.
- The headmasters perceive the advantages of using ICT in administrative jobs, as well as the advantages and disadvantages of students' using ICT in everyday life equally in the initial and final testing. However, they perceive fewer obstacles to using ICT in teaching in the final testing than in the initial.
- In the final testing, they report on higher levels of all general and all specific digital competences compared to the initial testing.

- As consistent predictors of the final general digital competences of the headmasters, identical general digital competences emerge from initial testing. The only exception is the competence *Communication and cooperation* for which the significant predictor was the *Use of ICT at home* in the initial testing and *Troubleshooting*, for which a significant positive predictor was *Frequency of using ICT in school* in the final testing.
- As consistent predictors of the final specific digital competences of the headmasters, the same specific digital competences from the initial testing are presented. The frequency of using the infrastructure in the initial testing also proved to be a significant set of predictors for all specific competences except for *Planning of the application of digital technologies within the school*.
- **The headmasters' attitude towards ICT** in the final testing was best predicted by their attitudes from the initial testing. None of the observed indicators of the use of the infrastructure has been statistically significant for the explanation of the attitudes of the headmasters in the final testing.
- The more frequent **use of ICT for various activities related to the work and the business of the school** in the final testing have headmasters who initially reported on the more frequent use of ICT for different activities.

Recommendations:

- Considering that the administrative staff, despite the fact that most of them did not receive new equipment, in the final testing report on a more frequent use of ICT in activities related to the work and business of the school with the existing equipment, it is recommended that all schools should be equipped in accordance with the plan, so as to use ICT more than once a month as they report.
- It is recommended that the ICT equipment should be equally accessible to administrative staff, as the availability of equipment is associated with the development of their digital competences, which indicates the correlation between the frequency of using ICT activities at home and digital competences and attitudes.
- Considering that the use of the specific infrastructure the headmasters have received during the project implementation had positive effects on the digital competences of the

headmasters, it is recommended to provide such infrastructure to headmasters of other schools as well.

1.4.2. The relationship between the use of business processes and administrative staff's digital competences, attitudes and experiences related to ICT

It was expected that certain business processes developed during the e-School project would be statistically significantly correlated with the digital competences of administrative staff, their attitudes and experiences related to ICT.

Prior to conducting the final testing, new business processes were not introduced into schools, so this hypothesis could not be verified.

1.4.3. The relationship between the education for the enhancement of digital competences and administrative staff's digital competences, attitudes and experiences related to ICT

It was expected that education for the enhancement of digital competences would be statistically significantly correlated with the digital competences of administrative staff, their attitudes and experiences related to ICT.

Administrative staff

- The administrative staff as a group participated in an insufficient number of educations (on average on less than one education). They assess the usefulness of education for their work as moderate and they are moderately satisfied with the participation in the e-School project.
- Administrative staff involved in a number of educations for the enhancement of digital competences assesses their general digital competences to be more developed and see more advantages of using ICT, and more frequently participates in ICT activities related to the work and business of the school. Estimates of the usefulness of education are significantly correlated only with the perception of the advantages of using ICT, and not with the digital competences and experience of administrative staff as well.

Headmasters

- The headmasters have participated on average on 8 educations. They consider the educations which were organised within the e-School project as useful for their work, are satisfied with their participation in the project as well as with the response of the teachers of their school to the educations organised within the e-School project.
- There is a significantly positive correlation between the number of educations in which the headmasters have participated and all of their general digital competences and some specific digital competences (*Managing the development of digital competences of school employees and students* and *Managing integration of digital technologies in learning and business processes*). The number of education is related to a higher perception of the advantages of using ICT in administrative jobs and more frequent involvement in ICT activities related to the work and business of the school. Headmasters participating in more educations perceive fewer obstacles to using ICT in teaching.
- Assessments of the usefulness of educations are significantly positively correlated only with the perception of the advantages of using ICT in administrative jobs and in the students' everyday life, and negatively with the obstacles to using ICT in teaching. The usefulness of educations is not correlated with general and specific digital competences or the headmasters' experiences.

Recommendation:

- Considering that the number of educations in which the administrative staff and headmasters have participated is associated with the frequency of ICT activities related to the work and business of the school as well as the development of digital competences, it is recommended to insist on educations and to offer content which is specific to school management and business.

1.5. 5th GOAL: The impact of the implementation of the e-School pilot project on the level of digital maturity of schools in relation to the Framework for the Digital Maturity of Schools.

The fifth aim of the research was to determine the impact of the implementation of the e-School pilot project on the level of digital maturity of schools in relation to the Framework for the Digital Maturity of Schools.

The Croatian Framework for the Digital Maturity of Schools, developed by the Faculty of Organization and Informatics of the University of Zagreb within the e-School project, consists of five areas and five levels of the digital maturity of schools. Areas of digital maturity are: Leadership, planning and management, ICT in learning and teaching, Development of digital competences, ICT culture and ICT infrastructure. For each of these areas, a school can be classified into one of five levels of digital maturity: (1) digitally unaware, (2) digital beginners, (3) digitally competent, (4) digitally advanced and digitally mature schools.

- The assessment of the school's model of digital maturity, through measures of different aspects of digital maturity developed in this scientific research of the effects of the e-School project, has confirmed five areas of digital maturity within the model.
- The digital maturity of the schools was determined through the process of self-evaluation and external evaluation in the initial and final testing conducted by the Faculty of Organization and Informatics of the University of Zagreb in cooperation with CarNet. The correlation between the results of self-evaluation and external evaluation is moderate, which indicates the reliability of the test. The results of self-evaluation and external evaluation coincided in 92 schools (61%) in the initial testing and for 86 schools (57%) in the final testing. Since the schools received the feedback after the initial evaluation that they overestimated themselves, they were much more cautious in self-evaluation in the final testing. On the other hand, external evaluation classified schools only in digital beginners and digital competent in the initial testing, while in the final testing a greater number of schools is classified into higher levels of digital maturity.
- In the initial testing, according to self-evaluation, 50% of schools were at the level of digital beginner, 45% at the level of digitally competent, and the remaining 5% at the advanced and mature level. According to external evaluation, 82% of schools were digital beginners, and the remaining 18% of schools were digitally competent. In the final testing, self-assessments

were much more critical, so 15% of schools estimated themselves as digital beginners, 64% as digitally competent, 18% as digitally advanced, and 3% as digitally mature. By external evaluation of digital maturity in the final testing, 2% of schools remained at the digital beginner level, 62% were estimated to be at the level of digitally competent schools, 32% of schools were evaluated as digitally advanced and 4% as digitally mature schools. According to self-evaluation, 5% of schools have lowered their overall digital maturity, 42% of schools remained at the same level, 46% of schools have increased their general digital maturity for one level, and 7% for two to three levels. According to the external evaluation, general digital competences were not reduced in any of the schools, 9% remained at the same level, and the highest percentage of schools (65%) increased their general digital maturity for one level, 24% for two levels and 2% for three levels. Based on the self-evaluation and external evaluation, it can be concluded that most schools have significantly improved their digital maturity during the e-School project implementation.

- In the initial study, only the ICT culture was assessed as digitally competent, while all other areas of digital maturity of the school were estimated to be digital beginner, both through the self-evaluation and external evaluation, and assessed as the lowest was the area of leadership, planning and management. In the final testing, there is a significant shift in all areas, especially in the area of leadership, planning and management. ICT culture is in the final assessment by external evaluation estimated as digitally mature in almost 50% of schools.

It was expected that schools at different levels of digital maturity in the final testing would differ with respect to the different outcome variables examined in this research of the effects of the e-School pilot project. Therefore, the specific objectives were: to examine whether schools are at a digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to ICT application (SG5.1); considering the use of digital educational content (DEC) and teaching scenarios that have been developed and implemented within the framework of the project (SG5.2); whether there is a correlation between the education of the educational and administrative staff and the level of digital maturity of the school in relation to the Framework for the Digital Maturity of Schools (SG5.3); whether the degree of development of community of practitioners has an impact on the level of digital maturity of the school relative to the Framework for the Digital Maturity of Schools (SG5.4); is there a correlation between the various business and teaching processes that will be developed during the project and the level of digital maturity of the school in relation to the Framework for the Digital Maturity of Schools (SG5.5); whether there is a correlation between the established infrastructure and the level of

digital maturity of the school relative to the Framework for the Digital Maturity of Schools (SG5.6); and whether the schools differ on the digital maturity level (according to the Framework for the Digital Maturity of Schools) related to the ICT management (e.g., school teams that will develop and implement the strategy) (SG5.7).

In order to use the data from (initial and final) online testing in the context of digital maturity, data from the level of individuals had to be converted to data on the level of a school. The result of a particular school on a scale was obtained by calculating the average result of the participants (depending on the problem set) from the school on that scale. Choosing the appropriate specific scales from online testing of the achievement of the fifth goal included a few steps. Firstly, a content review of the (1) Framework for the Digital Maturity of Schools, (2) Questionnaire for self-evaluation and external evaluation of the digital maturity of a school, and (3) questionnaires used in online testing was made. In the first step, all the measures that in their content corresponded to the elements of some of the areas of digital maturity of the school were considered. After selecting a set of measures for each area of digital maturity, in the second step, based on the results of exploratory factor analysis, those measures that had poor psychometric indicators had been eliminated, while in some cases certain measures were transferred from one area of digital maturity to another. After satisfactory structure and reliability have been achieved in all factor analyses for all areas, several confirmatory factor analyses were performed in order to compare the validity of the three theoretically possible models of digital maturity of a school. The final confirmatory factor analysis showed that the model that best suits data includes five interrelated factors, or areas of digital maturity, without superiority of total digital maturity. In other words, these analyses show that measurements from the initial and final online testings are matching with five areas of digital maturity from the theoretical model, and can be considered indicators of digital maturity of a school, not only on the basis of content but also on empirical similarity. In these measures, differences between schools at different levels of digital maturity as well as between schools that had different advancement in digital maturity were tested.

Given the limited number of schools in certain categories of digital maturity of schools, only the differences between the schools that remained at the same level and those that increased digital maturity for one level based on the self-evaluation of digital maturity were analysed[2]. Differences

[2] According to initial self-evaluation, most schools were concentrated in the second level, where they either remained in the final evaluation (12%), or advanced to the third level (32%). About the same number of schools were initially self-evaluated as being on the third level, where they either remained (30%) or advanced to the fourth level (12%) in the final evaluation. In all other groups, the number of schools was too low (≤5%) and were therefore not included in statistical analyses.

between the two groups of schools were analysed in the external evaluation: those that increased their digital maturity for one level and those that increased digital maturity for two levels[3].

1.5.1. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to ICT application

It was expected that the schools of different digital maturity level would differ with regard to the use of the ICT.

- In the initial assessment by external evaluation, it was found that the **headmasters** of digitally competent schools are more involved in *ICT activities related to the work and business of school* than those from digitally unaware schools. In the final testing of leadership, planning and management there were almost no digitally unaware schools, according to self-evaluation, and no significant differences were found in the average estimates of the headmasters on the scale of *ICT activities related to the work and business of school* between the schools at certain levels of digital maturity. Headmasters of all the schools involved in the analysis (regardless of the level of digital maturity to which the school belongs) report that they are involved in ICT activities related to the work and business of the school equally often.
- In the initial testing, **teachers** from schools which have been evaluated as digitally competent schools (according to external evaluations) are more often involved in *school- and learning-related ICT activities* than teachers from digital beginners. In the final testing, there is no difference between schools that have different general digital maturity on the scale *ICT activity associated with school and teaching* in the average estimates of the teachers. Teachers in digital beginner schools, digitally competent and digitally advanced schools (self-assessment) in the final testing use ICT equally frequent for various activities related to school and teaching. Likewise, there is no difference in the average scores on the scale of *ICT-based Teaching Activities*. Teachers in the final testing on average use ICT equally frequent for various teaching activities, regardless of the general level of digital maturity of their school.
- Differences in the average results on the scale *ICT-based Teaching Activities* among teachers in schools with different digital maturity was found neither in the initial nor in the final

[3] According to initial external evaluation, most schools were concentrated in the second level, and they advanced to third (56%) or fourth level (22%) in the final evaluation. In all other groups, the number of schools was too low (≤10%) and were therefore not included in statistical analyses.

testing. Teachers in the final testing on average use ICT for different teaching activities equally often, regardless of the general level of digital maturity of their school.

- **Administrative staff** on an average uses equally often *ICT activities related to the work and business of a school*, regardless of the level of general digital maturity of the school (determined on the basis of self-evaluation).
- Also, there is no difference in the average results on the scale *school- and learning-related ICT activities* (**expert associates**' assessment). Expert associates in digital beginners, digitally competent and digitally advanced schools (self-assessment) in the final testing apply school- and learning-related ICT activities equally often.
- With regard to the assessment of **students**, on the scale *school- and learning-related ICT activities*, no significant differences between schools on different levels of general digital maturity have been obtained. Students are equally often use different ICT activities for school-related tasks, regardless of the level of general digital maturity in their school.
- In the initial testing, according to self-assessment, educational staff and headmasters of digitally mature schools have reported that they use *different ICT devices* more often than those from digitally competent schools. According to external evaluation, employees of digitally advanced schools used ICT devices more frequently than employees from digital beginners and digitally competent schools. In the final testing, in schools which were according to self-evaluation placed on the level of digital beginners, digitally competent or digitally advanced schools, there is no difference in the average frequency of using different ICT devices (according to the assessment of **teachers, expert associates, administrative staff, headmasters,** and **students**). Employees and students use different ICT devices at school equally often, regardless of the general digital maturity of their school.
- **Administrative staff** on an average use *ICT activities related to the work and business of a school* equally often, regardless of the level of general digital maturity of the school (determined on the basis of external evaluation).
- There were no differences in the average results on the scale *school- and learning-related ICT activities* (**expert associates'** evaluation). Expert associates in digitally competent and digitally advanced schools (according to external evaluation results) apply the ICT for school- and learning-related ICT activities equally often in the final testing.
- In schools which were according to external evaluation placed on the level of digitally competent and digitally mature schools, there is no difference in the average frequency of

using different ICT devices (according to the assessment of **teachers, expert associates,** and **headmasters**). Employees use different ICT devices at school equally often, regardless of the general digital maturity of their school.

- With regard to the assessment of **student** on the scale *school- and learning-related ICT activities*, determined on the basis of external evaluation, no significant differences between schools at different levels of general digital maturity were obtained. Students also use different ICT activities for school-related tasks (in the final testing) equally often, regardless of the level of their general digital maturity.
- In schools which were according to external evaluation placed on the level of digitally competent and digitally mature schools, there is no difference in the average frequency of using different ICT devices of **teachers, expert associates,** and **headmasters**, although significant differences were obtained for **administrative staff** and **students**. Specifically, administrative staff and students of digitally advanced schools use ICT devices more often than administrative staff and students of digitally competent schools, and the obtained effects are small.
- When we consider changes in the levels of digital maturity of schools in the final testing, in **schools that according to the external evaluation progressed for two levels**, from the level of digital beginner to the level of a digitally advanced school, the **administrative staff** estimates that they have *used ICT devices* more frequently than the employees of schools that have progressed for one level - on the level of a digitally competent school.
- In schools which were, **according to self-evaluation in the initial testing, at the level of a digital beginner and made progress for one level, to the level of a digitally competent school, students** in the final testing estimated that they used ICT devices at school more often than the students of the school which remained on the same the level of digital maturity.

Recommendation:

- Since the differences between the more distant levels of digital maturity with regard to the application of ICT are more easily recognized, especially at the level of digitally unaware schools, it is recommended to specify the frequency of use of ICT at the levels of digital beginners, competent and digitally advanced schools. Specifically, the specification should relate to the use of ICT equipment, as well as the implementation of various types of ICT

activities of students, teachers, expert associates, administrative staff and headmasters, for each category individually.

1.5.2. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to the use of digital educational content (DEC) and teaching scenarios

It was expected that the application of digital educational content and teaching scenarios would be statistically significantly correlated to the level of digital maturity of a school.

- In schools which were according to external evaluation placed on the level of digital beginners, digitally competent and digitally mature schools, there is no difference in the average frequency of using digital educational content (DEC) and teaching scenarios. Teachers use digital educational content (DEC) and teaching scenarios equally frequent, regardless of the general level of digital maturity of their school.
- Also, in the final testing teachers report that they use digital educational content (DEC) equally frequent as those in schools which were according to external evaluation placed on the level of digitally competent and digitally advanced schools. However, teachers from digitally competent schools use teaching scenarios more often than teachers of digitally advanced schools, and the obtained effects are small.
- The hypothesis that the implementation of digital educational content and teaching scenarios will be significantly positively correlated with the level of digital maturity of the school has not been confirmed. The only difference obtained is that teachers in digitally competent schools (based on external evaluation) more often use teaching scenarios than teachers from digitally advanced schools. It is probable that in digitally competent schools, teachers will use developed and accessible teaching scenarios, while one of the features of digitally advanced schools is that teachers develop digital contents themselves.

Recommendation:

- Since there is no difference between the use of DECs and the teaching scenarios between schools of different digital maturity, it is recommended to specify the frequency of use of DECs and teaching scenarios at the levels of digitally competent, advanced and digitally

mature schools, so as to make that a discriminatory variable of different levels of digital maturity of schools as well.

1.5.3. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to the educations of teaching and administrative staff

It was expected that the implementation of education for the improvement of the digital competences of employees would be statistically significantly positively correlated with increasing the level of digital maturity of a school.

- When comparing schools that, based on self-evaluation, are at different levels of general digital maturity, there is a significant difference in the number of educations attended by school headmasters, with a medium effect. The **headmasters of digitally advanced schools** throughout the e-School project have attended **significantly more** educations than headmasters of schools at the level of digital beginners. Differences in the average number of educations of other school employees were not obtained. Teachers, expert associates, and administrative staff from schools at different levels of general digital maturity attended the same number of educations as part of the e-School project.
- When comparing digitally competent and digitally advanced schools, based on the external evaluation, there is a significant difference in the average number of educations attended by the school's expert associates. **Expert associates from digitally advanced schools** have participated in **more educations** than those from digitally competent schools, and the obtained effect is small. Teachers, headmasters and administrative staff from schools that were placed at these two levels according to external evaluation have participated in an equal number of educations during the e-School project.
- When comparing changes in the digital maturity levels of the final exam**, in the schools that were digital beginners in the initial self-evaluation, and during the project they progressed for one level to the level of digitally competent**, **teachers** reported that they participated in more educations than the teachers of the schools that remained at the same level of digital maturity.
- **In schools which were according to the external evaluation in the initial testing placed at the level of a digital beginner and progressed for two levels to the level of a digitally**

advanced school, the number of educations attended by **expert associates** is significantly higher than in schools that have progressed for one level of digital maturity.

- **In schools which were according to the self-evaluation in the initial testing placed at the level of a digitally competent school and progressed for two levels to the level of a digitally advanced school**, the number of educations attended by **headmasters** is significantly higher than in schools that have remained on the same level of digital maturity. In schools which were according to the **external evaluation** in the initial testing placed at the level of a digital beginner and progressed for two levels to the level of a digitally advanced school, the number of educations attended by **headmasters** is significantly higher than in schools that have progressed for one level of digital maturity.

Recommendation:

- Considering that more frequent education of school employees supports the development of digital maturity of the school, it is recommended to further organise educations and encourage employees to participate in them. Particularly important is that headmasters and expert associates are involved in educations, as this will have the biggest effect on the digital maturity of schools.

1.5.4. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to the degree of development of a community of practitioners

It was expected that the development of a community of practitioners will be statistically significantly positively correlated with the progression of the level of digital maturity of a school.

- In schools which were according to the self-evaluation in the final testing at different levels of general digital maturity do not differ from each other on the average use of the Yammer network as a tool of a community of practitioners. However, according to Yammer analytics data, the schools are significantly different in the total number of Yammer users in the school. In digitally competent schools, there are more Yammer users than in the digital beginners. Also, there are more Yammer users in schools that are digitally advanced than in digitally competent schools. No differences were obtained in other Yammer analytics between schools at different levels of general digital maturity.

- In schools which were according to the external evaluations in the final testing at different levels of general digital maturity differ from one another in neither indicator of the development of a community of practitioners.
- The analysis of changes in the digital maturity of schools that were **according to the self-evaluation in the initial testing placed at the level of a digital beginners** showed that between the two testing, the teachers in schools that progressed for one level during the project used the Yammer network more frequently than the teachers from schools that remained at the same level of digital maturity. When analysing the data obtained from the Yammer network analytics, no differences were found between schools that remained at the same level of general digital maturity and those that increased digital maturity for one level. Almost the same total number of messages was sent from both groups of schools, almost is the same total number of groups and users as well as the average number of messages sent per user per month. It can be noticed that schools vary greatly in the use of the Yammer network, regardless of whether they are at the same level of digital maturity or have progressed for one level.
- The analysis of changes in the digital maturity of **schools that were according to the self-evaluation in the initial testing placed at the level of a digitally competent school** showed that the teachers in schools that progressed for one level between the two testing did not differ in the use of the Yammer network from the teachers of the schools that remained at the same level of general digital maturity.
- If comparing differences between **schools which were according to the external evaluation in the initial testing placed at the level of a digital beginner and progressed for two levels to the level of a digitally advanced school in the final testing**, the only significant difference obtained is the number of the average messages per month. Teachers from the schools that have progressed for two levels, to the level of the digitally advanced schools, exchanged more messages on a monthly basis from the teachers from schools that progressed for one level of digital maturity. In both groups of schools, the teachers use the Yammer network with almost the same frequency, almost the same total number of messages was sent, a total number of groups and users is almost the same, as well as the average number of messages sent per user. Although in schools that have improved the level of digital maturity, teachers send more messages, this difference is not significant because the schools are very different in the total number of messages, which is partly due to the different size of the schools in the sample.

Recommendations:

- Due to the apparent difference in the use of the tools of the community of practitioners in schools which were digital beginner and advanced in digital maturity, it is recommended to encourage teachers to develop a community of practitioners and to use the Yammer network to develop digital maturity of schools which are still at the level of digital beginners.
- Since the results of the use of the Yammer network in the final testing show greater sensitivity to the self-evaluation of the digital maturity of the school than to the external evaluation, the level of use of the network should be specified depending on the level of digital maturity of the school, in order to equalise the results of self-evaluation and external evaluation.

1.5.5. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to the new business and teaching processes

It was expected that the implementation of new business and teaching processes that will be developed during the project will be statistically significantly positively correlated with the progression of the level of digital maturity of a school.

- New business processes were not introduced before the final testing within this research, so their effect was not verified.
- In schools which were according to the **self-evaluations in the final testing** at various levels of general digital maturity, from digital beginners to digitally advanced schools, as well as digitally competent and digitally advanced by the **external evaluation**, did not differ in the use of *repositories of educational content*.
- The analysis of changes in the digital maturity of schools that were **according to the self-evaluation in the initial testing placed at the level of a digital beginners** showed that more teachers in schools that progressed for one level between the two testing used *repositories of educational content* than the teachers of the schools that remained at the same level of general digital maturity.
- The analysis of changes in the digital maturity of schools that were **according to the self-evaluation in the initial testing placed at the level of a digitally competent schools** showed that there was no difference in the number of teachers who used the *repositories of*

educational content in schools that progressed for one level between the two testing and the schools that remained at the same level of general digital maturity.

- There was no difference in the number of teachers who used the repositories of educational content between the schools that were according to **external evaluation placed at the level of digital beginners in the initial testing and increased digital maturity for one or two levels in the final testing**,
- However, although in relation to the initial testing (10% of teachers used the repository) during the implementation of the e-School project the number of users increased, only 20% of teachers use the repository of educational materials, and in the final testing 9% of the teachers state that they did not even hear about repository and 18% declare that he have heard, but do not know what it is.

Recommendations:

- Teachers should be systematically informed about the repository of educational materials and encouraged to use it. A community of practitioners and exchange of examples of good practice could play a significant role in this.
- Considering that the results of the use of repository of educational content in the final testing show greater sensitivity to the self-evaluation of digital maturity of the school than to the external evaluation, it would be necessary to specify the frequency of use of the repository of educational content for each level of digital maturity of the school, in order to equalise the results of self-evaluation and external evaluation.

1.5.6. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to the ICT infrastructure

It was expected that the implementation of the ICT infrastructure will be statistically significantly positively correlated with the progression of the level of digital maturity of a school.

- Schools which were according to the **self-evaluations in the final testing** at various levels of general digital maturity, from digital beginners to digitally advanced schools, as well as digitally competent and digitally advanced by the **external evaluation**, did not differ in the *use of ICT infrastructure*.

- In schools which were according to the **self-evaluations in the initial testing placed at the level of a digital beginner** did not differ in the *use of ICT infrastructure* from the schools that have progressed for one level of digital maturity or remained on the same level.
- **In the schools that were digital beginners in the initial self-evaluation and during the project they progressed for one level to the level of digitally competent**, a significant number of teachers used presentation classroom than the teachers of the schools that remained at the same level of digital maturity.
- There was no difference in the average use of ICT infrastructure between the schools that were according to **external evaluation placed at the level of digital beginners in the initial testing and increased digital maturity for one or two levels in the final testing**. The teachers, expert associates, and headmasters use ICT infrastructure equally often, whether they have progressed for one level of digital maturity or remained on the same level.

Recommendations:

- It is recommended additional equipping the schools with the interactive classrooms and encouraging teachers to use them, as their use is associated with the development of digital competence of teachers, their attitudes and experiences, as well as attitudes and experiences of students, who are the essential components of the digital maturity of the school.
- Considering that the results of the use of ICT infrastructure do not differentiate between schools of different level of digital maturity in the final testing, the frequency of using ICT infrastructure for each level of digital maturity of the school should be specified.

1.5.7. The differences between schools of different digital maturity level (according to the Framework for the Digital Maturity of Schools) with regard to the management of the application of the ICT

It was expected that the adequate management of the implementation of the ICT will be statistically significantly positively correlated with the progression of the level of digital maturity of a school.

- According to the obtained results, 129 schools (85.4%) formed a school team, while 22 schools (14.6%) did not form a school team for the development and strategy implementation.

- Schools of different levels of digital maturity in the final testing, from digital beginner to digital advanced school, according to self-evaluation, as well as digitally competent and digitally advanced according to external evaluation, do not differ whether they have formed or not a school team for the development and strategy implementation.
- In the group of schools which formed the school team (129 schools), 52 schools have remained at the same level of general digital maturity (digital beginners and digitally competent), while 63 schools (49%) have increased their digital maturity for one level. In a group of schools that did not form a school team (22 schools), 12 schools remained at the same level, while 7 schools (32%) increased their general digital maturity for one level. Analyses have shown that almost the same number of schools is in categories which relate to the change of digital maturity (remaining on the same level and increasing for one level, based on self-evaluation), regardless of whether or not they have formed school teams.
- When digital maturity is estimated by **external evaluation**, data shows that in a group of schools that formed a school team, 10 schools remained at the same level, while 119 schools (92%) increased their digital maturity. Of these, 83 schools increased their general digital maturity for one level, 33 schools increased digital maturity for two levels, and 3 schools increased their digital maturity for as much as three levels. According to the analyses, the number of schools in the categories related to the change of digital maturity (increased by one or two levels) is the same, regardless of whether or not they have formed school teams.

Recommendations:

- Although the role of the school team for the development and strategy implementation for the implementation of ICT is not particularly prominent in the development of digital maturity of schools during the e-School project implementation, we believe that the role of this team after the end of the project will be more pronounced. During the project implementation, the schools have included in the structured activities as a part of the project, so school teams mainly coordinated the implementation of these activities. For the sustainability of further development of digital maturity of the schools, school teams could play a key role in implementing strategies for implementation of ICT.
- Considering that the formation of a school team for the development and strategy implementation for the implementation of ICT does not distinguish schools of different digital maturity in the final testing, it is necessary to specify at what level of digital maturity

the school is expected to establish a school team for the development and strategy implementation for the implementation of ICT.

1.6. Recommendations for improving The framework for the digital maturity of schools

- Considering that the analyses carried out within this research of the effects of the e-School project implementation show that it is possible to distinguish between five areas of digital maturity of a school (Leadership, planning and management, ICT in learning and teaching, Development of digital competences, ICT culture and ICT infrastructure) we believe that the Framework for the Digital Maturity of Schools should retain these five areas.
- However, as different levels of digital maturity cannot be clearly distinguished according to the different characteristics which determine the digital maturity according to the adopted Framework, which were investigated by this research, it is recommended that all levels of digital maturity of the schools should be precisely specified in view of the different characteristics: the use of ICT tools, the use of specific ICT activities, the use of digital educational content and teaching scenarios, the participation of educational and administrative staff in different educations, the degree of development of community of practitioners, the introduction of certain business and teaching processes, the establishment of infrastructure and management of the implementation of the ICT (e.g. formation of school teams).
- It is also recommended to accurately determine all other features/elements for each level of digital maturity, which were described in the model of the digital maturity of schools, in order to distinguish levels according to these characteristics. This would increase the validity of the model of the digital maturity of schools as well as the reliability of the assessment of features that determine the different levels of digital maturity. At the same time, it would facilitate the planning and implementation of evaluation research.

1.7. Recommendations for public policies in the context of ICT

Based on the findings of the e-School project's research, it is recommended to build a well-coordinated, strategically elaborated system for the management of introduction of modern technology in learning and teaching as well as school management processes. The success of introducing modern technology depends on the interaction of external (e.g. educational policies) and internal influences (e.g. school decision-making, organizational climate, management mode). Educational policies should be based on the empirical data provided by this research. Decisive internal influences are determined by the headmasters' attitudes toward the application of ICT in education because they influence the managing and creating a climate for a change in a school. Management includes planning, access to and use of resources and techniques of using ICT in the school curriculum. The headmasters should share their vision of the change with the teachers, enable them to collaborate and provide them with needed support. In order for the change to be successful, the efforts of each of these effects must be consistent, mutually complementary and allowing enough time for a change, as it cannot be achieved in a short time. According to the present research, a decade, and sometimes even several decades, is necessary for a successful implementation of a significant change (OECD, 2007). Only strategic planning can enable the integration of the vision and the means of achieving that vision through various specific activities in the introduction of ICT in school as well as the sustainability of the established system. It is important for teachers, expert associates and administrative staff to accept the introduction of changes.

It is recommended to take into account the following aspects when determining public education policies for the introduction of ICT in education. Objectives are to develop positive attitudes towards the introduction of technology in the education system, readiness for continuous educations, and applying ICT equipment and activities of all school employees - teachers, expert associates, administrative staff and headmasters:

Equipping schools with ICT devices and infrastructure

- It is recommended to systematically equip schools with ICT equipment and infrastructure according to the needs of a particular school because each school has its own specific needs. Therefore, it is necessary to examine the needs of schools and to introduce those devices that will be best used in a particular school. Particular attention should be given to differences in curricula, which are particularly pronounced between various secondary schools (gymnasiums, vocational schools). In this respect, the characteristics of the students

should be taken into account and the choice of appropriate devices for students of each school should be modified, for example, devices that are suitable for students without difficulties may not be equally suitable for students with developmental difficulties.

- The size of the school i.e. the number of students and teachers should be considered so that all students have the opportunity to use ICT. In secondary schools, more classrooms should be equipped with ICT equipment. Devices must be functional, easy to use and reliable.
- Although the sole presence of technology in schools is not related to its use, the results of this study confirm that the availability of ICT equipment is an incentive to use it. So, providing appropriate and quality equipment for schools, teachers and students is a first step towards the integration of ICT into the education process. In the initial stages of implementation of ICT in a school, it is more likely that the teachers would use reliable and infrastructure which is available to them.
- The most important feature of the equipment that will cause changes in learning and teaching is the possibility of interaction among students, and between students and teachers, as well as active involvement of students in the learning and teaching process.

Providing technical support in the use of ICT devices and activities

- It is recommended to design an efficient system to provide technical support directly in the school, but also through online services which will be quick and effective. Schools should be provided with IT specialists who would be available to teachers and assist them in the daily planning and implementation of ICT in teaching activities. This support is particularly important in the first phase of introducing ICT into the education system, when teachers face different challenges, from technical difficulties in the use of ICT devices, through insufficiently developed own skills in using ICT devices to managing students' activities in the use of ICT devices and activities during classes.

Encouragement of the development of digital and teaching competences

- The ICT infrastructure itself is not the basic prerequisite of the change, as much differences in the manner of work are, and they depend on the motivation and competences of the teachers. In the context of the ICT framework, the general digital and specific teaching competences should be distinguished as two major sub-groups of ICT competences. Teachers need adequate support in improving their digital competences and an encouragement in

applying new methods of teaching i.e. using ICT in teaching. If they feel insecure, their sense of incompetence would become an obstacle to the use of ICT in teaching and they would prefer to use familiar methods of working, which cannot contribute to change. At the beginning of introducing an innovation, a technical support is needed for teachers to develop their digital competences. When they master the fundamental digital skills and achieve the necessary threshold in the development of digital competences, i.e. middle level, their teaching competence and the ability to integrate ICT into the curriculum can become more pronounced. Therefore, it is recommended to systematically encourage teachers to use ICT devices and activities to develop digital competences as a prerequisite for the use of ICT in teaching as a specific digital competence.

- In the process of introducing ICT into the education system, the differences between potential users - teachers, expert associates, administrative staff and headmasters - should be taken into account. Only a small number of people can be considered to be innovators and be ready to adopt new processes immediately. The largest number will do it gradually, sooner or later, but there is also a number of those who will always resist changes. Those who are inclined to introducing change can, by their influence, play an important role in encouraging other groups to accept it. Therefore, organisational efforts should be aimed at employees who are ready for early adoption of changes in ICT application and should be provided with institutional support so as to serve as a positive model for others. They should be stimulated by rewarding them in various ways, for example financially, reducing teaching hours and so on.

Development and the implementation of digital educational content and teaching scenarios

- Development of the digital competences of teaching staff is not a guarantee that a quality integration of these competences would be realised in the teaching processes. The technology alone cannot compensate for the inadequate teaching methods. All forms of teaching taught by teachers need to be based on a constructivist paradigm, where learning is encouraged as an active construction and reconstruction of knowledge, and the students' thought processes are supported by ICT with the ultimate aim of encouraging higher levels of cognitive resonance in accordance with student-oriented teaching. This requires elaboration of the appropriate teaching methods that best use the existing knowledge of the effectiveness of teaching, taking into account all the advantages of ICT technology and

providing support which cannot be provided by traditional approaches to teaching. Therefore, it is recommended to further develop educational content repositories and teaching scenarios which would enable realisation of cognitive learning outcomes of higher levels. In order to do this, the teaching scenarios should contain authentic problem tasks relevant to everyday life, which would motivate students to actively engage in learning in line with the guidelines of the Strategy for education, science and technology.

- Teachers need time and support for the application of elements of DEC and teaching scenarios in teaching. That is why it is necessary to provide a time when teachers can exchange experiences and examples of good practice at the school's level.
- Teachers should also be encouraged to explore adequate digital content and activities, and to design them independently, which should be recognised in procedures for professional advancement and advancement to the higher-levels of academic rank.

Organization of professional educations

- In order for teachers to be motivated and enthusiastic to potentially improve the teaching process through technology, they must perceive that they have the capacity for its successful use. It is therefore essential to invest in quality education of teachers and their preparation to become competent technology users. It is recommended to continuously organise professional education in the use of ICT devices, communication and educational applications, as well as the development of various activities within the teaching scenarios. It is recommended to often run shorter workshops focused on narrow content and development of specific skills. It is especially important that the trainees be given practical tasks whose execution is monitored and evaluated by the workshop performer, who would provide quick and detailed feedback on how to improve the performance quality. It is recommended to formalise professional education and to issue a certificate of participation in the professional education after performing the practical tasks and achieving the expected learning outcomes. Workshops should be organized through a spiral curriculum which gradually increases the complexity of the expected outcomes of the workshops, first of the basic levels and later of the more complex ones.
- Due to the complexity of digital competences for learning and teaching, their development requires a longer period of time. Therefore, professional education should be distributed over time, organized in cycles, so that within a single cycle the development of one area of

digital competences is supported. Workshops should be carried out by people with experience in conducting professional education.

- Participation in educations alone is not enough if teachers are not encouraged and committed to applying what they have learned. The perception of positive changes in the digital competences of teachers as a result of educations is motivating and increases the likelihood of using ICT. The method of collegial observation of teaching can be a good mechanism of encouraging the application of the learned and a continuous way of improvement of one's own practice.
- Educated professional associates can play a particularly important role in encouraging teachers to use ICT in learning and teaching, which is why it is important to provide them with continuous professional education in the use of ICT.
- Apart from the professional education of educational staff, the success of introducing technology to educational institutions also depends on the education of administrative staff and headmasters, as it is related to the frequency of use of IC activities related to the work and business of the school as well as to the development of their digital competences. Therefore, it is recommended to organise educations for them as well and to offer them content specific for the management and operation of the school.

Development of a community of practitioners

- Development of a community of practitioners is particularly important in ensuring the readiness of teachers to introduce innovative teaching methods using ICT and to persist in these endeavours as well as to face different challenges in everyday practice. Activities that encourage the development of a community of practitioners should be carried out through direct communication of teachers in school-based professional training, but also through the use of modern technology such as the Yammer network.
- Development of a community of practitioners is also important for the advancement of digital competences of expert associates. Therefore, expert associates should be encouraged to use the Yammer network, which will facilitate communication and mutual support for the use of ICT in day-to-day work and the exchange of examples of good practice.

Application of ICT equipment and tools for performing administrative tasks

- Administrative work embodies a significant burden on teachers, expert associates and headmasters, so they need to be provided with digital tools that will make it easier to do these tasks and enable them to use them. It is recommended to connect the systems and tools, as similar tasks should not be repeatedly performed.

Application of ICT devices and tools in school management

- It is recommended to provide ICT devices for all headmasters, as headmasters who receive ICT equipment develop positive attitudes towards using ICT in administrative affairs, use ICT more for activities related to work and school business, which has a positive effect on the development of their digital competences.
- Since business processes have not been introduced before the final testing was conducted, recommendations based on empirical data cannot be offered. However, as the role of the headmasters has proved to be crucial in introducing technological innovations and the use of ICT in teaching, we believe that introducing specialised tools to help school headmasters manage school would contribute to the quality of introduction of technology into the education system.

1.8. Recommendations for designing a future sizeable e-Schools project

- For an efficient introduction of ICT into educational institutions, it is necessary to envision a period of more than two years, so that certain phases of the project do not overlap, i.e. in order to ensure that the project phases which are prerequisite for one another could be fully realised in the planned order. The phase of equipping schools with ICT equipment and infrastructure needs to be completed before the beginning of educations for teachers on applying ICT in work and teaching.
- It is recommended mandatory setting up of a team for the development and implementation of strategies of ICT introduction in all schools so as to coordinate the various activities within the project. Teams need to be provided with systematic support and their activities should be actively monitored.

- Educations need to be organised in accordance with the specific needs of teachers, expert associates, administrative staff and headmasters, so information on their needs should be obtained before educations.
- Educations should be of different levels of complexity and appropriate with respect to the teachers' prior knowledge. They should also be easily available so the teachers can balance them with their other responsibilities. A sufficient number of competent educators should be provided for the successful implementation of educations.
- It is recommended to provide a consistent encouragement of all school employees to use ICT in carrying out administrative and teaching activities and an assurance of adequate technical support at the level of both a school and overall project.
- It is recommended to develop new DECs and teaching scenarios and to improve the existing ones with the aim of Problem-based learning and the preparation of authentic problems. It is also recommended to create manuals with instructions for using the scenarios.
- To enhance the objectivity and reliability of self-evaluation and external evaluation, it is important to improve the Framework for the Digital Maturity of Schools by specifying features or elements within each level of digital maturity. This would make different evaluators' assessment easier and would increase the consensus between different evaluators.

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