

Applying TAM (Technology Acceptance Model) to Predict Effective ICT Use of Preschool Teachers during the COVID-19 Pandemic

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Abstract - During the COVID-19 pandemic, educational institutions were challenged to organize online activities, and it was especially challenging to organize them in preschool institutions. Based on the modified TAM (Technology Acceptance Model), the study aimed to examine the potential predictors of effective preschool teachers' use of information-communication technology (ICT) during the COVID-19 pandemic. Additionally, the main effect of previous work experience was tested. The participants were 104 employed preschool teachers. They completed two online questionnaires (Use of ICT and Digital competencies) created for this study's purpose and gave some demographic data. Hierarchical linear regression was performed in order to test TAM, i.e. to predict the effective use of ICT during the COVID-19 pandemic. The results showed that only the positive attitudes and recent experience were significant predictors of effective ICT use during COVID-19 pandemic, explaining overall 38% variances, while users' characteristics did not play a role. Furthermore, preschool teachers with less work experience self-assessed possessing higher levels of specific ICT competencies necessary for work during the COVID-19 pandemic. Previous experiences with ICT and a specific set of ICT competencies were crucial for preschool teachers to successfully transform activities into a virtual environment during the COVID-19 pandemic.

Keywords – ICT; TAM; preschool teachers; digital competencies; COVID-19 pandemic

I. INTRODUCTION

During COVID-19 emergency remote education has added a different dimension to the change in the use of ICT (information and communication technologies), especially in early childhood education [1-3]. Online learning, which requires the use of ICT, provided an important learning opportunity during the pandemic by offering educational content and materials and allowing young children to meet and interact with their teachers and friends [4-7].

Although increased ICT use was a necessary to provide children with online learning content and materials, negative consequences of overuse of technology in early childhood emerged [4, 7]. Numerous recent studies have shown the same problems for preschool emergency distance education [8-15]. The main problems for preschool educators were the absence of appropriate technological equipment and an internet connection, the lack of technological knowledge, the lack of knowledge to use educational technology and produce digital educational materials, as well as to make good use of the platforms available [8, 16], and limited time of due to their personal

and professional obligations or older children who also attended emergency online education [17]. Another major issue derives from the developmental stage of young children. Preschool children in the online learning environment cannot be autonomous learners, leading them to be distracted and uninterested in ICT distance education [18]. In addition, some studies reported that more than half of preschool teachers said they proceeded with distance education without receiving any training at all in using digital technologies [19]. Overall, it was concluded that the education process during the COVID-19 pandemic was inefficient and that teachers have negative views on distance education [20, 21].

A. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) and extended TAM have been widely implemented in the field of technology acceptance and used to determine the potential predictors of successful implantation of ICT [22, 23]. TAM is used to explain the relationship between humans and technology through Perceived Usefulness (PU) and Perceived Ease of Use (PEU). TAM was well applied in the field of technology in education with various modifications [24]. TAM includes Perceived Ease of Use and Perceived Usefulness, which are the important determinants of technology acceptance and user behavior. Extended TAM (Figure 1) includes another essential factor that indirectly influences user behavior, i.e., external variables that fundamentally lead to attitudes toward using a particular technology [25].

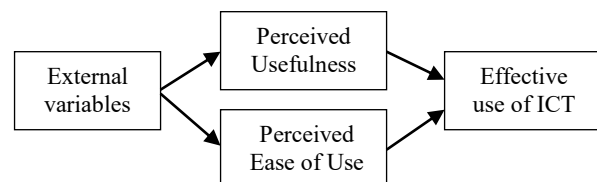


Figure 1. Modified Technology Acceptance Model

B. Application of TAM on effective ICT use of preschool teachers

This study evaluates the TAM's main variables for the effective use of ICT during the COVID-19 pandemic, such as Perceived Usefulness (the intention to use, positive attitudes towards ICT use), Perceived Ease of Use (usability and behavioral intention, ICT competencies, experience with ICT) and external variables (age, gender, and specific knowledge).

C. Previous research from TAM perspective in preschool education

To a large extent, Perceived Usefulness and Perceived Ease of Use directly influence user behavior (i.e., use of ICT during the COVID-19 pandemic). PU is described as users' attitudes toward ICT that determine the use of it and has proven to be a very important factor for technology adoption in numerous studies [24, 26]. For example, the positive attitudes among users, such as teachers, that use of ICT will make their work or that of their learners easier [27]. Preschool teachers must have a positive attitude toward the use of ICT for online learning and possess adequate skills in a digital environment in order to facilitate and encourage their own behavior, i.e., effective use of ICT in distance education [28]. Teachers' positive views and attitudes toward ICT integration in distance education are vital because they affect their actual use of ICT and therefore affect children's motivation and learning [29-31]. Only a little bit above half of the preschool teachers had positive attitudes toward the educational use of technology [32], and similarly, another study found only fairly positive attitudes toward integrating technology in kindergarten [33]. Another major issue influencing teachers' attitudes toward ICT is the lack of online platforms and digital educational technology optimized for children under six years old [34].

The perceived ease of use of new or existing ICT refers to users, i.e., teachers, view on technology as one that does not require much effort to learn how to use [35], i.e., that using ICT would be effortless and hassle-free [36]. Teachers would be more inclined to use ICT if they consider it easy to learn and use with minimal need for an expert consultation, i.e., if they already possess some specific competencies and experience. Preschool teachers have the most important role in online learning, and their competency in the use of ICT increases the effectiveness of online learning [28]. Some studies have found that preschool teachers did not have a clear understanding of the benefits of young children's technology use [37], and therefore, it is necessary for early childhood teachers to acquire ICT competencies in order to use ICT in distance education [38] effectively.

External factors are described as variables that can explain the procedure people go through in acquiring ICT skills [39]. The most important is the user's personal characteristics, i.e., age, gender, computer literacy, et cetera. [40]. Previous studies have shown that despite the growth of ICT usage, there is a significant decline among the elderly, lower-income earners than the younger, well-educated, and high-income earners [25]. Age, education, and socio-economic status were associated with beliefs of the importance of ICT, which can influence attitudes towards ICT use and directly influence behavior, i.e., effective use of ICT. Furthermore, gender, age, and technology experience (i.e., specific knowledge) had an influence on the intention to use technology [35]. Men, younger, with more previous computer knowledge, will be more inclined to use ICT professionally and privately. More recent studies have shown that younger preschool teachers have a high perception of ICT usefulness, whereas senior preschool teachers lack knowledge and need courses to help them more confidently manage children's learning activities using ICT during distance education. [41]. For effective use of ICT in online learning in kindergarten, preschool teachers must have the knowledge and skills to

use technology and deliver the lessons [42]. Furthermore, one of the most important factors affecting preschool teachers' attitudes was their ICT knowledge [32]. However, preschool teachers pointed out the urgent need to train in the use of technology, especially the use of ICT in educational settings [38, 43].

Although some previous studies have expanded and specified determinants of behavioral intention to use technology, they did not go a step forward to measure the actual effectiveness of ICT use. Moreover, there is a lack of knowledge in the literature about the antecedent variables of education technology's effective use for preschool teachers, especially during the COVID-19 pandemic. The presented paper emphasizes the importance of positive attitudes, familiarity and ease-of-use in the successful implementation of ICT in remote learning.

II. METHOD

A. Study aim

Based on the modified TAM, our study's main aim is to explore preschool teachers' effective ICT during the COVID-19 pandemic (Figure 2). According to the proposed modified TAM, in the prediction of primary school teachers' effective use of ICT during the pandemic COVID-19, three groups of factors are essential: external variables such as users' characteristics that shape experience in educational settings (years of work experience, level of ICT education which is indirectly measured by preschool teachers' need for additional ICT education i.e. preschool teachers with lower level of ICT education would self-assess necessary additional ICT education), attitudes which are a measure of perceived usefulness of ICT (in our study attitudes toward the usefulness of ICT and importance of ICT competencies) and previous and recent experience with ICT, i.e., the measure of ease of use (in our study previous use of ICT during the regular educational process and possession of specific ICT competencies necessary for work during the COVID-19 pandemic).

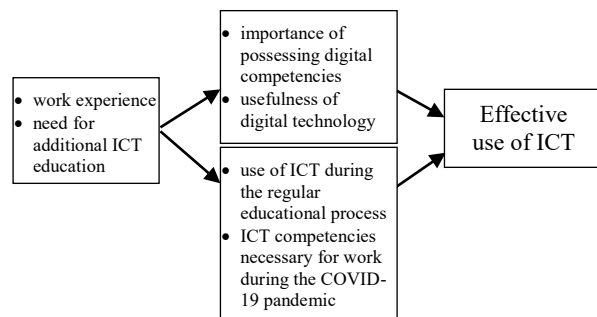


Figure 2. Tested TAM on preschool teachers effective ICT use

According to modified TAM, to predict the effective preschool teachers' use of ICT during the COVID-19 pandemic, work experience and the need for additional ICT education were introduced in the first step of the analysis. It was assumed that preschool teachers with a few years of work experience (due to inexperience) and with many years of work experience (due to their age) and preschool teachers with a higher self-evaluated need for additional ICT education (i.e., with a lack of ICT knowledge) would be less effective in the use of ICT during the COVID-19 pandemic. These variables present the antecedent that shapes users' attitudes and,

consequently, their ICT behavior; therefore, we introduce them in the first step of analysis as control variables. In the next step, the usefulness of digital technology and the importance of possessing digital competencies were introduced as measures of users' attitudes, i.e., indirect influence on ICT behavior. It was assumed that preschool teachers with more positive attitudes toward the importance and usefulness of digital technology would be more successful in using ICT during the COVID-19 pandemic. Finally, in the last step, the use of ICT during the regular educational process (use of ICT in previous work) and ICT competencies necessary for work during the COVID-19 pandemic were introduced as direct measures of effective preschool teachers' use of ICT during the COVID-19 pandemic. As proposed in the modified TAM, individuals who already used ICT during the regular educational process and who possess specific ICT competencies necessary for work during the COVID-19 pandemic would more easily and effectively use ICT during the COVID-19 pandemic.

B. Participants

The study involved 104 employed preschool teachers (95% of women) with the most frequent age span between 36 and 50 years old. All participants were from Croatia. Most of them had between 11 and 20 years of work experience (39.4%), less between 1 and 10 years (34.6%), and the least of them had more than 20 years of work experience (26%).

C. Procedure

The research was conducted during the school year. Principals and professional associates were asked to include preschool teachers in research and to forward an online survey to them. Participants were asked to fill out two online questionnaires (Use of ICT Questionnaire and Digital competencies Questionnaire) and to give some socio-demographic data (gender, age group, work experience).

D. Instruments

Two questionnaires (Use of ICT and Digital competencies) were created for this study's purpose.

Use of ICT Questionnaire (ICT) consisted of 20 items measuring the use of information-communication technology during the COVID-19 pandemic in educational work. On a 5-point Likert scale, participants must self-evaluate their use of ICT. Confirmatory factor analysis (KMO=0.788, Bartlett's Test=1229.45, $p=0.000$) shows the existence of three factors, i.e., subscales, namely: use of ICT during the pandemic COVID-19 ($k=5$, $\alpha=0.67$; e.g., *During the COVID-19 pandemic (using modern technology) I sent recorded activities to parents as ideas, which they could carry out with their children at home*); use of ICT during the regular educational process ($k=8$, $\alpha=0.86$; e.g., *During the regular educational process, I use digital technology in my work with children and parents*) and the ICT competencies necessary for work during the COVID-19 pandemic ($k=7$; $\alpha=0.93$; e.g., *We received instructions from the authorities on how to conduct the online educational process during the pandemic COVID-19*). All three subscales had satisfactory internal reliability (Cronbach α greater than 0.66) and Eigen values greater than 2, which explained an overall of 58.51% (each of them more than 10% of variance).

The Digital competencies Questionnaire (DC) consisted of 10 items measuring preschool teachers' attitudes toward digital competencies necessary for educational work. On a 5-point Likert scale, participants must self-evaluate their attitudes about digital competencies. Confirmatory factor analysis (KMO=0.705, Bartlett's Test=627.72, $p=0.000$) shows the existence of three factors, i.e., subscales, namely: the importance of possessing digital competencies ($k=5$, $\alpha=0.83$; e.g., *My digital competences are sufficient for daily educational work with children*); the usefulness of digital technology ($k=2$, $\alpha=0.89$; e.g., *Digital technology is very useful for the implementation of educational practice in kindergarten*) and the need for additional ICT education ($k=3$; $\alpha=0.72$; e.g., *You need additional education in the development of digital competencies necessary for everyday educational work*). All three subscales had satisfactory internal reliability (Cronbach α greater than 0.66), and Eigen values greater than 1, which explained an overall of 73.60% (each of them more than 10% of variance).

TABLE I. DESCRIPTIVE STATISTICS FOR SUBSCALES OF ICT AND DC

Subscales	Min	Max	M	SD	Skewness	Kurtosis
effective use of ICT during COVID-19 pandemic	1.00	5.00	2.99	0.77	-0.11	0.28
use of ICT during the regular educational process	1.00	5.00	3.64	0.74	-0.49	0.31
ICT competencies necessary for work during the COVID-19 pandemic	1.00	5.00	3.27	0.99	-0.20	-0.29
importance of possessing digital competences	2.80	5.00	3.91	0.69	0.01	-1.23
usefulness of digital technology	1.00	5.00	3.83	0.88	-0.88	1.44
need for additional ICT education	1.00	5.00	3.31	0.86	-0.19	0.28

Legend: Min – minimal value; Max - maximal value; M – mean; SD – standard deviation; Skewness & Kurtosis - asymmetry indices

III. RESULTS AND DISCUSSION

Before selecting the appropriate statistical procedures, pre-analysis was done (Table 1). It was concluded that inferential statistics could be applied based on descriptive indicators (asymmetry indices do not exceed value +/- 2).

Mean values of use of ICT during the COVID-19 pandemic indicate that participants self-evaluated only the average level of effective use of information-communication technology during the COVID-19 pandemic in their educational work and also the average level of their ICT competencies necessary for work during the COVID-19 pandemic. These results confirmed the problem, same as worldwide, with emergency distance learning in preschool education, lack of ICT competencies,

and specific knowledge in order to effectively use ICT in distance education [8-16, 37, 38]. However, their use of ICT during the regular educational process was slightly above average. Furthermore, their attitudes toward digital competencies were mostly positive, realizing the importance and usefulness of possessing digital competencies. After two years of distance education, preschool teachers have realized how important it is to have ICT competencies. However, that does not mean their overall view of distance education is positive, rather negative, but necessary in specific conditions such as the COVID-19 pandemic, as shown in previous studies [20, 21]. Nevertheless, preschool teachers self-evaluated only the average need for additional ICT education, which is in contrast with some previous study reports about preschool teachers' emergency distance education without any training at all in the use of digital technologies [19].

TABLE II. PREDICTING EFFECTIVE PRESCHOOL TEACHERS' USE OF ICT DURING THE COVID-19 PANDEMIC.

predictors	B	SE	β	p
1. step: external variables (preschool teachers characteristics)				
work experience	-0.042	0.133	-0.033	0.751
need for additional ICT education	0.161	0.119	0.139	0.179
First regression model	R = 0.137; R ² = 0.019; F _(2,96) = 0.92; p > 0.01 (n.s.)			
work experience	-0.021	0.122	-0.016	0.863
need for additional ICT education	0.133	0.012	0.115	0.236
2. step: Perceived Usefulness (positive attitudes)				
importance of possessing digital competencies	0.682	0.172	0.449	0.000
usefulness of digital technology	-0.048	0.135	-0.041	0.722
Second regression model	R = 0.447; R ² = 0.200; ΔR^2 = 0.181; F _(2,94) = 10.62; p < 0.001			
work experience	0.119	0.139	0.091	0.393
need for additional ICT education	0.099	0.101	0.085	0.330
importance of possessing digital competencies	0.101	0.195	0.066	0.608
usefulness of digital technology	-0.053	0.120	-0.046	0.660
3. step: Perceived Ease of Use (experience in effortless use of ICT)				
use of ICT during the regular educational process	0.322	0.150	0.241	0.035
ICT competencies necessary for work during the COVID-19 pandemic	0.632	0.163	0.462	0.000
Final regression model	R = 0.613; R ² = 0.376; ΔR^2 = 0.177; F _(2,92) = 13.03; p < 0.001			

Legend: B – unstandardized regression coefficients; SE – standardized error for unstandardized coefficients; β – standardized regression coefficients; R – explanation of variance; F – test for ANOVA (significance of regression model)

In order to test modified TAM the hierarchical regression analysis with 3 steps was performed (Table 2). The results show that the selected predictors explain only a small proportion of the preschool teachers' successful use of ICT during the COVID-19 pandemic (about 38%). The characteristics of preschool teachers (work experience and need for additional ICT education) did not at all predict their effective use of ICT during the COVID-19 pandemic. These external variables have been shown to have an

important influence on individuals' attitudes and behavior in previous studies [35, 39, 40]; however, they did not influence preschool teachers' effective use of ICT during the COVID-19 pandemic. One possible explanation is that preschool teachers self-evaluated only the average need for additional ICT education and not a lack of specific knowledge and ICT training like the ones in previous studies [38, 42, 43]. Results of ANOVA (Table 3) confirmed that years of work experience did not influence the need for additional ICT education, i.e., regardless of years of work experience, all preschool teachers estimated that they do not need urgent training or additional education in the use of ICT.

However, the perceived usefulness, i.e., preschool teachers' attitudes toward digital competencies, had significantly predicted their use of ICT during the COVID-19 pandemic. Higher self-evaluated levels of importance of possessing digital competencies predicted more effective use of ICT during the COVID-19 pandemic (explained about 18% of variance). In contrast, attitude about the usefulness of digital technology was not a significant predictor. Understanding how important digital competencies are for distance learning is a basic prerequisite for the effective use of ICT. As in previous studies, a positive attitude toward the use of ICT has proven to be significant in predicting preschool teachers' effective use of ICT [28-31]. However, it seems that attitude about usefulness of digital technology was not important for preschool teachers' effective use of ICT. It is possible that preschool teachers do not believe that ICT is much helpful in their everyday work (only necessary during the period of COVID-19 pandemic) due to the developmental stage of young children and the lack of online platforms and digital educational technology optimized for children under six years old [18, 34].

Preschool teachers' effective use of ICT during the COVID-19 pandemic was best predicted by the perceived ease of use. An additional 18% variance was explained, whereas both predictors (use of ICT during the regular educational process and ICT competencies necessary for work during the COVID-19 pandemic) were significant. Preschool teachers who self-evaluated higher levels of previous use of ICT during the regular educational process (specific prior knowledge) and with a higher level of ICT competencies necessary for work during the COVID-19 pandemic used ICT during the COVID-19 pandemic more effectively. These results confirmed our expectations with modified TAM. Previous experience with ICT and specific ICT pandemic make using ICT effortless and hassle-free for preschool teachers, which has proven to be crucial for the effective use of ICT [35, 36].

One-way ANOVA (Table 3) was performed to check for the main effects of previous work experience on ICT use and digital competencies of preschool teachers. Previous work experience was also an indirect measure of participants' age, i.e., older preschool teachers had more than 20 years of work experience and were more than 50 years old. Previous work experience had shown only a significant effect on ICT competencies necessary for work during the COVID-19 pandemic; for other subscales of the Use of ICT Questionnaire and Digital Competencies Questionnaire, there were no statistically significant differences. Post hoc analysis using Gabriel's correction (for non-equal group size) showed that preschool teachers with the least work experience self-evaluated the highest

level of ICT competencies necessary for work during the COVID-19 pandemic. In contrast, preschool teachers with the most work experience self-evaluated the lowest level of ICT competencies necessary for work during the COVID-19 pandemic which could be the effect of their age and practical experience in everyday life with ICT. These results were in accordance with previous studies, which have shown a lack of knowledge and ICT competencies in senior preschool teachers [25, 35, 41].

TABLE III. RESULTS OF ONE-WAY ANOVA: TESTING MAIN EFFECTS OF WORK EXPERIENCE OF ICT AND DIGITAL COMPETENCIES

subscales	Work experience	N	M	SD	F _(2,102)
effective use of ICT during the COVID-19 pandemic	1-10 years	36	3.23	0.93	F = 0.241 p = 0.786
	11-20 years	41	3.36	0.98	
	> 20 years	27	3.21	1.13	
use of ICT during the regular educational process	1-10 years	36	3.54	0.73	F = 0.532 p = 0.589
	11-20 years	41	3.71	0.67	
	> 20 years	27	3.68	0.87	
ICT competencies necessary for work during the COVID-19 pandemic	1-10 years	34	3.52	0.58	F = 24.10 p = 0.000
	11-20 years	38	2.93	0.66	
	> 20 years	27	2.40	0.66	
importance of possessing digital competences	1-10 years	36	3.87	0.72	F = 0.273 p = 0.762
	11-20 years	41	3.98	0.71	
	> 20 years	27	3.87	0.63	
need for additional ICT education	1-10 years	36	3.14	0.91	F = 1.62 p = 0.202
	11-20 years	41	3.31	0.85	
	> 20 years	27	3.53	0.77	
usefulness of digital technology	1-10 years	36	3.75	0.71	F = 0.372 p = 0.690
	11-20 years	41	3.83	0.95	
	> 20 years	27	3.94	0.99	

IV. CONCLUSION

The results of the research are in accordance with previous worldwide studies about emergency distance learning, i.e., the use of ICT in early education [4-7]. The proposed modified TAM was partially confirmed:

- Extended TAM, which included external variables such as users' characteristics that shape experience in educational settings, was not confirmed in our study (years of work experience and need for additional ICT education were not significant predictors of effective use of ICT during the COVID-19 pandemic);
- Basic TAM, with main variables that predict effective use of ICT during the COVID-19 pandemic, i.e., Perceived Usefulness and Perceived Ease of Use, was confirmed;
- Perceived Usefulness as a measure of users' attitudes (i.e., the measure of indirect influence on ICT behavior) has shown to be a significant predictor (positive attitude about the importance of possessing digital competencies predicted more effective use of ICT during the COVID-19 pandemic);

- Perceived Ease of Use which measures recent experience during the COVID-19 pandemic with ICT use and represents a direct measure of effective preschool teachers' use of ICT during the COVID-19 pandemic, has shown to be the most important and significant predictor (use of ICT during the regular educational process and possession of ICT competencies necessary for work during the COVID-19 pandemic predicted more effective use of ICT during COVID-19 pandemic);
- At last, it was shown the main effect of previous years of work experience on ICT competencies necessary for work during the COVID-19 pandemic as was found in recent studies (preschool teachers with the least work experience self-evaluated the highest level of ICT competencies necessary for work during the COVID-19 pandemic, while preschool teachers with the most work experience self-evaluated the lowest level of ICT competencies necessary for work during the COVID-19 pandemic).

The methodological limitations of the research are reflected in the preschool teachers' subjectivity in the self-assessment of their digital competencies and ICT knowledge. These limitations may be overcome in future research with objective assessments by the users of the educational service (e.g., young children and their parents), objective tests of ICT knowledge, or observations by a co-teacher as a critical friend, i.e., by the researcher applying a non-participatory monitoring methodology.

Earlier findings are confirmed in the obtained study, further emphasizing the importance of giving ICT skills to preschool teachers, especially in conditions of a COVID-19 pandemic. After all, it can be concluded that previous experiences with ICT in everyday work and a specific set of ICT competencies were crucial for effective emergency distance education of preschool teachers, i.e., for the successful transformation of activities into a virtual environment during the COVID-19 pandemic.

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