Investigation of the Factors Affecting the Secondary School Students' Project Based Virtual Learning Qualifications by Structural Equation Modelling*

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ABSTRACT

This study aims to determine the predictive effect of attitudes toward digital technologies, gender, grade level, and internet usage time on project based virtual learning qualifications (PBVLQ) of secondary school students. The research design is a predictive correlational study. The sample of the research was 703 6th, 7th and 8th grade students in a small town in the southeastern region of Anatolia in Turkey which was selected with the convenience sampling method. In order to collect data, Project Based Virtual Learning Qualifications Scale, and Digital Technology Attitude Scale were used. The data were analyzed by structural equation modeling. According to the results, it was determined that students' attitudes towards digital technology significantly predicted PBVLQ in large effect. In addition, according to other results, it was determined that gender and internet usage time directly predicted the attitude toward digital technology, and indirectly predicted project-based learning virtual qualifications through attitude towards digital technology. In line with the data obtained from the research, it can be suggested to provide learning environments that will increase the attitudes of secondary school students toward digital technology and to increase the PBVLQ

Keywords: *Project-based virtual learning, attitudes toward digital technologies, secondary school students, qualifications*

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INTRODUCTION

With the developments in science and technology in the 21st century, learning approaches and the skills expected to be acquired by individuals have changed. Thus, students are expected to become more empowered individually by gaining skills in creating their learning environments and managing their learning (Morales et al., 2013). With these new educational paradigms, the constructivist learning approach has also taken its place in the curriculum to gain higher-order thinking skills for students. The basic assumption of the constructivist approach is that students actively construct knowledge, and the purpose of the learning environments designed by teachers is to encourage students to deep understanding rather than surface

knowledge and memorization (Kakouri, 2018; Paz & Hernández-Ramos, 2009). Therefore, constructivist learning approach aims to support intrinsic motivation and self-controlled learning in a meaningful context (ChanLin, 2008). Project-based learning is a student-centered method with these features supporting constructivist learning (Guitert et al., 2018).

Project Based Learning (PBL) is a comprehensive didactic approach in which students learn through problem solving activities, work collaboratively and have the opportunity to use a range of interdisciplinary skills (Biasutti & EL-Deghaidy, 2015; Kakouri, 2018). In interdisciplinary PBL environments, students are encouraged to integrate ideas and combine the features of different disciplines focused on a particular project (Biasutti & EL-Deghaidy, 2015). Students are usually assigned to projects according to their skills in the process of creating a product, and learning in project design occurs through the sharing of information among members of a collaborative team (Hong et al., 2011). With these features, PBL includes learning experiences that integrate students into real-life projects where they develop their knowledge and skills (Kakouri, 2018). Therefore, project-based learning is considered important in the context of using scientific knowledge in solving problems frequently encountered in daily life, creating a serious sense of curiosity and motivation while acquiring new information in the context of problem solving (Kokotsaki et al., 2016). At the same time, project-based learning is frequently used as a learning method based on providing basic skills such as intuitive thinking, analyzing, observing and experimenting, collecting data, interpreting data, and discussing (Akerson et al., 2019; Kokotsaki et al., 2016; Nacaroğlu & Mutlu, 2016; Tonbuloğlu et al., 2013). In this process, students solve real-world problems by designing their research, planning their learning, organizing their research and applying a large number of learning strategies (Bell, 2010). Based on this information, it can be said that project-based learning bridges the gap between real life and artificial teaching, especially by bridging theoretical and practical.

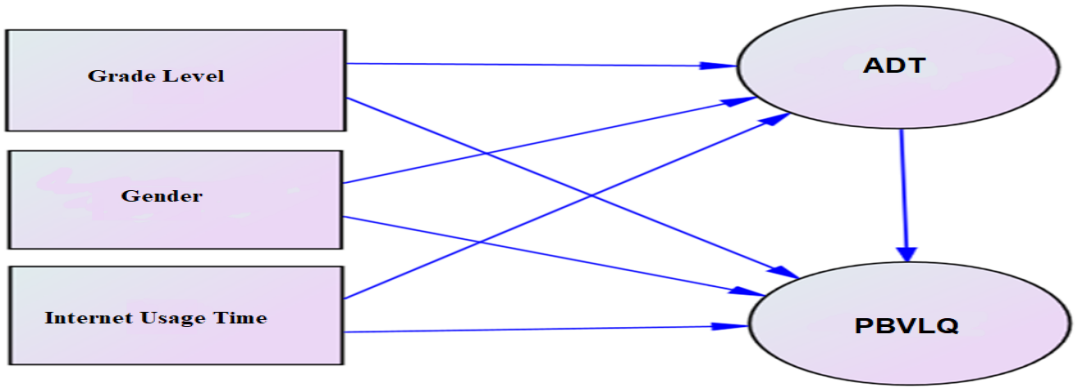
The use of advanced technologies can support the effective research process in PBL (Biasutti & EL-Deghaidy, 2015). As a result of developing technologies, it has also contributed to PBL with the popularity of virtual learning. In this way, it has become possible for students with a virtual learning program to carry out PBL activities (Paz & Hernández-Ramos, 2009). Moreover, the diversity of information provided by internet technology has greatly contributed to the information-gathering process, which is the first phase of PBL (Paz & Hernández-Ramos, 2013). The initial stage in PBVL is building work teams, and it is important to provide students with resources to create online groups. The next phase is the research phase and this process includes tasks such as planning and cooperation. Projects are developed as a result of research and collaboration of students in groups. Finally, the students finalize the collaboration process in groups by presenting the final form of their projects and discussing their projects in mixed groups created by the teacher (Guitert et al., 2018).

Integrating technology into PBL requires a strong connection with real-world scenarios and students must participate in a variety of actions (ChanLin, 2008). PBVLQ addresses dimensions such as project work, project execution, and finalization, starting a project, and project self-control (Yılmaz, 2012). The difficulties encountered in this process are initiating research, directing research, to managing time, and using technology efficiently (Kakouri, 2018). Therefore, students' competencies and attitudes toward technology are also important. Because while integrating technology with PBL, students are more likely to develop what they learn from technological skills and experiences (ChanLin, 2008).

The use of digital technologies is seen as an important component in carrying out educational activities in PBVL (Balaman, 2017; Chu et al., 2017; García, 2016; Guitert et al., 2018; Kakouri, 2018; Lin et al., 2013; Saracaloğlu & Çelik, 2018; Willard & Duffrin, 2003). In this respect, individuals' attitudes are thought to be important in the effective use and utilization of digital technologies (Erten, 2019). In this context, the examination of individuals' attitudes towards digital technology as an important predictor of PBVLQ in the digital environment can be guiding (Gönen et al., 2006). Therefore, it is important to investigate the effect of attitude towards digital technologies as a predictor of PBVLQ by using structural equation modeling.

The structural equation model facilitates the analysis of complex data sets, is stated to be used in the analysis of direct and indirect relationships between variables based on a theory (Byrne, 2001). This model is used in many disciplines to identify causes or consequences that previously existed among individuals or

groups (Fraenkel et al., 2012). Hence, this study aims to examine the variables affecting project-based virtual learning through structural equation modeling. The problem of this study is to examine the direct and indirect effects of gender, class level, internet usage time, and attitude toward digital technologies on PBVLQ (Figure 1).



PBVLQ: Project based virtual learning qualifications; ADT: Attitude towards Digital Technologies

Figure 1. The Hypothesized Model

The hypotheses in the model are stated below:

Hypothesis 1: Grade level is a statistically significant predictor of PBVLQ.

Hypothesis 2: Grade level is a statistically significant predictor of attitude towards digital technologies.

Hypothesis 3: Gender is a statistically significant predictor of PBVLQ.

Hypothesis 4: Gender is a statistically significant predictor of attitude towards digital technologies.

Hypothesis 5: Internet usage time is a statistically significant predictor of PBVLQ.

Hypothesis 6: Internet usage time is a statistically significant predictor of attitude towards digital technologies.

Hypothesis 7: Attitude towards digital technologies is a statistically significant predictor of PBVLQ.

RESEARCH METHOD

Research Model

This study is correlational research to determine the predictive effect of the ADT, gender, class level, and internet usage time variables on PBVLQ. Correlational studies can be examined in two groups predictive and exploratory correlational studies according to the purpose of the study (Fraenkel et al., 2012). The structural equation model is used as the analysis method to examine the explanatory relationships between variables in predictive relational models (Pituch et al., 2015; Tabachnick & Fidell, 2012). In Table 1, the endogenous and exogenous variables of the research are shown.

Table 1. ***The Endogenous and Exogenous Variables of the Research***

Variables	Endogenous	Exogenous
PBVLQ	x	
ADT		x
Gender		x
Grade Level		x
Internet Usage Time		x

Population and Sample

The target population consists of 6th, 7th and 8th grades students in a small town in the southeastern

region of Anatolia in the 2019-2020 academic year in Turkey. The sample consists of 703 students from the 6th, 7th, and 8th-grades students studying selected from the population by using the convenience sampling method (Fraenkel et al., 2012). To get reliable results in SEM, the sample size should be twenty times the variables used in defining latent variables (Jackson, 2003). Within the scope of this study, since the number of observed variables considered in the research is 16 (PBVLQ = 5, ADT = 8, GR = 1, GL= 1, IUT = 1), it will be appropriate to conduct the study with at least 320 students.

Data Collection Tools

In this study, The Project Based Virtual Learning Qualifıcations Scale (PBVLQS) developed by Yılmaz (2012) and the Digital Technologies Attitude Scale (ADT) developed by Cabı (2016) were used to collect data.

The Project Based Virtual Learning Qualifıcations Scale

PBVLQS is a 5-point Likert type consisting of 5 sub-dimensions (group work, execution, conclusion, introduction, self-control) and 22 items. To determine the 5-factor structure validity for the sample of this study, a confirmatory factor analysis (CFA) was performed for the PBVLQS with the data collected from 188 6th, 7th and 8th grade secondary school students. According to the CFA results, it is seen that $\chi 2$ / df value is 1.13. So, it is said that that is little difference between the expected and the observed model (Suhr, 2006). Standardized factor loadings of the scale range from 0.35 to 0.65. According to the results of the confirmatory factor analysis carried out, the fit indices of the measuring tool were found as CFI = 0.99, NFI = 0.92, NNFI = 0.98, GFI = 0.90, AGFI = 0.87, RMSEA = 0.027. Based on these values, it was determined that the five-dimensional model in the original scale was also suitable for this sample (Kline, 2010a; Schermelleh-Engel et al., 2003; Suhr, 2006; Tabachnick & Fidell, 2012). The Cronbach Alpha of the PBVLQS was found 0.83. Kline (2010a) stated that the reliability coefficient of around .90 is “excellent”, the reliability coefficients around .80 are “very good”, and the reliability coefficients around .70 are “sufficient”.

The Digital Technologies Attitude Scale

ADT was developed by Cabı (2016) to examine high school students attitudes toward digital technology and consisted of 39 items and 8 sub-dimensions (competence, social networks, use of technology in class, interest in technology, technology for me, negative aspects, entertainment, purposeful use, and conscious use). The 8-dimensional model in the original scale was tested by making CFA for the ADT scale with the data collected from 329 6th, 7th and 8th-grade students. According to the CFA results, it is seen that $\chi 2$ / df value is 1.38. The fit indices of the measuring tool were found as CFI = 0.98, NFI = 0.94, NNFI = 0.98, GFI = 0.88, AGFI = 0.85, RMSEA = 0.034. In light of these findings, it was determined that the eight-dimensional model was also suitable for this sample (Kline, 2010a; Schermelleh-Engel et al., 2003; Suhr, 2006; Tabachnick & Fidell, 2012). At the same time, the Cronbach Alpha reliability coefficient was determined as α = .87 and it was found to be reliable for this study (Kline, 2010a).

Data Analysis

Before analyzing the data, erroneous and missing data were determined (Field, 2009; Pallant, 2013). It was determined that 52 data forms contain missing data. After eliminating the missing data, 703 data sets remained. Later, the scores obtained from each scale were converted into standard z-scores to determine outliers (Tabachnick & Fidell, 2012). Univariate and multivariate normal distributions of the data were checked to perform SEM (Byrne, 2001). In the examination of the univariate normality assumption for the data, the skewness and kurtosis values, examination of the histogram and Q-Q plots, and Kolmogorov-Smirnov test ($p>0.05$) and z scores (between +3 and -3) were examined. In addition, outliers were determined by calculating Mahalanobis distances for multiple normality, and extreme values ($p>0.01$) were excluded from the sample.

In the next step, Pearson Product-Moment Correlation Coefficient is used to determine the direction and degree of relationship between variables, and The Multivariate Kurtosis Coefficient was calculated to test the multivariate normality assumption for SEM. Considering the multivariate normality analysis values, it can be stated that the data meet the multivariate normality assumptions (multivariate kurtosis:4.645,

multivariate c.r.: 2.910). It can be accepted that the data set shows multivariate normal distribution when the critical ratio value for multivariate normal distribution is less than 5 (Bentler, 2006). Since the data show a multivariate normal distribution, the hypothesis model was tested using the Maximum Likelihood method (Kline, 2010b).

SEM analysis was carried out with a two-stage approach by analyzing the measurement model and the structural model separately, taking into account the data set (Yılmaz & Çelik, 2016). In this context, CFA was conducted as the first step of the two-step approach in this study. Afterwards, analyzes were made by drawing the paths with SEM. When interpreting the effect size results obtained, R2 = 0.02 small effect; 0.13 medium effect; 0.26 was considered as the large effect (Cohen, 1988). On the other hand, the classification of the effect size can also be made according to the size of the standardized regression coefficients. Kline (2010b) made a classification according to the effect size of the standardized regression coefficients, based on Cohen's (1988) suggestions about the effect size. Accordingly, if the standardized regression coefficient (β) is less than 0.10, it is considered as a small effect, if it is around 0.30, it is considered as a medium effect, and if it is greater than 0.50, it is considered as a large effect.

FINDINGS

Findings of Measurement Model and Descriptive Analysis

The descriptive analysis results of the variables analyzed are given in Table 2.

Table 2. *Descriptive Analysis Results*

			N	%	PBVLQ	ADT
Gender	Female		342	48.6	3.53	3.26
	Male		361	51.4	3.52	3.56
Grade level	6		183	26.0	3.46	3.27
	7		309	44.0	3.55	3.44
	8		211	30.0	3.55	3.50
Internet Usage Time	None		76	10.8	3.02	2.90
	Less than 1 hour		312	44.4	3.43	3.32
	1-2 hour		230	32.7	3.69	3.57
	3-4 hour		70	10.0	3.83	3.80
	5-6 hour		15	2.1	3.98	3.91
	Mean	Sd	Min	Max	Kurtosis	Skewness
PBVLQ	3.5289	.798	1.00	5.00	-.781	.810
ADT	3.4191	.581	1.51	4.97	-.285	.253

Then, the correlations of the relationships between the observed variables were examined (Table 3).

Table 3. *Correlation Coefficient Values Between Variables*

Variables	Gender	GL	IUT	PBVLQ	ADT
GL	.056	1.00			
IUT	.048	.185**	1.00		
PBVLQ	-.010	.037	.279**	1.00	
ADT	.257**	.142**	.414**	.590**	1.00

**The correlation is significant at the 0.01 level.

Findings of Structural Model

The values for the significance of the standardized regression coefficients and the regression coefficients are shown in Table 4.

In Table 4, it is seen that the path between IUT and PBVLQ is not significant (β =-.043, c.r.=-1.216, p>.01). According to these results, the fifth hypothesis of the study was rejected.

Table 4. ***Findings Regarding the First Model***

			B	β	S.E.	C.R.(t)	p
PBVLQ	<---	GL	-.061	-.058	.033	1.862	.063
ADT	<---	GL	.056	.058	.036	1.576	.115
PBVLQ	<---	GR	-.341	-.216	.051	-6.703	***
ADT	<---	GR	.350	.241	.053	6.621	***
PBVLQ	<---	IUT	-.038	-.043	.031	-1.216	.224
ADT	<---	IUT	.345	.424	.031	11.252	***
PBVLQ	<---	ADT	.880	.809	.052	16.824	***

Findings Regarding the Second Model

The findings for the second model are given in Table 5.

Table 5. ***Findings of the Second Model***

			B	β	S.E.	C.R.(t)	p
PBVLQ	<---	SD	-.066	-.062	.032	-2.022	.043
ADT	<---	SD	.057	.059	.036	1.601	.109
PBVLQ	<---	GR	-.334	-.212	.051	-6.620	***
ADT	<---	GR	.351	.242	.053	6.607	***
ADT	<---	IUT	.340	.416	.030	11.150	***
PBVLQ	<---	ADT	.854	.786	.047	18.210	***

In Table 5, it is seen that the path between grade level and attitude towards digital technologies is not significant (β =-.059, c.r.=1.601, p> .01). So, the second hypothesis of the study was rejected.

Findings Regarding the Third Model

Standardized regression coefficients and values of the analyzes performed for the third model are given in Table 6.

Table 6. ***Findings Regarding the Third Model***

			B	β	S.E.	C.R.(t)	p
PBVLQ	<---	GL	-.056	-.053	.032	-1.783	.075
PBVLQ	<---	GR	-.334	-.211	.051	-6.622	***
ADT	<---	GR	.355	.244	.053	6.675	***
ADT	<---	IUT	.349	.427	.030	11.571	***
PBVLQ	<---	ADT	.852	.783	.047	18.305	***

In Table 6, it is seen that the path between grade level and PBVLQ is not significant (β =-.053, c.r.=-1.783, p>.01). According to these results, the first hypothesis of the research was rejected.

Findings of the Final Model

After the hypotheses were rejected, the model was modified. In this modified model, all paths were found to be statistically significant (p <.01). The standardized regression coefficients of the final model and regression coefficients are given in Table 7.

Table 7. ***Findings Regarding the Final Model***

			B	β	S.E.	C.R.(t)	p
PTSÖY	<---	CSYT	-.236	-.150	.049	-4.806	***

DTYT	<---	CSYT	.243	.173	.056	4.377	***
DTYT	<---	İKS	.318	.404	.030	10.687	***
PTSÖY	<---	DTYT	1.024	.909	.060	17.207	***

It was determined that four hypotheses of SEM were accepted and three were hypotheses rejected. Fit indexes for the final model are given in Table 8.

Table 8. ***Fit Indices for the Final Model***

Fit Indices	Acceptable fit values	Good fit values	The Final Model
χ^2/sd	$2 \leq \chi^2/sd \leq 5$	$0 \leq \chi^2/sd < 2$	1.801
GFI	$0.90 \leq GFI < 0.95$	$0.95 \leq GFI \leq 1.00$	0.982
AGFI	$0.85 \leq AGFI < 0.90$	$0.90 \leq AGFI \leq 1.00$	0.962
NFI	$0.90 \leq NFI < 0.95$	$0.95 \leq NFI \leq 1.00$	0.980
NNFI/TLI	$0.95 \leq NNFI < 0.97$	$0.97 \leq NNFI \leq 1.00$	0.984
IFI	$0.90 \leq IFI < 0.95$	$0.95 \leq IFI \leq 1.00$	0.991
CFI	$0.95 \leq CFI < 0.97$	$0.97 \leq CFI \leq 1.00$	0.991
RMSEA	$0.05 \leq RMSEA \leq 0.08$	$0 \leq RMSEA < 0.05$	0.034
RMR	$0.05 \leq RMR \leq 0.08$	$0 \leq RMR < 0.05$	0.019
SRMR	$0.05 \leq SRMR \leq 0.08$	$0 \leq SRMR < 0.05$	0.008

According to Table 7, it has been found that all the values have a good fit (Brown, 2015; Kline, 2010a; Schermelleh-Engel et al., 2003; Suhr, 2006; Tabachnick & Fidell, 2012). As a result of the analyzes performed, the final model, standardized path coefficients (β), and variance ratios (R2) are shown in Figure 2.

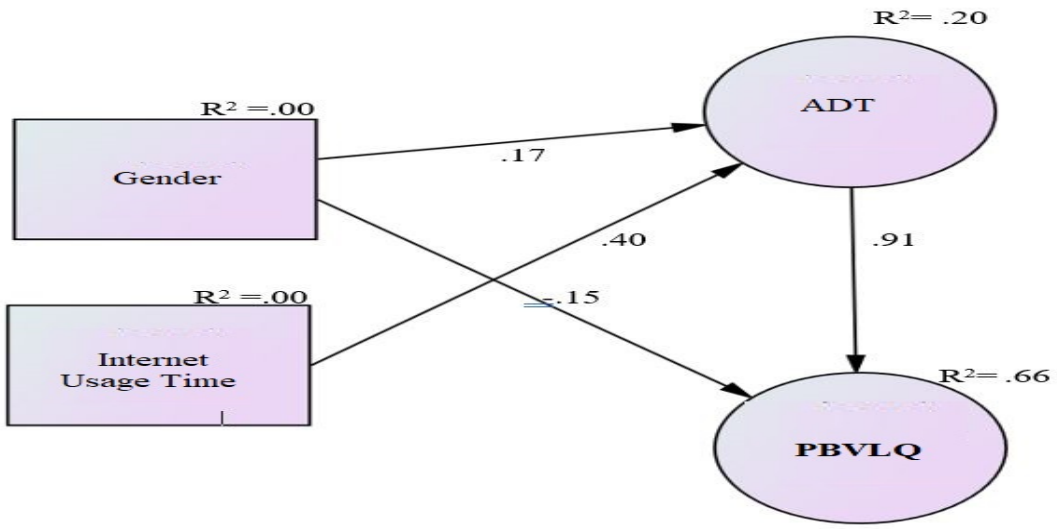


Figure 2. ***The Final Model***

According to this model, gender directly (β = -0.150; c.r (t) = -4.806; p <.01) affects PBVLQ at a statistically significant level. At the same time, gender directly (β = 0.173; c.r (t) = 4.377; p <.01) positively significantly affects the ADT. Likewise, it was determined that an increase of 1 standard deviation related to gender causes an increase of 0.173 standard deviations on ADT. It is seen that ADT has a partial mediating role in the relationship between gender and PBVLQ. IUT, on the other hand, is seen to have a statistically significant positive effect directly (β = 0.404; c.r (t) = 10.687; p <0.05). IUT and gender explain approximately 20% of ADT.

The ADT affects PBVLQ directly (β = 0.909; c.r (t) = 17.207; p <.01) positively and statistically significantly. It has been found that an increase of 1 standard deviation in attitude towards digital technologies leads to an increase of 0.91 standard deviations on PBVLQ. So ADT has a large effect on PBVLQ. When the final model is examined, gender, IUT, and ADT together explain approximately 66% of the variance of PBVLQ with a large predictive effect in practice (Kline, 2010b). When the effect sizes are examined, gender

and IUT explain about 20% (R2=0.20) of the variance in ADT. It has a moderate predictive effect in practice (Kline, 2010b).

DISCUSSION AND CONCLUSION

In this study, the model created to determine the predictive effect of the variables of attitude towards digital technologies, gender, class level, and internet usage time on PBVLQ was tested by SEM. According to the results, it was concluded that grade level does not have a predictive effect on PBVLQ and attitude toward digital technologies in secondary school students. However, Yılmaz (2012) found a significant difference according to grade level in terms of all sub-dimensions of PBVLQ in his study with prospective teachers. Especially, this difference occurred in the sub-dimension of project finalization qualifications, but no significance was found in other sub-dimensions. It is thought that such a difference may arise from the sample consisting of prospective teachers. In a study, no significant difference was found in students' attitudes towards computers from digital technologies in terms of grade level (Altun et al., 2011). These results are parallel with the present study. However, in some studies, it was concluded that attitudes toward technology differ significantly according to grade levels (Akın & Baştuğ, 2005; Van Braak et al., 2004; Yalmancı & Aydın, 2014). In this respect, the results of these studies are not similar to present study. According to another result, internet usage time has an indirect effect on PBVLQ through attitude towards digital technologies. Furthermore, according to the findings of the study, a standard deviation change related to gender causes an 0.51 standard deviation change in PBVLQ. Based on this, it was concluded that gender has a lower predictive effect on PBVLQ (Cohen, 1988; Kline, 2010a). In addition, the attitude towards digital technologies has a partial mediating role between gender and PBVLQ. In Yılmaz's (2012) study, in the self-control competencies sub-dimension of the PBVLQ, a significance in favor of males. Furthermore, Kayıran (2009) and Korkmaz (2002) also found results in line with the present study.

Besides, it was concluded that gender has a moderate predictive effect on attitudes toward digital technologies (Cohen, 1988; Kline, 2010a). So, it was concluded that the positive effect of gender on attitude towards digital technologies is in favor of male individuals. There are many studies in the literature on the difference between attitudes toward digital technologies and gender (Altun et al., 2011; Anderson et al., 2008; Arslan et al., 2011; Aydın et al., 2017; Cabı et al., 2016; Kubiatko et al., 2010; Liu et al., 2013; Mehloff & Sisler, 2001; Poellhuber et al., 2011; Sargın, 2013; Volman et al., 2005). In some studies, it has been determined that male individuals have better and more positive experiences of teamwork and using digital technologies than girls (Poellhuber et al., 2011; Sargın, 2013). At the same time, in terms of attitudes toward technology, it has been stated that male individuals are more competent in digital technologies and that males use technology more in their studies (Arslan et al., 2011; Aydın et al., 2017). In another study examining attitudes toward information and communication technologies, it was observed that gender differences are very small at the primary education level, and girls exhibit less positive attitudes than boys at the secondary education level (Kubiatko et al., 2010; Volman et al., 2005). These results can be interpreted as female individuals being shy about their technology use skills and worrying about trust (Mehloff & Sisler, 2001). However, in studies examining secondary school students' attitudes toward internet use in some studies, it was concluded that attitudes towards internet use did not make a significant difference in terms of gender (Çetin et al., 2012; Yavuz, 2016). The reason for the lack of significance in this study may be that the study sample was chosen only from 7th graders. In the present study, 6th, 7th and 8th grades were chosen as samples.

According to the findings of the study, internet usage time has a moderate predictive effect on attitude toward digital technologies (Cohen, 1988; Kline, 2010b). In the literature, it has been stated that internet usage time positively affects individuals' attitudes toward digital technologies (Aydın et al., 2017; Çetin et al., 2012; Yavuz, 2016). These studies parallel with the present study. As a result, gender and internet usage time,

which are predictors of attitude towards digital technologies, explain 20% of its variance. According to an important finding of the study, a standard deviation change in students' attitudes toward digital technologies causes a 0.91 standard deviation change in the same direction in PBVLQ. Therefore, it was concluded that attitude toward digital technologies has an large predictive effect on PBVLQ (Cohen, 1988; Kline, 2010a). There are experimental studies indicating that technology attitude has a positive effect on project-based virtual learning (Biasutti et al., 2018; Biasutti & EL-Deghaidy, 2015; González-Marcos et al., 2016; Guitert et al., 2018; Kakouri, 2018; Karaduman & Öztürk, 2014; Yılmaz, 2012). In their study, Biasutti and EL-Deghaidy (2015) developed interdisciplinary projects on the Moodle platform via Wikis. It was emphasized that individuals enjoy and are satisfied with developing projects in such a virtual environment. Karaduman and Öztürk (2014) concluded in their study that digital citizenship activities based on project-based learning in the virtual learning environment positively affect attitudes of digital technologies. Similarly, in another study, it was stated that eighth grade students participating in a virtual environment-supported project-based learning experience developed positive attitudes and beliefs while carrying out their projects (Paz & Hernández-Ramos, 2009). Therefore, it has proven particularly effective when project-based learning is combined with digital technologies (Edelson et al., 1999; Solomon, 2003) because the digital technologies promotes teamwork (Kloppenborg & Baucus, 2004) and develop communication, cooperation and negotiation skills (Bell, 2010).

Considering that digital technologies offer various benefits and opportunities in the learning process, it is thought that the use of digital technologies meets the individual learning needs of students and provides a kind of personalized guidance (Mama & Hennessy, 2013; Santos & Boticario, 2015). In addition, recent studies have shown that there are significant relationships between the use of digital technologies in support of the project studies, and the attitudes of individuals towards these technologies, their willingness to learn and their satisfaction (Paechter et al., 2010). In this context, it can be said that digital technology tools should be used frequently in order to make students feel safe in the classroom and support their learning by creating a flexible and supportive classroom environment in a project-based virtual learning environment and a fun environment to develop positive teacher-student and peer relationships (Başer et al., 2017; Biasutti et al., 2018; Hogue et al., 2011; Hong et al., 2011).

Finally, it was concluded that secondary school students' gender, internet usage time and attitudes toward digital technologies are significant predictors of PBVLQ. In virtual project-based learning environments, it can be interpreted as project work, execution, finalization, introduction, self-control, and the effective realization of competencies depending on the development of positive attitudes toward digital technologies. Based on all these results, it can be said that it is an important step in understanding the nature of the different variables and the relationships between variables that affect the PBVLQ of secondary school students, which are limited in the literature.

The most important result reached as a result of this study is that the attitude towards digital technologies has a large effect on PBVLQ. In this context, in order to improve the PBVLQ of individuals, digital competencies should be developed by including digital technologies in in-class and extracurricular activities. It is thought that this situation will positively reflect on the attitudes of individuals toward digital technologies and thus on their PBVLQ. According to the results obtained from the research, it is possible that the efforts to improve internet usage time can directly reflect the attitude towards digital technologies. As a result it can be said that PBVLQ can improve by increasing daily internet usage time.

In the present study, the hypothesis obtained using the path analysis technique is limited to the external variables included in the model, gender, grade level, daily internet usage time and attitude toward digital technologies. In future studies, a new model can be created and tested, which examines the effect of factors such as technology self-efficacy, which may have predictive effects on project-based virtual learning

qualifications. Therefore, the study is limited to the 6th, 7th and 8th grade students studying in two different secondary schools in a province in the Southeastern Anatolia Region of Turkey. Accordingly, the scope of the research can be expanded to secondary school students in other provinces. The data obtained in this study were reached only with Likert type measurement tools, that is, the research findings were limited to the qualities measured by the measurement tools. In future studies, in-depth analyzes and evaluations can be made using different data collection methods such as observation and interviews. Also, the effectiveness of the research can be tested by experimental designs for the predictive effect of PBVLQ.

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