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Validation of the Professional Technology Competencies Model for Elementary School Principals

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Abstract

Introduction: The main objective of this study was to validate the model of technological professional qualifications of elementary school principals in Fars province.

Methodology: The method of conducting this research was descriptive survey. The research population in the quantitative part was managers working in primary education in Fars province, which according to the obtained statistics was 3950 people, of which 351 people had to be selected based on the Morgan and Krejsi table. Initially, 6 cities from Fars province were randomly selected using the multi-stage cluster sampling method. The main tool in the quantitative part was a researcher-made questionnaire taken from the qualitative part, the indicators of which were adjusted and compiled under the supervision of the supervisor and consultant, and after assessing the face validity, the content validity was estimated. The content validity of the tool was estimated with the Lawshe coefficient. To measure the reliability of the research tool, Cronbach's alpha was used and it was obtained above. /7.

Findings: In the qualitative part, a model of school principals' technological competence was developed, which consisted of 67 basic themes, 15 organizing themes, and six comprehensive themes. The results of the quantitative part showed that the square of the convergent validity of each construct was greater than the correlation values between other constructs, so the research model was confirmed in terms of divergent validity according to the Fornell and Larker method. Also, the SRMR index was equal to 0.066, which indicates a high fit of the model

Conclusion: It can be concluded that improving the technological competence of school principals can provide the basis for the appropriate use of modern educational technologies for all factors affecting education and those affected by education.

Key Words: Professional qualifications, technology, primary education managers

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Introduction

Advanced technologies in today's societies have transformed all aspects of human life. For this reason, economic, social and cultural subsystems in these societies have been integrated with technological facilities in various ways under the influence of specific needs. The education system, as one of the important and fundamental subsystems in any society, has benefited from information and communication technology at various levels of primary, secondary, higher education and in-service vocational training with different goals and methods. In fact, ICT can be used as a powerful tool to improve the quality and efficiency of education and transform traditional methods of education and help improve the teaching and learning process. Developed countries and some developing countries have developed programs and activities to cope with technological changes. Teachers and school administrators in the 21st century need to develop skills that allow them to make the best use of computers as an educational tool. These skills will help students learn better and prepare them for a technologically advanced society, a society in which students' lifestyles, attitudes, and skills face new challenges on a daily basis (Atstsaury et al., 2024). To achieve this goal, teachers and administrators need to be well prepared, have sufficient time for training, and receive ongoing support to ensure that they acquire knowledge, skills, and confidence in ICT education (Nurhidayat et al., 2024).

If the education system intends to provide desirable school services to all students, it must provide managers with a development in the field of high-quality technological professional qualifications model. The professional development of teachers and the improvement of the teaching-learning process and, as a result, the success of students, depend on the development of the technological professional qualifications model of managers. Therefore, by looking ahead in the field of developing the technological professional qualifications model of school managers, the grounds for realizing the goals of the education system in the field of development are prepared (Nourad Seddiq et al., 2017). School managers, having desirable technological professional qualifications, will be able to lead schools in a way that provides the prerequisites for the development of the education system. Without a doubt, education will reach development when it has developed human resources.

On the other hand, the model of technological professional competencies of administrators and their perception of this has a significant impact on the professional development of teachers and the success of students (Boudreaux, 2015). Designing and validating the model of technological professional competencies of school administrators is valuable because it can lead to student academic progress and can also lead to the progress and improvement of teacher performance (Wise, 2017).

Despite the research that has been conducted on teachers' technological skills and competencies, it has not yet been precisely determined what technological skills and competencies elementary school principals should be equipped with in order to have an effective teaching-learning process. Therefore, research in this field is necessary so that through its results, teachers can improve their level of education and take more initiative in their teaching. This research can also lead to the design of training that will bring teachers to the necessary level of preparation and skills commensurate with the available technological facilities (Tahmasibizadeh et al., 2010).

By conducting this research, the main indicators of the technological professional competence model of elementary school principals have been identified and validated, and a comprehensive model for the technological professional competence of school principals has been designed.

Methodology

In the quantitative part, a descriptive survey method was used. The main goal of this part was to validate the content of the model and the components extracted from the qualitative part of the research.

The research population in the quantitative part was managers working in primary education in Fars province, which according to the statistics obtained, was 3950 people, of which 351 people were selected based on the Morgan and Krejci table. Initially, 6 cities from Fars province were randomly selected using the multi-stage cluster sampling method. These cities were Abadeh, Kazerun, Jahrom, Fasa, Lar, and Marvdasht. Then, the questionnaire was distributed to all school managers. Finally, 342 analyzable questionnaires were collected.

As mentioned, the main tool in the quantitative part was a researcher-made questionnaire taken from the qualitative part, the indicators of which were prepared and compiled under the supervision of the supervisor and consultant, and after assessing the face validity, content validity was assessed. Content validity was estimated by Lavesh. For this purpose, 6 university professors were asked to respond to a questionnaire designed as a three-part Likert-type option: essential, useful but not essential, and not essential. The formula for obtaining it is mentioned below.

By collecting the opinions of the experts, the CVR value was calculated using the following formula:

$$CVR = \frac{n_e - N/2}{N/2}$$

In this formula, N is the total number of experts and Ne is the number of experts who selected the essential option. The CVR value depends on the number of experts participating in this section. Considering the number of experts in this study, which was 20, the CVR value should be 0.42or more.

In the second stage of CVI, the validity of the model was examined. In this way, each item was preceded by the words irrelevant, needs major revision, relevant but needs revision, and completely relevant. The number of experts who chose options 3 and 4 was divided by the total number of experts. If the resulting value was less than 0.7, the item was rejected, if it was between 0.7 and 0.79, revision should be performed, and if it was greater than 0.79, it was acceptable

In this study, Cronbach's alpha was used to assess the reliability of the components and general items of the questionnaire, the results of which are detailed in the table below.

Table ۱- Reliability of the components of the questionnaire for assessing the technological competence of elementary school principals

Component	Alpha	Composite reliability
Troubleshooting	./84	./81
Systems thinking	./75	./83
Digital Craze	./70	./83
Execution skills	./73	./76
Information literacy	./74	./83
Digital communication	./83	./89
Safety	./83	./88
Recognition	./70	./82
Application	./69	./81
Recognition	79/0	./86
Application	./90	./84
Design	./92	./84
Production	./80	./86
Individual	./81	./87
Moral	./75	./84

Research Findings

The findings of the qualitative part of this research have been accepted into an independent article and published in a reputable journal.

A summary of the designed qualitative model is given below:

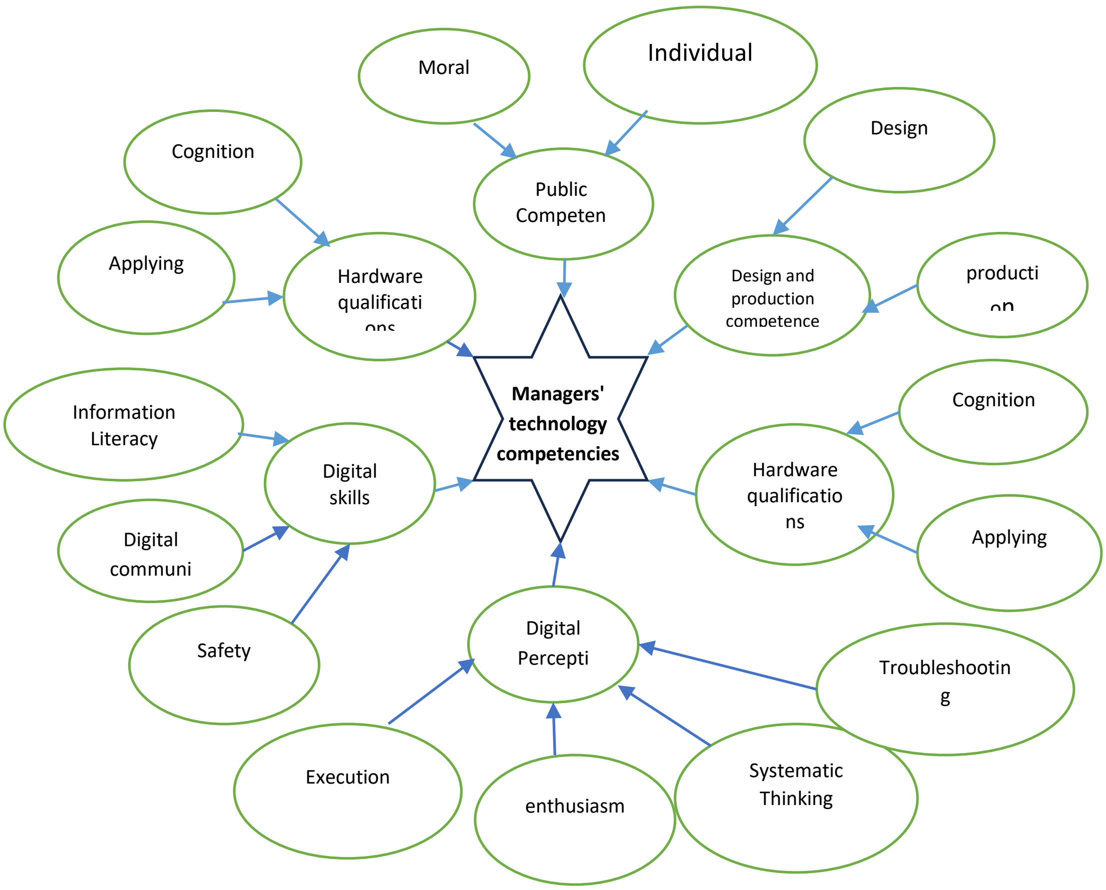

Figure 1: Thematic network of the primary school managers' technological competencies model

Through a thematic analysis process based on the Atride and Stirling model and after reviewing and eliminating basic repetitive themes, 67 basic themes were finally designed, 15 organizing themes including (personal, ethical, design, production, hardware knowledge, hardware application, software knowledge, software application, information literacy, digital communication, digital safety, troubleshooting, systems thinking, digital passion, and implementation) and six main overarching themes including (general competencies, design and production competencies, hardware competencies, software competencies, digital skills, and digital perception).

Quantitative analysis:

The Kolmogorov-Smirnov test was used to examine the normality of the distribution, and the results are shown in the table below:

Table 2- Kolmogorov-Smirnov test for research variables

Normality result	Significance level	Statistics	Research variables
. It's not normal	p= 0.05	045/0	Technology competencies

As can be seen in the table, since the significance level is ./05, the null hypothesis is rejected, meaning that the research variables are not all normal and it is better to use the partial least squares method.

The main research question:

Does the model of components of the technological competencies model of elementary school managers in Fars province have the necessary validity?

In this section, the data were analyzed using PLS software. In this section, it is necessary to explain the relevant model. In PLS analysis, manifest variables are repeatedly used to conceptualize a hierarchical model; in such a way that a higher-order latent variable can be constructed through all manifest variables and lower-order items.

Confirmatory factor analysis was used to validate the components. Confirmatory factor analysis is essentially a method for testing hypotheses and is used in cases where the researcher has previously assumed relationships between indicators (factors) and questions (items) and intends to evaluate the data against a previously determined structure. In this method, the items of each factor or indicator uniquely measure their respective dimension. Confirmatory factor analysis examines whether the items (indicators) proposed to represent each dimension are truly representative of that dimension. It also reports how accurately the selected items represent or fit their factor or latent variable, which is described in the following steps.

In first-order confirmatory factor analysis, the relationship between a factor or factors (latent variables) and items (observable variables) is measured. In this method, no relationship between latent variables is examined. This type of measurement model is only to ensure that the latent variables are measured correctly. In first-order confirmatory factor analysis, the relationship between a factor and multiple items or multiple factors and multiple items can be examined.

According to theoretical principles, the factor loading should be greater than 0.3, but the higher this loading, the greater the contribution to the measurement of the relevant variable and vice versa. According to the above figure, it can be said that in the model in question, all the obvious variables with factor loadings greater than 0.5 are included in the model, which indicates a very favorable level for measuring the variables. All coefficients are significant at the 0.95 confidence level;

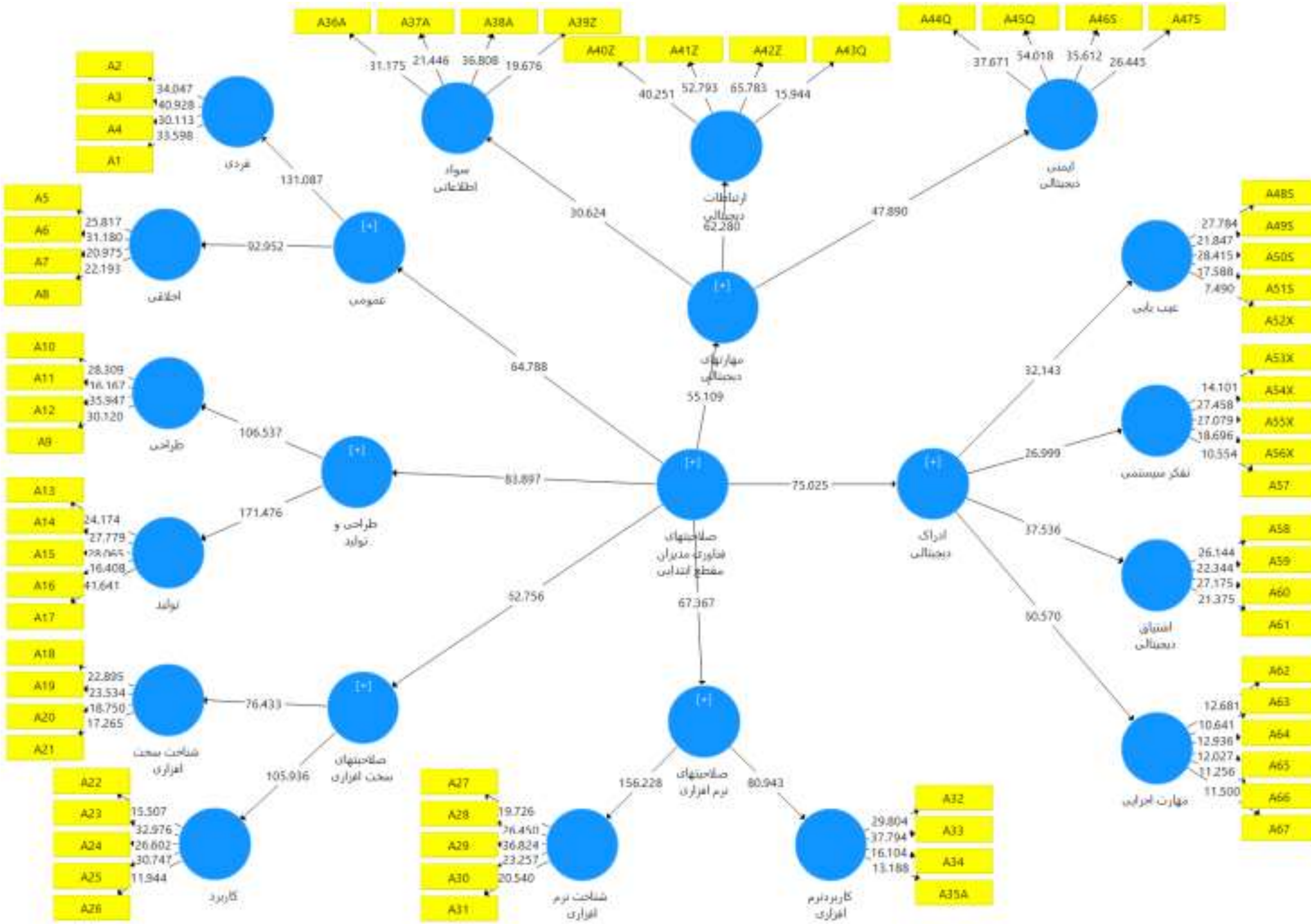

Table3- First-order factor analysis

Component		Items	Factorial load
Individual	1	Having enough intelligence to do things , especially . technological activities	./79
	2	. Having sufficient motivation to advance in your career	./80
	3	Having a positive attitude towards various types of technology . and its use in the teaching profession	./83
	4	Having patience in learning new activities , especially . technological activities	./78

Moral	5	Understanding the social and legal issues of technology . application	./75
	6	Understanding the ethical and human issues of applying technology in various matters, especially the teaching profession .	./79
	7	Correct use of technology based on formal laws and societal . customs	./74
	8	Timely application and appropriate use of technology according . to different educational and teaching conditions	./75
Design	9	Ability to identify and plan flexible and implementable educational goals.	./76
	10	Ability to recognize and implement teaching methods based on . various educational environment conditions	./78
	11	. Ability to plan for the use of technologies in teaching	./66
	12	The ability to formulate goals and make goals flexible in line with . various educational and teaching conditions	./80
Production	13	The ability to produce supplementary content in the simplest and most understandable way possible.	./74
	14	Ability to produce supplementary course content in line with the educational level and existing courses.	./73
	15	Ability to produce attractive supplementary content and use various applications and programs.	./76
	16	The ability to distribute and make produced content available to target and larger groups.	./69
	17	Identifying the audience's need for additional and updated content.	./81
Getting to know the hardware	18	Familiarity with the computer , its components , and how they .work	./73
	19	. Familiarity with video , projectors , and interactive players	./75
	20	Introduction to smart boards and their troubleshooting	./73
	21	Familiarity with the types of equipment that help teachers achieve educational goals.	./69
Hardware usage	22	Ability to work with and troubleshoot computers.	./65
	23	. Ability to work with video , projectors , and interactive players	./79
	24	Ability to work with smart boards and troubleshoot them	./78
	25	Ability to work with modems and other communication equipment	./78
	26	Ability to build and use other equipment according to conditions and facilities in order to achieve educational goals.	./65
Familiarity with software	27	Complete understanding of LMS programs and other web-based programs for classroom and school management	./70
	28	Complete understanding of educational software such as simulators	./75
	29	Understanding how to design electronic forms and share their . links	./81
	30	Complete knowledge of teaching resources and teaching aids to make learning effective.	./72
	31	Introduction to Task List software: To assign and update tasks	./71

Application of software	32	Ability to use systems such as LMS, Skyroom, and other web-based applications	./80
	33	Ability to use various software such as Photoshop andADSL .	./80
	34	Ability to use textbooks and teaching aids in a useful and timely manner in different situations, according to various educational conditions	./66
	35	Ability to usetask lists	./61
Information literacy	36	. The ability to search and filter	./78
	37	Digital information . The ability to evaluate information , data , . and digital content	./74
	38	. Knowledge of digital technologies with educational activities	./81
	39	Having knowledge of integrating technology and familiarity with . Internet networks	./65
Digital communication	40	. Establishing relationships through digital technologies	./84
	41	.Distributing information and content on the web	./86
	42	Collaboration and partnership with media and educational . channels	./88
	43	Ability to manage digital identity	./67
Digital safety	44	. Ability to protect digital devices and content	./81
	45	The ability to protect your and your students' personal data and . preserve their identity	./84
	46	. Protect the physical and mental health and safety of students	./81
	47	Protecting the surrounding space and online learning environment .	./78
Troubleshooting	48	Understanding one's own spirituality and the shortcomings and .positive and negative aspects of one's work	./77
	49	Complete understanding of the systems thinking process in order .to solve problems	./73
	50	. Mobilizing technical capabilities to solve educational problems	./75
	51	Ability to communicate with experts to resolve technology . problems	./69
	52	.Fixing technology problems and getting feedback from them	./45
Systems thinking	53	. Familiarity with systems thinking and approach	./66
	54	. Ability to interact with all stakeholders	./79
	55	The ability to identify the whole with its parts in school dynamics .	./81
	56	The ability to conceptualize and practice leadership to improve . learning	./75
	57	The ability to organize and examine multiple aspects of a topic . simultaneously	./50
Digital passion	58	The desire and use of digital technologies and the welcome of . their updating	./76
	59	. Ability to understand digital social media	./72
	60	The ability to harness the power of the Internet to prevent harm . to users	./71
	61	Ability to use and develop online advertising and digital public relations	./71

Execution	62	. Identifying suitable platforms for implementing various content	./59
	63	. Ability to use hardware and software to execute content	./53
	64	Correct and appropriate introduction of the produced content to . the target group	./63
	65	The ability to create motivation for the audience to use the content .	./57
	66	Ability to attract financial resources and mobilize facilities to .implement various technologies	./59
	67	Assisting and supporting teachers in using technologies	./62

Based on Table 3, it can be concluded that in the first-order factor analysis, all factor loadings of the items had appropriate values and no items were eliminated. Then, the second-order factor analysis was examined.

Table 3- Second-order structural model

Second-order variables			Values		Quality index	Reliability	
Exogenous	Endogenous	Factorial load	T value	Coefficient of determination	Model prediction	Alpha	Composite reliability
Digital Perception	Troubleshooting	0/77	3/1432	0/60	0/26	0/84	0/81
	Systems thinking	0/77	26/99	0/60	0/27	0/75	0/83
	Digital Craze	0/81	37/53	0/66	0/33	0/70	0/82
	Execution skills	0/88	50/57	0/88	0/25	0/63	0/76
Digital skills	Information literacy	0/78	30/62	0/62	0/31	0/74	0/83
	Digital communication	0/89	62/28	0/69	0/50	0/83	0/89
	Safety	0/85	47/89	0/72	0/45	0/83	0/88
Hardware qualifications	Recognition	0/88	76/43	0/79	0/39	0/70	0/82
	Application	0/93	10/935	0/89	0/42	0/69	0/81
Soft competencies	Recognition	0/94	15/226	0/89	0/46	0/79	0/86
	Application	0/90	80/94	0/82	0/41	0/90	0/84
	Design	0/92	10/536	0/85	0/64	0/92	0/84

Design and production	Production	0/95	17/741	0/90	0/48	0/80	0/86
General qualifications	Individual	0/94	13/081	0/94	0/53	0/81	0/87
	Moral	0/92	92/95	0/92	0/47	0/75	0/84

The above table examines the elements and components of the second-order structural model, all of which are at a desirable level. If the Q2 index has a positive value, this indicates a favorable fit of the model and its appropriate predictive power. Also, convergent validity is achieved when the composite reliability is greater than 0.70.

The significance of the path coefficients only indicates the existence of relationships and does not determine their intensity. The fact that the path coefficients are higher than 2.58 indicates the correctness of the relationships with a confidence level of 99%. The coefficient of determination (R^2) is one of the five main criteria for model fitting in the partial least squares method. This index indicates the amount of change in each of the dependent variables of the model that is explained by the independent variables. It should be noted that the R^2 value is calculated only for the endogenous variables of the model and for exogenous structures this value is equal to zero. The higher the R^2 value related to endogenous structures, the better the model fit will be. Chin (1998) has defined three values of 0.19, 0.33 and 0.67 as the criterion values for weak, medium and strong values of the structural part of the model fit by the R2 criterion, which values of the coefficient of determination of this model are at a very acceptable level.

Also, the criterion of the predictive power of the model, which also determines the predictive power of the indicators related to the structures, has been determined as three values of 0.020, 0.15, and 0.35, which in the present study shows that the values of all variables were very acceptable. Also, the RMSR value in this model was 0.072, which is an acceptable value less than 0.80, so the aforementioned model has a very good fit. Finally, the final model drawn based on qualitative data analysis was subjected to testing and validation.

Table -t -coefficients Final model

direction	T value	Significance level
General competencies - digital skills	23/65	P< 0.01
General Competencies - Design and Production	36/40	P< 0.01
General Qualifications - Hardware Qualifications	22/3	P< 0.01
General qualifications - software qualifications	22/69	P< 0.01

Digital skills-digital perception	30/8	P< 0.01
Design and Production - Digital Perception	69/6	P< 0.01
Hardware Competencies - Digital Perception	32/0	n.s.
Software Competencies - Digital Perception	2/69	P< 0.01

As can be seen, the components of general technological competencies of elementary school managers have a significant effect on digital skills, design and production, and software and hardware competencies. Also, digital skills, design and production competencies, and software competencies have a significant effect on digital perception of managers. The t-statistic is outside the range of negative 1.96 to positive 1.96 and the significance level is calculated as P<0.01. According to the path coefficient, it can be said that there is a direct and significant relationship between the above variables. Also, the path of the effect of hardware competencies on digital perception was not significant.

Variable	Alpha coefficient	AVE	Q2
Digital Perception	0/89	0/746	0/20
Digital skills	0/88	0/393	0/52
Publ i cpowers	0/87	0/534	......
Design and production	0/87	0/624	0/29
Hardware qualifications	0/83	0/776	0/22
Software qualifications	0/85	0/599	0/21

The common measure for establishing convergent validity at the construct level is the average variance extracted (AVE). This measure is defined as the average value of the total square root of the loadings of the descriptors corresponding to each construct (the sum of the square roots of the loads divided by the number of descriptors). Therefore, AVE is equivalent to the commonality of a construct. An average value of extracted variance equal to 0.50 or higher indicates that, on average, the construct explains more than half of the variance of the corresponding descriptors. Conversely, when AVE is less than 0.50, it indicates that, on average, more error remains in the items than the variance explained by the constructs. Therefore, according to the obtained AVE values, it can be said that although this value is lower than the standard in the Strategic attitude, the aforementioned model has convergent validity at the desired level.

The Q2 criterion, introduced by Stone and Geiser (1975), evaluates the predictive power of the model on the dependent variables. According to them, models with acceptable structural fit should be able to predict the indices related to endogenous constructs. This means that if the relationships between constructs in a model are properly defined, the constructs will be able to have a sufficient impact on each other's indices and, in this way, the hypotheses will be properly confirmed. Experts have determined the values of 0.2, 0.15 and 0.35 as low, medium and strong predictive power (Ringel et al., 2015). Therefore, the above model has acceptable structural fit.

Table ۸ - Discriminant validity of Fresnel and Larker

Variable	1	2	3	4	5	6
Digital Perception	0/864					
Hardware qualifications	0/741	0/881				
Software qualifications	0/757	0/809	0/774			
Design and production	0/797	0/816	0/793	0/790		
General qualifications	0/851	0/743	0/712	0/707	0/731	
Digital skills	0/795	0/743	0/745	0/722	0/701	0/672

As is clear from the data in the table above, the square of the convergent validity of each construct is greater than the correlation values between other constructs, so the research model is confirmed in terms of divergent validity according to the Fornell and Larker method. Also, the SRMR index is equal to 0.066, which indicates a high fit of the model.

Discussion and conclusion

The results of the model test showed that the components of general technological competencies of elementary school managers have a significant effect on digital skills, design and production, and software and hardware competencies. Also, digital skills, design and production competencies, and software competencies have a significant effect on digital perception of managers. The t-statistic is outside the range of negative 1.96 to positive 1.96 and the significance level is calculated as $P<0.01$. According to the path coefficient, it can be said that there is a direct and significant relationship between the variables under study. Also, the path of the effect of hardware competencies on digital perception was not significant. Based on the results obtained, the relationships of the variables can be explained as follows:

Impact on Digital Skills:

- This section includes abilities such as using digital technologies, managing digital information, and communicating through digital media. By having general technological competencies, administrators can strengthen these skills and effectively use digital technologies in the educational environment.

Impact on Design and Production:

- This component includes abilities in the field of designing digital content and producing it for use in educational processes. General technological competencies of managers also impact this area and help managers to participate effectively in the design and production of digital content.

Impact on software competencies:

- This section refers to the ability of managers to use the software required to implement educational technologies. Managers who have general technological competencies can strengthen these competencies and effectively use software tools in the educational environment.

In addition, research shows that digital skills, design and production competencies, and software competencies have a significant impact on managers' digital perception. This means that improvements in these areas can increase managers' ability to understand and effectively use digital technologies. In other words, these skills help managers to achieve a deeper understanding and more effective application of digital technologies in the educational environment, which in turn can have a positive impact on the quality of education and management. Familiarity with various software and hardware, participation and mutual cooperation techniques is important and necessary for teachers Mosibi Ardakani et al. (2021), Kane et al. (2022), Zare Sheikh Kalai and Javadipour (2022). Garcia et al. (2019) also considered the recognition and use of hardware and software as characteristics and competencies of managers. Therefore, in the field of software competencies, it is consistent with the research of Garcia et al. (2019); Aftabhi et al. (2019) and Aliabadi (2018).

Differences in the nature of skills:

- Hardware competencies focus more on practical and technical skills in working with physical equipment such as computers, networks and digital devices. These skills alone may not improve managers' overall understanding of the applications and potential of digital technology, as digital awareness is more related to systems thinking, problem solving and innovation.

Limited impact on systems thinking and innovation:

- Digital literacy involves more complex abilities such as systems thinking, innovation in the use of technology, and interacting with others in the digital space. Hardware skills alone may not sufficiently enhance these aspects of digital literacy.

Focus on implementation and operational aspects:

- Hardware competencies are usually limited to technical and operational implementation. While these skills are essential for implementing technologies, they may not help to foster strategic insight and an overall understanding of the broader applications of technology in education and management.

The need to combine with software and digital skills:

- A combination of software, digital, and hardware skills is needed to build a strong digital mindset. If hardware competencies are deployed without supporting software and digital skills, their impact on digital mindset may be less. Overall, this finding suggests that to improve digital mindset, managers need to develop a balanced set of different skills that include software and digital skills alongside hardware competencies.

According to the research findings and the conceptual framework of the model of technological professional competence components in elementary schools in Fars province, the following suggestions can help education planners and policymakers in improving and developing the technological skills and competences of school principals:

1. Developing specialized training and empowerment programs for school principals:

- Suggestion: Holding specialized workshops and training courses in various areas of technological competences, including digital content design and production, educational software and hardware, and digital skills.

Feasibility: These courses can be held in person and online, and school administrators can be asked to participate in these programs periodically to keep their skills and knowledge up to date.

2. Establishing networks of cooperation and technological support among school administrators:

- Recommendation: Establish networks of cooperation and exchange of experiences among school administrators to share best practices in using technology and solving technological problems.

- Feasibility: These networks can take the form of online groups, specialized forums, or periodic meetings where administrators can share their experiences and benefit from the support of colleagues.

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