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Educational Leadership And Skills In The 4th Industrial Revolution

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Abstract:
Background: *The 4th Industrial Revolution brings constant changes in technology and knowledge. The school cannot be left behind. Principals and executives are called upon to lead in this new environment. But are they ready? Do they have the right skills? Flexibility, digital knowledge, communication and critical thinking are more important than ever. Experience alone is not enough. New tools and continuous learning are needed. are prepared. It tries to record the needs and deficits. It identifies difficulties and paves the way for capacity building.*
Materials and methods: *This research examines the skills needed by education executives in the era of the 4th Industrial Revolution. A quantitative methodology was used. The tool used was a self-report questionnaire. The questionnaire was based on the work of Awodiji and Naicker (2023). It included 53 questions. The questions covered five key skills: flexibility, information management and evaluation, communication and collaboration; critical thinking and problem-solving, creativity and innovation. The questionnaire was sent via email to primary and secondary schools throughout Greece. The sample consisted of 886 people. The answers were given on a four-point Likert scale. The analysis of the data was done with the SPSS 29.0 software. Regularity, reliability and correlation checks were carried out. Statistical methods such as Pearson, t-Test and One Way Anova were applied.*
Results: *Participants reported a high level in three skills. These are flexibility, information management and evaluation, and critical thinking with problem-solving. Communication and collaboration, as well as creativity and innovation, were recorded at a moderate level. Statistically significant associations between skills were found. For example, critical thinking is positively associated with flexibility, communication and creativity. Also, communication and collaboration is directly related to creativity and innovation. No gender differences were identified. However, some differences were observed in terms of the level of education and the grade of school. Kindergarten principals performed lower in information management skills. Also, those who did not have postgraduate studies scored lower rates in flexibility and communication.*
Conclusions: *The findings show that education executives possess key skills to meet modern educational challenges. Flexibility, critical thinking and information management skills are at a satisfactory level. Nevertheless, there is room for improvement in communication, collaboration and innovation. Positive statistically significant correlations show that skills work complementary. affect the others. Training seems necessary. Especially in terms of technology and applications of 4IR.*
The training of executives must focus on strengthening the weakest sectors. School leaders need support and modern tools to meet the demands of the times.
Key Word: *Fourth Industrial Revolution (4IR), Educational Leadership, 21st Century Skills, Education 4.0*

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I. Introduction

In the era of the Fourth Industrial Revolution (4IR), educational leadership is a critical factor in managing the challenges and changes emerging in the context of rapid technological developments through the cultivation of skills that will help future citizens respond to competitiveness, employability and innovation8, 18.

School leaders are called upon to develop in pupils a set of skills that will equip them for the future, adapted to the demands of this new era7, [25], while pointing out12, 15 the need to empower principals and teachers in order to enhance their capacities in adopting, integrating and applying new technologies in educational processes. Similarly, Research[24] proposes strategies for developing the necessary skills in 4IR's workforce, such as empowering digital skills, proficiency in cutting-edge technology, entrepreneurial mindset, and combining technical and soft skills. They also point [out 10, 14] the need for tailor-made training programmes and mechanisms, such as professional learning communities and mentoring to strengthen the leadership competencies in schools, recognizing the value of specialized leadership in promoting innovative processes and learning experiences.

4IR is an excellent time in the evolution of industrial production, as it is characterized by the integration of technologies from the physical, digital and biological sectors4. This revolution involves the implementation of

advanced technologies based on information and communication technologies6, enhancing industrial connectivity and automation globally4. Education 4.0, recognized as the fourth industrial revolution in the field of education, marks a fundamental change in teaching and learning methodology. It incorporates advanced technologies and innovative teaching practices to upgrade the learning experience and performance, seeking to adapt the educational environment to the dynamically changing demands of the digital age23. In addition, it aims to align with the principles of sustainable development, focusing on the importance of education in addressing global challenges. It promotes collaborative problem-solving, critical thinking and sustainability initiatives, empowering students to actively contribute to a sustainable future23, with school leadership being highlighted as a central axis of this process. The research highlights that leadership has a fundamental role to play in adapting and reforming schools to meet the challenges of the digital age22. In particular, an in-depth understanding of the new requirements under 4IR and the skills that will be required in the future is considered essential for school leaders25. Responding to the challenges of the new era, new leadership approaches have been proposed that focus on developing skills such as communication, creativity, innovation, and predictability27. The ethical dimension of leadership is also seen as crucial for the smooth integration of values and principles into educational practice5, but also for creating a positive and conducive school environment, raising educational quality and improving learning outcomes20.

In the era of Education 4.0, school leaders are called upon to develop and apply skills, such as flexibility, information management and evaluation, communication and collaboration, critical thinking and problem-solving, creativity and innovation, in order to effectively navigate modern challenges1. In particular, school leaders should be able to recognise changes and adapt to them quickly combined with the right resources, knowledge and flexibility28. In addition, the management and evaluation of ever-increasing information and data can help school leadership to promote teaching and learning21, while school leadership should have the ability to articulate and promote its vision and values through mentoring and developing positive relationships within and outside the school unit and building trust13. Also, the ability of the school leader to solve problems through analytical thinking, reasoning, implementation of strategies and decision-making is imperative in today's fast pace and developments. The perception of things from various perspectives, with observation and with critical reflection, can lead to the solution of problems and educational issues22. Finally, the ability to think creatively, originally, inventively, to conceive new ideas, actions and innovations, contribute to the production of new knowledge with significant implications for the effective functioning of the school and the achievement of learning objectives3.

Based on this theoretical framework, a key question examined in this research study concerns the investigation of the skills necessary for school principals in view of the fourth industrial revolution. It is observed that existing research examining the level of skills possessed by principals to effectively lead in the school environment and prepare students for the requirements of the 21st century are Limited.

Thus, the research objectives are formulated as follows:

- To what extent do school leaders have skills relevant to their work in the 4IR era?
- Is there a correlation between the types of skills?
- Do demographic and occupational factors influence the skills possessed by education executives?

II. Material And Methods

The present study is an exploratory survey and aimed to capture the current situation among Primary and Secondary Education teachers regarding Artificial Intelligence (AI). It was conducted using data collection through an anonymous self-report questionnaire. The questionnaire was distributed via email to all schools in the country through the Directorates of Primary and Secondary Education in Greece, in December 2023. The data was collected with the Google Forms platform and the statistical analysis and processing was carried out with the IBM SPSS v29 statistical software package.

Sample: The research sample of the study included a total of 1736 Primary and Secondary Education teachers from all over Greece, who participated voluntarily. A notable aspect of the methodology was the instruction given to the participants, which asked them to refrain from completing the questionnaire if they answered "Not at all" to question A1, which concerned their level of knowledge about Artificial Intelligence (AI). This process revealed that 51% of teachers had no knowledge of AI, while 49% said they had a little to very good understanding of the subject. After excluding questionnaires where participants had no knowledge of AI, the final sample was limited to 862 participants, which formed the basis for further processing and analysis of the data.

The questionnaire: This survey is part of a broader quantitative survey conducted between October-November 202329, 19. For the needs of the survey, the self-report questionnaire was structured and used in their surveys2.

The questionnaire was sent to the addresses of all school units (primary and secondary education) in Greece via email. The sample of the survey consisted of 886 people who responded and completed the questionnaire.

The first part of the questionnaire contains demographic/occupational data (gender, age, school level, years of service as headmasters/deputy headmasters/supervisors, status of education executive in the school unit). The second part deals with five types of skills for 4IR: a) Flexibility (4 questions), b) Information management and evaluation (5 questions), c) Communication and Collaboration (22 questions), d) Critical thinking and problem-solving (15 questions) and e) Creativity and innovation (7 questions). The total number of questions is 53. Respondents were asked to answer on a four-point Likert scale (1=never, 2=rarely, 3=sometimes, 4=often, 5=always).

Statistical analysis: The data were analyzed using the SPSS 29.0 for Windows package statistical software. Initially, the normal distribution of variables was checked using the Kolmogorov-Smirnov test which showed a normal distribution (>0.05). Subsequently, the data were analyzed using descriptive statistics (distribution of frequencies, percentages, mean values (M.T.) and standard deviations (T.A.). Pearson, t-Test and One Way Anova. The reliability check of the internal consistency of the variables of the questionnaire (Table 1) ranges from a=0.824 to a=0.960 (high values). The total value of the index a=0.971 is also high (>0.70). Also, the values of the correlation indicators range from +0.337 to +0.874>+0.3 demonstrating a high internal consistency of the variables for skills related to the 4th industrial revolution.

III. Results

Regarding the demographic and professional data of the participants, 55.5% are women and 44.5% are men, with 58.7% belonging to the age category of 51-60 years. The majority (65.5%) have a master's degree, while 20.1% do not have additional studies. As far as the school unit works as education executives, 37.7% are executives in Junior High Schools, 37.2% in Primary Schools and 25.1% in Kindergartens. Of the executives in the sample, the majority (56.4%) are Directors. As for the years of service as school executives, 39.7% have "21 years or more" and 35.4% have "0-10" years of service.

Table 1 *Breakdown of average values and standard skill variances.*With regard to the participants' responses to the skills: *a) flexibility*, the total M.T. is 4.12(0.023) "often". b) *communication and cooperation* the total M.T. is 4.52(0.028) "always", c) *communication and collaboration skills*, the total M.T. is 3.59(0.030) "sometimes", d) *critical thinking and problem-solving*, the total M.T. is 3.81(0.022) "often" and e) *Critical thinking and problem-solving*, the total M.T. is 3.27(0.033) "sometimes". Overall, for all skills, the M.T. is 3.82(0.021) "frequently"

Table 1: Distribution of average values and standard skill deviations

	M.T.*	**T.A.**
Flexibility	4,12	0,023
Information management and evaluation	4,52	0,028
Communication and Collaboration	3,59	0,030
Critical thinking and problem-solving	3,81	0,022
Creativity and innovation	3,27	0,033
Total	3,82	0,021

**Note. (1=never, 2=rarely, 3=sometimes, 4=often, 5=always)*

Educational Leadership Skills Correlation Checks

A Pearson correlation test was carried out between skills (Flexibility,

Information Management and Evaluation, Communication and Collaboration, Critical Thinking and Problem Solving, Creativity and Innovation).

Table 2 *Correlation Check.* According to the results, large and statistically significant positive correlations are found between: a) critical thinking and problem-solving with flexibility (r=0.628, p<0.01), communication and collaboration (r=0.659, p<0.01) and creativity and innovation (r=0.639, p<0.01). b) Communication and collaboration with creativity and innovation (r=0.703, p<0.01). Moderate and statistically significant positive correlations are found between: a) flexibility with information management and evaluation (r=0.425, p<0.01), communication and collaboration (r=0.470) and creativity and innovation (r=0.445). b) Between information management and evaluation through communication and collaboration (r=0.454, p<0.01) and critical thinking and problem solving (r=0.430, p<0.01). A small and statistically significant positive correlation is demonstrated between information management and evaluation with creativity and innovation (r=0.262, p<0.01).

Table 2: Correlation check

		(1)	(2)	(3)	(4)	(5)
(1) Flexibility	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	886				
(2) Information management and evaluation	Pearson Correlation	0,425**	1			
	Sig. (2-tailed)	<0,001				
	N	886	886			
(3) Communication and Collaboration	Pearson Correlation	0,470**	0,454**	1		
	Sig. (2-tailed)	<0,001	<0,001			
	N	886	886	886		
(4) Critical thinking and problem-solving	Pearson Correlation	0,628**	0,430**	0,659**	1	
	Sig. (2-tailed)	<,001	<0,001	<0,001		
	N	886	886	886	886	
(5) Creativity and innovation	Pearson Correlation	0,445**	0,262**	0,703**	0,639**	1
	Sig. (2-tailed)	<0,001	<0,001	<0,001	<0,001	
	N	886	886	886	886	886

*** Correlation is significant at the 0.01 level (2-tailed)*

Associations of Skills with Demographic and Professional Characteristics

Skills (flexibility, information management and evaluation, communication and collaboration, critical thinking and problem-solving, creativity and innovation) were correlated as dependent variables with the demographic characteristics of the participants as independent variables. The correlation with *Gender* was made with the t-Test of independent samples. According to the results there are no statistically significant differences ($p>0.05$). Gender does not appear to be It affects respondents' perceptions of their skills.

Table 3 *Analysis of Skill Variation with School Work Unit*. The correlation of the *School Unit of Work of Principals/Supervisors* with skills was done with the analysis of one-way dispersion (One Way Anova). The findings on the variation with skills showed that there is equality of average values of the school work unit of the participants as education executives with the four skills (flexibility, communication and cooperation, critical thinking and problem solving; creativity and innovation). Therefore, there is no statistically significant correlation ($p>0.05$). It is shown that there is no equality of average values with the skill of Information Management and Evaluation [$F(2)=5.760$, $p=0.003<0.05$]. Therefore, the school work unit of the participants as education executives affects the skill related to information management and evaluation.

Table 3: Analysis of Skill Variation by School Unit

		Sum of Squares	df	Mean Square	F	Sig.
Information management and evaluation	Between Groups	5,473	2	2,736	5,760	,003
	Within Groups	419,485	883	,475		
	Total	424,958	885			

Table 4 *Average price comparisons.* Comparisons of the average values show that the statistically significant differences between the "Kindergarten Heads" and the Directors of Primary ($p=0.011<0.05$) and Junior High School ($p=0.005<0.05$). These differences show that the average value of the skill level for Information Management and Evaluation is 0.172 points lower than the Heads of Kindergarten Teachers compared to the Directors of Primary Schools and 0.189 points less than the Directors of Gymnasiums/Lyceums. Heads of Kindergarten Teachers have less information management and evaluation skills than Directors of Primary Schools or Junior High Schools.

Table 4: Average price comparisons

Test Tukey HSD						95% Confidence Inter	
Dependent Variable	(I) School unit	(J) School unit	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Information management and evaluation	Nursery school	Municipal	-,172*	,060	,011	-,31	-,03
		Junior High School/High School	-,189*	,060	,005	-,33	-,05

*** The mean difference is significant at the 0.05 level.*

The correlation of *Studies* with skills was done using the one-way Anova dispersion analysis. The findings on variation with skills showed that there is equality of average values of the respondents' Additional Studies with the three skills (information management and evaluation, critical thinking and problem-solving, creativity and innovation). Therefore, there is no statistically significant correlation ($p>0.05$). average parity with communication skills with collaboration [$F(3)=2.892$, $p=0.035<0.05$] and flexibility [$F(3)=5.546$, $p=0.000<0.05$]. Therefore, the level of study of respondents affects skills related to communication and collaboration and flexibility.

Table 5 *Average price comparisons.* Comparisons of average values show that statistically significant differences with skills: a) Communication and collaboration are found between those who have a Master's degree and those who do not have additional studies (basic degree) ($p=0.023<0.05$). This difference shows that the average value of the level of communication and cooperation skills is 0.220 points higher in those with a master's degree than in those who do not have additional studies. b) Flexibility, the differences are found in those who do not have additional studies compared to those who have additional studies [2nd degree ($p=0.011<0.05$), master's degree ($p=0.003<0.05$), doctorate ($p=0.036<0.05$)]. This difference shows that the average value of the level for the flexibility skill for those who do not have additional studies is 0.354 points lower than for those with a 2nd degree, 0.204 points lower than for those with a master's degree and 0.244 points lower than for those with a doctorate.

Table 5: Average price comparisons

Test Tukey HSD						95% Confidence Interva	
Dependent Variable	(I) Studies	(J) Studies	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Communication and cooperation	Master	2nd degree	-,004	,141	1,000	-,37	,36
		Phd	-,012	,105	,999	-,28	,26
		I don't have	,220*	,077	,023	,02	,42
Flexibility	I don't have	2nd degree	-,354*	,115	,011	-,65	-,06
		Master	-,204*	,058	,003	-,35	-,05
		Phd	-,244*	,090	,036	-,48	-,01

** The mean difference is significant at the 0.05 level.*

IV. Discussion

The results of the survey show that respondents present at a high level the skills of flexibility and adaptability, information management and evaluation, and critical thinking and problem-solving. Similar are the views16, which argue that leaders with greater flexibility are self-aware and have learned to be open and criticised, while they argue21 that school leaders have a core mission to examine a large and be able to transform the information into knowledge. Similarly, it argues22 that those who are critical thinking on specific issues make a great effort to guide organizations in a reasonable, fair and empathetic way. In contrast, communication and collaboration skills and creativity and innovation are at moderate levels, a finding that is in line with other similar research10. Also, similar surveys2, 29, 8, [17] show that teachers have moderate levels of online applications and need training in new technologies and issues related to 4IR, while at the same time school staff want to become more familiar with the use of applications and new technologies.

Also, according to the findings of the research, large and statistically significant positive correlations are found between: a) critical thinking and problem-solving with flexibility ($r=0.628$), with communication and collaboration ($r=0.659$) and with creativity and innovation ($r=0.639$), b) in communication and cooperation with creativity and innovation ($r=0.703$). Accordingly, they argue9 that critical thinking is just as important as solving problems related to the elimination of obstacles to achieving a goal. Similar positions are expressed13 who argue that communication and collaboration is a critical competence for the 21st century, while considering26 that communication skills are one of the most basic skills needed by school leaders. They also believe11, 12 that the leader in 4IR must be particularly important for innovation and be a model for experimentation, new methods and technological applications.

V. Conclusion

From the analysis of the results, it can be seen that the respondents have a high degree of skills such as flexibility, adaptability, information management and critical thinking. These skills are considered essential for those exercising leadership duties. The relevant views of the literature reinforce the finding. Flexibility is linked to self-awareness and the ability to accept criticism. Critical thinking is related to the rational and fair way of leadership. Also, the ability to manage information helps to meaningfully transform it into knowledge, which is essential for any educational leader. In contrast, the skills of communication, collaboration, creativity and

innovation appear at a moderate level. Other similar surveys show the same. It seems that these areas need more support, both individually and organisationally. In addition, the use of technology and online tools by teachers is not sufficient. The findings show that there is a need for training. The teachers and school executives themselves state that they want to become more familiar with new technologies. The transition to the fourth industrial revolution requires knowledge and skills that have not yet been acquired to the extent required. The correlations identified between skills show that these competences do not work in isolation. Critical thinking is directly related to flexibility, communication and creativity. Also, cooperation seems to be closely linked to innovation. This means that the development of one skill can positively affect the others. The above is consistent with what is supported in the international literature. Critical thinking helps solve problems. Communication is considered a key skill for school leaders. Innovation and creativity are important, especially in the context of the new technological era. The leader needs to lead by example, try new approaches and encourage change.

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