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Examining and classifying key factors influencing teachers' creativity in integrating Information and communication technologies in education

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This study explores how teachers' socio-demographic characteristics influence their creativity in classroom integration of Information and communication technology (ICT). Using a quantitative, exploratory methodological approach involving 110 teachers, we examined factors such as age, gender, education level, and teaching experience in relation to ICT use. multiple correspondence analysis was employed to develop a typology of innovative teachers based on these socio-demographic factors and their degree of ICT integration. Furthermore, multiple linear regression analysis revealed that socio-demographic characteristics significantly correlate with ICT use. Our final model, incorporating four independent variables — age, experience, university degree, and gender — explains 42% of the variance in teachers' ICT integration, a considerable level of explanatory power. These findings offer valuable insights for designing educational policies and professional development programs aimed at fostering creativity in ICT use, tailored to the socio-demographic profiles of teachers.

Keywords: creativity, communication technology, education, teacher, sociodemographic characteristics, multiple correspondence analysis, regression analysis.

Relationships and Activities: none.

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Изучение и классификация ключевых факторов, влияющих на креативность учителей в интеграции информационно-коммуникационных технологий в образование

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В исследовании изучается, как социально-демографические характеристики педагогов влияют на их креативность в интеграции информационно-коммуникационных технологий (ИКТ) в классе. Используя количественный, исследовательский методологический подход с участием 110 педагогов, мы изучили такие факторы, как возраст, пол, уровень образования и опыт преподавания в отношении использования ИКТ. Для разработки типологии инновационных учителей на основе этих социально-демографических факторов и степени их интеграции ИКТ был использован множественный анализ соответствий. Кроме того, анализ множественной линейной регрессии показал, что социально-демографические характеристики значительно коррелируют с использованием ИКТ. Наша окончательная модель, включающая четыре независимые переменные — возраст, опыт, высшее образование и пол — объясняет 42% дисперсии в интеграции ИКТ. Эти результаты дают ценную информацию для разработки образовательной политики и программ профессионального развития, направленных на поощрение креативности в использовании ИКТ, адаптированных к социально-демографическим профилям учителей.

Ключевые слова: креативность, коммуникационные технологии, образование, учитель, социально-демографические характеристики, множественный анализ соответствий, регрессионный анализ.

Отношения и деятельность: нет.

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ICT — Information and communication technology, TICE — Technology, Information, Communications and Entertainment.

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Introduction

In today's digital age, children are digital natives, growing up with constant access to computers and the Internet. To be effective, teachers must connect with students within this contemporary context. Research demonstrates that integrating Information and communication technology (ICT) into education can enhance student creativity, emphasizing the need for teachers to incorporate these technologies into their daily lessons. For instance, a study by Granger C, et al. (2002) found that teachers skilled in ICT tend to be more innovative and successful, suggesting that technology-literate educators can design lessons that foster greater creativity [1]. Recognizing and supporting these innovative teachers is crucial, as they can unlock creativity in their students, leading to improved educational outcomes [2].

Creativity in teaching is influenced by multiple factors, including socio-demographic characteristics such as gender, age, teaching experience, average class size, and education level [3]. This research investigates how these specific characteristics impact teachers' creative practices, especially in ICT integration. While many socio-demographic factors could be considered, our focus on these particular characteristics is informed by previous literature highlighting their relevance to teaching effectiveness. For example, age has traditionally been associated with wisdom and creativity, with studies indicating a positive correlation between age, creative achievement, and expertise, likely due to accumulated knowledge and experience [1].

In the 21st century, the role of teachers demands not only content expertise but also the ability to teach creatively using technology [3]. Creativity in education can be defined as the ability to conceive, seek, and discover new methods and ideas [4, 5], underscoring the need for teachers to innovate in their instructional approaches.

The primary aim of this study is to explore how teachers' socio-demographic characteristics influence their creativity, with a focus on ICT integration. This research is significant, as most previous studies have focused on student creativity, leaving a gap in understanding the role of teachers' backgrounds in fostering creativity in education. By addressing this gap, our study contributes to educational theory and provides insights for policymakers to design professional development programs that enhance teacher effectiveness, ultimately benefiting student learning.

Review of Literature

Generally, the world has rapidly grown in every sector due to the era of globalization. In globalization, the education sector has to be able to compete with other sectors. This is because the education sector is a main foundation towards the success of the country. Thus, the teachers, who are the key players in this sector, need to be equipped with the latest tools and technologies to ensure the students obtain quality education. It is very clear that teachers who are proficient in utilizing technology are more creative compared to the teachers who do not use technology. In some studies, it is found that ICT is able to enhance teaching and learning effectively. It can make it easier for the teachers and students in carrying out the teaching and learning process. Owing to this, the subject of ICT has been integrated into the education system [6-8].

Furthermore, ICT plays a big role in teaching kids who don't like school much. First, ICT makes kids want to learn more. The main reason these kids quit school is they think they can't get the ideas being taught. This is no surprise, considering that many students have difficulty understanding material when it is presented through the traditional lecture-based teaching method [9].

The bulk of the research to date suggests that there are indeed significant relationships between various teachers' socio-demographic characteristics and ICT use. For example, female teachers have been found to use computers more frequently for administrative tasks than males, who use computers more frequently for professional tasks. Regarding teaching experience, a general tendency has been found; teachers with more experience are less likely to use ICT. However, this relationship has been found to be curvilinear and moderated by age. Fennema E, et al. have found that older teachers are less likely to learn a new skill such as programming, which is necessary to effectively use computers for teaching [10]. Other studies also demonstrate the role of liking learning and computers in using ICT: how teachers feel about tech may influence the extent to which their students use computers and how good they are at it [3, 11].

Several studies have indicated a clear connection between teachers' backgrounds and the utilization of technology in the classroom. For example, female teachers may use computers for administrative tasks while men prefer them for professional development. However, when experience is considered, an unexpected pattern arises. In general, older teachers generally employ ICT tools less than their younger colleagues, although there are exceptions. Programming seems to be among those skills which are not embraced by elderly teachers. This could be attributed to being naturally comfortable with traditional teaching techniques or inadequate opportunities for embracing ICT skills. Understanding fully age's impact requires considering such factors like gender, class size, educational level, access to ICT training and professional development opportunities need to be considered [12-14].

ICT and computer technology fields have traditionally been male-dominated and it is often claimed that the gender imbalance is the result of systemic discrimination and perceived difficulty that women have with ICT subjects. As a result, male instructors are likely to have more experience and positive attitudes towards computers and ICT and serve as role models for their

male and female students. Female instructors, conversely, may also be disadvantaged by poor attitudes and lack of encouragement from peers and may also avoid ICT use or information-seeking behaviors that are seen as male activities [13, 15, 16].

The use of ICT in education has increased significantly lately as teachers have been using different digital tools to advance their teaching practices. However, one fundamental aspect which can highly influence effective execution of ICT is class size. The question of how class size affects teachers' utilization of ICT has increasingly become an area of interest in educational research. This study seeks to examine the impact of class size on teachers' use of ICT in order to enhance students learning outcomes. Through analyzing the relationship between class size and ICT use, this research will offer insights into the challenges and opportunities that teachers encounter when incorporating technology within diverse classroom environments. Therefore, it is important to understand these dynamics so as to develop strategies that will make integration of ICT more optimal in schools hence enhancing a better learning experience for all students [17-20].

As technology increasingly affects our daily lives and previous studies have shown that certain socio-demographic characteristics assessed in isolation are associated with teachers' use of ICT[1] [1, 4, 8, 21-27].

The current study examines the relationship between instructor socio-demographic attributes and their utilization of ICT in teaching and learning activities. As such, this study can highlight the importance of considering psycho-social components in explaining ICT usage behaviors. If significant relationships are found that attribute to specific demographics that categorize usage patterns, institutions and policy makers can take these findings into consideration for future utilization of ICT. It is far more efficient and effective to design training programs as well as allocate resources that are tailored to specific groups rather than to use a "one size fits all" approach. For instance, if younger instructors are found to utilize technologies more than their older counterparts, resources could be focused on the older group to increase their training and usage, whereas consideration should be taken as to whether a different system is more effective for the older instructors. If specific groups are identified as underutilizers, these findings can serve as evidence of identifying a need or gap in ICT utilization, whereby it is necessary to provide support for them to increase their usage towards the level of their counterparts. In contrast, findings that suggest no differences amongst demographics can challenge the growing stereotype that the younger generations are more ICT savvy, by showing that in this case it is not simply an age factor that creates a difference. Overall, understanding the varying needs and tendencies of different groups is essential for creating an environment where ICT is effectively and equally utilized to benefit all students and instructors.

Research Questions

The main research questions guiding this study are:

1. Can we establish a typology of teachers who effectively use of ICT in education for instruction based on their socio-demographic variables and teaching methods?
2. What factors influence teachers' decisions to integrate ICT into their teaching practices?
3. How do socio-demographic variables impact the integration of ICT in teaching?

Research Methodology

This study was conducted with ethics board approval to investigate the impact of socio-demographic factors on innovative teaching techniques employed by teachers. The research protocol underwent review by a constituted ethical committee to ensure adherence to ethical principles and the welfare of participants.

To examine associations between demographic variables and educational innovation, we adopted a quantitative exploratory methodology, collecting data through structured questionnaires.

Step I: Designing a Questionnaire and Collecting Data

Building on a comprehensive literature review, we developed a structured questionnaire following Jebb, et al.'s (2021) approach [28]. The questionnaire comprised 7 items across the following variables:

Socio-demographic Factors: Age, gender, educational background, years of teaching experience, and average class size.

ICT Usage: Frequency and types of ICT used in classroom settings (e.g., Zoom, Blackboard). Respondents rated their usage on a Likert scale ranging from "Never" to "Very often."

The questionnaire was administered to a sample of 110 teachers selected through random sampling to ensure demographic diversity and support result generalizability.

Step II: Analyzing the Data

After data collection, responses were analyzed using R version 4.3.3. Six participants with incomplete responses were excluded, resulting in a final sample of 104 teachers. Quantitative data analysis focused on identifying patterns and correlations in how socio-demographic factors influence ICT usage, aligning with our research hypotheses.

Results

Typology of innovative teachers

Based on respondents' experiences and socio-demographic variables, a typology was developed. We used multiple correspondence analysis (MCA) on these

[1] Villeneuve SP. L'évaluation de la compétence professionnelle des futurs maitres du Québec à intégrer les technologies de l'information et des communications (TIC) : maitrise et usages. 2011. https://papyrus.bib.umontreal.ca/xmlui/handle/1866/6057.

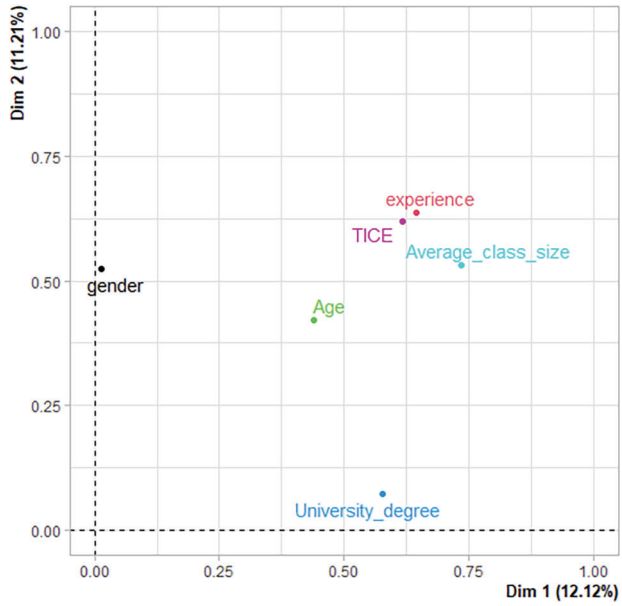

Figure 1 Map of categorical variables.

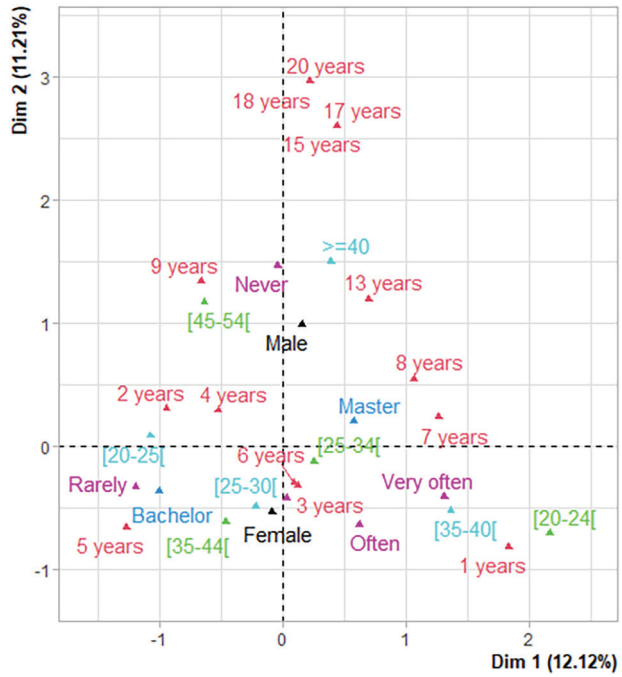

Figure 2 Visualization of multiple correspondence analysis.

variables to create a scatterplot of individuals on two factorial axes (Figure 1).

The first two dimensions together explain 23.330% of the total variance, meaning that they capture around a quarter of the variability present in the data.

The chi-square distance between the different categories of variables and respondents was used to identify associations between variables. To visualize these relationships, the data were represented as points in Euclidean space. Variables that are 180 degrees apart have a negative association, while orthogonal variables are considered independent. Variables that are close to each other on the graph have a positive association. The stronger the correlation between variables, the closer the points are to the periphery of the graph.

The variables that contribute most to the construction of the first dimension are Average_class_size, University_degree, Technology, Information, Communications, and Entertainment (TICE) and experience, while the variables that contribute most to the construction of the second dimension are TICE and gender (Figure 1). These are the square correlation ratios of the variables on the two dimensions. A thorough depiction of the categories is necessary for a deeper comprehension of these relationships (Figure 2).

Subtle dynamics within the sample were reflected in the multiple correspondence analysis graph, which showed inverse associations between some variables and similar groups of response categories.

In dimension 1:

Group 1 in this group, frequent modalities include classes with an average size of 35 to 40 students, often or very often use ICT, teachers with a Master's level university degree, average experience of one year, age ranges mainly between 20 and 34.

Group 2 frequent modalities in this data group include teachers with a bachelor's degree, those who rarely use ICT, teachers aged 35 to 44, classes with an average size of 20 to 30 students, those with five years' experience, female teachers.

In dimension 2

Group 1 the most frequent modalities in this group include teachers who never use ICT, those with class sizes averaging at least 40 students, male teachers, those with a master's-level university degree, and teachers aged 45 to 54.

Group 2 the most frequent modalities in this dataset are teachers with a bachelor's degree, those who rarely use ICT in education, teachers aged 35 to 44, those with class sizes averaging between 20 and 30 students, teachers with 5 years' experience, and female teachers.

Group 3 in this group, the dominant trends emerge through the most common modalities: classes averaging 35 to 40 students, often or very often using ICT, a predominance of teachers with a Master's degree and around a year's experience, and a balanced distribution between the 20 to 24 and 25 to 34 age groups.

Hierarchical ascending classification (HAC)

As shown in Figure 3 and Table 1, the classification methodology employed in this study streamlines automatic separation into four distinct groups:

Class 1/4: These teachers take care of average sized classrooms with approximately 30 to 35 students. They generally have a Bachelor's degree and are rarely using teaching with ICT. Their age range is between 45 and 54, and they have around 5 years' professional experience.

Class 2/4: These teachers manage slightly larger classes of 25 to 30 students. They use ICT occasionally.

Table 1

Results of the hierarchical ascending classification

Variable labels	Characteristic features	% of class in modality	Probability
	CLASSE 1/4		
Average_class_size	[20-25]	92.59	0.000
University_degree	Bachelor	68.42	0.000
TICE	Rarely	82.61	0.000
Age	[45-54]	72.73	0.000
Experience	5 years	90.00	0.000
Experience	2 years	73.33	0.000
Experience	3 years	17.14	0.000
	CLASSE 2/4		
Average_class_size	[25-30]	70.27	0.000
TICE	Sometimes	71.87	0.000
Experience	6 years	82.35	0.000
Experience	3 years	57.14	0.000
Gender	Female	47.06	0.000
Age	[25-34]	50.00	0.000
	CLASSE 3/4		
Average_class_size	⩾40	66.66	0.000
TICE	Never	52.17	0.000
Gender	Male	36.11	0.000
University_degree	Master	19.70	0.000
Experience	15 years, 17 years	100.00	0.000
Age	[45-54]	27.27	0.000
	CLASSE 4/4		
TICE	Very often	87.50	0.000
Average_class_size	[35-40]	72.73	0.000
Experience	1 years	100.00	0.000
Age	[20-24]	100.00	0.000
University_degree	Master	30.30	0.000
Age	[25-34]	28.00	0.000

Average professional experience is higher than for Class 1, at around 9 years. The majority are younger women, aged between 25 and 34.

Class 3/4: In contrast to class 1, these teachers are in charge of larger classes, with over 40 students. They never use ICT and seem to be exclusively male. Their level of education is higher, with a Master's degree. Their professional experience is substantial, exceeding 15 years, and their age range remains between 45 and 54.

Class 4/4: These teachers teach intermediate-sized classes of around 35 to 40 students. They stand out for their very frequent use of ICT in their teaching methods. Despite holding a Master's degree, they seem less experienced than Class 3 teachers, with an average of around 1 years' experience. Their age range is between 20 and 34.

Different relationships that exist between different variables in this research are indicative of fascinating patterns in ICT for education use by teachers. First, it seems as though there is a relation between teachers' experience level and their intention to use ICT with most of the young inexperienced teachers indicating frequent usage than the older ones. Also, teachers' educational levels

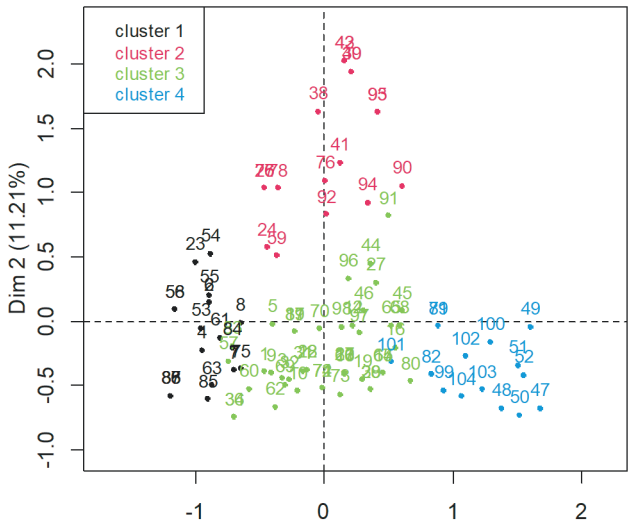

Figure 3 Hierarchical ascendant classification (HAC).

seem to determine the extent that they would adopt ICT with a bias towards those who have completed masters' programs. Besides, gender differences among the teaching staff also appear to determine their level of utilization

Table 2

The Stepwise Regression method

	Model 1		Model 2	
	Coef.	P-value	Coef.	P-value
Average_class_size	0.097	0.477		
Gender	-0.657	0.005	-0.649	0.006
Experience	-0.097	0.004	-0.087	0.004
Age	-0.583	0.000	-0.608	0.000
University_degree	0.704	0.011	0.806	0.001
Constant	4.24	0.000	4.30	0.000
Adj. R^2	0.421		0.424	
No. of cases	104		104	

Note: Adj.R2=Adjusted R-squared; Coef.=Estimate. Dependent Variable: TICE.

of ICT with more females using it predominantly in certain classes. Lastly, average class size also seems to matter on how much teachers will interact through an ICT; this has been found mostly true where medium-sized classes register greater use compared to others. Hence, these links involving different variables above demonstrate that how complex running factors influence teachers' adoption of ICT, thus making it essential for educators designing training programs and policies take into consideration such factors as these.

Regression analysis

A multiple linear regression analysis was carried out with the aim of finding a multiple linear regression model to explain teachers' use of ICT by the following explanatory variables: Gender, age, experience, average class size and teacher's university degree. For this step, we performed a regression analysis taking into account all the proposed variables. We consider the model:

$ICT=\beta_0+\beta_1.gender+\beta_2.Age+\beta_3.Experience+\beta_4.Avg\_class\_size+\beta_5.University\_degree+\varepsilon$ (1)

The results of the multiple linear regression analysis show a significant association between four independent factors and the dependent variable (teachers' use of ICT). With an adjusted R-squared of 0.42, the optimal model (2) was chosen with great care, using the bottom-up stepwise method based on Akaike's information criterion. This indicates that the four independent variables in our model contribute 42% of the variance of the dependent variable (TICE) Table 2.

$ICT = 4.30 - 0.61.Age - 0.65.Gender - 0.09.Experience + 0.81.University\_degree$ (2)

The study found several factors that affect teachers' use of ICT in education:

- **Age and experience of teachers:** The study revealed that younger and less experienced instructors employ ICT more often than their older counterparts.
- **University degree:** The findings showed that those who have pursued Masters degrees tend to integrate ICT into their teaching practices to a higher extent.
- **Gender:** It was found that women teachers use ICT more often although the research does not specify in what type or subject area they do so.
- **Class Size:** Compared to teachers working with smaller or larger groups, those with medium-sized classes were found to have the highest levels of interaction with ICT.

Conclusion

This study uses a quantitative methodology to investigate how socio-demographic factors affect teachers' use of ICT. The study aims to improve our understanding in the field of education by examining the relationships between teachers' use of ICT and their age, gender, average class size, university degree and teaching experience. In order to better support teachers in their efforts to improve educational outcomes, policies, professional development and educational program design will all be influenced by the realization that these socio-demographic factors have an impact on teacher creativity.

Our study identified teacher profiles according to age, gender, average class size, level of education and teaching experience, and use of ICT. The results have theoretical significance, enriching understanding of the complex dynamics between teachers' characteristics and their use of ICT. It also contributes to the construction of explanatory models to guide future research on the integration of ICT into teaching. From a pedagogical point of view, this study offers valuable perspectives for developing teacher training programs adapted to the different profiles identified, thus promoting more effective and equitable use of ICT in the classroom.

This information provides a valuable starting point for further research into the links between teacher profiles and student performance. It would also be interesting to analyze the data by taking into account other variables, such as the subject taught, the socio-economic background of the students or the education policies in place.

Such analyses would make it possible to develop targeted strategies for improving the quality of teaching and fostering the success of all students.

Relationships and Activities: none.

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