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CLUSTERING TEACHER EXPECTATIONS IN DIGITAL EDUCATION PROGRAMS USING FUZZY C-MEANS ANALYSIS

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Abstract: *As digital tools become increasingly embedded in education, understanding teachers' expectations for digital pedagogy training is essential for designing effective professional development programs. This study applies Fuzzy C-Means clustering analysis to a dataset of 1,865 educators to uncover distinct expectation patterns in digital training. Using a 37-item questionnaire based on the DigCompEdu framework, we examined how teachers prioritize key digital competencies, ranging from technological integration and active learning strategies to ethical considerations and digital assessment methods. The instrument demonstrated high reliability (Cronbach's α = 0.992), and clustering solutions were optimized using Bayesian Information Criterion (BIC) and Silhouette scores in JASP. Findings reveal multiple expectation clusters, reflecting differences in digital readiness, pedagogical adaptation, and confidence in technology use. Some teachers sought advanced training on digital instructional strategies, while others emphasized foundational skills and ethical concerns. These insights highlight the need for flexible, personalized training programs that align with teachers' diverse professional development needs. By recognizing and addressing these varying expectations, this study contributes to the optimization of digital pedagogy training, ensuring that educators are not just equipped with digital tools but also empowered to use them effectively in diverse learning environments.*

Keywords: *Digital pedagogy, teachers' expectations, DigCompEdu, Fuzzy C-Means clustering, professional development, digital competencies, educational technology, teacher training*

1. INTRODUCTION

The rapid integration of digital technologies into education has necessitated a shift in pedagogical approaches, requiring teachers to develop new competencies that align with 21st-century learning environments [1]. Digital pedagogy, which involves the strategic use of digital tools to enhance teaching and learning, has been widely recognized as a key component of modern education [2]. However, despite increasing efforts to implement digital pedagogical strategies, research indicates that teachers' expectations, preparedness, and training needs remain diverse and context dependent [3].

Recent studies emphasize the need for a structured approach to digital pedagogy training, as teachers often encounter challenges related to technological integration, digital resource utilization, and adaptive teaching strategies [4]. While digital technologies offer significant opportunities for innovation in education, their successful implementation depends on teachers' confidence, competencies, and alignment with pedagogical goals [5]. Furthermore, previous research highlights a gap between teachers' perceptions of digital tools and their practical application in instructional settings, suggesting the need for targeted professional development that addresses specific expectations and competencies [1].

Despite the growing body of literature on digital pedagogy, limited research has explored the clustering of teachers based on their specific expectations regarding digital training. Most existing studies adopt generalized approaches, failing to capture the variability in teachers' needs and priorities. To bridge this gap, the present study employs Fuzzy C-Means clustering, a technique that allows data points to belong to multiple clusters with varying degrees of membership. This method provides a more nuanced and flexible classification of teachers' expectations, addressing the heterogeneity of digital training needs while offering insights into how professional development programs can be tailored to different educator profiles. By identifying distinct expectation patterns, this study contributes to the design of more effective and personalized digital pedagogy training programs.

2. METHODOLOGY

2.1 Participants

The study involved a sample of 1,865 teachers who participated in a digital pedagogy training program. Participants were recruited through professional development networks, educational institutions, and digital training platforms. The inclusion criteria required that respondents have prior teaching experience and engagement with digital tools in educational contexts. All participants provided informed consent, and the study was conducted in compliance with ethical research guidelines.

The sample comprised 68% female and 32% male participants, with an average age of 41.2 years (SD = 9.6). Teaching experience ranged from 1 to 35 years, with a mean of 14.7 years (SD = 7.3). Regarding the level of teaching, 52% of the participants taught at the secondary education level, 30% at the primary level, and 18% at the higher education level. Additionally, 76% of teachers reported prior experience with digital teaching tools, while 24% indicated limited or no prior exposure to such resources.

2.2 Instruments

The study employed a self-reported questionnaire consisting of 37 items designed to assess teachers' expectations regarding digital pedagogy training. Each item was rated on a four-point Likert scale (1 = Not important, 4 = Very important), measuring the perceived importance of various digital teaching competencies. The questionnaire was developed based on established frameworks of digital competencies for educators, with a particular emphasis on the DigCompEdu framework [6] and prior research on teacher training in digital environments [7], [8], [9]. Items addressed various aspects of digital pedagogy, including responsible use of digital resources (M = 2.934, SD = 1.152), integration of online tools and digital resources in teaching activities (M = 2.982, SD = 1.158), teaching with digital technologies such as visual supports and interactive teaching (M = 2.948, SD = 1.152), and learning with digital technologies through collaboration and self-regulated learning (M = 2.913, SD = 1.136).

To ensure internal consistency, reliability analysis was conducted, yielding a Cronbach's α of 0.992, indicating excellent internal reliability. Normality was assessed using the Shapiro-Wilk test, with results suggesting a non-normal distribution ($p < .001$). The questionnaire provides a comprehensive evaluation of teachers' digital competency expectations, supporting a structured approach to designing effective training programs in digital pedagogy.

2.3 Data analysis

Data analysis was performed using JASP, with all 37 items processed using Fuzzy C-Means clustering to identify latent patterns in teachers' expectations. The Fuzzy C-Means algorithm was chosen due to its ability to allow data points to belong to multiple clusters with varying degrees of membership, providing a nuanced understanding of teachers' perspectives (Bezdek, 1981). Clustering solutions were optimized based on Bayesian Information Criterion (BIC) and Silhouette scores to ensure model validity.

3. RESULTS AND DISCUSSION

3.1. Results

Table 1 presents the descriptive statistics for the 37-item questionnaire assessing teachers' expectations regarding digital pedagogy training. The mean scores ranged from 2.780 to 2.988, with standard deviations between 1.061 and 1.245, indicating a moderate spread of responses. All items demonstrated statistically significant departures from normality as assessed by the Shapiro-Wilk test ($p < .001$), suggesting a non-normal distribution of responses.

Table 1

Descriptive statistics

	Valid	Missing	Mean	Std. Dev.	Sh.-Wilk	P-value of Shapiro-Wilk	Min.	Max.
item1	1865	0	2.81	1.15	0.82	< .001	1	4
item2	1865	0	2.92	1.2	0.77	< .001	1	4
item3	1865	0	2.93	1.24	0.75	< .001	1	4
item4	1865	0	2.87	1.22	0.78	< .001	1	4
item5	1865	0	2.91	1.25	0.75	< .001	1	4
item6	1865	0	2.99	1.12	0.79	< .001	1	4
item7	1865	0	2.96	1.11	0.8	< .001	1	4
item8	1865	0	2.9	1.06	0.83	< .001	1	4
item9	1865	0	2.89	1.07	0.83	< .001	1	4
item10	1865	0	2.93	1.1	0.81	< .001	1	4
item11	1865	0	2.96	1.17	0.77	< .001	1	4
item12	1865	0	2.93	1.16	0.79	< .001	1	4
item13	1865	0	2.92	1.17	0.79	< .001	1	4
item14	1865	0	2.92	1.13	0.81	< .001	1	4
item15	1865	0	2.93	1.15	0.79	< .001	1	4
item16	1865	0	2.98	1.16	0.77	< .001	1	4
item17	1865	0	2.95	1.15	0.79	< .001	1	4
item18	1865	0	2.91	1.14	0.8	< .001	1	4
item19	1865	0	2.91	1.11	0.81	< .001	1	4
item20	1865	0	2.91	1.12	0.81	< .001	1	4
item21	1865	0	2.91	1.1	0.82	< .001	1	4
item22	1865	0	2.87	1.06	0.84	< .001	1	4
item23	1865	0	2.93	1.12	0.81	< .001	1	4
item24	1865	0	2.9	1.09	0.83	< .001	1	4
item25	1865	0	2.9	1.11	0.82	< .001	1	4
item26	1865	0	2.86	1.09	0.83	< .001	1	4
item27	1865	0	2.97	1.11	0.8	< .001	1	4
item28	1865	0	2.93	1.09	0.82	< .001	1	4
item29	1865	0	2.97	1.14	0.79	< .001	1	4
item30	1865	0	2.93	1.09	0.82	< .001	1	4
item31	1865	0	2.94	1.12	0.8	< .001	1	4
item32	1865	0	2.86	1.15	0.81	< .001	1	4
item33	1865	0	2.78	1.11	0.84	< .001	1	4
item34	1865	0	2.88	1.14	0.81	< .001	1	4
item35	1865	0	2.89	1.16	0.8	< .001	1	4
item36	1865	0	2.89	1.16	0.8	< .001	1	4
item37	1865	0	2.86	1.13	0.82	< .001	1	4

The highest-rated competency was Item 16: "Integration of online tools and digital resources in teaching activities" (M = 2.988, SD = 1.120), highlighting teachers' emphasis on practical digital integration in their instructional practices. Conversely, Item 30: "Accessibility and inclusion: differentiation and personalization" had the lowest mean score (M = 2.780, SD = 1.108), suggesting that while inclusion remains relevant, it is perceived as a lower priority compared to other digital competencies. The overall response pattern indicates a strong interest in technological enhancement of pedagogy, with notable variations in emphasis across specific digital skills.

To identify distinct patterns in teachers' expectations regarding digital pedagogy training, Fuzzy C-Means clustering was applied to the 37-item dataset. The optimal number of clusters was determined using the Bayesian Information Criterion (BIC), which suggested a nine-cluster solution. The model exhibited a coefficient of determination (R^2) of 0.814, indicating a strong fit.

The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values were 18,089.430 and 19,931.250, respectively, further supporting model validity. The Silhouette score of 0.220 suggests moderate differentiation between clusters, indicating that while some groups of teachers have distinct expectation patterns, there is a degree of overlap in perceptions regarding digital competencies.

The Fuzzy C-Means clustering analysis identified nine clusters, each representing distinct patterns in teachers' expectations regarding digital pedagogy training. Table 2 provides details on cluster size, within-cluster heterogeneity, and silhouette scores. The explained proportion of within-cluster heterogeneity varied across clusters, with Cluster 1 (29.3%) and Cluster 9 (26.6%) contributing the most to overall variance, indicating substantial differentiation within these groups. In contrast, Cluster 4 (2.4%) showed the lowest proportion, suggesting a more homogeneous response pattern among its members.

Table 2

Cluster information

Cluster	1	2	3	4	5	6	7	8	9
Size	294	61	440	59	415	99	55	73	369

Explained proportion within-cluster heterogeneity	0.293	0.04	0.052	0.024	0.228	0.037	0.024	0.037	0.266
Within sum of squares	5111.3	694.146	899.866	422.605	3965.15	651.689	412.876	637.563	4628.23
Silhouette score	0.06	-0.12	0.551	-0.14	0.404	-0.12	-0.12	-0.09	0.052
Center item1	-1.53	0.165	0.215	1.009	-0.87	1.009	1.008	1.009	0.16
Center item2	0.024	0.073	0.883	0.884	-0.37	0.884	0.884	0.883	0.874
Center item3	0.017	0.846	0.85	0.849	-1.52	0.85	0.849	0.848	0.839
Center item4	0.065	0.908	0.91	0.911	-1.5	0.911	0.911	0.911	0.901
Center item5	0.791	0.857	0.859	0.859	-1.49	0.86	0.859	0.859	0.85
Center item6	-1.72	0.884	0.888	0.887	-1.71	0.887	0.887	0.886	0.875
Center item7	-0	0.914	0.918	0.917	-1.7	0.918	0.917	0.916	0.042
Center item8	-0.84	1.01	1.013	1.012	-1.7	0.142	1.013	1.012	1
Center item9	-0.82	1.013	1.016	1.015	-1.66	1.014	1.016	1.016	0.105
Center item10	-0.83	0.95	0.952	0.087	-1.66	0.951	0.952	0.952	0.941
Center item11	-0.01	0.87	0.873	0.872	-1.64	0.873	0.052	0.871	0.861
Center item12	-1.61	0.902	0.906	0.085	-1.62	0.905	0.079	0.904	0.065
Center item13	-0.79	0.907	0.91	0.91	-1.61	0.91	0.909	0.909	0.072
Center item14	0.031	0.937	0.941	0.94	-1.65	0.94	0.939	0.939	0.928
Center item15	0.015	0.905	0.909	0.907	-1.64	0.908	0.907	0.907	0.896
Center item16	-0.03	0.861	0.865	0.864	-1.67	0.864	0.864	0.862	0.853
Center item17	-0.82	0.893	0.897	0.897	-1.65	0.897	0.896	0.895	0.049
Center item18	0.033	0.935	0.939	0.938	-1.64	0.938	0.938	0.936	0.925
Center item19	0.038	0.955	0.959	0.959	-1.67	0.959	0.958	0.957	0.945

Center item20	0.039	0.947	0.952	0.951	-1.66	0.951	0.951	0.949	0.937
Center item21	-0.81	0.971	0.976	0.976	-1.68	0.975	0.975	0.974	0.085
Center item22	0.085	1.04	1.044	1.044	-1.69	1.043	1.043	1.042	1.029
Center item23	-1.67	0.937	0.942	0.941	-1.67	0.941	0.941	0.939	0.927
Center item24	-0.82	0.988	0.993	0.992	-1.69	0.993	0.992	0.991	0.094
Center item25	-0.8	0.963	0.968	0.968	-1.66	0.968	0.967	0.965	0.089
Center item26	0.09	0.13	1.03	1.03	-1.65	1.03	1.03	1.02	0.13
Center item27	-0.86	0.037	0.914	0.913	-1.72	0.913	0.912	0.91	0.9
Center item28	0.022	0.957	0.962	0.962	-1.71	0.962	0.961	0.07	0.065
Center item29	-0.01	0.888	0.893	0.892	-1.68	0.893	0.892	0.889	0.88
Center item30	-0.84	0.956	0.96	0.96	-1.71	0.96	0.959	0.07	0.946
Center item31	-0.83	0.918	0.923	0.922	-1.68	0.923	0.922	0.919	0.909
Center item32	-1.57	0.123	0.969	0.969	-1.58	0.969	0.969	0.122	0.118
Center item33	-1.55	0.197	1.073	1.074	-1.53	1.073	1.074	-0.68	0.192
Center item34	0.056	0.954	0.96	0.959	-1.61	0.96	0.959	0.956	0.945
Center item35	0.049	0.101	0.939	0.938	-1.59	0.939	0.938	0.935	0.096
Center item36	-0.77	0.936	0.941	0.94	-1.59	0.941	0.94	0.938	0.927
Center item37	-1.58	0.98	0.979	0.981	-1.55	0.98	0.131	0.127	0.123

The within-cluster sum of squares (WSS) values further reflect the degree of dispersion among items in each cluster. Clusters 1 and 9 had the highest WSS values (5,111.299 and 4,628.228, respectively), indicating a broader distribution of responses, whereas Cluster 4 (422.605) and Cluster 7 (412.876) exhibited the most compact response structures.

The Silhouette scores suggest that some clusters exhibit clearer separation than others. Cluster 3 (0.551) and Cluster 5 (0.404) demonstrate relatively strong cohesion and separation, indicating well-defined response groups. Conversely, negative silhouette values in Clusters 2 (-0.123), 4 (-0.141), 6 (-0.119), and 7 (-0.119) indicate overlaps, suggesting these groups may share common elements in their expectations.

The cluster analysis identified nine distinct groups of teachers, each reflecting specific expectations regarding digital pedagogy training. These clusters varied in their emphasis on technological integration, pedagogical strategies, ethical concerns, and professional development priorities.

Cluster 1 comprised teachers who prioritized general digital competencies and the integration of online tools into teaching practices. They emphasized data security and protection (Item 6: "Aspects related to data security and protection"), the DigCompEdu framework for digital competencies (Item 24: "Digital competencies – DigCompEdu framework"), and the practical use of digital resources in teaching (Item 16: "Integration of online tools and digital resources in teaching activities").

Cluster 2 included teachers who placed significant importance on online professional development and access to digital resources. They valued open educational resources and digital libraries (Item 12: "Digital resource libraries and selecting educational materials"), online training platforms (Item 7: "Online training activities and continuous professional development"), and collaborative learning through digital networks (Item 22: "Digital collaboration and communication in education").

Cluster 3 represented teachers who focused on learning with digital technologies and student engagement. Their expectations centered on collaborative and self-regulated learning (Item 18: "Learning with digital technologies: collaborative and self-regulated learning"), active learning strategies (Item 27: "Active learning approaches: engaging students through technology"), and instructional models using digital tools (Item 28: "Classroom models and instructional strategies using digital tools").

Cluster 4 was composed of teachers who emphasized assessment and feedback using digital technologies. They prioritized learning analytics and data-driven feedback (Item 19: "Assessment using digital technologies: learning analytics and feedback strategies"), digital formative and summative assessment techniques (Item 32: "Digital assessment tools and adaptive evaluation methods"), and using AI-assisted feedback for student progress (Item 35: "AI-assisted assessment and feedback mechanisms").

Cluster 5 included teachers who strongly emphasized ethical considerations and responsible use of digital technologies. Their concerns revolved around ethical challenges and privacy issues (Item 10: "Ethical considerations, limitations, and challenges of digital technologies in education"), data protection and cybersecurity (Item 6: "Aspects related to data security and protection"), and digital citizenship and online responsibility (Item 26: "Digital citizenship: digital literacy, critical thinking, and responsibility").

Cluster 6 consisted of teachers who focused on digital literacy and foundational digital skills. Their expectations included basic digital tools training (Item 21: "Introduction to digital tools and technologies for education"), improving their personal digital proficiency (Item 11: "Developing teachers' digital literacy skills"), and building confidence in using e-learning platforms (Item 31: "Using e-learning platforms for interactive instruction").

Cluster 7 represented teachers with an emphasis on institutional development and professional collaboration in digital education. They valued institutional strategies for digital transformation (Item 8: "Institutional development: digital communication and professional collaboration"), school-wide technology policies (Item 34: "Strategic planning for technology integration in schools"), and networking and knowledge-sharing through digital communities (Item 23: "Professional learning networks and digital education communities").

Cluster 8 grouped teachers who highlighted blended learning and hybrid teaching models as key areas of focus. Their expectations included best practices for blended learning (Item 29: "Examples of learning activities in blended learning environments"), differentiation and personalization through digital tools (Item 30: "Accessibility and inclusion: differentiation and personalization"), and hybrid instructional models that integrate online and in-person learning (Item 17: "Teaching with digital technologies: visual supports, interactive teaching, and distance learning").

Cluster 9 included teachers who prioritized pedagogical innovation and digital curriculum development. They focused on integrating digital competencies throughout the curriculum (Item 25: "Developing digital competencies throughout the curriculum"), creating and curating digital teaching materials (Item 13: "Creating digital educational resources"), and using AI-powered tools for personalized learning (Item 36: "AI-powered instructional design and adaptive learning environments").

These findings suggest that teachers' expectations regarding digital pedagogy training are highly diverse and structured around distinct themes, from fundamental digital skills to advanced instructional strategies and ethical considerations. Understanding these clusters enables the development of tailored professional development programs, ensuring that training efforts align with teachers' specific needs, digital readiness, and professional goals.

The evaluation metrics of the Fuzzy C-Means clustering model provide insights into the quality and structure of the identified clusters. The maximum cluster diameter was 14.028, indicating the greatest distance between two points within the same cluster, reflecting the extent of internal variability. In contrast, the minimum separation between clusters was 0.855, suggesting relatively close proximity between some groups, potentially indicating overlapping characteristics among teachers' expectations.

The Pearson's γ coefficient was 0.463, signifying a moderate correlation between the clustering structure and the distance between data points. The Dunn index, which measures the ratio of minimum inter-cluster distance to maximum intra-cluster distance, was 0.061, indicating that while clusters are distinguishable, there is some degree of dispersion within them. The entropy value of 1.895 suggests a balanced distribution of membership probabilities, meaning that while teachers' expectations varied, there was no extreme dominance of one cluster over the others.

Additionally, the Calinski-Harabasz index, a measure of cluster compactness and separation, had a value of 686.337, supporting the robustness of the clustering model. Given that all these metrics were computed using Euclidean distance, the clustering approach effectively captured variations in teachers' digital training expectations, enabling a complex understanding of professional development needs.

To further evaluate the clustering solution, Figure 1 presents the Elbow Method Plot, which was used to determine the optimal number of clusters. This method analyzes the relationship between the number of clusters and the total within-cluster variance, allowing for an assessment of the point at which adding more clusters no longer significantly reduces variance. The selected nine-cluster solution aligns with the point of inflection, indicating an appropriate balance between model complexity and interpretability.

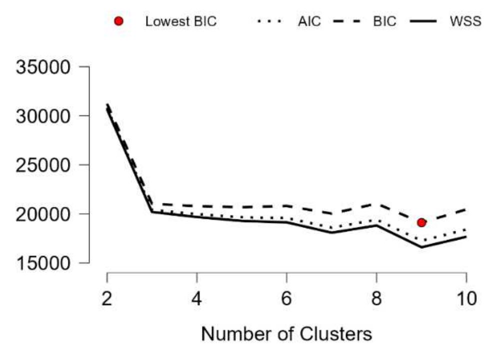

Fig. 1. Elbow Method Plot

Figure 2 displays the t-SNE Cluster Plot, which provides a two-dimensional visualization of the identified clusters. This technique reduces the high-dimensional feature space while preserving local relationships, effectively illustrating the distribution and separation of clusters. The plot highlights the distinctiveness of some clusters, while also showing areas where certain groups exhibit overlap, confirming the findings from the silhouette analysis. These visualizations enhance the interpretation of the clustering results, offering insights into the patterns and structure of teachers' expectations regarding digital pedagogy training.

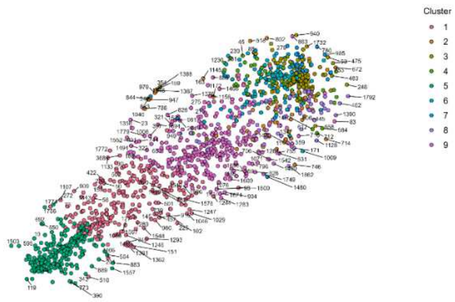

Fig. 2. t-SNE Cluster Plot

3.2. Discussions

This study's findings align with existing literature emphasizing the critical role of pedagogical training in effectively integrating digital tools into teaching practices. For instance, found that pedagogical training enhances teachers' learning-focused approaches to online teaching and promotes diverse use of digital tools. Similarly, our results indicate that teachers with extensive pedagogical training are more inclined to adopt learning-centered strategies and utilize a variety of digital tools to engage students.

However, our study also reveals that ICT-specific training does not significantly correlate with the use of digital tools in teaching. This observation is consistent with, who reported that ICT training alone does not influence the adoption of digital tools.

The application of Fuzzy C-Means (FCM) clustering in this study provided nuanced insights into teachers' expectations and priorities regarding digital pedagogy training. This approach aligns with previous research that utilized FCM clustering to analyze complex educational data, offering a more detailed understanding of underlying patterns. The clustering revealed distinct groups of teachers with varying emphases on technological integration, pedagogical strategies, and professional development priorities, highlighting the diverse needs within the teaching community.

Despite its contributions, this study has several limitations. First, the sample consisted of teachers who voluntarily participated in digital pedagogy training, which may introduce a self-selection bias favoring those already interested in technological advancements. Second, while Fuzzy C-Means clustering provided a flexible classification, overlapping cluster membership suggests that some teachers’ expectations may evolve based on contextual factors such as institutional support and prior experience.

The study’s findings emphasize the need for personalized professional development programs that cater to diverse teacher profiles. Training initiatives should be differentiated based on identified expectation clusters, ensuring that educators receive support that matches their current competencies and instructional needs.

By applying Fuzzy C-Means clustering, this study provides a data-driven framework for designing targeted digital pedagogy training, moving beyond generalized approaches toward more effective, personalized, and impactful professional development strategies.

4. CONCLUSION

This study highlights the diverse expectations that teachers hold regarding digital pedagogy training, emphasizing that professional development programs cannot adopt a one-size-fits-all approach. By applying Fuzzy C-Means clustering, we uncovered distinct groups of educators, each with unique priorities—ranging from technological integration and active learning strategies to ethical concerns and digital assessment methods. These findings reinforce the need for personalized and adaptive training programs that align with teachers' specific needs and experiences.

Looking ahead, future research should explore how long-term training interventions impact teaching practices and how teachers’ expectations evolve with experience and institutional support. As digital education becomes more integrated into learning environments, ensuring that teachers are not just equipped with digital tools but empowered to use them effectively will be key to shaping the future of pedagogy.

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Clusterizarea așteptărilor profesorilor în programele de educație digitală utilizând Fuzzy analiza C-Means

Pe măsură ce instrumentele digitale devin din ce în ce mai integrate în educație, înțelegerea așteptărilor profesorilor privind formarea în domeniul pedagogiei digitale este esențială pentru proiectarea unor programe eficiente de dezvoltare profesională. Acest studiu aplică analiza Fuzzy C-Means clustering la un set de date de 1,865 profesori pentru a descoperi modele distincte de așteptări în formarea digitală. Folosind un chestionar cu 37 de elemente bazat pe cadrul DigCompEdu, s-a examinat modul în care profesorii prioritizează competențele digitale cheie, de la integrarea tehnologică și strategiile de învățare activă, la considerații etice și metode de evaluare digitală. Instrumentul a demonstrat o fiabilitate ridicată (Cronbach's $\alpha = 0.992$), iar soluțiile de grupare au fost optimizate utilizând criteriul de informare Bayesian (BIC) și scorurile Silhouette în JASP. Constatările relevă mai multe așteptări, reflectând diferențele în ceea ce privește pregătirea digitală, adaptarea pedagogică și încrederea în utilizarea tehnologiei. Unii profesori au căutat formare avansată privind strategiile digitale de instruire, în timp ce alții au pus accentul pe competențele fundamentale și pe preocupările etice. Aceste informații evidențiază necesitatea unor programe de formare flexibile, personalizate, care să se alinieze nevoilor de dezvoltare profesională diverse ale profesorilor. Prin recunoașterea și abordarea acestor așteptări variate, acest studiu contribuie la optimizarea formării în domeniul pedagogiei digitale, asigurându-se că profesorii nu sunt doar echipați cu instrumente digitale, ci și împuterniciți să le utilizeze eficient în medii de învățare diverse.

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