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Building a mechanism to empower teachers to innovate their teaching through digital education

Lina Zhang^{1,*}

¹ School of Life and Health, Zhengzhou Vocational and Technical College, Zhengzhou, Henan, 450000, China

Corresponding authors: (e-mail: zhanglina098210@163.com).

Abstract The advent of the digital era has brought about a profound and widespread transformation in the field of education. In this transformation process, teachers' digital literacy plays a crucial role. Therefore, it is particularly important to explore and construct a systematic and scientific system to improve teachers' digital literacy. This paper focuses on how education digitalization empowers the mechanism of teachers' practical teaching innovation, aiming to provide a theoretical basis and practical path for education digital transformation. Through a combination of empirical research and logical reasoning, this paper discusses the current situation of teachers' practical teaching innovation in the context of education digital transformation and the dilemmas they face in this process. The study reveals the far-reaching impact of the digital empowerment mechanism on teachers' teaching innovation, thus providing new ideas and directions for the high-quality development of education. The results show that there is a significant positive correlation between the improvement of teachers' digital literacy and their teaching innovation ability. This finding provides a new perspective for deepening the digital transformation of education, especially in promoting the diversification and flexibility of education and teaching methods, the empowering role of digitalization becomes more and more prominent. The innovation of teachers' practical teaching also benefits from the transformation of teaching methods and means brought about by the digital empowerment of education. This not only promotes better allocation of educational resources, but also lays the foundation for the overall improvement of educational quality. The practical teaching innovation of teachers empowered by education digitalization promotes the change of teaching mode and plays a positive role in promoting the quality of education in the future.

Index Terms digitalization of education, teachers' digital literacy, practice teaching, teaching innovation, empowerment mechanism

I. Introduction

I. A. Background and significance of the study

The rapid arrival of the digital era is driving unprecedented changes in education. The State has clearly identified the digital transformation of education as one of the core strategies for the modernization of education. Teachers' digital literacy occupies a crucial position in this transformation process, because the quality of teachers is directly related to the effectiveness of the digital transformation of education. By improving the digital literacy of teachers, it not only stimulates their innovative potential in practical teaching, but also provides strong support for promoting the high-quality development of education.

With the rapid development of artificial intelligence, big data and other cutting-edge technologies, the field of education is facing unprecedented opportunities and challenges. These technologies are profoundly changing the traditional education and teaching model and prompting a deep integration between the digital transformation of education and educational innovation. However, to achieve this goal, we must rely on a team of teachers who are innovative and master modern digital tools. Teachers' digital literacy is becoming the key to unlocking the digital transformation of education and promoting the equitable development of education.

As the core force of education and teaching, teachers' digital literacy directly determines their ability to innovate in practical teaching. With the increasing penetration of digital technology into the field of education, teachers not only need to improve their mastery of digital teaching tools, but also need to flexibly apply these tools in their daily teaching to promote students' learning. This process cannot be separated from a scientific and effective cultivation mechanism, only through such a mechanism can we provide sufficient support for teachers to practice teaching innovation, thus playing a positive role in improving the quality of education and teaching. In the context of the gradual construction of the national wisdom education platform, the digital transformation of education has

entered the concrete implementation stage from macro planning, and also provides a stronger guarantee for teachers to improve their digital literacy.

Teachers' practical teaching innovation is an intrinsic requirement to promote the modernization of education, and the enhancement of teachers' digital literacy is not only reflected in the simple application of technology, but also needs to be stimulated through a systematic training mechanism to stimulate their innovative potential. The digitalization of education empowers teachers to practice teaching innovation, which not only creates a more flexible and open teaching mode, but also helps optimize the allocation of educational resources, and ultimately realizes the overall improvement of education quality.

I. B. Main contributions and innovations of this study

Although the research field of digital transformation in education has made a breakthrough in the cultivation of teachers' digital literacy, the systematic research on digitally empowered teachers' practical teaching innovation is still insufficient. In this study, we analyzed the connotation structure of teachers' digital literacy, and constructed a cultivation mechanism that includes three dimensions: digital literacy base cultivation, practice and teaching innovation, and evaluation of empowerment effect. The research team innovatively designed the evaluation system of "Teachers' Digital Literacy Improvement Index" to quantitatively analyze teachers' digital teaching ability, and introduced artificial intelligence and big data technology to establish the evaluation model of "Teaching Innovation Index". With the support of the smart education platform, a targeted digital literacy training course was developed, and the questionnaire survey and experimental data analysis verified the promotion effect of teachers' digital literacy on teaching innovation.

This study breaks through the limitations of the traditional single training model and proposes a synergistic promotion mechanism that combines policy leadership, technical support and practical innovation. Through the comprehensive use of literature analysis, questionnaire survey and experimental design, we collected multi-dimensional data support, which not only enriches the theoretical content of digital transformation in education, but also provides concrete operational guidelines for promoting teachers' practical teaching innovation.

II. Literature review

II. A. Theoretical basis of the study

The theory of teachers' digital literacy constitutes the core theoretical foundation of this study, and this theoretical system subdivided digital literacy into three progressive dimensions: the cognitive level, the practical level and the innovation level. The cognitive dimension is mainly reflected in teachers' in-depth understanding and accurate grasp of the essential features of digital technology, which is not only limited to the surface technical operation, but also involves a deeper understanding of the educational value of digital technology. The practical level requires teachers to have the ability to effectively integrate digital technology into the teaching process, including the integration of technology in teaching design, the application of technology in classroom implementation, and the analysis of data in teaching evaluation. The innovation level, as the highest level of digital literacy, emphasizes teachers' ability to use digital technology to solve teaching problems and innovate teaching modes, and the cultivation of this ability needs to rely on a sound guarantee mechanism and systematic practical training. The research results of Teachers' Digital Literacy Enhancement Guarantee Mechanism Construction Enabling Digital Transformation of Regional Education show that the coordination and harmonization of teaching resources construction and curriculum teaching management in the context of technological empowerment is the key to promoting the development of teachers' digital practice ability.

The integration of teacher professional development theory and education digital transformation theory provides methodological support and macro guidance for digital literacy enhancement. The professional development theory emphasizes the continuity and stage characteristics of teachers' growth, and believes that the acquisition of digital literacy is a gradual learning process that requires continuous theoretical learning, practical exploration, and reflective improvement to achieve a spiral rise in competence. This developmental model highlights the dynamic role of teachers as learning subjects, and requires the close integration of abstract theoretical knowledge with concrete teaching practice, and the validation and refinement of digital skills in actual teaching contexts. The theory of digital transformation of education explains the background and development trend of the era of digital literacy improvement from a more macroscopic perspective, and the Digitalization of Education for a Stronger Education: Values, Challenges, and Paths points out that the digital transformation not only involves the updating of technological means, but also involves a fundamental change in the concept of education and a deep-level reconstruction of the teaching mode.

The theory of smart education and the theory of artificial intelligence education change together build the technical support system and future development direction of teachers' digital literacy improvement. The smart

education platform creates a favorable external environment for the comprehensive improvement of teachers' digital competence through multiple empowerment mechanisms such as resource allocation, data mining, network connection and technical support. This platform-based empowerment model not only effectively promotes the rapid improvement of teachers' digital skills, but also promotes the continuous innovation of teaching methods and education models. The rapid development of artificial intelligence technology has put forward higher-level requirements for teachers' digital literacy, and teachers need to master basic digital skills while deeply understanding the mechanism of educational application of intelligent technology and be able to flexibly utilize these advanced technologies in specific teaching practices. The research results of the human-machine symbiosis mechanism reveal the inherent law of the deep integration of intelligent technology and teaching practice, emphasizing that teachers should have data literacy and the ability to apply intelligent technology in order to adapt to the objective requirements of the intelligent development of education. The application practice of blockchain technology in the field of vocational education shows that digital transformation requires the establishment of a working mechanism for the collaborative promotion of multiple subjects, and this finding is an important inspiration for the cultivation of teachers' digital literacy.

II. B. Status of research

The new generation of digital technologies, such as Big Data, Internet of Things and Artificial Intelligence, are developing at an unprecedented speed, profoundly affecting the structure of society, economic model, life pattern and even people's way of thinking, bringing unprecedented changes [1]. This is not only a technological change, but also a comprehensive and profound social change, whose influence has permeated all walks of life, and has brought about significant changes in the innovation and development of the education system [2]. The digital transformation of education has become the core topic of current research in the field of education [3].

In the context of the digital transformation of education, the application of digital technology for education and teaching has shifted from shallow teaching reform to deep teaching reform. The educational environment, model, and concept have changed accordingly, and digital technology knowledge and skills have become the basis for the deep integration of technology and teaching [4]-[7]. As a result, teachers, as an important driving force and the main implementer of educational change, their innovation ability is no longer emphasized on pure teaching ability, but more on digital innovation ability rooted in teachers' digital knowledge and literacy [8]. At the same time, the cultivation of teachers' innovation ability urgently needs to empower teachers' digital competence, while the development of teachers' digital competence is an important challenge in the new era, so the enhancement of digital knowledge and literacy is a dual response to the cultivation of teachers' competence and the real needs of educational innovation [9]-[11]. In addition, the development of teachers' literacy under technological empowerment urges teachers to be able to select appropriate technologies for digital teaching innovation according to the knowledge structure, teaching methods and objectives of different disciplines, etc., which requires teachers to have solid digital literacy and professional knowledge to innovate and change educational and teaching activities and reach the realization of the goal of educating people [12]-[14].

III. Research methodology

III. A. Literature analysis methodology

This study conducted a literature search on academic platforms such as China Knowledge Network, Wanfang Database and Science Network. By setting search terms such as "teachers' digital literacy", "evaluation of teaching ability" and "digital transformation of education", research papers and policy documents in the past five years were collected. The study of "Construction of Teachers' Digital Literacy Enhancement Guarantee Mechanism to Enable the Digital Transformation of Regional Education" shows that the enhancement of teachers' digital literacy requires the establishment of a framework of a guarantee system with "two institutions, three teams, and five goals". Research on the Evaluation System of Teaching Competence of Teachers in Applied Universities has constructed a three-dimensional evaluation model of competence composition, work area and teaching activities, which provides an important reference for the design of innovative assessment tools for teachers' practical teaching. Macro Trends, Key Technologies and Development Scenarios of Digital Transformation in Higher Education points out that new technologies such as artificial intelligence and big data are changing the traditional teaching mode. Enabling Education with Intelligent Technologies: New Dynamics for High-Quality Development of Education emphasizes the positive role of intelligent technologies in enhancing the effectiveness of the education system.

Through in-depth analysis of existing research literature, it is found that current scholars' exploration of teachers' digital literacy enhancement mainly stays at the level of training system and evaluation standards. The Quadruple Mechanism of the National Intelligent Education Platform Empowering the Digital Transformation of

Regional Education puts forward the theoretical model of resource empowerment, data empowerment, connection empowerment, and technology empowerment, which opens up a new way of thinking for exploring the mechanism of digital empowerment in education. Based on existing research results and practical needs, this study focuses on constructing a scientific and effective education digital empowerment mechanism with the aim of promoting the overall improvement of teachers' practical teaching innovation ability. This research perspective not only reflects the inheritance and development of existing theories, but also highlights the innovative value and practical significance of the study.

III. B. Empirical research methodology

For the study of teachers' digital literacy level and teaching innovation ability, we conducted an in-depth empirical research based on a multi-dimensional assessment framework, and adopted a research method combining questionnaire survey and in-depth interviews. Through the development of the Digital Literacy and Practical Teaching Innovation Questionnaire specifically for college teachers, we designed an evaluation system covering the three core dimensions of digital technology application ability, teaching design innovation level, and teaching practice transformation effect, and used a five-point Likert scale for self-assessment and peer review. In order to enhance the reliability and validity of the study, we conducted in-depth interviews with representatives of teachers of different disciplinary backgrounds and teaching ages, aiming at comprehensively exploring the actual problems and breakthrough innovations faced by teachers in the process of digital teaching practice. Based on a large amount of primary research data, we creatively constructed a formula for calculating the teachers' digital literacy improvement index, i.e.:

$$DS = \frac{\sum_{i=1}^n S_i}{n} \quad (1)$$

where DS represents the index of teachers' digital literacy improvement, S_i denotes the score of the i th literacy improvement item, and n is the number of literacy improvement items, the quantitative assessment of teachers' performance in the development of digital resources, application of smart tools, and data analysis effectively reflects the overall level of digital literacy in the teacher population.

At the same time, we also established an index calculation formula to measure the effectiveness of teachers' practical teaching innovation, i.e.:

$$TI = \frac{\sum_{i=1}^m I_i}{m} \quad (2)$$

The formula defines TI as the practical teaching innovation index, I_i represents the innovation score of the i item, m is the number of innovative items, and the evaluation dimensions involve multiple dimensions such as the innovation of teaching methods, the innovation of resource integration and the innovation of classroom organization.

During the semester-long empirical study, we selected teachers from three different types of universities as the research subjects, designed and implemented a digital literacy training course following the "cognition-practice-innovation" progression model, and made full use of the digital tools and resources provided by the National Intelligent Education Platform to promote teachers' innovative practices. Through continuous tracking, the research team systematically collected data on teachers' acceptance of digital technology, frequency of application, and the effect of innovative practice, and combined with student feedback, constructed an all-around evaluation system, providing solid data support for in-depth exploration of digital teaching innovation.

III. C. Experimental design

This study utilized a quasi-experimental design approach to investigate the mechanism of digital technology's influence on teachers' practice teaching innovation. During the experimental period that lasted 16 weeks, 120 teachers with different teaching experiences and professional backgrounds were selected from three colleges and universities as research subjects. The participants were divided into an experimental group (TX1) and a control group (TX2) by stratified sampling, with 60 participants in each group.

Based on the understanding of the laws of digital teaching innovation, teachers in the experimental group participated in systematic training courses, while teachers in the control group continued their regular teaching and research activities. The course system contains three core contents of digital technology application, teaching design optimization and innovation practice, and 4 credit hours of blended learning are arranged every week. The training adopted a project-based learning approach to guide teachers to use digital technology, and was

accompanied by an online resource library and a learning community to provide continuous support. The research team developed a multi-dimensional assessment system, using a self-assessment questionnaire to understand the mastery of digital skills, peer review to examine the innovation of instructional design, student feedback to assess the degree of improvement in teaching effectiveness, and an expert review team to make a comprehensive assessment of the innovative results. The experimental process set up three time points for tracking and evaluation, and the study used a combination of quantitative and qualitative analysis methods. SPSS 26.0 software was used for difference test and correlation analysis in data processing, and the specific innovative performance of teachers was explored in depth through classroom observation, case study analysis and in-depth interviews. Three months after the end of the experiment, we conducted a follow-up survey on the teachers in the experimental group to examine the sustainability of their innovative ability. Based on the collected data, the research team constructed a relationship model with digital literacy as the independent variable and teaching innovation as the dependent variable, and used AMOS 24.0 software to conduct path analysis through structural equation modeling. The model was also validated in groups for different disciplines and teacher group characteristics to explore the multiple paths of digitally empowered teaching innovation. This data-driven research idea enables us to grasp the mechanism of digital literacy enhancement on teaching innovation more clearly.

IV. Results and discussion

IV. A. Data analysis

By analyzing the relevant data collected during the 16-week experimental period, we used the SPSS 26.0 statistical software to systematically explore the relationship between the teachers' digital literacy improvement index and the practical teaching innovation index. Specifically, we statistically analyzed the basic data of teachers in the experimental group and the control group, and the results of their specific statistical analysis are shown in Table 1. The results show that the mean value of the digital literacy improvement index of teachers in the experimental group is 3.76 (standard deviation 0.52), and that of the control group is 2.83 (standard deviation 0.47). After using the independent samples t-test, the results showed a significant difference between the two groups ($t=9.64$, $p<0.001$), a difference that suggests that systematic digital literacy training plays a positive role in significantly improving teachers' ability to apply digital technology. In terms of practical teaching innovation, the mean value of teachers in the experimental group was 3.89 (standard deviation 0.48), which was much higher than that of the control group, which was 2.91 (standard deviation 0.51), and the difference was also statistically significant ($t=10.12$, $p<0.001$). Further Pearson's correlation analysis showed that there was a significant positive correlation between the index of teachers' digital literacy improvement and the index of practice teaching innovation ($r=0.782$, $p<0.001$), which further verified our core research hypothesis that the improvement of digital literacy has a significant contributing effect on teachers' practice teaching innovation.

Table 1: Digital literacy and practice teaching innovation

Index	EC		CC		<i>t</i>	<i>p</i>
	Means	STD	Means	STD		
DS	3.76	0.52	2.83	0.47	9.64	<0.001
TI	3.89	0.48	2.91	0.51	10.12	<0.001

DS and TI ($r=0.782$, $p<0.001$)

In order to gain a deeper understanding of the internal logic of the digital empowerment mechanism, we analyzed the path relationships between the variables through structural equation modeling. Using the model constructed by AMOS 24.0 software, the path relationship between the variables was obtained as shown in Figure 1. The results show that the path coefficient of digital technology application ability on instructional design innovation is 0.68 ($p<0.001$), while the path coefficient of instructional design innovation on the transformation of teaching practice is 0.74 ($p<0.001$). The overall model fit was good (CFI=0.926, TLI=0.912, RMSEA=0.067). These data suggest that by mastering digital technology tools, teachers are able to realize innovative breakthroughs at the instructional design stage, thus promoting the translation of innovations into actual teaching.

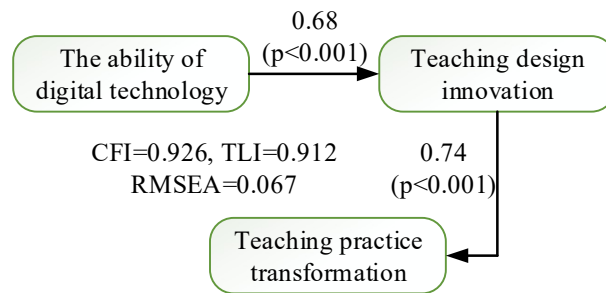


Figure 1: The path relationships among various variables

In addition, based on the longitudinal analysis of the tracking data, we found that the improvement of teachers' digital literacy has a strong continuity characteristic. The three-month tracking data after the end of the experiment showed that teachers in the experimental group still maintained a high level of frequency of using digital tools and innovative teaching practices. Specifically, 82.3% of the teachers continued to use the digital technologies mastered during the training in their classrooms, and 74.5% of the teachers indicated that they would take the initiative to explore new digital teaching methods. The qualitative analysis further confirmed the central role of synergistic promotion of top-level design and specific initiatives, and the interview results showed that teachers generally believed that institutional safeguards, technical support and professional guidance were indispensable. Through the word frequency analysis of the interviews, we found that "platform convenience", "resource richness" and "interactive effect" were the key words repeatedly mentioned by teachers, indicating that the national smart education platform has played an important role in empowering teachers' pedagogical innovation. This indicates that the national smart education platform plays a crucial role in empowering teachers' teaching innovation.

In summary, the mechanism of digitalization of education to empower teachers' practical teaching innovation constructed in this study is fully supported by data, which lays a solid foundation for further theoretical discussion and wide dissemination of practice.

IV. B. Discussion of results

By analyzing the experimental data from the teacher groups in three universities, this study finds that the digitalization of education has demonstrated significant practical value in empowering teachers' practical teaching innovation, which is reflected in systematic changes on multiple levels. An in-depth analysis of the mechanisms behind the data reveals that there is an intricate correlation between teachers' digital literacy and practical teaching innovation, which is not only reflected in the use of technological tools, but also penetrates into the concepts of instructional design, the integration of teaching resources, and classroom organization in multiple dimensions. During the 16-week experimental period, we observed that teachers from different disciplinary backgrounds showed significant differentiation in the use of digital tools for teaching innovation, which reveals that we must take into account the characteristics of disciplines in the process of promoting digital transformation in education. Despite the limitations of this study in terms of sample representativeness and experimental period, the tracking analysis of teachers' behavioral changes found that participating teachers generally showed strong willingness to innovate and motivation for continuous learning, and this endogenous professional development motivation has become a key factor in the sustained promotion of the digital transformation of education.

The construction of the national smart education platform has provided teachers with convenient technical support and rich teaching resources, effectively solved the practical difficulties encountered by teachers in the process of digital teaching innovation, and enabled teachers to design and implement innovative teaching activities more flexibly. The results of the study show that only by organically combining policy support, technology empowerment and teacher initiative can the expected goal of digital transformation of education be truly realized, and the establishment of such a mechanism not only promotes the professional development of teachers, but also lays a solid foundation for advancing educational fairness and improving the quality of education. Although the systematic assessment of students' learning effects still needs to be strengthened, the education digital empowerment mechanism constructed in this study provides a feasible practical path for promoting teachers' practical teaching innovation.

V. Conclusion

Based on the in-depth research on the cultivation mechanism of education digitalization-enabled teachers' practical teaching innovation, we found that the improvement of teachers' digital literacy plays an irreplaceable

key role in promoting teaching innovation. A large amount of research data shows that the significant improvement of teachers' digital literacy not only enhances their ability to use digital technology for instructional design, but also stimulates the widespread practice of innovative teaching behaviors.

In the teacher training experiments carried out by several universities, the index of teachers' digital literacy improvement and the index of practical teaching innovation show a strong correlation, which fully verifies the facilitating effect of digital literacy on teaching innovation. We note that the combination of policy leadership and specific implementation has constructed a systematic mechanism to create a favorable environment for the continuous improvement of teachers' digital literacy. From the perspective of teaching practice, teachers with strong digital literacy are able to skillfully use technical means such as intelligent recommendation and big data analysis to provide students with personalized learning support and timely feedback, and this change in teaching style directly promotes the innovation of teaching evaluation methods. In-depth analysis of the data of teachers from different subject backgrounds shows that there are obvious differences in their professional characteristics and teaching needs, which reveals that we must implement differentiated cultivation strategies in the process of promoting digital empowerment in education. Through the establishment of a comprehensive cultivation mechanism, we have seen the overall improvement of teachers' professionalism, and the quality of teaching and the equity of education in higher education have also increased. The future digital transformation of education needs to continuously deepen the teachers' digital literacy enhancement project, and promote the continuous development of teachers' practical teaching innovation by strengthening the institutional guarantee and technical support, which is of great significance to the construction of a high-quality and intelligent education system.

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References

- [1] Balkin, J. M., & Sonnevend, J. (2016). The digital transformation of education. *Education and social media: Toward a digital future*, 9-24.
- [2] Gillpatrick, T. (2020). Innovation and the digital transformation of education. *The Journal of Limitless Education and Research*, 5(3), 194-201.
- [3] Bilyalova, A. A., Salimova, D. A., & Zelenina, T. I. (2020). Digital transformation in education. In *Integrated science in digital age: ICIS 2019* (pp. 265-276). Springer International Publishing.
- [4] Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences*, 12(11), 784.
- [5] McCarthy, A. M., Maor, D., McConney, A., & Cavanaugh, C. (2023). Digital transformation in education: Critical components for leaders of system change. *Social sciences & humanities open*, 8(1), 100479.
- [6] Sepúlveda, A. (2020). The digital transformation of education: connecting schools, empowering learners. *TIC EDUCACÃO*, 249.
- [7] Tulchinsky, G. (2017). Digital transformation of education: Challenges for higher school. *Russian Journal of Philosophical Sciences*, (6), 121-136.
- [8] Mohamed Hashim, M. A., Tlemsani, I., & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies*, 27(3), 3171-3195.
- [9] Martínez-Pérez, S., Cabero-Almenara, J., Barroso-Osuna, J., & Palacios-Rodríguez, A. (2022, June). T-MOOC for initial teacher training in digital competences: Technology and educational innovation. In *Frontiers in Education* (Vol. 7, p. 846998). Frontiers Media SA.
- [10] Pinto-Santos, A., Reyes, C. G., & Cortés-Peña, O. (2022). Training and educational innovation: An evaluative perspective of the digital teaching competence. *International Journal of Emerging Technologies in Learning (IJET)*, 17(7), 38-53.
- [11] Garzón Artacho, E., Martínez, T. S., Ortega Martín, J. L., Marin Marin, J. A., & Gómez García, G. (2020). Teacher training in lifelong learning—The importance of digital competence in the encouragement of teaching innovation. *Sustainability*, 12(7), 2852.
- [12] García-Vera, A. B. (2021). Functional resignification and technological innovation as a digital teaching competence. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 16(1), 93-99.
- [13] Budnyk, O., Matveieva, N., Fomin, K., Nazarenko, T., & Kalabska, V. (2021). Preparation of future teachers for the introduction of digital innovation in a rural school: problems and prospects. *Revista Brasileira De Educação Do Campo*, 6, e13124-e13124.
- [14] Amalia, I. Z., Sari, E., & Ahmad, M. (2024). Education Transformation: The Impact of Digital Mindset on Chemistry Teacher Innovation. *JMSP (Jurnal Manajemen dan Supervisi Pendidikan)*, 9(1), 12-25.