Jurnal Pendidikan Indonesia Gemilang Vol.4, No.1, 2024, pp. 54-66
e-ISSN 2809-5073. DOI. 10.52889/jpig.v4i1.355

Pre-service Biology Teachers' Digital Competences Profile

Submitted 28 January 2024, Revised 16 February 2024, Accepted 17 February 2024

Aidil Adhani[1*], Nursia Nursia[2]

Department of Biology Education, Faculty of Teacher Traning and Education,
Universitas Borneo Tarakan, Tarakan, Indonesia

Corresponding Email: *adhani89@gmail.com

Abstract

Education in the digital era increasingly demands teachers to have the ability to utilize technology as a tool in the learning process. Pre-service biology teachers need to understand and master various technologies related to the biology field, such as educational software, online learning platforms, and other digital media. This study aimed to objectively and comprehensively describe the profile of digital competence among biology pre-service teachers. This study utilizes a quantitative descriptive research design. The data collection uses a specially designed questionnaire to measure the digital competence of biology pre-service teachers. The research findings found that the average score of the average level of digital competency among pre-service biology teachers is 3.13, indicating a moderate level. The findings can be the basis for developing training programs and enhancing digital competence for pre-service biology teachers.

Keywords*:* Profile, Digital competences, Pre-service biology teachers

INTRODUCTION

Education in the digital era requires teachers to utilize technology as part of the learning process effectively. Technological advances have dramatically transformed how humans access information across disciplines, including biology (Dias-Trindade *et al.,* 2020). Therefore, biology pre-service teachers must understand and master various biology-related technologies, such as educational software, online learning platforms, and digital media. This means that future biology teachers must have adequate digital literacy.

Digital competence refers to an individual's ability to use digital technology to achieve specific goals effectively (Zhao *et al.*, 2021; Alnasib, 2023; Wang, 2023). It encompasses skills related to searching, acquiring, processing, and communicating information and transforming it into knowledge (Díaz-Burgos et al., 2023). According to Montilla *et al.* (2023), Providing teachers with the essential digital skills to navigate the digital era is crucial. An exceptional biology pre-service teacher can incorporate technology into their lessons to create engaging and immersive learning experiences for their students. Digital competence is essential for improving learning effectiveness and efficiency (Stopar & Bartol, 2018) and preparing students for an increasingly advanced digital world (Redecker & Punie, 2017; Kassymova *et al.*, 2023). It is also integral to making distance learning more accessible and flexible for all students (Yang, 2020). Educators must implement engaging and effective learning by utilizing digital technology. Furthermore, educators must recognize digital technology's role in education and teach students how to use it responsibly and safely.

Previous research has emphasized the significance of digital competence in improving educational outcomes (Scheel *et al.,* 2022; Kassymova *et al.,* 2023). Additionally, studies have identified deficiencies in this area among pre-service teachers (Guillen-Gamez *et al.,* 2020; Sixto-García *et al.,* 2020). However, there is still a lack of understanding regarding biology pre-service teachers' precise digital competence profile and the factors contributing to their inadequacies. Therefore, this research aims to evaluate the digital competence of pre-service biology teachers, focusing on their level of understanding, mastery, and utilization of technology for learning purposes. The study aims to inform the development of targeted training programs to improve the digital competence of pre-service biology teachers. This will enhance the quality of learning in today's digital environment. The identified aspects will be used to guide the development of these programs.

METHOD

This study employs a quantitative descriptive research design to provide an objective and comprehensive description of the digital competence profile among pre-service biology teachers. The researcher will collect numerical data and conduct statistical analysis to offer a clear overview of students' digital competence. The study's population comprises all pre-service biology teachers at a public university in Tarakan, Indonesia. The researcher will employ a quota sampling technique to select a representative sample of pre-service biology teachers who have yet to begin their thesis and are from the cohorts of 2019-2021. The sample size will be 90 individuals, with each cohort comprising 30 individuals. Data will be collected using a specially designed questionnaire to measure the digital competence of pre-service biology teachers. The questionnaire will contain statements related to the investigated aspects of digital competence, rated on a Likert scale of 1-5. Respondents will receive the questionnaire through a Google Form. The collected data will be analyzed using descriptive statistical techniques, such as mean and standard deviation, and interpreted according to the digital competence criteria table (Table 1).

Table 1. Criteria of Digital Competence

No	Score	Criteria
1	4,21 – 5,00	Very High
2	3,41 – 4,2	High
3	2,61 – 3,4	Moderate
4	1,81 – 2,6	Low
5	1,0 – 1,8	Very Low

(Sudjana, 2005)

RESULTS AND DISCUSSION

Table 2. Results of Digital Competence Analysis for Pre-service Biology Teachers

Digital Competence Aspect	Standard Deviation	Average Score	Criteria
Information and Data Literacy	0.60	3.22	Moderate
Communication and Collaboration	0.62	3.25	Moderate
Digital Content Creation	0.68	2.93	Moderate
Safety	0.61	3.26	Moderate
Problem-Solving	0.67	3.00	Moderate
Average		3.13	Moderate

Based on the findings presented in Table 2, it is evident that the pre-service biology teachers from a public university in Tarakan, Indonesia exhibit a moderate level of digital literacy, with an average score of 3.13. This indicates that while they possess adequate skills to utilize digital technology effectively for educational and daily purposes, they still need to reach the threshold of high proficiency in this domain. Recognizing the significance of digital competence in education, as reported by Cuhadar (2018), highlights the essential role of digital tools in the modern learning environment. Therefore, it becomes imperative for pre-service biology teachers to master educational software and integrate digital tools seamlessly into their teaching methodologies (Kassymova *et al.,* 2023). They play a key and central role in achieving and promoting the integration of ICT in professional practice and in developing guidelines for using ICT in educational spaces with the support of administrations and curricula (Romero-Tena *et al.,* 2020). Moreover, universities should consider enriching their curricula by incorporating courses that nurture digital competency among students (Reisoğlu & Çebi, 2020; Kordigel & Aberšek, 2022). This would deepen their understanding and broaden their skillset in leveraging digital technology for educational purposes.

This research examines five aspects of digital competence. Firstly, information and data literacy received an average score of 3.22, indicating moderate levels of competence. Information and data literacy encompasses essential skills such as effectively accessing, evaluating, and utilizing information (Shomedran, 2020; Arjaya *et al.,* 2023). It is crucial for biology educators to adeptly navigate through various information sources, discern their reliability, and employ them purposefully in educational contexts (Heuling *et al.,* 2021; Fibriana *et al.,* 2018). This enriches their subject knowledge, keeps them abreast of contemporary developments, and empowers their students to critically evaluate information (Cebi & Reisoglu, 2020; Pettersson, 2018).

Enhancing information and data literacy skills necessitates tailored learning approaches focusing on information processing techniques like search engine usage, source evaluation, and data analysis (Astini, 2019; Nahdi *et al.,* 2022). Additionally, organizing training sessions and workshops dedicated to information and data literacy can bolster students' proficiency in this domain (Kristyanto, 2020; Sobchenko & Vorozhbit-Horbatiuk, 2022). By improving their information and data literacy skills, pre-service biology teachers will be better equipped to provide their students with meaningful, well-informed, evidence-based learning experiences, fostering a conducive environment for holistic educational development.

The score for the Communication and Collaboration aspect is 3.25, which falls within the moderate range. This indicates a satisfactory yet improvable level of competency in using digital media for communication and collaboration in online environments (Dias-Trindade *et al.,* 2021; Mas'ud *et al.,* 2022). Several studies emphasize the crucial role of digital communication and collaboration skills in educational contexts (Elstad & Christophersen, 2017; Cabezas-González *et al.,* 2021). Effective communication is crucial for meaningful interaction among students, teachers, parents, and fellow educators (Galindo-Domínguez & Bezanilla, 2021). Communication can take various forms, including text, audio, or visual.

Furthermore, digital collaboration skills enable seamless cooperation within digitally connected learning environments, allowing students to engage in group projects, exchange resources, and ideas, and collectively construct knowledge (Perifanou *et al.,* 2021; From, 2017; Lindsay, 2019; Gopinathan *et al.,* 2022). Communication and collaboration skills can be improved through various methods, such as engaging in collaborative discussions on digital platforms or utilizing online forums (Hazar, 2018; Hendrix, 2022). Higher education institutions may also offer training sessions focusing on effective digital communication, including language proficiency and online etiquette (Snyder, 2016). Using collaborative tools and platforms such as Google Classroom and Google Meet, along with other online learning platforms, can significantly assist pre-service biology teachers in promoting effective communication and collaboration (Rosmalah *et al.,* 2021; Mas'ud *et al.,* 2022). Introducing students to these tools and strategies designed to facilitate communication and collaboration in the learning context is essential (Hatos *et al.,* 2022). By improving their communication and collaboration skills, pre-service biology teachers can become effective educators capable of engaging with their students and colleagues. This fosters an environment conducive to productive collaboration and enriched educational experiences for all involved parties.

The students have demonstrated moderate competence, as evidenced by the average score of 2.93 in the Digital Content Creation aspect. This level of competence is crucial for pre-

service biology teachers as it enables them to produce creative and relevant digital content using various platforms (Antón-Sancho *et al.*, 2021; Budai *et al.*, 2023). It is recommended by Umoren *et al.* (2020) that digital service providers offer digital content in forms that stimulate users' critical thinking. Using digital tools and technologies is essential for crafting engaging learning materials that promote active student participation (Paskevicius, 2021). To improve these abilities, students should become familiar with various creative software and platforms, such as Google Classroom, Adobe Flash, Unity 3D, and Canva, as well as technologies like Augmented Reality (Suyanto *et al.*, 2020; Oktavian & Aldya, 2020; Khaerudin *et al.*, 2021; Analicia & Yogica, 2021; Nirwanto *et al.*, 2021). Learning to use these tools and understanding instructional design principles is essential to creating visually appealing and informative content (Rahman, 2018). Proficiency in practical design principles, such as clear layout, engaging visual elements, and structured content arrangement, plays a crucial role in enhancing the quality of digital content (Abrori *et al.*, 2016). Students must also learn how to manage digital content to gain a comprehensive understanding of this context. This includes decoding and consciously using the thousands of images they encounter daily (Treglia & Tomassoni, 2019). It empowers students to become innovative teachers who can create engaging learning materials.

Similarly, digital safety, the fourth aspect of digital competence, earned an average score of 3.26, placing it in the moderate range. This represents the highest average score among all four aspects. These findings are consistent with Napal *et al.*'s (2018) discovery that prospective teacher students demonstrate more proficiency in digital safety issues. Pre-service biology teachers must understand the importance of safeguarding privacy and data security when utilizing digital technologies (Torres-Hernández & Gallego-Arrufat, 2022). Teachers must comprehend privacy protection, implement data security measures, and take necessary safety precautions, given the prevalent use of digital devices in education (Niyu & Purba, 2021). Basic digital security principles, such as using strong passwords and being cautious when disclosing personal information, are essential to improving security (Natamulia, 2022). In addition, addressing security threats such as phishing is crucial (Sari & Sutabri, 2023).

Moreover, according to Baeva (2021) and Ardiansyah *et al.* (2021), teachers and students must be engaged in discussions and activities addressing relevant digital safety issues within the educational context. This can include discussions about protecting students' data, ethics in technology usage, and actions to take when facing undesired security situations (Manik, 2022). Furthermore, students need to have strong digital literacy to verify the reliability of the information they use (Ni'mah, 2021) and recognize online manipulation or fraud attempts

(Qutni & Oesman, 2022). With a strong understanding of digital safety, students can protect themselves and their students from potential risks and threats in the digital environment. Universities and educational institutions must also ensure good security policies and practices (Hasututiningsih *et al.,* 2021). Silalahi *et al.* (2022) further explained that universities could adopt data security policies, involve staff and students in digital security training, and develop comprehensive privacy policies. Learning safety and security can be achieved by designing intelligent, personalized systems and services that enhance human-technology interaction by adapting students' activities to their cognitive state in digital education (Burov *et al.,* 2021).

Problem Solving, evaluated with an average score of 3.00 and categorized as moderate, is a critical aspect of digital competence. This assessment measures students' proficiency in recognizing, analyzing, and resolving complex issues using digital technology (Ferrari, 2013). The ability to employ digital technologies in problem-solving is indispensable for pre-service biology teachers. They play a pivotal role in imparting critical thinking skills, systematic problem analysis, and applying appropriate technological solutions to address challenges (Rosida *et al.,* 2019; Fatimah, 2019). Incorporating digital technology into learning contexts further enhances problem-solving activities. Students can familiarize themselves with software or applications that offer efficient or innovative solutions to problems (OECD, 2016; Hazar, 2018). For instance, modeling software, simulations, or data analysis tools tailored to biology can provide students with practical experiences in addressing complex issues while deepening their understanding of subjects of the subject (Ferrari, 2013). By integrating digital tools into problem-solving tasks, pre-service biology teachers equip themselves with essential skills and prepare their future students for the challenges of the digital age. They foster an environment where students can explore, experiment, and innovate, thereby nurturing a generation of learners adept at leveraging technology to overcome obstacles and drive progress.

The data indicates that pre-service biology teachers at a public university in Tarakan, Indonesia possess moderate digital competence. While some aspects require improvement, such as digital content creation and problem-solving, the overall average score suggests that the students have achieved satisfactory digital competence. Citations that provide insight into digital competence aspects are necessary to understand why developing this area in pre-service biology teachers is imperative. Çebi & Reisoğlu (2020) stated that strengthening students' digital competencies will equip them to adapt quickly to technological advances within education. Systematic training should help pre-service teachers develop digital pedagogical competency (Howard *et al.,* 2021; Bentri *et al.,* 2022).

CONCLUSION

The research findings found that the average score of digital competence among pre-service biology teachers at a public university in Tarakan, Indonesia is 3.13, indicating a moderate level. This conclusion provides a comprehensive understanding of the level of digital competence among pre-service biology teachers. It guides the development of better teaching programs to prepare them as effective educators in the digital era.

ACKNOWLEDGEMENT

The author would like to thank the Research and Community Service Institute of Universitas Borneo Tarakan for supporting research funding through the 2023 budget allocation. This support has contributed significantly to the successful implementation of the research until the publication stage. The author acknowledges the important role of the Research and Community Service Institute of Universitas Borneo Tarakan in supporting research development and knowledge advancement in this field.

REFERENCES

Abrori, F.M., Yulinda, R., Adhani, A., Wijarini, F., & Nugroho, E. D. (2016). *Media Pembelajaran Biologi*. Yogyakarta: Genom.

Alnasib, B. N. M. (2023). Digital competencies: Are pre-service teachers qualified for digital education?. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 11 (1), 96-114. https://doi.org/10.46328/ijemst.2842

Analicia, T & Yogica, R. (2021). Media Pembelajaran Visual Menggunakan Canva pada Materi Sistem Gerak. *Jurnal Edutech,* 9 (2), 260-266. https://doi.org/10.23887/jeu.v9i2.38604

Antón-Sancho, Á., Vergara, D., Lamas-Álvarez, V.E., Fernández-Arias, P. (2021). Digital Content Creation Tools: American University Teachers' Perception. *Applied Science*, 11 (24), 11649. https://doi.org/10.3390/app112411649

Arjaya, I. B., Hermawan, I. M., Ekayanti, N. W., & Paraniti, A. A. (2023). Metacognitive contribution to biology pre-service teacher's digital literacy and self-regulated learning during online learning. *International Journal of Instruction*, *16*(1), 455–468. https://doi.org/10.29333/iji.2023.16125a

Astini, N. K. S. (2019). Pentingnya Literasi Teknologi Informasi dan Komunikasi Bagi Guru Sekolah Dasar untuk Menyiapkan Generasi Milenial. *Prosiding Seminar Nasional Dharma Acarya ke-1*, ISBN 978-602-53984-1-4, 113-120.

Baeva, L. (2021). Digital Education and Personal Safety. *Advances in Social Science, Education and Humanities Research*, 555, 286-292. https://doi.org/10.2991/assehr.k.210527.004

Bentri, A., Hidayati, A., & Kristiawan, M. (2022). Factors supporting digital pedagogical competence of primary education teachers in Indonesia. *Frontiers in Education, 7,* 1–9. https://doi.org/10.3389/feduc.2022.929191

Budai, B. B., Csuhai, S., & Tózsa, I. (2023). Digital Competence Development in Public Administration Higher Education. *Sustainability*, *15*(16), 1–15. https://doi.org/10.3390/su151612462

Burov, O., Krylova-Grek, Y., Lavrov, E., Orliyk, O., Lytvynova, S., & Pinchuk, O. (2021). Cyber Safety in the Digital Educational Environment: External and internal risks. *Advances in Intelligent Systems and Computing*, 364–370. https://doi.org/10.1007/978-3-030-68017-6_54

Cabezas-González, M., Casillas-Martín, S., García-Peñalvo, F.J. (2021). The Digital Competence of Pre-Service Educators: The Influence of Personal Variables. *Sustainability*, 13 (4), 2318. https://doi.org/10.3390/su13042318

Çebi, A. & Reisoğlu, I. (2020). Digital Competence: A Study from the Perspective of Pre-service Teachers in Turkey. *Journal of New Approaches in Educational Research*, 9 (2), 294-308. https://doi.org/10.7821/naer.2020.7.583

Cuhadar, C. (2018). Investigation of pre-service teachers' levels of readiness to technology integration in education. *Contemporary Educational Technology*, 9 (1), 61-75. https://doi.org/10.30935/cedtech/6211

Dias-Trindade, S., Moreira J. A., & Ferreira A. (2020). Assessment of university teachers on their digital competences. *Qwerty*, 15 (1), 50-69. https://doi.org/10.30557/QW000025

Dias-Trindade, S., Moreira, J., & Ferreira, A. (2021). Evaluation of the teachers' digital competences in primary and secondary education in Portugal with Digcompedu Checkin in pandemic times. *Acta Scientiarum. Technology*, *43*(e56383), 1–11. https://doi.org/10.4025/actascitechnol.v43i1.56383

Díaz-Burgos, A., García-Sánchez, J.-N., Álvarez-Fernández, M. L., & de Brito-Costa, S. M. (2023). Psychological and educational factors of digital competence optimization interventions pre- and post-covid-19 lockdown: A systematic review. *Sustainability*, *16*(1), 51. https://doi.org/10.3390/su16010051

Elstad, E., & Christophersen, K. A. (2017). Perceptions of digital competency among student teachers: Contributing to the development of student teachers' instructional self-efficacy in technology-rich classrooms. *Education Sciences*, 7 (27), 1-15. https://doi.org/10.3390/educsci7010027

Fatimah, R. A. (2019). Teknologi Pendidikan dalam Pemecahan Masalah Pembelajaran. *Prosiding Seminar Nasional Teknologi Pendidikan Pascasarjana*, Universitas Negeri Medan. Retrieved from http://digilib.unimed.ac.id/38787/3/ATP%2046.pdf

Ferrari, A. (2013). *Digcomp: A framework for developing and understanding digital competence in Europe (Technical Report)*. Retrieved from the website of Publications Office of the European Union: Publications Office of the European Union, viewed 3 July 2023, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83167/lb-na26035-enn.pdf

Febriana, M., Nurkamto, J., Rochsantiningsih, D., & Muhtia, A. (2018). Teaching in rural Indonesian schools: Teachers' challenges. *International Journal of Multicultural and Multireligious Understanding*, *5*(5), 11-20.

From, J. (2017). Pedagogical Digital Competence-Between Values, Knowledge and Skills. *Higher Education Studies*, 7 (2), 43-50. http://doi.org/10.5539/hes.v7n2p43

Galindo-Domínguez, H., & Bezanilla, M. J. (2021). Digital Competence In The Training Of Pre-Service Teachers: (Perceptions) of Students In The Degrees of Early Childhood Education and Primary Education. *Journal of Digital Learning in Teacher Education*, 37 (4), 262–278. https://doi.org/10.1080/21532974.2021.1934757

Gopinathan, S., Kaur, A.H., Veeraya, S., Raman, M. (2022). The Role of Digital Collaboration in Student Engagement towards Enhancing Student Participation during COVID-19. *Sustainability*, 14 (11), 6844, 1-22. https://doi.org/10.3390/su14116844

Guillen-Gamez, F. D., Mayorga-Fernández, M. J., & Del Moral, M. T. (2020). Comparative research in the digital competence of the pre-service education teacher: face-to-face vs blended education and gender. *Journal of E-Learning and Knowledge Society*, *16*(3), 1-9. https://doi.org/10.20368/1971-8829/1135214

Hatos, A., Cosma, M.-L., & Clipa, O. (2022). Self-assessed digital competences of Romanian teachers during the covid-19 pandemic. *Frontiers in Psychology*, *13*, 1–19. https://doi.org/10.3389/fpsyg.2022.810359

Hazar, E. (2018). Digital competence in primary education: The case of Turkish language, mathematics and personal and social development courses. *International Online Journal of Education and Teaching (IOJET)*, 5 (2), 443-458. http://iojet.org/index.php/IOJET/article/view/322/246

Hendricks, M. D., Meyer, M. A., & Wilson, S. M. (2022). Moving up the ladder in rising waters: Community science in infrastructure and hazard mitigation planning as a pathway to community control and flood disaster resilience.

Heuling, L. S., Wild, S., & Vest, A. (2021). Digital competences of prospective engineers and science teachers: A latent profile and correspondence analysis. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 9 (4), 760-782. https://doi.org/10.46328/ijemst.1831

Howard, S.K., Jun-Ma, J. T., & Yang, J. (2021). What to teach? Strategies for developing digital competency in pre-service teacher training. *Computers & Education*, 165, 104149. https://doi.org/10.1016/j.compedu.2021.104149

Kassymova, G. M., Tulepova, S. B., & Bekturova, M. B. (2023). Perceptions of digital competence in learning and teaching English in the context of online education. *Contemporary Educational Technology*, 15 (1), 396, 1-14. https://doi.org/10.30935/cedtech/12598

Khaerudin, M., Srisulitiowati, D.B., & Warta, J. (2021). Game Edukasi dengan Menggunakan Unity 3D untuk Menunjang Proses Pembelajaran. *Jurnal Sistem Informasi*, 8 (2), 263-272. https://doi.org/10.35968/jsi.v8i2

Kordigel Aberšek, M., & Aberšek, B. (2022). New Digital Competence for Science Technology and Engineering Education. *Journal of Baltic Science Education*, *21*(1), 108–120. https://doi.org/10.33225/jbse/22.21.108

Kristyanto, D. 2020, 'Literasi Data dan Tantangan Industrialisasi 4.0 Bagi Masyarakat Pesisir Di Indonesia', *Nusantara: Journal of Information and Library Studies*, vol. 3, no. 2, pp. 188-205. https://doi.org/10.30999/n-jils.v3i2.979.

Lindsay, J. A. (2019). Online Global Collaborative Educators and Pedagogical Change. *Thesis Doctor of Philosophy, University of Southern Queensland, Queensland* https://doi.org/10.26192/bcv7-n778

Manik, J. S. (2022). Peran Guru dalam Menjaga E-Safety Peserta Didik di Era Teknologi Digital di Indonesia. *Edukatif: Jurnal Ilmu Pendidikan*, 4 (4), 5098-5108. https://doi.org/10.31004/edukatif.v4i4.3085

Mas'ud, S. H., Sumatri, M.S., & Dhieni, N. (2022). Analisis Kompetensi Digital Guru Pendidikan Anak Usia Dini dalam Jabatan (In-Service Teacher). *Aulad: Journal on Early Childhood*, 5 (2), 213-220. https://doi.org/10.31004/aulad.v5i2.328

Montilla, V. R., Rodriguez, R., C. Aliazas, J. V., & Gimpaya, R. (2023). Teachers' pedagogical digital competence as relevant factors on academic motivation and performance in Physical Education. *International Journal of Scientific and Management Research*, *06*(06), 45–58. https://doi.org/10.37502/ijsmr.2023.6604

Nahdi, D. S., Cahyaningsih, U., Jatisunda, M. G., Suciawati, V., & Sofyan, D. (2022). Pre-service elementary teacher's digital literacy with cognitive style and self-regulated learning. *International Journal of Educational Innovation and Research*, *1*(1), 19–26. https://doi.org/10.31949/ijeir.v1i1.1862

Napal, M., Peñalva-Vélez, A., & Mendióroz, A.M. (2018). Development of digital competence in secondary education teachers' training. *Education in Science*, 8 (3), 1-12. https://doi.org/10.3390/educsci8030104

Natamulia, G. (2022). Literasi Digital Safety Guru SDN Sambongpermai. *Skripsi*. Universitas Pendidikan Indonesia, Bandung. Retrieved from http://repository.upi.edu/79723/15/S_PGSD_1800049_Title.pdf

Ni'mah, A. (2021). Hubungan Literasi Digital dan Keterampilan Penggunaan Google Classroom Sebagai Media Pembelajaran Berbasis ICT Pada Materi Hidrokarbon. *Skripsi*, Universitas Islam Negeri Walisongo, Semarang. Retrieved from https://eprints.walisongo.ac.id/id/eprint/13929/1/Skripsi_1708076047_Alfin_Ni_mah.pdf

Nirwanto, B. G., Murtono, M., & Fathurrohman, I. (2021). Media Puzzle Berbantu Augmented Reality pada Muatan Pelajaran IPA Tema Ekosistem. *Jurnal Edutech*, 9 (2), 275–283. https://doi.org/10.23887/jeu.v9i2.38503

Niyu & Purba, H. (2021). E-SAFETY: Keamanan Di Dunia Maya Bagi Pendidik dan Anak Didik', *Prosiding* PKM-CSR, 4, 729-737. https://doi.org/10.37695/pkmcsr.v4i0

OECD. (2016). *Teachers' ICT and problem-solving skills: Competencies and Needs. Education Indicators in Focus, 40*. OECD Publishing, Paris. https://doi.org/10.1787/5jm0q1mvzqmq-en.

Oktavian, R & Aldya, R. (2020). Integrasi Pemanfaatan Media Pembelajaran Berbasis Adobe Flash dengan Lingkungan untuk Meningkatkan Minat Belajar Biologi. *Inteligensi: Jurnal Ilmu Pendidikan*, 3 (1), 40-46. https://doi.org/10.33366/ilg.v3i1.1823

Paskevicius, M. (2021). Educators as Content Creators in a Diverse Digital Media Landscape. *Journal of Interactive Media in Education*, 1 (18), 1–10. https://doi.org/10.5334/jime.675

Perifanou, M., Economides, A. A., & Tzafilkou, K. (2021). Teachers' Digital Skills Readiness During COVID-19 Pandemic. *International Journal of Emerging Technologies in Learning (iJET),* 16 (8), 238–251. https://doi.org/10.3991/ijet.v16i08.21011

Pettersson, F. (2018). On the issues of digital competence in educational contexts – a review of literature. *Education and Information Technology*, 23, 1005–1021. https://doi.org/10.1007/s10639-017-9649-3

Qutni, D., & Oesman, A. M. (2022). Urgensi Literasi Digital bagi Generasi Milenial dalam Konservasi Budaya. *LIBRARIA: Jurnal Perpustakaan*, 10 (2), 291-312. http://dx.doi.org/10.21043/libraria.v10i2.17468

Rahman, A. (2018). Desain Model dan Materi Pembelajaran Berbasis Teknologi Informasi. *Al-Ishlah: Jurnal Pendidikan Islam*, 16 (2), 128-143. https://doi.org/10.35905/alishlah.v16i2.743

Redecker, C., & Punie, Y. (2017). *Digital competence framework for educators (DigCompEdu).* Publications Office of the European Union. https://doi.org/10.2760/159770

Reisoğlu, İ., & Çebi, A. (2020). How can the digital competences of pre-service teachers be developed? examining a case study through the lens of digcomp and digcompedu. *Computers & Education*, *156*. https://doi.org/10.1016/j.compedu.2020.103940

Romero-Tena, R., Barragán-Sánchez, R., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2020). The challenge of initial training for early childhood teachers. A cross sectional study of their digital competences. *Sustainability*, *12*(11), 2–17. https://doi.org/10.3390/su12114782

Rosida, E. N., Kurniati, L., & Kusumawati, R. (2019). Analisis Pemecahan Masalah Matematika Berdasarkan Pemanfaatan Teknologi Digital Siswa. *SQUARE: Journal of Mathematics and Mathematics Education*, 1 (1), 33-39. http://dx.doi.org/10.21580/square.2019.1.1.4089

Rosmalah., Rahman, S.A., Asriadi. (2021). Analisis Kompetensi Literasi Digital Guru Dalam Pelaksanaan Pembelajaran Daring di Masa Pandemic Covid-19. *Prosiding Seminar Nasional Hasil Penelitian 2021*, Universitas Negeri Makassar, Makassar. ISBN: 978-623-387-014-6.

Sari, P., & Sutabri, T. (2023). Analisis kejahatan online phising pada institusi pemerintah/pendidik sehari-hari. *Jurnal Digital Teknologi Informasi*, 6 (1), 29-34. https://doi.org/10.32502/digital.v6i1.5620

Scheel, L., Vladova, G., & Ullrich, A. (2022). The influence of digital competences, self-organization, and independent learning abilities on students' acceptance of Digital Learning. *International Journal of Educational Technology in Higher Education, 19* (44), 1-33. https://doi.org/10.1186/s41239-022-00350-w

Shomedran. (2020). Menakar kompetensi dan profesi lulusan pendidikan luar sekolah di era digital. *Jurnal Pendidikan dan Pemberdayaan Masyarakat (JPPM)*, 7 (1), 82-92. http://dx.doi.org/10.36706/jppm.v7i1.11573

Silalahi, D. E., Handayani, E. A., Munthe, B., Simanjuntak, M. M., Wahyuni, S., Mahmud, R., Jamaludin., Laela, N. A., Sari, D. M. M., Hakim, A. R., & Safli, M. (2022). *Literasi Digital Berbasis Pendidikan: Teori, Praktek Dan Penerapannya*. Padang: PT. Global Eksekutif Teknologi.

Sixto-García, J., & Duarte-Melo, A. (2020). Self-destructive content in university teaching: New challenge in the digital competence of educators. *Communication & Society*, *33*(3), 187–199. https://doi.org/10.15581/003.33.3.187-199

Snyder, S. (2016). Teachers' Perceptions of Digital Citizenship Development in Middle School Students Using Social Media and Global Collaborative Projects. *Dissertation*, Walden Dissertations and Doctoral Studies, Walden University. Retrieved from https://core.ac.uk/reader/147835640

Sobchenko, T., & Vorozhbit-Horbatiuk, V. (2022). Results of digital competence development for philology students within blended learning. *Educational Challenges*, *27*(2), 185–198. https://doi.org/10.34142/2709-7986.2022.27.2.13

Stopar, K., & Bartol, T. (2018). Digital competences, computer skills and information literacy in secondary education: Mapping and visualization of trends and concepts. *Scientometrics*, *118*(2), 479–498. https://doi.org/10.1007/s11192-018-2990-5

Sudjana. (2005). *Meode Statistika*. Bandung: Tarsito.

Suyanto, M. U. Y., Romadhona, D., Hidayati, N., & Askhar, B. M. (2020). Pemanfaatan Aplikasi Digital dalam Pembelajaran Interaktif bagi Siswa Sekolah Dasar di Era New Normal. *Jurnal Pengabdian Masyarakat Manage*, 1 (2), 122-128. http://dx.doi.org/10.32528/jpmm.v1i2.3986

Torres-Hernández, N., Gallego-Arrufat, MJ. (2022). Indicators to assess pre-service teachers' digital competence in security: A systematic review. *Education and Information Technology*, 27, 8583–8602. https://doi.org/10.1007/s10639-022-10978-w.

Treglia, E. & Tomassoni, R. (2019). The Development of Digital Competences and Emotional Skills Through the Use of Audio-Visual Technologies. *International Journal of Digital Literacy and Digital Competence (IJDLDC), 10*(1), 55-60. http://doi.org/10.4018/IJDLDC.2019010105

Umoren, M., Ikedife, G., Iko, G. E., & Oshionebo, E. (2020). Transformative basic education in public secondary school students' Digital Service co-creation and sustenance of Digital Safety in Lagos State, Nigeria. *International Journal of Innovation in Education*, *6*(3/4), 217–231. https://doi.org/10.1504/ijiie.2020.111092

Wang, S. (2023). A review of research exploring pre-service teacher education for the Digital Era. *International Journal of Education and Humanities*, *9*(1), 188–193. https://doi.org/10.54097/ijeh.v9i1.9407

Yang, X. (2020). Teachers' Perceptions of Large-Scale Online Teaching as an Epidemic Prevention and Control Strategy in China. *ECNU Review of Education*, 3 (4), 739–744. https://doi.org/10.1177/2096531120922244

Zhao, Y., Sanchez Gomez, M. C., Pinto Lorente, A. M., & Zhao, I. (2021). Digital competence in higher education: Students' perception and personal factors. *Sustainability*, 13 (21), 12184, 1-17. https://doi.org/10.3390/su132112184