Cybersecurity and Innovative Technology Journal, Vol.2, No.2, 2024, pp. 104-111
e-ISSN 3025-6682. DOI. 10.52889/citj.v2i2.454

Analysis of Teacher Readiness to Implement Bioinformatics to Biology Learning in Senior High School

Submitted 8 August 2024 Revised 12 November 2024 Accepted 12 November 2024

Indah Juwita Sari[1], Eli Setiawati[2], Rihadatul Aisy[3*], Alpha Bayoh Jr[4]

Department of Biology Education, Faculty of Teacher Training and Education,
Universitas Sultan Ageng Tirtayasa, Serang, Indonesia

[2]Health Information Technology Program, Information Systems Department,
University of Maryland, Baltimore County, Baltimore, United States

Corresponding Email: *2224210060@untirta.ac.id.

Abstract

This study aimed to analyze teachers' readiness in applying bioinformatics to biology learning in senior high schools. Bioinformatics is a combination of computer science, statistics, and biology to analyze and interpret complex biological data. The application of bioinformatics into learning can foster students' realization of the real-life commitment of bioinformatics, enhance their understanding, and expand their curiosity about bioinformatics. The application of bioinformatics into biology learning needs to be supported by teacher readiness in terms of understanding, skills and factors that influence teacher readiness in applying bioinformatics. This research used a case study method with a qualitative descriptive approach to analyze the readiness of biology teachers from several senior high schools in Banten province in implementing bioinformatics into biology learning. The results of this study show that most teachers understand and realize the importance of bioinformatics in learning, on the other hand some teachers also feel not fully confident and able to apply bioinformatics into learning effectively. Although most teachers have adequate access to technology, teachers are not familiar with bioinformatics concepts and software such as BLAST and NCBI. Therefore, to fulfill the aspect of teachers' understanding and skills in applying bioinformatics to learning, focused training is needed that discusses the basic concepts of bioinformatics, the use of bioinformatics software, and its application in learning to improve teacher competence and create interactive and relevant biology learning.

Keywords: Teacher Readiness, Bioinformatics Education, Biology Learning, Innovative Technology

INTRODUCTION

Education is very important to develop human resources and national character who have the ability and skills to face education in the 21st century (Syarah et al., 2021). Learning is important in the world of education to be able to add and update knowledge that is very useful for the future of humans including students. According to Jayawardana and Gita (2020), the quality of student learning outcomes is highly dependent on the learning process carried out by educators or teachers at school. Along with the progress of the times, learning has also developed. Learning is a process of teaching and learning activities that occur between students and teachers supported by teaching tools (Priantini et al., 2022). There are many branches of science that can be studied in the world of education, one of which is science such as biology.

According to Adi and Meishanti (2023), the biology learning process more often applies conventional learning, where the teacher only explains verbally the concepts, facts and processes of biological material to students so that it is less well illustrated. This can make

students less active during the learning process and assume that biological material is difficult material to understand because the teacher only applies a teacher-centered learning process while in the curriculum used now, students are expected to be active in solving problems and in drawing conclusions from understanding the material presented during learning so that the learning process should be student centered (Jayawardana, 2017). This statement is in accordance with the paper of Jayawardana and Gita (2020) which explains that students consider biological material to be difficult material to understand because it uses many foreign terms and in the learning process, students only listen to the teacher explain. This view needs to be straightened out so that students can consider that biology material is interesting, fun and easy to understand because it can be applied and useful in daily life. One way to straighten out this view is that teachers need to innovate in the biology learning process which can be done in various ways, such as applying new learning methods, using interactive media, one of which is by utilizing digital technology and the internet which has progressed at this time (Eliza et al., 2022).

According to Melisa (2023), learning using technological media can have a significant impact on learning progress. This is because the use of technology in learning is needed to support the teacher's success in achieving learning goals. Latifah (2019) explains that advances in information technology in the field of biology are currently increasingly sophisticated and have experienced a tremendous surge in recent decades, which has had a profound impact on the understanding of life and biological processes. One of the most striking innovations in this context is the application of bioinformatics in biology learning. Kovarik et al (2013) explain that although bioinformatics is ubiquitous in biology now, these tools and concepts receive little attention in most high school science classes. Bioinformatics is a discipline that combines computer science, statistics, and biology to analyze and interpret complex biological data. With the ability to process genomic and proteomic data on a large scale, bioinformatics has paved the way for new discoveries in genetic research, drug development, and disease understanding. Through the integration of advanced technologies such as big data analysis and machine learning, bioinformatics not only accelerates scientific research but also improves diagnostic accuracy and therapeutic effectiveness (Parikesit & Nurdiansyah, 2020). Bioinformatics content at the high school level includes the concepts of genetics, mutations, biochemical evolution, protein interactions in cells, gene regulation, and DNA technology (Sari et al., 2024). By utilizing the same bioinformatics tools that scientists use, such as (NCBI), Basic Local Alignment Search Tool (BLAST), The Sequence

Manipulation Suite (SMS), and UniProt, students' interest will increase (Nurfadillah et al., 2023).

According to Mahrus et al., (2021), bioinformatics can help facilitate learning biology, one of which is in genetics material. This is in accordance with the statement of Sari et al., (2022) in their research that the application of bioinformatics to learning can foster students' realization of the real-life commitment of bioinformatics, increase their understanding, and expand their curiosity about bioinformatics. Before integrating bioinformatics into the biology learning process, a teacher needs to understand bioinformatics education first, this is done to determine the teacher's readiness in applying bioinformatics to biology learning. However, there are still many teachers who do not understand and have difficulties in using technology in the learning process. According to Widianto (2021), not all educators understand and are open about technology, especially senior educators, they prefer manual methods compared to using supporting media such as websites and so on. This is in line with the research of Aulia et al., (2024) which explains that some of the problems or challenges faced by teachers in applying technology to the learning process, one of which is the lack of teacher skills in using technology, so that many teachers have difficulty integrating technology in a learning process due to the lack of adequate technology training. The training in question is like the research conducted by Mahrus et al., (2021) which involves educators in bioinformatics application training by utilizing bioinformatics software and websites to provide more understanding to teachers before integrating it into biology learning.

So to find out how far the readiness of teachers in applying bioinformatics into biology learning, this research focuses on analyzing the readiness of teachers in applying bioinformatics, especially in learning biology in high schools. This is important to study, given recent developments in education that increasingly integrate technology and identify the challenges teachers face in adopting technology, including bioinformatics in today's modern curriculum. This research emphasizes that teacher preparedness is a key factor for successful technology-based learning. With advances in the field of bioinformatics and educational technology, this research provides insights into how teachers can adapt in preparing for the implementation of bioinformatics in biology learning to improve the quality of biology learning by utilizing innovation in their learning.

METHOD

This research used a case study method with a qualitative descriptive approach to analyze the readiness of teachers in applying bioinformatics to biology learning in high schools. This research uses the case study method because it focuses on a case or issue that is

studied and examined from various aspects such as various perspectives on the problem, process or event (Assyakurrohim et al., 2023). The resource persons in this study were biology teachers from several schools in Banten Province who were selected based on certain criteria, such as the availability of facilities and infrastructure that support bioinformatics learning in schools and teachers' experience in teaching using technology. The instrument used was a questionnaire consisting of open and closed questions. The questions were developed by the researcher to collect data on knowledge, technology skills, attitudes towards using bioinformatics, and challenges faced in the learning process. Data were collected through online or offline distribution of questionnaires to biology teachers who were willing to participate (Wahyudi & Jatun, 2024). Data analysis was conducted using descriptive qualitative data analysis, so as to provide a comprehensive picture of teacher readiness and factors that influence teacher readiness in the application of bioinformatics in biology learning.

RESULTS AND DISCUSSION

Teachers' Understanding of Basic Bioinformatics Concepts

Based on the results of interviews with three informants who are biology teachers from different schools in Banten province, teachers' understanding of the basic concepts of bioinformatics is still not good, this is judged by the answers of the three teachers in the interview questionnaire given. One of them already knows about the basic concepts of bioinformatics and thinks that bioinformatics has an important role in learning biology, especially in the field of genetics, namely as a database that stores biological information and can help researchers in making and developing vaccines. While two of them do not understand well about the basic concepts of bioinformatics, but both of them think that bioinformatics plays an important role in learning because it can make it easier for teachers to convey material in biology learning which is quite complicated. The three speakers have never attended a workshop or seminar on the use of bioinformatics in learning biology, so they still do not know and recognize and have never used bioinformatics software or websites such as the National Center Biotechnology Information (NCBI), Basic Local Alignment Search Tool (BLAST), The Sequence Manipulation Suite (SMS), UniProt and so on.

Teachers' Skills in Using and Operating Technology

Readiness in applying technology to learning must of course be supported by teachers' skills in using and operating technology. From the interviews with the three informants, it is known that the teachers' skills in using technology can be considered quite good, because in the current curriculum teachers have used basic technology in implementing learning in the classroom. However, all three of them have never applied technology related to

bioinformatics to classroom learning. In interviews conducted with the three interviewees, two of them stated that they felt capable and able when later they would apply bioinformatics to learning, while the other interviewee felt unsure. From this statement, all three were encouraged to understand more about bioinformatics and felt the need to prepare themselves to apply bioinformatics to biology learning. All three interviewees felt the need to prepare themselves by learning more about bioinformatics and felt the need to attend technology training related to bioinformatics education. All three interviewees feel that this needs to be learned so that later it can be integrated in learning biology which has complex and abstract material, so that in the future it can facilitate the learning process in the classroom.

So far, teachers feel comfortable in using technology such as computer or laptop devices in supporting biology learning, but have never used software related to bioinformatics such as NCBI and so on. This is because teachers still rarely involve the use of technological devices in learning biology even though internet access and facilities such as laptops and computers are quite adequate so that teachers have not explored much about software related to bioinformatics.

From the previous statement, teachers realize that knowledge about bioinformatics is an obstacle in itself to apply it in learning biology. Teachers who do not have knowledge about bioinformatics will find it difficult to apply it in learning, one of which has difficulty in understanding the language used in some bioinformatics software and so on, so it is necessary to have training to help support teacher readiness in applying bioinformatics to biology learning.

Teacher Readiness to Use Technology for Bioinformatics

Teachers' readiness to use technology for bioinformatics is strongly influenced by their comfort and understanding of the technology tools available. From the teachers' responses, it appears that two teachers feel quite comfortable using technology in learning, while the other teacher shows uncertainty due to a lack of knowledge about bioinformatics. This confirms the importance of increased understanding and training for teachers so that they can be more confident in applying bioinformatics to the learning process, thus improving the quality of biology teaching in schools.

The three biology teachers already have access to adequate technology, such as internet networks and laptops, but they have never used bioinformatics software such as the National Center Biotechnology Information (NCBI), Basic Local Alignment Search Tool (BLAST), The Sequence Manipulation Suite (SMS), UniProt and so on in the learning process. This shows that there is potential to utilize technology in teaching, but the understanding and

application of bioinformatics still needs to be improved. Therefore, more targeted training and a deeper understanding of bioinformatics is needed so that teachers can integrate these technologies effectively in their teaching, so that students can gain maximum benefit from more interactive and relevant biology learning. In line with the research of Rahmadani *et al.,* (2017) that many biology teachers have difficulty in understanding the terms and interfaces of bioinformatics software such as NCBI, BLAST, SMS, UniProt and so on. This creates challenges in the application of bioinformatics material in the classroom, because a lack of understanding can hinder their ability to teach these concepts to students.

Challenges Faced by Teachers in Implementing Bioinformatics

Teachers' readiness to use technology for bioinformatics is influenced by several obstacles they face, such as lack of knowledge about bioinformatics, limited internet access, and internet access problems experienced by students due to quota limitations. This shows that although teachers have the desire to apply bioinformatics in learning, teachers need support in terms of knowledge and infrastructure to optimize the use of these technologies. The three biology teachers revealed that they experienced obstacles in applying bioinformatics, one teacher stated that it was quite difficult, while the other two teachers felt that the application of the material was indeed quite challenging and required more practice.

This difficulty indicates the need for training and practical experience so that teachers can be better prepared in applying bioinformatics to biology learning. Research conducted by Suparman et al., (2023) explained that training in the use of bioinformatics applications showed positive results, where teachers felt more confident after receiving training and support in the use of technological devices. In addition, the three biology teachers also admitted that they faced difficulties in understanding the terms used in bioinformatics software, such as NCBI, BLAST, SMS, UniProt and so on. Therefore, it is crucial to provide training that focuses on understanding the terms and how to use these software, so that teachers can more effectively integrate bioinformatics into the learning process, so that they can provide more effective and relevant learning experiences for students.

CONCLUSION

This research shows that the readiness of biology teachers in Banten Province to implement bioinformatics still needs to be improved, especially in terms of knowledge and experience. Although most teachers have adequate access to technology and are comfortable using basic technology, they are not yet familiar with the concepts of bioinformatics and software such as NCBI, BLAST, SMS, UniProt, and others. The main obstacle is the lack of understanding, training, and practical experience related to bioinformatics. Teachers

recognize the importance of bioinformatics in facilitating students' understanding of complex biology material, especially genetics, but they need support in the form of training and resources. Therefore, focused training is needed that includes basic concepts, software usage, and practical applications to enhance teachers' competencies and create interactive and relevant biology learning.

REFERENCES

Adi, S., & Meishanti, O. P. Y. (2023). Studi Literatur tentang STEM (Sains, Technologi, Engineering, and Mathematics) dalam Pembelajaran Biologi. *EDUSCOPE: Jurnal Pendidikan, Pembelajaran, dan Teknologi*, *9*(1), 88-101.

Assyakurrohim, D., Ikhram, D., Sirodj, R. A., & Afgani, M. W. (2023). Metode studi kasus dalam penelitian kualitatif. *Jurnal Pendidikan Sains Dan Komputer*, *3*(01), 1-9.

Aulia, A. F., Asbari, M., & Wulandari, S. A. (2023). Kurikukulum Merdeka: Problematik Guru dalam Implementasi Teknologi Informasi pada Proses Pembelajaran. *Journal of Information Systems and Management (JISMA)*, *3*(2), 65–70. https://doi.org/10.4444/jisma.v3i2.955

Eliza, D., Sriandila, R., Fitri, D. A. N., & Yenti, S. (2022). Membangun Guru yang Profesional melalui Pengembangan Profesionalisme Guru dalam Penerapan Profesinya. *Jurnal Basicedu*, *6*(3), 5362-5369.

Jayawardana, H. B. A. (2017). Paradigma pembelajaran biologi di era digital. *Jurnal Bioedukatika*, *5*(1), 12-17.

Jayawardana, H. B. A., & Gita, R. S. D. (2020). Inovasi pembelajaran biologi di era revolusi industri 4.0. In *Prosiding Seminar Nasional Biologi* (Vol. 6, No. 1, pp. 58-66).

Kovarik, D. N., Patterson, D. G., Cohen, C., Sanders, E. A., Peterson, K. A., Porter, S. G., & Chowning, J. T. (2013). Bioinformatics education in high school: implications for promoting science, technology, engineering, and mathematics careers. *CBE—Life Sciences Education*, *12*(3), 441-459.

Latifah, N. (2019). *Pengembangan Praktikum Virtual Berbasis Android Sebagai Media Pembelajaran Biologi Untuk Meningkatkan Keterampilan Proses Sains Peserta Didik Kelas Xi Di Tingkat SMA/MA* (Doctoral dissertation, UIN Raden Intan Lampung).

Mahrus, Lalu Zulkifli, Saprizal Hadisaputra, & Ida Ayu Putu Armyani. (2021). Penggunaan Bioinformatika dalam Pembelajaran Sains Untuk Menyelesaikan Kesulitan Belajar Siswa pada Materi Genetika di SMPN 20 Mataram. Jurnal Pengabdian Magister Pendidikan IPA, 4(4), 290–295. https://doi.org/10.29303/jpmpi.v4i4.1128

Melisa, M. (2024). Analisis Kesiapan Guru dalam Menggunakan Teknologi Informasi dan Komunikasi untuk Pembelajaran Kurikulum Merdeka. *Al-Miskawaih: Journal of Science Education*, *3*(1), 443-462.

Nurfadillah, A., Amir, N. I., Asrun, B., Firani, L. S., & Bunga, J. (2023). Pengenalan Bioinformatika, Aplikasi dan Database pada Siswa-Siswi SMK Laniang Makassar.

ABDIKAN: Jurnal Pengabdian Masyarakat Bidang Sains dan Teknologi, *2*(1), 108-114.

Parikesit, A. A., & Nurdiansyah, R. (2020). Drug repurposing option for COVID-19 with structural bioinformatics of chemical interactions approach. *Cermin Dunia Kedokteran*, *47*(3), 222-226.

Priantini, D. A. M. M. O., Suarni, N. K., & Adnyana, I. K. S. (2022). Analisis kurikulum merdeka dan platform merdeka belajar untuk mewujudkan pendidikan yang berkualitas. *Jurnal Penjaminan Mutu*, *8*(02), 238-244.

Rahmadani, W., Harahap, F., & Gultom, T. (2017). Analisis faktor kesulitan belajar biologi siswa materi bioteknologi di SMA negeri se-kota Medan. *Jurnal Pendidikan Biologi*, *6*(2), 279-285.

Sari I. J., El Islami R. A. Z., & Safkolam. R. (2022). Implementation of Bioinformatics Learning in Senior High School: A Systematic Review. International Journal of Biology Education Towards Sustainable Development, 2(2):87-98.

Sari, I. J., Pongsophon, P., & Vongsangnak, W. (2024). *Pendidikan Bioinformatika Bagi Calon Guru Biologi Abad 21.* Tangerang: Media Edukasi Indonesia

Suparman, S., Roini, C., Limatahu, I., Sari, I. J., Hasan, S., & Hasanudin, M. (2023). PELATIHAN BIOINFORMATIKA PADA GURU MGMP BIOLOGI SMA KOTA TERNATE DALAM MENGANALISIS DATA GENBANK. *Martabe: Jurnal Pengabdian Kepada Masyarakat*, *6*(9), 3299-3308.

Syarah, M. M., Rahmi, Y. L., & Darussyamsu, R. (2021). Analisis Penerapan Pendekatan STEM Pada Pembelajaran Biologi. *BIO-EDU: Jurnal Pendidikan Biologi*, *6*(3), 236-243.

Wahyudi, N. G., & Jatun, J. (2024). Integrasi Teknologi dalam Pendidikan: Tantangan dan Peluang Pembelajaran Digital di Sekolah Dasar. *Indonesian Research Journal on Education*, *4*(4), 444-451.

Widianto, E. (2021). Pemanfaatan media pembelajaran berbasis teknologi informasi. *Journal of Education and Teaching*, *2*(2), 213-224.