J. Pedagogi Hayati Vol. 7 No. 2
©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132

Emotion Detection with AI: Development of Learning Media for Evaluation of Cognitive Load of Prospective Teacher in Genetics Lectures

Iffa Ichwani Putri [1,2], Adi Rahmat[3]*, Riandi[3], Lala Septem Riza[4]

[1]Doctoral Program of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Indonesia, Bandung, Indonesia
[2]Department of Biology Education, Faculty of Education, Universitas Islam Riau, Pekanbaru, Indonesia
[3]Department of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Indonesia, Bandung, Indonesia
[4]Department of Computer Science Education, Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author: adirahmat@upi.edu

ABSTRACT. Cognitive load can be measured, one of which is by emotions through facial expressions during learning. This research aims to develop learning media by integrating artificial intelligence (AI) that is able to detect the emotions of prospective teachers during genetics lectures. Using AI technology, the system can evaluate students' cognitive load in real-time through facial expression analysis. This learning media is equipped with emotion detection features, interactive learning materials, and an informative dashboard to monitor student learning progress. This research is a development research that refers to the Borg & Gall model. The data collection technique is in the form of questionnaires and questions integrated into AI media that detects student emotions, which are then analyzed using machine learning algorithms to identify the level of cognitive load during the lecture session. The results of the study showed that this learning medium was able to identify the emotional expression of each student in the genetics of mendelism with a percentage of 61.64% (surprised-happy) describing a moderately low-very low cognitive load, and 38.42% (sad-angry) describing a high cognitive load. So that with the acquisition of this data, it is known that more than 50% of students' emotional recordings (low cognitive load) can follow and understand the information obtained in the Mendelism genetics lecture. The application of this technology is expected to improve the quality of learning and help students achieve a better understanding of genetics courses.
***Keywords**: artificial intelligence; cognitive load; emotion; genetics.*

ABSTRAK. Beban kognitif dapat diukur salah satunya dengan emosi melalui ekspresi wajah selama pembelajaran berlangsung. Penelitian ini bertujuan untuk mengembangkan media pembelajaran dengan mengintegrasikan kecerdasan buatan (AI) yang mampu mendeteksi emosi calon guru selama perkuliahan genetika. Dengan menggunakan teknologi AI, sistem ini dapat mengevaluasi beban kognitif siswa secara real-time melalui analisis ekspresi wajah. Penelitian ini merupakan penelitian pengembangan yang mengacu pada model Borg&Gall. Teknik pengumpulan data berupa kuesioner dan soal yang terintegrasi pada media AI pendeteksi emosi mahasiswa, yang kemudian dianalisis menggunakan algoritma pembelajaran mesin untuk mengidentifikasi tingkat beban kognitif selama sesi perkuliahan berlangsung. Media pembelajaran ini dilengkapi dengan fitur deteksi emosi, materi pembelajaran interaktif, dan dashboard yang informatif untuk memantau kemajuan belajar siswa. Hasil penelitian menunjukkan bahwa media pembelajaran ini mampu mengidentifikasi ekspresi emosi masing-masing mahasiswa pada genetika mendelisme dengan persentase 61.64% (terkejut-senang) menggambarkan beban kognitif cukup rendah-sangat rendah, dan 38.42% (sedih-marah) menggambarkan beban kognitif tinggi. Sehingga dengan perolehan data tersebut diketahui bahwa lebih dari 50% rekaman emosi mahasiswa (beban kogntif rendah) dapat mengikuti serta memahami informasi yang

©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132
diperoleh pada perkuliahan genetika mendelisme. Penerapan teknologi ini diharapkan dapat meningkatkan kualitas pembelajaran dan membantu mahasiswa mencapai pemahaman yang lebih baik tentang mata kuliah genetika.
Kata Kunci: beban kognitif; emosi; genetika; kecerdasan buatan.

INTRODUCTION

A deep understanding of students' emotions during the learning process is key in creating an optimal educational environment. Emotions not only serve as indicators of engagement and motivation levels, but can also significantly affect cognitive abilities and learning outcomes (Limanjaya, Khoswanto, & Sugiarto, 2023). Especially in the context of genetics lectures, which are known as a complex and demanding field of study, understanding students' emotions has become increasingly crucial.

Cognitive load is one of the factors that determine learning outcomes. Various studies related to cognitive load have been conducted to support the optimal learning process (Aries Tejamukti, 2017; Juanengsih, Rahmat, Wulan, & Rahman, 2018; Nursit, 2015; Rahmat, Nuraeni, Soesilawaty, Alawiyah, & Garnasih, 2015; Rahmat et al., 2014) . Cognitive load is also associated with problem-solving abilities (Yohanes & Yusuf, 2021) and used in designing learning media (Afidah, 2020).

However, measuring emotions objectively and sustainably in a dynamic classroom environment is a challenge in itself. Traditional methods such as observation and questionnaires are often limited in capturing the nuances of complex emotions and can be influenced by subjective biases (Daffa Ulhaq, Zaidan, & Firdaus, 2023). This underscores the need for a more innovative and accurate approach to understanding students' emotions.

Rapid advances in the field of artificial intelligence (AI) have opened up new opportunities in overcoming this challenge. AI technology, particularly in the field of emotion detection, has the potential to provide more objective, real-time, and continuous measurement of emotions. By utilizing the analysis of facial expressions, voices, or even writing patterns, AI can provide deeper insights into students' emotions during the learning process.

This research focuses on the use of AI in detecting the emotions of prospective teacher students during genetics lectures. Genetics, as a field of study that is loaded with abstract and complex concepts, has the potential to cause a high cognitive load on students. Excessive cognitive load can hinder the learning process, reduce motivation, and even trigger negative emotions such as frustration and anxiety (Nursit, 2015; Rahmat et al., 2015; Suwarno, 2020). Therefore, understanding students' emotions in the context of genetics lectures can provide valuable information for lecturers to design more effective and adaptive learning strategies.

Several studies related to emotion detection have been carried out by several researchers before (Daffa Ulhaq et al., 2023; Limanjaya et al., 2023). Likewise, related to the development of website-based learning media that has been developed by other researchers (Azwal & Sari, 2019; Hastuti & Ghoni, 2022; Mardin, Handani Uno, Despianti, & Lakutu, 2022; Rahmawati, Achdiani, & Handayani, 2021; Royani, Haris, & Hadisaputra, 2021). However, there has been no research linking emotion detection to cognitive load during learning.

By integrating AI technology in the development of learning media, it is hoped that a tool can be created that is able to accurately detect student emotions and provide relevant feedback. This information can be used to evaluate students' cognitive load and identify factors that affect their learning experience. Through a better understanding of emotions and cognitive load, it is hoped that the quality of genetic learning will improve, so that prospective teachers are more competent and ready to face various challenges in the world of education.

METHODS

This research is a research and development (R&D) reference to Borg and Gall. The design of this research consists of four major stages, namely introduction, planning, development and implementation.

The research sample was 38 prospective teachers of the biology education study program, semester 4 who attended a genetics lecture. The research was carried out at one of the private university in Riau. The research instruments used in this study include AI-based learning media developed specifically to detect student emotions during the lecture process. Emotional indicators of facial expressions for a picture of cognitive load based on modifications (Ouwehand, Kroef, Wong, & Paas, 2021) (Table 1).

©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132

This AI technology is able to analyze the facial expressions generated by students to identify their emotions in real-time through the use of webcams, to measure and describe the cognitive load of students in genetics lectures.

Table 1. Indicators of Emotion and Cognitive Load

Emotions-Facial expressions	Overview of Cognitive Load
Happy	Very Low
Neutral	Low
Surprise	Relatively low
Sad	Rather High
Fear/angry	High
Disgust	Very High

RESULTS AND DISCUSSION

Based on the development of learning media by integrating AI, it is designed completely starting from the initial display, instructions for use, presentation of materials, animated videos, practice questions and the display of student emotional recordings. AI is used to record and analyze emotions through students' facial expressions during lectures, can describe the cognitive load of students while attending lecture materials.

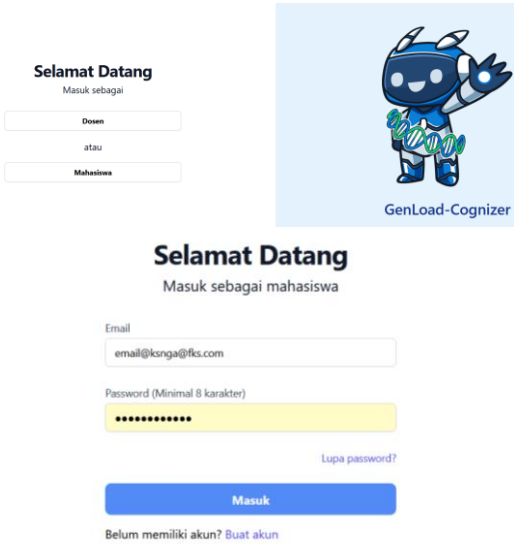

Figure 1. Login Page

Figure 1 shows the initial interface of this learning medium, which consists of a login menu for students and lecturers. The "Create Account" feature allows new users to register, while the "Forgot Password" feature facilitates access restoration for users who have forgotten their passwords in accessing them.

This intuitive interface allows students and lecturers to easily log in to the system using their email and password. This ease of access contributes to the positive acceptance of learning media by users, as expressed in the qualitative feedback collected during the study. The active participation of students and lecturers in using this learning media shows the potential for its application in a broader educational context.

Upon successful login, the user will be greeted with the "Introduction and Instructions for Use" menu as shown in Figure 2. This menu aims to provide orientation to new users regarding the features and how to use learning media. Instructions for use presented in the form of voice recordings with the "Play" button make it easy for users to understand the instructions auditively.

The presentation of instructions for use in this audio format is one of the strategies implemented to accommodate various learning styles of users. In addition, the use of voice recordings can also help reduce the cognitive load of users, as they do not need to read long and complex texts. The results of the study show that most users are satisfied with the instructions for use in audio format, because it is considered easier to understand and follow.

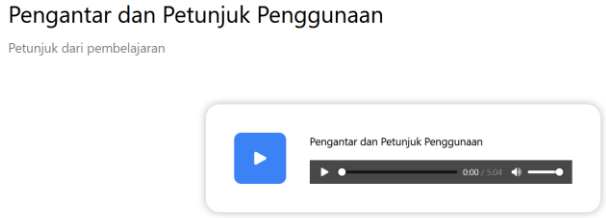

Figure 2. Introductory Menu and Instructions for Use

The developed learning media provides access to comprehensive genetics lecture materials, as shown in Figure 3. The genetics lecture material menu allows students to choose the topic they want to study specifically. Once the topic is selected, the relevant lecture material will be displayed in an easy-to-understand format, with a combination of text, images, and videos.

©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132

The presentation of this structured and interactive lecture material aims to increase student involvement in the learning process. The results of the study showed that students felt more motivated and interested in learning genetic material when presented through this learning medium. The flexibility in choosing topics also allows students to tailor their learning to their individual needs and interests, thus enhancing the overall learning experience.

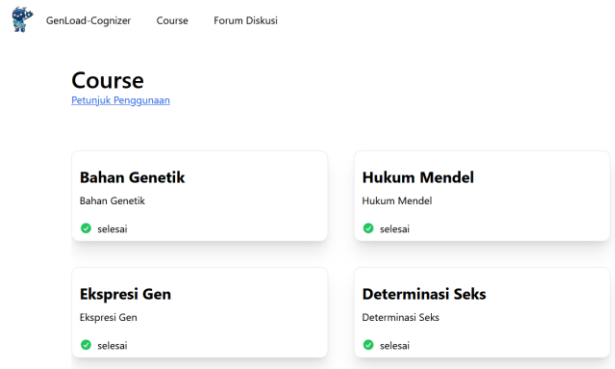

Figure 3. Genetics Lecture Material Menu

Before starting learning genetic material, the developed learning media will detect user emotions through a laptop webcam. Figure 4 illustrates the interface of this emotion detection feature, which asks the user for permission to access the webcam. Users are given clear instructions regarding the ideal face position, adequate room lighting, and the importance of maintaining a stable face position during the detection process.

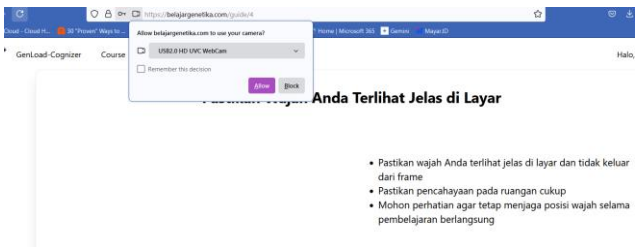

Figure 4. Emotion Detection Feature

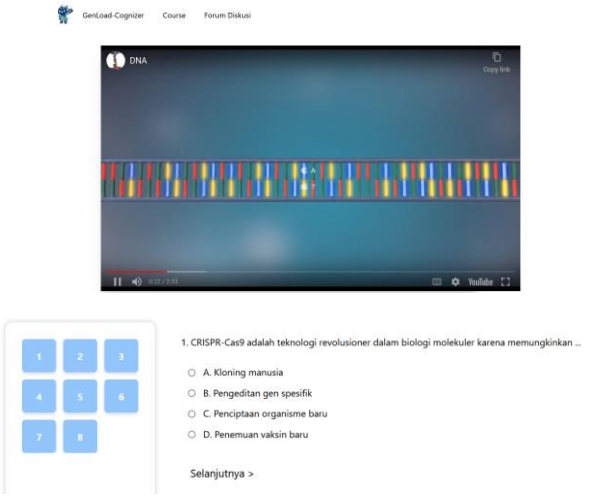

Figure 5. Materials Presented in the Form of Videos and Practice Questions

This emotion detection feature is a key component in learning media, as it allows the system to identify user emotions in real-time and provide relevant feedback. The results showed that the accuracy of emotion detection was quite high, with most of the users' emotions being identified precisely. This shows that AI technology used in learning media has great potential in understanding user emotions objectively and sustainably.

Genetics lecture materials are presented in a variety of multimedia formats, including engaging learning videos and interactive practice questions, as illustrated in Figure 5. The learning videos aim to explain genetic concepts visually and attractively, while practice questions allow students to test their understanding of the material they have learned.

As long as students interact with the learning material, the webcam remains active in the background to continuously detect their emotions. The emotional data recorded during this learning process is the basis for evaluating the cognitive load of students. The results of the study showed that there was a correlation between the emotions shown by students and their level of cognitive load. For example, expressions of confusion or frustration often indicate a high cognitive load, while expressions of interest or pleasure indicate a lower cognitive load.

The dashboard in Figure 6 provides a visual representation of the results of student emotion detection and the scores obtained on each topic of the genetics course. The data displayed on this dashboard provides a comprehensive picture of student learning development, both emotionally and cognitively.

©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132

This dashboard allows lecturers to monitor student emotions individually and in groups, so that they can identify students who may be experiencing difficulties or need special attention. In addition, the score data presented on the dashboard also provides information about the level of student understanding of genetic material. By analyzing emotional and grade data simultaneously, lecturers can gain a deeper understanding of the factors that affect students' academic performance.

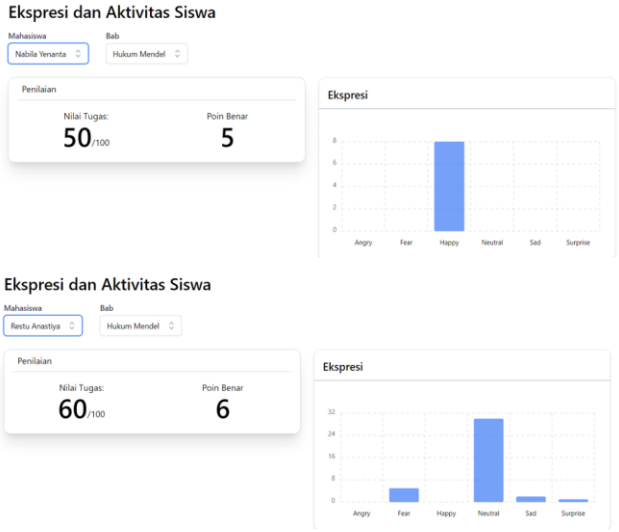

Figure 6. Dashboard of Emotion Detection Results

The results of recording emotions through facial expressions displayed in the dashboard can describe the cognitive load of prospective teacher while using learning media with AI in genetics lectures (Table 2).

Table 2. Results of Detection of Facial Emotions in the Genetics of Mendelism Lecture

Emotions-Facial expressions	Percentage (%)	Overview of Cognitive Load
Happy	16.50	Very Low
Neutral	30.57	Low
Surprised	14.53	Relatively low
Sad	9.99	Rather High
Fear/Angry	28.40	High
Disgust	0.00	Very High

Based on table 2, it is known that during the genetics lecture, the highest percentage of mendelism material was Neutral emotions-facial expressions (30.57%). Neutral describes low cognitive load. Furthermore, there were 28.40% of Fear/Angry expressions that described High cognitive load. For the emotions of Happy (16.50%) and Surprised (14.53%), they described the cognitive load as quite low-very low, respectively. For sad emotions (9.99%) describe a fairly high cognitive load.

Based on the findings of table 2, it is known that students have a variety of face-emotional expressions in attending the Mendelism genetics lecture. In general, if we look at more than 50% of the emotions that are released are surprised, neutral, and happy, which is 61.64%. This illustrates that by using AI-integrated learning media, the cognitive load of students is generally in the category of Quite Low to Very Low. None (0%) of students expressed disgusted emotions while attending the Mendelism genetics lecture.

The difference in emotional expression in each student is influenced by the mental effort of students in using multimedia genetics learning which includes material presentations, animated videos, and interactive practice questions. So that with the use of integrated lecture media, AI can detect and provide results of a picture of cognitive load during lectures.

The use of AI technology in this learning medium provides new opportunities for lecturers to understand students' emotions and learning needs more deeply. By constantly monitoring students' emotions, lecturers can identify early signs of learning difficulties and provide timely interventions. At the college level, particularly in genetics courses, students often grapple with challenging materials during the biology learning process. In addition, this learning media can also increase student motivation and involvement in the learning process, so that it has a positive impact on the effectiveness of learning.

The development of lecture media by integrating AI in detecting emotions will help in measuring the cognitive load of students in lectures. Powered by (Pan, Froese, Liu, Hu, & Ye, 2022; Yao et al., 2020) that the application of AI in the higher education system will easily enrich the stakeholders of higher education institutions because they will gain the scope to accurately and exchange knowledge quickly through AI which will improve the higher education system if the acquired knowledge is applied in practice that has an impact on the attitude of stakeholders of higher education institutions in the adoption of AI.

The Situational Approach integrated with multimedia instruction can help student learning

©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132

achievements that can be utilized, help students in understanding abstract concepts, related to life experiences through a variety of learning materials and activities (Wei, He, & Huang, 2018).

Based on (Zawacki-richter, Marín, & Bond, 2019) that with the use of artificial intelligence systems in learning will pay attention to the presentation of teaching content to students and, at the same time, support them by providing feedback and adaptive instructions to solve questions related to the content, as well as detect students' difficulties/mistakes when working with content or exercises. So it is possible by monitoring student actions with the use of artificial intelligence systems.

CONCLUSIONS AND SUGGESTIONS

This research succeeded in developing an effective AI-based learning media to detect the emotions of prospective teacher students during genetics lectures. This learning media is equipped with accurate emotion detection features, interactive learning materials, and an informative dashboard to monitor student learning progress. The results of the study show that this learning medium is able to identify students' emotions in real-time and provide relevant feedback. In addition, there was a significant correlation between student emotions and the level of cognitive load and academic performance of students.

ACKNOWLEDGMENTS

The Authors expresses gratitude to the supported of department, faculty and institution Universitas Islam Riau and Universitas Pendidikan Indonesia.

REFERENCES

Afidah, V. N. (2020). PRINSIP- PRINSIP TEORI BEBAN KOGNITIF DALAM MERANCANG MEDIA PEMBELAJARAN MATEMATIKA. *JP2M (Jurnal Pendidikan Dan Pembelajaran Matematika)*, *1*(2). https://doi.org/10.29100/jp2m.v1i2.195

Aries Tejamukti. (2017). Analisis Beban Kognitif Dalam Pemecahan Masalah Matematika. *STKIP PGRI Tulungagung*, (ISBN:978-602-50110-3-0).

Azwal, R. A., & Sari, M. (2019). Pengembangan Media Pembelajaran pada Website Tanpa Jaringan untuk Kemandirian belajar Peserta Didik. *Natural Science: Jurnal Penelitian Bidang IPA Dan Pendidikan IPA*, *5*.

Daffa Ulhaq, M. R., Zaidan, M. A., & Firdaus, D. (2023). Pengenalan Ekspresi Wajah Secara Real-Time Menggunakan Metode SSD Mobilenet Berbasis Android. *Journal of Technology and Informatics (JoTI)*, *5*(1). https://doi.org/10.37802/joti.v5i1.387

Hastuti, I. D., & Ghoni, A. (2022). PENGEMBANGAN MEDIA PEMBELAJARAN BERBASIS WEBSITE PADA MATERI TATA SURYA. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *11*(1). https://doi.org/10.33578/jpfkip.v11i1.8640

Juanengsih, N., Rahmat, A., Wulan, A. R., & Rahman, T. (2018). Pengukuran Beban Kognitif dalam Perkuliahan Biologi Sel. *Edusains*, *10*(1).

Limanjaya, L. C., Khoswanto, H., & Sugiarto, I. (2023). Sistem Untuk Mengklasifikasikan Emosi Dan Mendeteksi Wajah Pada Pembelajaran Daring. *Jurnal Teknik Elektro*, *15*(2). https://doi.org/10.9744/jte.15.2.41-47

Mardin, H., Handani Uno, A., Despianti, S. R., & Lakutu, D. N. (2022). PENGEMBANGAN MEDIA PEMBELAJARAN BERBASIS WEBSITE BAGI GURU SD IT QURRATU ‘AYUN KOTA GORONTALO. *Jurnal Pendidikan Dan Pengabdian Masyarakat*, *5*(3). https://doi.org/10.29303/jppm.v5i3.3760

Nursit, I. (2015). PEMBELAJARAN MATEMATIKA MENGGUNAKAN METODE DISCOVERY BERDASARKAN TEORI BEBAN KOGNITIF. *JPM : Jurnal Pendidikan Matematika*, *1*(1). https://doi.org/10.33474/jpm.v1i1.403

Ouwehand, K., Kroef, A., Wong, J., & Paas, F. (2021). Measuring cognitive load: Are there more valid alternatives to Likert rating scales? *Frontiers in Education*. frontiersin.org. https://doi.org/10.3389/feduc.2021.702616

Pan, Y., Froese, F., Liu, N., Hu, Y., & Ye, M. (2022). The adoption of artificial intelligence in employee recruitment: The influence of contextual factors. *The International Journal of …*. https://doi.org/10.1080/09585192.2021.1879206

Putri, I. I., & Rahmat, A. (2024). *Assessing Genetics Learning Media Effectiveness : Students Perspectives*. Atlantis Press SARL.

©Program Studi Pendidikan Biologi
FKIP Universitas Maritim Raja Ali Haji
ISSN 2503-0752 e-ISSN: 2579-4132
https://doi.org/10.2991/978-2-38476-216-3

Rahmat, A., Nuraeni, E., Soesilawaty, S. A., Alawiyah, D., & Garnasih, T. (2015). Beban kognitif dan kemampuan penalaran siswa SMA, MA, dan SMA berbasis pesantren pada pembelajaran Biologi. *Prosiding Semnas Sains & Entrepreneurship Ii*, (1994).

Rahmat, A., Soesilawaty, S. A., Fachrunnisa, R., Wulandari, S., Suryati, Y., & Rohaeni, H. (2014). Beban Kognitif Siwa SMA pada Pembelajaran Biologi Interdisiplin Berbasis Dimensi Belajar. *Prosiding Mathematics and Science Forum 2014*.

Rahmawati, R., Achdiani, Y., & Handayani, M. N. (2021). PENGEMBANGAN MEDIA PEMBELAJARAN BERBASIS WEBSITE WIX PADA MATA PELAJARAN PRODUKSI PENGOLAHAN HASIL NABATI DI SMKN 2 CILAKU CIANJUR. *EDUFORTECH*, *6*(2). https://doi.org/10.17509/edufortech.v6i2.39293

Royani, E., Haris, M., & Hadisaputra, S. (2021). Pengembangan Media Pembelajaran Kimia Berbasis Website 2 Apk Builder pada Materi Larutan Asam Basa. *Chemistry Education Practice*, *4*(2). https://doi.org/10.29303/cep.v4i2.2670

Suwarno, M. (2020). Teori Beban Kognitif dalam Pengembangan Multimedia Pembelajaran Matematika. *Alauddin Journal of Mathematics Education*, *2*(2). https://doi.org/10.24252/ajme.v2i2.16924

Wei, P. C., He, F., & Huang, S. (2018). Effects of instructional multimedia integrated situational approach on students' learning achievement. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(7), 3321–3327. https://doi.org/10.29333/ejmste/91244

Yao, W., Khan, F., Jan, M. A., Shah, N., ur Rahman, I., Yahya, A., & ur Rehman, A. (2020). Artificial intelligence-based load optimization in cognitive Internet of Things. *Neural Computing and Applications*, *32*(20). https://doi.org/10.1007/s00521-020-04814-w

Yohanes, B., & Yusuf, F. I. (2021). TEORI BEBAN KOGNITIF: PETA KOGNITIF DALAM PEMECAHAN MASALAH PADA MATEMATIKA SEKOLAH. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4). https://doi.org/10.24127/ajpm.v10i4.4033

Zawacki-richter, O., Marín, V. I., & Bond, M. (2019). *Systematic review of research on artificial intelligence applications in higher education – where are the educators ?*