Biology Departement
Faculty of Mathematics and Natural Sciences
Universitas Negeri Padang

CERTIFICATE

No. **049/ICoBioSE/Bio/2022**

This Certificate is Awarded to

Astuti Muh Amin

as

PRESENTER

of

The 4th International Conference on Biology, Science and Education (ICoBioSE) 2022
"Envisioning Tropical Biodiversity and Conservation Research and Education throughout Covid-19 Pandemic"
October, 27th 2022

Dr. Yulkifli, S.Pd., M.Si

Dean of FMIPA
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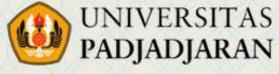
ICoBioSE 2022

BOOK OF ABSTRACT

THE 4th INTERNATIONAL CONFERENCE ON BIOLOGY, SCIENCE AND EDUCATION

Envisioning Tropical Biodiversity and Conservation Research and Education throughout Covid-19 Pandemic

October 27th, 2022
Padang, Indonesia

THE UNIVERSITY OF
SYDNEY

University of the Philippines
LOS BAÑOS

UNIVERSITAS
PADJADJARAN

ABSTRACT BOOK

The 4th International Conference on Biology, Sciences and Education (ICoBioSE)

ICoBioSE 2022

Universitas Negeri Padang

Padang, West Sumatera, Indonesia

October 27th, 2022

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FOREWORD

Distinguished guests and participants

Assalamualaikum Warahmatullahi Wabarakatuh.

Good Morning Ladies and Gentlemen. Welcome to Padang, a fascinating city, and welcome to **The 4ᵗʰ International Conference on Biology, Science and Education (ICoBioSE) 2022**

First of all, I would like to thank each one of you for joining The 4ᵗʰ International Conference on Biology, Science and Education (ICoBioSE) 2022. I'd like to extend a warm welcome to all of the keynote speakers, invited speakers, and delegates who have taken time out of their busy schedules to join us here today for this conference. We are grateful to have you all here.

This international conference aims to facilitate scientific publications of lecturers, biologists and biology education practitioner, diploma, master, and doctoral students as well as natural science experts. I am very proud to say that this conference is the third year held by the Department of Biology, Faculty of Mathematics and Natural Sciences at Universitas Negeri Padang.

This year theme " Envisioning Tropical Biodiversity and Conservation Research and Education troughout Covid-19 Pandemic". And this conference was attended by more than 609 participants from various universities.

In closing, I would like to thank the Rector of Universitas Negeri Padang and also Dean of Faculty of Mathematics and Natural Science Universitas Negeri Padang for supporting the academic climate at our departement. I would also like to thank all contributors for your good cooperation. Special thanks for ICoBioSE committes for their hard work and patience.

Your Sincerely

Dr. Syamsurizal, M.Biomed
General Chair of ICoBioSE 2022

RUNDOWN OF The 4th ICoBioSE 2022

Time	Activity	Person in Charge
07:15 – 07:45 AM	Registration	PIC Yusni Atifah, M.Si
07:45 – 08:30 AM	Opening 1. Universitas Negeri Padang Video Profile 2. Recitation of The Holy Qur'an 3. National Anthem of Indonesia "Indonesia Raya" 4. Traditional Dance Performance for Opening 5. Welcoming Speech General Chair, ICoBioSE 2022 Dr. Syamsurizal, M.Biomed Dean of FMIPA UNP Dr. Yulkifli, S.Pd, M.Si. Rector of UNP: Prof. Ganefri, Ph.D 6. Recitation of the Prayer	PIC MC : Shintia Putri Riski
08:30 - 08:40	Opening Keynote Speaker Sessions	PIC Ikmanisa Khairati, S.Pd
08:40 - 09:25	Keynote Speaker: Dr. Louise Sutherland University of Sydney, Australia	Moderator Yosi Laila Rahmi, M.Pd
09:25 - 10:10	Keynote Speaker : Dr. David Emmanuel M. General Museum of Natural History, University of the Philippines Los Banos, Philippines	
10:10 - 10:55	Keynote Speaker: Dr. Muhyiatul Fadilah, S. Si., M. Pd. Universitas Negeri Padang, Indonesia	
10:55-11:00	Coffee Break	PIC Ikmanisa Khairati, S.Pd
11:00 - 12:00	Breakout Room Zoom (Meeting Room #room number)	PIC IT Team
	SCIENTIFIC SESSION 1 Invited Speaker	PIC Moderator
	Room 1 Dr. Aa Juanda Universitas Muhammadiyah Sukabumi	Dr.Fitri Arsih, S.Si., M.Pd
	Room 2 Dr. Helendra, M.S. Universitas Negeri Padang	Dr. Suci Fajrina, M.Pd.
	Room 3 Dr. Moralita Chatri, M.P. Universitas Negeri Padang	Ria Anggryani, M.Pd.

	Room 4 Dr. Iyan Robiansyah, M.Sc. Research Center for Plant Conservation, Botanic Gardens and Forestry –BRIN	Reki Kardiman, Ph.D.
	Room 5 Dr. apt. Bantari Wisynu Kusuma Wardhani, S.Farm., M.Biomed Universitas Pertahanan Republik Indonesia	Afifatul Achyar, M.Si.
	Room 6 Dr. Priyanti, M.Si. Universitas Islam Negeri Syarif Hidayatullah	Yusni Atifah, M.Si.
	Scientific Paper 01 Scientific Paper 02 Scientific Paper 03 Scientific Paper 04 Scientific Paper 05	
12:00 - 13:00	Break and Lunch	
13.00 - 13:05	Preparation	PIC Afmi Randi Maltika, S.Pd.
13:05 - 13:50	Keynote Speaker Febri Doni, Ph.D Universitas Padjajaran, Indonesia	Moderator Fitra Arya Dwi Nugraha, M.Si
13:50 - 14:35	Keynote Speaker Dimitris Argyriou University of Copenhagen, Denmark	
14:35 - 14:40	Coffee Break	PIC Afmi Randi Maltika, S.Pd.
14:40 - 15:15	Breakout Room Zoom (Meeting Room #room number)	PIC IT Team
	SCIENTIFIC SESSION 2	PIC Moderator of each Room
15:15 - 15:50	Breakout Room Zoom (Meeting Room #roomnumber)	PIC IT Team
	SCIENTIFIC SESSION 3	PIC Moderator of each Room
15:50 - 16.00	Break	PIC Afmi Randi Maltika, S.Pd.
16:00 - 16:30	Closing The 4th International Conference on Biology, Science and Education (ICoBioSE)	PIC MC: Shintia Putri Riski

PARALLEL SESSION SCHEDULE ICoBioSE 2022

Sesi	Room 1 Moderator : Dr. Fitri Arsih, S.Si.,M.Pd Invited Speaker : Dr. Aa Juanda, M.Pd		Room 2 Moderator : Dr. Suci Fajrina, M.Pd Invited Speaker : Dr. Helendra, M.S	
1	11.00-11.30 WIB	Dr. Aa Juanda	11.00-11.30 WIB	Dr. Helendra, M.S
	11.30-11.35 WIB	Dr. Fitri Arsih, S.Si., M.Pd	11.30-11.35 WIB	Dr. Suci Fajrina, M.Pd
	11.35-11.40 WIB	Prof. Dr. Abdul Razak, M.Si	11.35-11.40 WIB	St. E. Sururiyatul Muaziyah
	11.40-11.45 WIB	Melati Latifah	11.40-11.45 WIB	Auliani Arafah
	11.45-11.50 WIB	Asti Febrina	11.45-11.50 WIB	Dios Sarkiti
	11.50-11.55 WIB	**Q&A**	11.50-11.55 WIB	**Q&A**
2	14.40-14.45 WIB	Helsa Rahmatika, M.Pd	14.40-14.45 WIB	Yanti Elfika Desti
	14.45-14.50 WIB	Ita Krissanti	14.45-14.50 WIB	Nita Hernaya
	14.50-14.55 WIB	Dinda Rahmatul Husna	14.50-14.55 WIB	Heru Setiawan
	14.55-15.00 WIB	Tesya Asnita	14.55-15.00 WIB	Astuti Muh Amin
	15.00-15.05 WIB	Avisha Putri Sundapa	15.00-15.05 WIB	Andi Nisa Fajar Dini
	15.05-15.10 WIB	**Q&A**	15.05-15.10 WIB	**Q&A**
3	15.10-15.15 WIB	Weni Febrianti	15.10-15.15 WIB	Ririn Erlina
	15.15-15.20 WIB	Dinda Zahra Saskia	15.15-15.20 WIB	Putri Septi
	15.20-15.25 WIB	**Q&A**	15.20-15.25 WIB	**Q&A**

Sesi	Room 3 Moderator : Ria Anggriyani, M.Pd Invited Speaker : Dr. Moralita Chatri, M.P		Room 4 Moderator : Reki Kardiman, p.hD Invited Speaker : Dr. Iyan Robiansyah, M.Sc	
1	11.00-11.30 WIB	Dr. Moralita Chatri, M.P	11.00-11.30 WIB	Dr. Iyan Robiansyah, M.Sc
	11.30-11.35 WIB	Dr. Syamsurizal, M.Biomed	11.30-11.35 WIB	Ninik Nihayatul
	11.35-11.40 WIB	Rahmi Rizalmi	11.35-11.40 WIB	Zakiah Syifah Urrahmah
	11.40-11.45 WIB	Kiki Putri Amalia	11.40-11.45 WIB	Alysa Nur Chasanah
	11.45-11.50 WIB	Tika Apriani	11.45-11.50 WIB	Dewi Puspita
	11.50-11.55 WIB	**Q&A**	11.50-11.55 WIB	**Q&A**
2	14.40-14.45 WIB	Puja Malona	14.40-14.45 WIB	Hasan Zayadi
	14.45-14.50 WIB	Nedia Gusti	14.45-14.50 WIB	Wara Asfiya
	14.50-14.55 WIB	Nisa Firdha	14.50-14.55 WIB	Surya Fajar
	14.55-15.00 WIB	Asmaul Husna	14.55-15.00 WIB	Inda Dwi Solina
	15.00-15.05 WIB	Filza Yunisa	15.00-15.05 WIB	Febrina Artauli Siahaan
	15.05-15.10 WIB	**Q&A**	15.05-15.10 WIB	**Q&A**
3	15.10-15.15 WIB	Yosi laila Rahmi, M.Pd	15.10-15.15 WIB	Reza Fauzi
	15.15-15.20 WIB	Silvira Aulia	15.15-15.20 WIB	Zihan Ayu Anggraini
	15.20-15.25 WIB	Ridha Agusri	15.20-15.25 WIB	Nida Humaida
	15.25-15.30 WIB	**Q&A**	15.25-15.30 WIB	**Q&A**

Sesi	Room 5 Moderator : Afifatul Achyar, M.Si Invited Speaker : Dr. Apt. Bantari Wisynu Kusuma Wardhani, S.Farm., M.Biomed		Room 6 Moderator : Yusni Atifah, M.Si Invited Speaker : Dr. Priyanti, M.Si	
1	11.00-11.30 WIB	Dr. Apt. Bantari Wisynu Kusuma Wardhan, S.Farm., M.Biomed	11.00-11.30 WIB	Dr. Priyanti, M.Si
	11.30-11.35 WIB	Dra. Des M, M.S	11.30-11.35 WIB	Dwi Umi Siswanti

	11.35-11.40 WIB	Dr. dr. Elsa Yuniarti, S.Ked., M.Biomed	11.35-11.40 WIB	Shanti Listyawati
	11.40-11.45 WIB	Shanaz Dhiyaul	11.40-11.45 WIB	Sri Wahyuni
	11.45-11.50 WIB	Siti Nurfadilah	11.45-11.50 WIB	Kumala Dewi
	11.50-11.55 WIB	**Q&A**	11.50-11.55 WIB	**Q&A**
2	14.40-14.45 WIB	Dewi Imelda Roesma	14.40-14.45 WIB	Dra. Des M, M.S
	14.45-14.50 WIB	Dr. Irdawati, M.Si	14.45-14.50 WIB	Dr. Dwi Hilda Putri, M.Biomed
	14.50-14.55 WIB	Azizah Nur Rochmah	14.50-14.55 WIB	Sri Widiyanti
	14.55-15.00 WIB	Morina Adfa	14.55-15.00 WIB	Agni Isador Harsapranata
	15.00-15.05 WIB	Yohanna	15.00-15.05 WIB	Zulfadli
	15.05-15.10 WIB	**Q&A**	15.05-15.10 WIB	**Q&A**
3	15.10-15.15 WIB	Annisa Mirti	15.10-15.15 WIB	Frizkia Nolanda
	15.15-15.20 WIB	Aisyah Nabila	15.15-15.20 WIB	Nur Vaizi
	15.20-15.25 WIB	Inggita Utami	15.20-15.25 WIB	Jannah Khoftiah
	15.25-15.30 WIB	**Q&A**	15.25-15.30 WIB	**Q&A**

TABLE OF CONTENT

KEYNOTE SPEAKER

Dr. Louise Sutherland

University of Sydney, Australia
Teachers Professional Learning, Science Education, Psychology of education

Dr. David Emmanuel M. General

Museum of Natural History,
University of the Philippines Los Banos, Laguna, Philippines Entomology, Myrmecology, Ant Taxonomy, Ant Ecology

Dr. Muhyiatul Fadilah, S. Si., M. Pd.

Universitas Negeri Padang, Indonesia
Biology education, Science Education

Febri Doni, Ph.D

Universitas Padjajaran, Indonesia
Plant-microbe interactions, System of Rice Intensification, plant pathology, agroecology.

Dimitris Argyriou

University of Copenhagen, Denmark
Food Science, Forestry, Environmental Science, Botany, Ecology, Ethnobotany

PLENARY SESSION

Systems thinking in the time of a pandemic: teaching and learning to support informed actions

Louise Sutherland

School of Education and Social Work, The University of Sydney, NSW Australia.

Abstract. The causes and impacts of the pandemic are just one example of some of the complex issues facing our world today. We need to take a holistic view of the phenomenon to address these issues. In Education, this is conceptualised as Systems Thinking. Rather than considering linear cause and effect relationships between the individual parts, a system approach addresses the interconnections among the different components and the associated feedback mechanisms, including the multiple and cyclical mechanisms contributing to an observed phenomenon. The cognitive processes our students need to develop to demonstrate systems thinking is a recent focus in Education research. Systems Thinking requires the knowledge and understanding of appropriate scientific concepts and a degree of flexibility in identifying and considering the interactions of a range of temporal and spatial factors contributing to the observed phenomenon. The development of System Thinking may involve three core skills; (a) identifying the organisation of the system, including the identification of the relevant elements and interrelationships; (b) analysing system behaviour by considering the dynamic and time-related processes that emerge from the structure of the system, and (c) system modelling, considering the interactions between the elements and subsystems and how simultaneous interactions result in macro-observable phenomena. Students' development of System Thinking is not linear; there are multiple trajectories through which students move to develop a more coherent understanding of a complex system In this talk, I will discuss how we can organise our instruction to support students' development of systems thinking. Key modifications to our practices to support the development of students' systems thinking include: 1) Engaging students in authentic ill-defined problems; 2) Supporting deep and meaningful learning through explicit representations, such as concept maps; and 3) Providing feedback to support students' cognitive development. Using examples from a recent study, I will illustrate how concept maps can provide opportunities for students to create explicit representations of the development of their knowledge as well as giving us insights into the developmental pathways of System Thinking.

Philippine wildlife conservation and biodiversity research in the Covid Era, 2020-2022: challenges and triumphs

David Emmanuel

University of the Philippines Los Baños, Los Baños, Laguna, Philippines.

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Abstract. The Philippine government imposed one of the strictest lockdowns during the pandemic. People were mostly restricted to staying home for months. Two such lockdowns were imposed. The effect of the lockdowns on wildlife conservation is a mixed bag, where illegal wildlife trade slowed down but bird poaching, particularly on Luzon Island intensified. Collecting permits for research expired. Field work became impossible. Nevertheless, biodiversity research continued. Dozens of new species were described, based on specimens already collected pre-covid. This taxonomic work continues, even as travel restrictions have eased.

Shifting Laboratorial Work toward Residential Fieldwork to Improve Biology Preservice Teachers' Multiliteracy: Biodiversity Lesson Learned after Pandemic

Muhyiatul Fadilah

Departement Biology, Biolofy Education Program, Universitas Negeri Padang, Padang, Indonesia.

Abstract. Animal Biodiversity is a compulsory course for students in Biology Education Program. The course consists of theoretical and practical activities. Before the pandemic, we set laboratory work in followed theoretical class, as an opportunity to practice identifying and classifying animals. Due to the pandemic and its face-to-face restriction, we conducted remote learning in which participants stayed in their own residential areas. To maintain inquiry skills, we instructed 26 students remotely to hold half-semester independent fieldwork activities with one basic rule, which is residential-based work. There are 4 stages of distance learning; Reviewing relevant research work, pre-fieldwork presentation, on-field data gathering, and final academic writing. Descriptively, we identify and classify students' ideas evolvement that perform multiliteracy connection during the process. To clarify the written ideas, we make some deep personal talks and interviews. We found that residential fieldwork enhances 5 basic literacy, which is science literacy, digital literacy, financial literacy, cultural literacy, and numeracy literacy as well as disaster and conservation awareness. Compare to routine-laboratory work, residential-based fieldwork brings more basic research skills and could be recommended to develop citizen science skills after pandemics pass. This biodiversity course shifting mode can orient preservice biology teachers to build real-life benefits of biodiversity learning such as optimizing local potency for conservation, and ecotourism, developing local material-based learning resources, and disaster mitigation.

Deciphering the microbial modulation of rice plants' genetic potentials: From earlier views to the omics era

Febri Doni

Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Jatinangor 45363, West Java, Indonesia.

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Abstract. Rice, the main staple food for about half of the world's population, has had the growth of its production stagnate in the last two decades. One of the ways to further improve rice production is to enhance the associations between rice plants and the microbiome that exists around, on, and inside the plant. This article reviews recent developments in understanding how microorganisms exert positive influences on plant growth, production, and health, focusing particularly on rice. A variety of microbial species and taxa reside in the rhizosphere and the phyllosphere of plants and also have multiple roles as symbiotic endophytes while living within plant tissues and even cells. They alter the morphology of host plants, enhance their growth, health, and yield, and reduce their vulnerability to biotic and abiotic stresses. While abundant evidence is confirming the impacts microbes on plants' gene expression, the molecular events that occur within the plant's cellular environment are not established, and investigations on these aspects of plant-microbial interaction are still limited. Thus, this article also reviews current understanding of the several biochemical and molecular mechanisms whereby plants' genetic potentials can be elicited or influenced by beneficial microbes. Means for further research and progress for applying this knowledge for crop improvement are discussed.

Environment, citizen science and local communities as agents of change

Dimitris Aargyriou

Forest and People Organization Copenhagen, Denmark.

E-mail:

Abstract. Nature and nature's contributions to people are vital for human existence and good quality of life. The biosphere, upon which humanity as a whole depends, is being altered to an unparalleled degree. We've all heard it before - the Earth is getting warmer, CO2 levels are rising, species are getting extinct and extreme weather events are getting more and more common. The floods, forest fires and landslides that recently occurred in Indonesia are only some of the examples. It is apparent that the systems that we have been basing our development upon are failing to sustain life on earth as we know it. We cannot solve our problems with the same thinking we used when we created them. We need a change. There is an urgent need to protect and manage nature as sustainably as possible. But it's hard to manage what you can't measure with data. Currently, 68% of the environmental SDG indicators (UNEP 2019) are lacking data. Citizen Science, which is the involvement of the public in scientific endeavors, might hold the answers and be able to fill this gap. Meanwhile, the value of Indigenous and local knowledge in understanding climate adaptation processes and actions to reduce risks from human-induced climate change is recognized in climate processes (IPBES 2022). This keynote session will explore the ways that Indigenous peoples and local communities are playing a significant role in preserving nature and forests, and can contribute to measuring our environment. At the same time, it will highlight how co-created projects towards this goal can promote transparency in the decision-making process, including public desires and needs, and finally democratize science.

INVITED SPEAKER

Student formal-postformal reasoning in vertebrate zoology practice using level of inquiry embeded formative assessment (LoI-eFA) assisted by numeric taxonomy

A Juhanda[1*], N Y Rustaman[2], T Hidayat[2], A R Wulan[2]

[1]Department of Biology Education, Universitas Muhammadiyah Sukabumi, Indonesia
[2]Postgraduate Studies on Science Education Study Program, Universitas Pendidikan Indonesia, Indonesia.

[*]E-mail: aajuhanda@ummi.ac.id

Abstract. This study aims to determine the formal-postformal operational reasoning of students in Vertebrate Zoology practice using an integrated level of inquiry formative assessment (LoI-eFA) assisted by numerical taxonomy. The research method uses mixed methods type embedded experimental design. Research participants consisted of 24 UMMI Biology education students who contracted Vertebrate Zoology practicum in the 4th semester of the 2019/2020 academic year. The instrument used consisted of 28 questions of formal-post-formal reasoning (divided into groups A and B), rubric for assessment of formal-post-formal reasoning, self-assessment, student response questionnaires, and lecturer interview format. The results showed that there was an increase in students' formal-postformal operational reasoning through the use of LoI-eFA ($p < 0.05$). This is indicated by an increase in the average achievement of pretest and posttest obtained by students. The highest indicator of formal-postformal reasoning is achieved in proportional reasoning and the lowest is systematic. The average achievement of students for formal-postformal reasoning at the LKM and self-assessment shows that there is a total average suitability that is both in the good category. In addition, students and lecturers gave positive responses to the implementation of the LoI-eFA.

Student response to the implementation of animal development lectures by applying self-regulated learning model assisted with integrated metacognitive skills module

Helendra Helendra[*] and **Lufri Lufri**
Biology Department, Universitas Negeri Padang, Padang, Indonesia

[*]E-mail: helendra@fmipa.unp.ac.id

Abstract. The ability to study independently and metacognitive skills are needed by students in order to improve their learning outcomes. Several studies that have been conducted by experts prove that there is a relationship between the ability to study independently and the achievement of student learning outcomes. The implementation of independent learning known as self-regulated learning (SRL) is very helpful if the learning resources owned by students are adequate. The module developed by the lecturer can be used as a learning resource to facilitate the implementation of the SRL model. This study aims to determine student responses to the implementation of Animal Development lectures by applying a self-regulated learning model assisted by the integrated metacognitive skills module (SRL-MK). The implementation of the SRL-MK model is carried out from September to October 2021 for Biology Department students entry year 2020, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. The data collection instruments are in the form of observation sheets and student response questionnaires consisting of 16 question items with using a Likert scale. Observation sheets are used to summarize all learning activities that can be seen from the task sheets that are done according to the SRL syntax. The research data was processed qualitatively for learning activities and quantitatively for student responses from the questionnaire. The results of data analysis show that all activities that must be done by students according to the syntax of the SRL-MK model have been carried out well. The results of the analysis of student responses from the questionnaire answers are as follows: (a) the ease of following the learning model is 0.82 (very positive), (b) the benefits of the learning model are 0.80 (very positive), (c) the usability of the module in learning of 0.83 (very positive) and (d) the role of lecturers in learning of 0.87 (very positive), with an average overall student response of 0.83 (very positive). So, it can be concluded that student activities in the implementation of Animal Development learning with the SRL-MK model can be carried out well according to the model syntax, and the student response is very positive.

Potensial of leaf extracts of some plants as botanical fungicides to control plant disease

C Moralita[*], A S Rahayu, N R Fitri, F Azmi, H Tusa'diyah and Z Aini

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Abstract. Farmers generally performed using chemical fungicides to control plant diseases because it is more practical. But the continuous use of fungicides can have a negative affect on the environment such as water and soil pollution, decreasing the balance of the ecosystem. In addition, it also causes poisoning to humans due to the presence of non-biodegradable residues in agricultural products. Based on the negative impact caused by synthetic fungicides, it is necessary to search for other alternatives with biological control such as the use of botanical fungicides. Botanical fungicides are fungicides obtained from plant extracts. This is because plants produce secondary metabolites such as terpenes, phenols, flavonoids, quinones, tannins, alkaloids, saponins and sterols which are antifungal. Several in vitro studies have been carried out using plant fungicides to inhibit the growth of Fusarium oxysporum, such as leaf extract of kelengkeng (Dimocarpus longan L.) pucuk merah (Syzygium oleina), rambutan (Nephelium lappaceum L.), sukun (Artocarpus altilis Park.) and sikeduduk (Melastoma malabatrichum L.) The results showed that leaf extracts of these plants showed strong antifungal activity at an extract concentration of 40%. It can be concluded that leaf extracts from these plants have the potential to control plant diseases.

Conservation of Indonesia threatened Plant Species

Iyan Robiansyah

Research Center for Plant Conservation, Botanic Gardens and Forestry –BRIN

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Abstract. Indonesia is one of the centres for plant biodiversity in the world. The country is a habitat for around 30,000-40,000 plant species. This high diversity of plant species is under pressure due to threats from habitat conversion and degradation, unsustainable use, pollution, invasive species, and climate change. From a total of 4,477 Indonesian plant species that have been assessed for their conservation status using IUCN Red List Categories and Criteria, one species has been declared to be extinct, 3 species are extinct in the wild, and the other 997 species (22.3%) are threatened with extinction. Kalimantan has the highest number of threatened plants (352 species), followed by Sumatera (319 species) and Papua (169 species). The effectiveness of the Indonesian protected area network in conserving the threatened plant species in situ has not been measured. Furthermore, there are only 179 species (17.9%) of these threatened species that have been conserved ex-situ at the Indonesian Botanic Gardens. Comprehensive conservation actions are urgently required to conserve Indonesian threatened plant species.

Overcome obstacle anti-cancer resistance model in the pharmacological experiment

Bantari WK Wardhani[1]

[1]Laboratory of Pharmacology and Toxicology, Faculty of Military Pharmacy, The Republic of Indonesia Defense University, Sentul, Bogor, Indonesia
E-mail: bantariwisynu@gmail.com

Abstract. Chemotherapeutic drug resistance cancer remains clinically bottleneck problems in cancer therapy. Development of specific drug resistance models are critical in the study of chemotherapy resistance cancer. One of the approaches is using the drug resistance cell lines and animal models. Developing drug resistance cell lines from available cell lines is a challenging process that commonly takes 3 - 18 months, as well as animal models. Those processes include optimizing dose of anti-cancer drugs, treatment interval, and duration of treatment to induce resistance. Another problem is reversibility of cancer cell lines and animal models, even after 18 months of treatment. Therefore, this article brings an alternate strategy to generate anti-cancer cells resistance and animal models using genome editing techniques. One powerful technique, CRISPR-Cas9 systems, mediates DNA modification by replacement in the presence of exogenous donor DNA template in knock-in and resection in the absence of exogenous DNA template in knock-out. This technique generates specific in vivo and in vitro models for studying anti-cancer resistance.

Keywords: genome editing, anti-cancer drug resistance, CRISPR-Cas9 systems, knocked in, knocked out.

Natural dye fro Bintaro (*Cebera manghas)* fruit peel extract on cotton fabric

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Abstract. Bintaro (*Cerbera manghas*) became one of ornamental plant in open green space and street edge. The fallen fruit as well as peel hasn't been used as natural dye on cotton fabric. The research aimed to observe the dyeing ability of bintaro fruit peel as natural dye and to get the best mordant concentration. Data were collected with the dipping process of cotton fabric at a various concentration of chalk mordant (70 g/10 L and 60 g/10 L), alum (70 g/10 L and 60 g/10 L), and ferrous sulphate (60 g/10 L and 50 g/10 L). The result showed that cotton fabric have light brown to brown colour. The best mordan concentration showed to F2b which the cotton fabric had already coloured by bintaro fruit peel and added allum 60 g. Based on the heaviness, cotton fabric which has been dyed with the bintaro fruit peel extract had differences among variation of fixator concentration. The Asymp. Sig. value was 0,029 (<0,05). Dyed and fixated cotton fabric should be tested for absorbing quality, sharpness and colour evenness.

PARALLEL SESSION BIOLOGY

Design specific primary gen Methallothionein Tor Fish (*Tor tambra*)

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Abstract. Penggunaan penanda biologis *(biomarker)* logam berat diperlukan untuk mendeteksi sekaligus memantau keberadaan logam berat pada tataran molekuler. Gen *Metallothionein merupakan gen yang ditemukan pada organ ikan yang mengalami pencemaran logam berat.* Pendeteksian adanya gen methallotionein pada instrumen PCR membutuhkan sebuah primer berupa sekuens DNA rantai pendek sebagai pengenal DNA target secara spesifik. Desain primer dilakukan secara insilico menggunakan situs NCBI, Primer3Plus dan OligoAnalyzer. Sekuen nukleotida dari gen methallotionen dapat dicari dalam situs NCBI dengan format FASTA yang dianalisis lebih lanjut menggunakan program Primer3Plus dan OligoAnalyzer. Hasil perancangan primer gen tmethallotionein diperoleh 2 kandidat primer dengan menggunakan 2 perbedaan suhu optimum di program Primer3Plus yakni dari Tm optimum 50°C dan 60°C. Primer yang memiliki kriteria primer terbaik yakni primer 1 pada suhu 58/57°C dengan urutan basa primer forward 5'- GAT TGC GCC AAG ACT GGA ACT –3' dengan panjang basa 21, Tm 58°C, % GC sebesar 52,4% , hairpin dengan nilai $\Delta G = 46,9$ kcal/mol, self dimer dengan nilai $\Delta G = 4,2$ serta cross dimer dengan nilai $\Delta G = 61,2$ kcal/mol dan urutan basa primer reverse yaitu 5' – ATC ACG TTG ACC TCC TCA CTG -3' dengan panjang basa 21, Tm 56,7°C, % GC sebesar 52,4 % , hairpin dengan nilai $\Delta G =$ none, self dimer dengan nilai $\Delta G =$ none serta cross dimer dengan nilai $\Delta G = 59,7$ kcal/mol

Specific activity of thermophilic bacterial xylanase enzyme using rice straw as substrate and its potential as an environmentally friendly fabric bleach

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Abstract. Xylanase is an extracellular enzyme with a significant industrial application. The thermophilic bacteria that produce xylanase enzymes can hydrolyze xylan into xylose and xylooligosaccharides. Natural carbon sources derived from agricultural waste, such as rice straw, can be used to make xylan carbon sources. One of the applications of xylanase in business is as an environmentally acceptable bleaching agent (biobleaching). The goal of this study was to determine the specific activity of the xylanase enzyme at various substrate concentrations and to assess the xylanase enzyme's potential action on fabric brightness. This is an experimental study. This is a RAL-based experimental study with six treatments and three replications. The kappa number will be used to determine the effect of the xylanase enzyme in whitening the fabric. The specific activity of the xylanase enzyme was maximum at a substrate concentration of 4%, or 0.419 U/mg protein, according to the findings. Based on the results of the kappa number, the potential activity of the xylanase enzyme on fabric brightness demonstrates that the xylanase enzyme from agricultural waste substrates can reduce the kappa number (2.21) whereas the kappa number without xylanase is larger (3.42).

Keywords: Xylanase Enzyme, Biobleaching, Thermophilic Bacteria, Agricultural Waste

Optimizing the temperature of Thermophilic Bacteria to Produce Bioethanol as Biofuel

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Abstract. Bioethanol is an alternative energy source to replace fossil fuels. The advantage of using bioethanol is that it is renewable, environmentally friendly and can reduce pollution levels. Bioethanol can be produced by thermophilic bacteria. Thermophilic bacteria are more beneficial in bioethanol production because they have a large spectrum of substrates, can degrade hexoses and pentoses simultaneously, operate at high temperatures which minimize the risk of mesophyll contamination. This study aims to determine the potential of thermophilic bacteria from Mudiak Sapan hot springs in producing bioethanol as biofuel and to determine the optimum temperature for thermophilic bacteria to produce bioethanol. This research is a descriptive and experimental study based on RAL with six treatments and three replications. To test the isolates of thermophilic bacteria producing bioethanol, bacteria were screened on solid selective medium TMM (Thermophilic Minimum Media) and the bioethanol content was measured using a distillation apparatus. The results of this study showed that twelve isolates of thermophilic bacteria had the ability to produce bioethanol and isolates MS 9 was the isolate that produced the highest bioethanol content of 1.001%. Meanwhile, the optimum temperature for thermophilic bacteria to produce bioethanol is 55°C with the highest bioethanol content of 1,000%.

Analysis of the Spatial Distribution of Coffee-Based Agroforestry Land (*Coffea* sp) in the Buffer Area of Bromo Tengger Semeru National Park (BTNSP)

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Abstract. Indonesia is a country that has high biodiversity. Deforestation in some areas causes habitat loss, damage/degradation, and fragmentation, which leads to a decline in biodiversity. A landscape-based approach is needed to address these problems. This approach seeks to facilitate multiple interests in the management of areas at a landscape scale. This study aimed to analyze the spatial distribution of coffee-based agroforestry (*Coffea* sp) in the buffer zone of BTNSP East Java. This research was conducted from January-December 2022 in the buffer village area of TNBTS in Poncokusumo (Sumberejo) and Wajak (Patokpicis and Bambang) Districts of Malang Regency which is directly adjacent to BTNSP. This research was conducted utilizing a preliminary survey, identifying, and analyzing the existing land use and physical aspects (soil profile, elevation) and climate (temperature, humidity, rainfall) in the buffer zone of BTNSP to get a general picture of the area that has the potential to become a buffer zone. coffee-based agroforestry areas in the region. Then, the spatial distribution of coffee grounds was analyzed based on the type of coffee and stands in the 3 buffer zones of TNBTS. The results of this study indicate that there are 5 types of coffee found and the distribution between regions has different compositions and types of stands. Differences in land space provide different profiles of coffee types and stands.

Test of vitamin C in catechins gambir (*Uncaria gambier* Roxb.) at different concentrations and doses

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Abstract. Gambir (Uncaria gambir Roxb) is a plant that is widely cultivated in West Sumatra, with the main component of gambier which act as antimicrobial and antioxidant compounds. Vitamin C is one of antioxidants which have the main function of inhibiting an oxidation reaction and inhibiting a free radical. This study aims to determine the levels of vitamin c in catechin Gambir with different concentrations and doses. This research is an experiment with a Factorial Completely Randomized Design where Factor A (concentration) and Factor B (dose), conducted at the Laboratory of Biological FMIPA UNP. The method used in this research is UV spectrophotometry. Data were analyzed using ANOVA followed by the DMRT test with a significant of 5%. The results showed that concentrations and dosage used Gambir catechins affect the levels of vitamin C where the Sig <0.005% with concentration of 95% and dose of 200 mg.

The effect of Wheat Grass (*Triticum aestivum* L.) juice on uric on uric acidl levels in Mice (*Mus musculus* L.) hyperuricemia

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Abstract. Hyperuricemia is a condition where uric acid level is overly high in the blood. This condition does not cause symptoms, but if left untreated it can lead to more serious problems such as gout and kidney stones. One of the plants known to have various health benefit is Triticum aestivum L. The purpose of this study is to determine the effect of wheat grass juice on uric acid level in mice. This study is an experimental research with a Completely Randomized Design (CRD) with sample of 25 mice which were grouped into negative control, positive control which given a high purine diet (HPD) and allopurinol, P1 ; given HPD and 50% concentration of wheat grass juice, P2 ; HPD and 75% concentration of wheat grass juice, P3; HPD and 100% concentration of wheat grass juice. Data was analyzed using One Way ANOVA and continued with DMRT as the follow-up test. The result shows that wheat grass juice has the effect ($p<0.05$) on reducing uric acid level in hyperuricemic mice at 75% concentration of wheat grass juice.

Impact of growing media and Wheatgrass (*Triticum aestivum L.*) Ddosage on anemic Mice

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Abstract. Anemia is a health decreased levels of hemoglobin in the blood caused by iron deficiency needed for hemoglobin synthesis can lead to anemia. Alternative iron needs can be done by consuming snacks that contain iron, one of which is wheat grass. This study aims to impact of growing media and doses of wheat grass (*Triticum aestivum* L.) on the Hb of male mice (*Mus musculus* L.). This study is an experimental with population in this study, namely male mice aged 8-10 weeks weighing 20-30 g. Sample were 40 male mice that met the criteria and treatment of anemia by induced $NaNO_2$. Hb sample examination using haemometer Sahli. The results of the statistical test showed that the value of Fcount <Ftable on the planting medium, Fcount>Ftable on the dose, it can be concluded that the husk growing media and soil had no effect while the dose effect on hemoglobin levels at 100% concentration

Starter concentration of SSA 4 thermophilic bacteria in producing xylanase

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Abstract. Advances in the field of biotechnology have led to the use of enzymes in industry increasingly. The high public awareness of environmental pollution makes enzyme technology as an alternative to replace various chemical processes. Enzymes can be used in various industrial sectors such as textiles, food, detergents, paper and cosmetics, as well as biofuels. One of the enzymes that is often used is the enzyme xylanase. Thermophilic microorganisms that can produce thermostable enzymes are thermophilic bacteria. One of the important factors affecting the success of the manufacturing process of the production of the xylanase enzyme is the concentration of the starter. The production of the thermophilic bacterial xylanase enzyme SSA 4 produced the highest specific enzyme activity at a concentration of 4% which was 0.137 U/mg. This shows that low starter concentrations can overwhelm microbial growth well. The increase in the concentration of the starter causes the enzyme activity to decrease, this happens.

Potential of thermophilic bacteria to produce bioethanol at variation of incubation pH

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Abstract. Bioethanol is a type of alcohol whose production process can be done using microbes through a fermentation process. The bioethanol production process can be carried out in two stages, namely hydrolysis and fermentation by microorganisms. The bioethanol fermentation process can be carried out by microorganisms such as yeast and thermophilic bacteria. The use of thermophilic bacteria in the field of biotechnology is more beneficial because thermophilic bacteria are efficient at high temperatures. This study aims to determine the potential of thermophilic bacteria in Sapan Sungai Aro hot springs in producing bioethanol and to determine the optimum pH of thermophilic bacteria in producing bioethanol. This research is a type of experimental research based on RAL using three replications and six treatments. Testing of thermophilic bacteria producing bioethanol was carried out by growing bacteria in a selective medium, namely TMM solid medium (Thermophilic Minimum Medium) and the concentration of bioethanol was measured by the distillation method. This study found that sixteen thermophilic bacteria had the ability to produce bioethanol and SSA 8 isolate was the producer of bioethanol with the highest concentration of 1.001%. while the optimum pH of thermophilic bacteria in producing bioethanol is pH 8 with the highest concentration of bioethanol is 1.001%.

MACRONUTRIENT CONTENT IN SOLID AND LEACHATE FERTILIZER FROM HETEROGENIC ORGANIC WASTE

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Abstract. Food waste can still be used as compost or the leachate as liquid fertilizer. Manufacture of fertilizers from organic waste with homogeneous ingredients does not always produce macronutrients in accordance with the standards of the Ministry of Agriculture, so a heterogeneous composition is needed to increase macronutrients. The purpose of this study was to analyze the macronutrient content of solid fertilizers and leachate fertilizers from food waste. The research was conducted from April to June 2022 in the Laboratory of Ecology, Ahmad Dahlan University. The research stages were in the form of substrate preparation and stacked bucket composter, production and optimization of solid fertilizer and leachate content, measurement of macro nutrients, and data analysis. Organic waste or substrate consisting of leftover rice, chicken egg shells, fish offal, lamtoro leaves, and banana peels were prepared with a total of 10 kg in each stacked bucket with three replications. The leachate that was stored for 15 days was fermented with EM4, and the solids remaining after 15 days were dried. The content of macro elements (C-organic, C/N ratio, and a combination of N, P, K elements) of solid fertilizer and leachate fertilizer was measured after one month and the data were analyzed quantitatively descriptively. The results showed that macro nutrients of solid fertilizers from heterogeneous organic waste had met the minimum standard for solid fertilizers based on the regulation of the minister of agriculture number 261/KPTS/SR.310/M/4/2019 with a C-organic value of 15.93% (minimum 15%), C/N ratio of 7.21 (standard ≤ 25), and a combination of elements N, P, K of 4.46 (minimum 2%). On the other hand, the organic C in leachate liquid fertilizer is only 1.07% and the combined elements of N, P, K are only 0.57%. The conclusions of this study indicate that solid fertilizer from heterogeneous organic waste contains macronutrients that are in accordance with the standards of the Ministry of Agriculture compared to liquid fertilizer leachate.

Keywords: banana peel, fish offal, egg shell, leftover rice, lamtoro leaf

Potensial of *Mutingia calabura* L. Leaf Extract as Antifungal against *Fusarium oxysporum* and *Sclerotium rolfsii*

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Abstract. *Fusarium oxysporum* and *Sclerotium rolfsii* are soil-borne pathogenic fungi that can survive for a long time in the soil without a host. Control is usually done by using synthetic fungicides which often cause negative effects. One alternative control that is safe the use of fungicides derived from plants such as leaf extract of *Mutingia calabura* L.. The leaves of this plant have antimicrobial compounds. The aim of this study was to examine the potential and antifungal activity of *M. calabura* L. leaf extract in inhibiting the growth of *F. oxysporum* and *S. rolfsii* colonies. This research was conducted at the Biology Laboratory, Faculty of Mathematics and Natural Sciences, Padang State University. This study consisted of 5 treatments and 3 replications with *M. calabura* L. leaf extract at a concentration of 0% (control), 10%, 20%, 30% and 40%. The data obtained were analyzed by means of variance (ANOVA) with Duncan's New Multiple Range Test (DNMRT) further test. The results showed that the leaf extract of *M. calabura* L. had the potential to inhibit the growth of *F. oxysporum* and *S. rolfsii*. At concentrations of 10%, 20%, 30% and 40% showed significant differences in the diameter of the colonies of *F. oxysporum* and *S. rolfsii*.

Keywords: *Fusarium oxysporum,* leaf extract, *M. calabura, Sclerotium rolfsii*

The morphology and stomata anatomy characteristic of Plagiobryoides cellularis in Galunggung Mountain tourist area Tasikmalaya

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Abstract. Plagiobryoides cellularis is a part of mosses that has stomata. Furthermore, Plagiobryoides cellularis has different characteristics compared to the other mosses. These facts prove that some Bryophytes have stomata. However, Bryophyte stomata are located in the capsule, unlike other land plants. To understand the characteristic of Plagiobryoides cellularis stomata and all over morphologies, we utilize a light microscope and SEM as the observation tools. Plagiobryoide cellularis, from a morphological perspective, indicates unique characteristics from other mosses. Besides, the presence of stomata located in the capsule has barely like other stomata land plants. With stomata formed from 2 guard cells and surrounded by subsidiary cells that are hard to distinguish from epidermal cells.

Gastrointestinal helminthiasis in *Rusa timorensis* in Kampung Cai Ranca Upas Ciwidey, Bandung

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Abstract. *The Timor deer (Rusa timorensis) is an endemic Indonesian wildlife whose population is currently decreasing and is on the verge of extinction. This study aims to determine the type of worm eggs and the prevalence of gastrointestinal helminthiasis in general in Timor deer in Cai Ranca Upas Village, Ciwidey Regency, Bandung Regency, as a breeding location and tourist attraction in West Java. A total of 42 samples of Timor deer feces were examined using the Kato Katz method. The results of the examination showed that five samples were positively infected with gastrointestinal helminth parasites with worm eggs of Trichuris sp., Bunostomum sp., hookworm., Paramphistomum sp., Ostertagia sp., and Trichostrongylus sp. The prevalence of helminthiasis in captive Timor deer is 11,9 %.*

Literature study : breast cancer and its causative factors

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Abstract. Breast cancer is the number one cause of death from cancer and the high mortality rate from breast cancer is because many breast cancer sufferers are diagnosed at an advanced stage. This is due to the delay in breast cancer patients doing examinations in health services. Many risk factors play a role in influencing the time span of examination of breast cancer patients in health services. This research is a literature study that aims to look at the factors that cause breast cancer. Factors related to the incidence of breast cancer are obesity, age of giving birth to their first child, history of breastfeeding, and age of menarche.

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Small carnivore diversity in oil palm landscape near Kerinci Seblat National Park, West Sumatra.

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Abstract. The conversion of forests to plantations in Indonesia has an impact on the presence and diversity of small carnivores, especially in narrow and fragmented areas. This research was conducted in the High Conservation Value (HCV) forest in two oil palm plantations, the first is fragmented, and the second is non-fragmented and bordered by the Kerinci Seblat National Park. Camera traps were installed from 2015-2018. Photos from camera traps were processed using Camera Sweet, then the diversity index and relative abundance index (RAI) were calculated. We found 12 species of small carnivores, 6 species were found in fragmented HCV, and 10 species in non-fragmented. There is no significant difference in the value of the diversity index of the two HCVs. *Arctictis binturong*, *Martes flavigula*, *Paradoxurus hermaphroditus*, and *Prionailurus bengalensis* were species that can be found in both HCVs. *Hemigalus derbyanus* and *Viverra tangalunga* were only found in fragmented HCV. Meanwhile, *Arctogalidia trivirgata*, *Catopuma temminckii*, *Neofelis diardi*, *Paguma larvata*, *Pardofelis marmorata*, and *Prionodon linsang* were only found in non-fragmented HCV. Both HCVs have unique small carnivore diversity. Species found only in fragmented forests represent isolation. This needs more action to prevent the extinction of small carnivores in oil palm plantation areas.

Diversity of Grasshoppers Used as Food Ingredients in Kampung Melayu Nagari Limo, Kecamatan Bonjol, Kabupaten Pasaman

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Abstract. Grasshoppers have various roles including as predators, scavengers, and decomposers of organic material. In addition, grasshoppers can also be used as food ingredients because of their high protein content. However, for some people, consuming grasshoppers is still considered extreme or unusual. Data or information on the diversity of grasshoppers in Kampung Melayu has never been published before, so it is necessary to conduct an in-depth study on this matter. This study aims to describe the level of diversity of grasshopper species in the rice fields in Kampung Melayu, especially those used as food ingredients. This research is a qualitative descriptive study and the sampling method used is the hand sorting method. From the results of the study, it was found that 5 types of grasshoppers were *Valanga nigricornis, Oxya hyla, Oxya japonica, Pseudoxya diminuta,* and *Atractomorpha sinensis*.

Identification of Hg and CN Degrading Bacteria in Sekotong People's Mining

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Abstract. The people's gold mining in West Lombok district, especially in the Sekotong sub-district, reached 1497 glondong units and 570 (38%) was disposed into the river. If the situation continued, problems would arise in the environment. This study aimed to determine the microorganisms found in gold mining waters. Sampling was carried out by purposive sampling with consideration of the location of gold processing activities in Pelangan village, Sekotong sub-district, West Lombok district. The procedure consisted of sampling, isolation and identification of bacteria. The results of found that based on observational data on macroscopic and biochemical characteristics, the 1st bacterial isolate was identified as Moraxella sp. 64.70%, and the second isolate of bacteria was identified as Pediococcus spp. 81.25% and the 3rd bacterial isolate was identified as Moraxella sp. 92.13%. It concluded that bacteria was found in the gold mining location of Pelangan village, Sekotong sub-district, West Lombok district were Moraxella sp., and Pediococcus spp

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The Effect of Green Planning Design on Pedestrian Comfort on the Pedestrian Path, Jln. Kyai Tapa, Grogol Petamburan, West Jakarta

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Abstract. Urban areas have a variety of activities both indoors and outdoors. Green open space is one of the means to support urban community activities. Green open space is one of the important factors for the urban environment, pedestrian paths are one of the areas that can become green open spaces for urban areas. In addition to being a means of accessibility for the community, pedestrian paths can also be an identity for urban areas. The purpose of this study is to identify how an appropriate and good landscape design will have an effect on users and the surrounding environment and look for factors that can influence utilization of pedestrian paths in order to solve problems that arise so that the use of pedestrian paths can run optimally. The problem encountered at the research location is the lack of precise green arrangement on the pedestrian path, causing the influence of the existing green layout design to be not optimal for pedestrian activities. With the right arrangement of plants, in addition to adding comfort to the user, it will also increase the aesthetic value of an area. In this study, the method used is quantitative method which is used to test certain theories by examining the relationship between variables obtained from survey results and data collection. Green Planning Design, the use of plant species and pedestrian activities are the aspects studied in this study. The success of green open space is strongly influenced by the landscape design applied to the area, both from the spatial arrangement to the arrangement of the supporting elements that will be used on the pedestrian path

. Keywords: *Landscape Design, Comfort, Pedestrians*

Differences in leaf functional traits of *Canarium vulgare* Leenh. in two Ggrowth stages: adult tree vs Seedling

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Abstract. This comparative study aimed to understand the life strategies adopted by the tropical tree species: *Canarium vulgare* Leenh by measuring functional leaf traits in two different developmental stages. This study found that there was a noticeable increase in Leaf Mass per Area (LMA), Leaf Dry Matter Content (LDMC), Leaf Density (LD), Stomatal Density (SD) and Leaf Vein Density (LVD), but not in Leaf Length (LL), Leaf Width (LW), Leaf Slenderness (LS), Leaf Thickness (LT) and Leaf Area (LA). In which the LMA, LDMC, LD, SD and LVD were found higher in the leaf of adult trees compare to seedlings. These changes indicate there was a shifting in the resource allocation to the leaf, in which the adult tree invests more construction costs in the leaf compared to seedlings. This strategy would benefit the adult tree to cope with the environment, for instance, increasing the hydraulic rate and increasing its ability to defend against herbivory as plants develop.

Gene Transfer in Grafting Technique: Increasing ß-Carotene Quality of Cassava

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Abstract. Cassava is a food consumption that has important nutrients such as carbohydrates, protein, fat, and beta carotene. The nutritional content (including beta carotene) in cassava can be increased. Increasing the compound content in plants can be done by grafting techniques. In grafted plants, molecular signal transport occurs which is facilitated by vascular tissue that is connected during wound healing due to the cutting process. The purpose of this literature study was to determine the mechanism of beta carotene gene transfer in grafted cassava. Relevant articles were collected from 1995 to 2021 through searches on sites such as Google Scholar, Elsevier, Springer. It was found that gene transfer can occur through various mechanisms including through the Horizontal Gene Transfer (HGT) system, the intercellular liaison system (plasmodesmata), physiological phenomena (translocation of old cells to meristem cells), and the vascular system (phloem). It is possible that genes can be transferred in the form of chromatin, mRNA, sRNA, or transfer of organelles such as plastids

ANALISIS VARIASI GENETIK TUMBUHAN TERANCAM PUNAH *Hopea bancana* MENGGUNAKAN TEKNIK PCR RAPD

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Abstract. *Hopea bancana* (Resak minyak) adalah salah salah satu pohon yang termasuk ke dalam Famili *Dipterocarpaceae*. Spesies ini merupakan tumbuhan endemik Pulau Mursala, Tapanuli Tengah. *Hopea bancana* dimanfaatkan kayunya dan dimasukkan ke dalam kategori Kritis *(Critically Endangered)* oleh IUCN *Red List*. Ancaman utama terhadap spesies ini adalah hilangnya habitat akibat konversi lahan dan penebangan liar. Oleh karena itu, perlu upaya konservasi untuk melestarikan jenis ini. Informasi variasi genetik jenis endemik sangat diperlukan oleh pemulia tanaman untuk menentukan populasi yang harus dikonservasi. Penelitian ini bertujuan untuk memperoleh metode PCR RAPD yang optimum dari spesimen daun kering *Hopea bancana* dan mengetahui tingkat variasi atau keragaman genetik dari *Hopea bancana* menggunakan penanda molekuler RAPD. Penelitian ini merupakan penelitian deskriptif yang dilaksanakan mulai bulan Mei hingga Juli 2022 di Laboratorium Genetika dan Bioteknologi, Jurusan Biologi, FMIPA, Universitas Negeri Padang. Sampel yang digunakan adalah spesimen daun kering *Hopea bancana* yang merupakan koleksi Pusat Penelitian Konservasi Tumbuhan dan Kebun Raya, BRIN. Proses isolasi DNA menggunakan metode CTAB. Optimasi kondisi PCR RAPD dilakukan dengan menggunakan enzim DNA polymerase dari isolat berbeda yaitu *Thermus aquaticus* dan *Thermococcus kodakaraensis*. Primer RAPD yang digunakan sebanyak 10 buah, yaitu OPA-02, OPA-04, OPB-12, OPC-15, OPE-12, OPE-14, OPE-15, OPJ-20, OPM-09, dan OPN-15. Produk PCR dielektroforesis pada gel agarose 1% dengan tegangan listrik 50 volt selama 2 jam. Analisis skoring pita dan hasil skoring digunakan untuk analisis variasi genetik menggunakan aplikasi PAST 4.08. Hasil penelitian menunjukkan bahwa kondisi PCR yang optimum adalah menggunakan enzim *Thermococcus kodakaraensis* yang terdapat pada KOD FX Neo-Toyobo. Nilai *jaccard's similarity* menunjukkan bahwa 16 spesimen daun kering *Hopea bancana* yang diamati memiliki variasi genetik yang tinggi. Sampel yang memiliki kekerabatan dekat adalah 781A dan 781B.

ANALYSIS OF GENETIC VARIATION OF THREATENED PLANTS *Hopea bancana* (Boerl.) Sloot USING POLYMERASE CHAIN REACTION START TARGETED CODON

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Abstract. *Hopea bancana* is a plant that has a very limited distribution, namely on Mursala Island (North Sumatra). Based on the IUCN, this plant is categorized as Critically Endangered due to illegal logging and overexploitation, so conservation is needed for breeding this species. Data on the genetic variation of *H. bancana* is needed as a conservation strategy in an individual and as a basis for individual development through breeding programs. This study aimed to determine the genetic profile of 16 dried leaf specimens of *H. bancana* using SCoT PCR molecular markers and to analyze the genetic variation of *H. bancana* on Mursala Island. The primer used in this study is S33. DNA band scoring and scoring analysis using the PAST 4.08 application. Analysis of the level of genetic diversity using Jaccard's similarity. The results of this study showed that the genetic profile obtained from 16 samples of dried leaf specimens of *H. bancana* had a polymorphic DNA band pattern. Jaccard's similarity value showed that the sixteen samples of *H. bancana* had high genetic variation values and no genetic similarity. There are several samples that have kinship, namely 668 C, 668 F, 781 B, 820, 822, and 825.

Keywords: Conservation, *Hopea Bancana* (Boerl.) Sloot, Genetic Variation, PCR SCoT

Varietal identification of liberica coffee in Kepulauan Meranti using RAPD marker: a preliminary study

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Abstract.. Identity of plant variety is essential for crop production system. Two liberica coffee varieties, Lim 1 and Lim 2, have been cultivated in Kepulauan Meranti where peat lands area predominantly found. In addition to their adaptability to peat lands, the two varieties also were reported resistant against Hemileia vastatrix, one of main fungal pathogens in coffee plants. Molecular-based techniques, such as Random Amplified Polymorphic DNA (RAPD) marker, are considered as reliable approaches compared to morphological-based method for identifying plant varieties. This study aimed to analyze RAPD profiles to identify Lim coffee varieties. We sampled Lim 1, Lim 2, and local coffee genotype from Kabupaten Bengkalis and extracted genomic DNA from young leaves and carried out PCR (Polymerase Chain Reaction) using three primers (OPA-04, OPE-03, OPE-18). Results of electrophoresis showed that all three primers produced polymorphic bands. RAPD profiles generated by OPE-03 and OPE-18 could dishtinguish the three different coffee varieties or genotype. In addition, two bands (1,500 and 2,500 bp) amplified by PCR with OPA-04 were specifically observed in Bengkalis coffee, while 650 bp band revealed by PCR with OPE-03 was only present in Lim 1. Based on our result, we suggest that RAPD marker is suitable for identifying liberica coffee varieties and can be used for further investigation to develop liberica varietal specific markers.

Keanekaragaman Ikan di Sungai Sipisang Nagari Nan Tujuah Kecamatan Palupuh Kabupaten Agam

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Abstract. Pisces (Fish) has a very important role. For humans, fish is a source of food that has a high protein content and many types of fish are used as a food source. For ecosystems, fish are the balance of the food chain in the waters. The purpose of this study was to determine the diversity of fish species in the Sipisang River, and their role in human life as a food source. This research was conducted on the Sipisang River, in Jorong Sipisang, Nagari Nan Tujuah, Palupuh District, Agam Regency, West Sumatra. Observations were made by survey sampling method, and using improvised tools such as mineral drinking bottles, fishing rods and tangguk. From the observation of the survey sampling method, it was found that there are six different species of fish in the Sipisang River. With three Orders and four Families.

Keywords: Diversity of Pisces (fish), Sipisang River

Genus *Batocera* Dejean, 1835 (coleoptera: Cerambycidae: Lamiinae: Batocini): species distribution checklist in Indonesia

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Abstract. Genus *Batocera* of sub-family Lamiinae described from the examined beetle collection in Daugavpils University Beetles Collection (DUBC - Ilgas, Daugavpils District, Latvia) gathered from different areas in Indonesia. This paper provides checklist describing and illustrating different species of *Batocera*.

Nutritional control of pepper growth with a Hydroponic system using the Singh's Fuzzy time series method

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Abstract. Research into Hydroponic technology is currently very interesting, especially with the increasingly narrow land area that can be utilized in agriculture. Hydroponic technology helps in the development of cultivated plants with limited land, even with limited sunlight. In this study, the authors conducted research on controlling the growth of bell pepper plants with Hydroponic technology. In controlling the growth of bell pepper plants, the author keeps records in monitoring and following up as needed so that the bell pepper plants can grow normally. In this research, the author used 5 units of bell pepper plants in a laboratory scale. The data recorded is the collection of water Ph data, nutrient levels based on PPM (Parts Per Millions). Data was taken for 29 days after 60 days of plant seedling period. After the supervision data is obtained, then analysis is carried out using the Fuzzy Time Series Singh Method, which is used to determine the pattern and forecasting of nutrition for bell pepper plants from time to time. The accuracy of forecasting in the provision of nutrients in this study the author sees from the resulting RMSE results of 22.573, and for MAPE 5.183%, with this data it can be concluded that the forecasting method is in a good category.

Functional and species diversity of butterflies in relationship to vegetation structure of Kiarapayung Biodiversity Park, West Java, Indonesia

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Abstract. Anthropogenic disturbances due to increasing industrialization, human population and urbanization are reducing biodiversity worldwide. Over the past decades, Indonesia has invested significant effort in reforestation to compensate for the loss of forest resources such as through Biodiversity Park (Taman KEHATI) in the urban areas. However, the specific impact of revegetation on ecological communities are poorly understood. To address this knowledge gap, we investigated butterflies (Lepidoptera: Papilionoidea) communities in the Kiarapayung Biodiversity Park, quantifying both functional and species diversity. We surveyed 4 transects along the park and found 41 species from 5 families of butterflies. Transect 3 has the most diverse butterfly community according to the Shannon-Wiener (3.12) and Simpson index (0.95). Meanwhile functional diversity richness and evenness also revealed that transect 3 has higher values than other transects. These results confirm with the fact that transect 3 has the most successful revegetation area along the Kiara Payung Biodiversity Park.

DNA barcoding reveals the identity of remains from the bird strike incident

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Abstract. A bird strike refers to a collision between birds and a plane. This incident risks the flight because it could damage the aircraft engine and threaten airlines' safety. The airports have been implementing safety measures to prevent and minimise the risk of bird strikes, such as monitoring wildlife and habitat management. While monitoring birds will provide baseline data to estimate the level of risk for each species, it is vital to have data on birds directly involved in bird strikes; hence, the airport can determine more precisely which species have the most significant potential to cause bird strikes. Therefore, identifying the remains of birds from the aeroplane is essential in bird strike management. In this study, we applied DNA barcoding using the cytochrome oxidase I barcode gene to identify the birds' remains. Samples consisting of three feathers and tissues collected from the plane were analysed. The cytochrome oxidase I sequence analysis showed that all six samples were identified as *Haliaeetus leucogaster* (White-bellied sea eagle). We also identified the feathers by comparing them with reference specimens, which showed that they came from wing feathers of *H. leucogaster*. We concluded that DNA barcoding could be used to identify the species of bird involved in bird strike incidents.

Using multicriteria analysis for community empowerment planning in a conservation area: a case study of the Manupeu Tanah Daru and Laiwangi Wanggameti (Matalawa) National Park, Indonesia

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Abstract. The interaction of local communities with the forest area of Matalawa National Park (TN Matalawa) has risen to several problems, such as forest fires, illegal grazing, forest encroachment, and land claims which cause the decrease in the forest area. The community empowerment program is one of the solutions to reduce community dependence on protected forests. This study aimed to develop a community empowerment plan around TN Matalawa. We collected data in 15 sample villages, determined using GIS analysis. We identified the potentials, problems, and empowerment program plans at the village level and then clustered the empowerment activities based on the regulation. This research used multicriteria analysis to determine the priorities of community empowerment activities through matrices and maps. Results predict that during 2022-2026, TN Matalawa will carry out 220 community empowerment activities across 54 villages. The empowerment activities carried out were: providing access - 29 activities (13% of the total number of activities), water utilization - 10 activities (5%), ecotourism development - 25 activities (11%), and development of productive economic businesses - 156 activities (71%). These results can be used as a reference for empowerment activities for the achievement of community welfare and the sustainability of the TN Matalawa.

Potential crude methanol extract, its fractions and isolated compounds of lichen *Teloschistes flavicans* (Sw) Norman Growing in Bengkulu as an antibacterial against *Staphylococcus epidermidis*

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Abstract. *Teloschistes flavicans* (Sw) Norman was a unique plant that has various activities such as antioxidant, anticancer, antibacterial, and fungicidal activities. In this study, we investigated the antibacterial activity of crude methanol extract, its fractions (n-hexane, ethyl acetate, methanol-H2O), and isolated compounds of *T. flavicans* against *Staphylococcus epidermidis*. Agar well diffusion method with 5 concentrations tested of 5, 10, 15, 20, and 25% crude methanol and its fractions, and isolated compounds at a concentration of 0,2% has been carried out. Clindamycin was used as a positive control, while the negative was DMSO. The results showed that the ethyl acetate fraction was found the largest diameter of the inhibition zone (21.52 ± 0.01 mm) among all fractions and crude methanol extract at a concentration of 25%. The secondary metabolite contents of *T. flavicans* might be responsible for this activity and appear to have a synergistic effect. Furthermore, Parietin and Vicanicin were isolated from the ethyl acetate fraction by guided bioassay and demonstrated antibacterial activity against *S. epidermidis*.

Effect of Honey Extender for Spermatozoa Dilution on Fertility and hatchability of Javaean Barb Fish (*Systomus orphoides*)

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Abstract. Javaen barb fish (*Systomus orphoides*) population was declined due to overfishing and environmental changes. Cultivation efforts have been made, but the high sperm concentration causes a decrease in fertility. Honey extender is used to dilute sperm, maintain buffer balance, and provide nutrition for sperm. The purpose of this study was to obtain the optimum concentration of honey extender on the fertility and hatchability rate of javaen barb fish (S. orphoides) sperm. The honey concentrations used were 0%, 0.2%, 0.4%, 0.6%, 0.8%, and 1%. The ratio between sperm and the mixture of extenders (fish Ringer and honey) used was 1:10. Sperm and egg collection was done by stripping. Evaluation was carried out by observing of fertility and hatchability rate. Analysis of data using one-way ANOVA followed by Tukey's test. Based on the results of the ANOVA test and Tukey's test, it was seen that there was a significant difference ($P<0.05$) on the fertility and hatchability rate. The significant difference was found in hatchability rate, but not difference on fertility. Honey concentration 0.8% was the optimum concentration that produced the highest percentage hatchability ($96,33 \pm 6.27\%$) after dilution with honey extender.

Biofertilizers effect on growth and proline level of *Amaranthus tricolor* L. under salinity stress

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Abstract: Amaranth (*Amaranthus tricolor* L.) plays an important role in supporting human health treatment. Salinity stress is a major problem for agricultural land in the world. The application of biofertilizers can increase the availability of nutrients and support plant growth under stress conditions. This research was to analyse the effect of biofertilizer on growth and proline level of *A. tricolor* L. under salinity stress and to determine the optimum dose of biofertilizer needed for optimum growth of *A. tricolor* L. under salinity stress. The biofertilizer dose used was 10 l/ha, 20 l/ha, and 30 l/ha, each combined with NaCl; 2.500, 5.000, 7.500, and 10.000 ppm. The parameters measured were root length, fresh and dry weight, and proline level. Salinity treatment reduced root length, fresh weight, and dry weight also increased proline level of *A. tricolor* L. Application of 20 l/ha of biofertilizer increased root length, fresh weight, and dry weight while application of 30 l/ha of biofertilizer decreased proline level. It was conducted that biofertilizer can be used to improving and supporting plant growth of *A. tricolor* L. under salinity stress.

Natural compounds, pharmacological activities, and conservation of *Eria* (Orchidaceae)

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Abstract. *Eria* is one of the most important medicinal orchid genera. The present study aimed to summarise natural compounds, pharmacological activities, and conservation of *Eria* to reveal the potential of the genus as bioresources for natural product-based medicines and to highlight the importance of conservation of the genus in its development for bioresources for medicines. *Eria* contains 39 natural compounds from different classess of secondary metabolites including alkaloids (2), terpenoids (2), phenolic compounds (1), flavonoids (4), flavanone (2), bibenzyls (3), and phenanthrenes (8), tannins (2), sterols (3) steroids (1), coumarins (1), quinones (2), and others (8). Furthermore, *Eria* possesses various pharmacological activities including antioxidant, antinociceptive, antipyretic, antiinflammatory, and antibacterial activities. A vast array of bioactive compounds and pharmacological activities of *Eria* indicates that the genus has potential as bioresources of natural products to be developed as medicines. *Erianin*, a natural compound initially isolated from *Eria carinata* and further has been found in other orchid species, has been found to possess anticancer properties. In the development of *Eria* as bioresources for natural products for medicinal purposes, orchid conservation approach is required to ensure the long-term survival of the orchids and for the sustainable use of the orchids.

Innovative herbal toothpaste combination of calcium carbonate (CaCO3) form sea urchin shell (*Diadema setosum*) and activated charcoal from coconut shell as antiplaque for smokers.

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Abstract. Smoking can cause tooth decay due to plaque formation. Plaque can cause toothache if not treated immediately. Toothpaste on the market often causes side effects such as tooth irritation and allergic reactions. Herbal toothpaste from a mixture of activated charcoal from coconut shells and calcium carbonate from sea urchins was chosen as a product that has the potential to overcome this problem. The aim of this study was to identify a toothpaste formula with a certain concentration of CaCO3 and activated charcoal that had the best effectiveness as an anti-plaque. Toothpaste is made in 4 formulas with different concentrations of coconut shell activated charcoal and sea urchin CaCO3 in formula 1 (6:40), formula 2 (8:35), formula 3 (10:30) and formula 4 (12:25). Data were analyzed descriptively and using one way ANOVA statistical test. This study used 28 dentures then immersed in an artificial saliva solution and simulated tooth coloration and dental plaque formation. The results of the observations showed that the evaluation of physical properties had good results including organoleptic, homogeneity, pH and viscosity tests. Statistical tests showed that coconut shell activated charcoal toothpaste and sea urchin calcium carbonate had significant differences in activity as natural ingredients in overcoming plaque.

Keyword : activated carbon, calcium carbonate, coconut shell, toothpaste, sea urchin shell

New Report from Sebelas Maret Avifauna to Support Green Campus Program

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Abstract. The last report on bird identification on the UNS was in 2015 with the results of 50 bird species, while the development and reforestation processes proceeded rapidly after that. Avifauna is a collection of birds that inhabit a certain location, the wealth and abundance of which is the basis for further studies. Birds are one of the animals that are closely related to human life and the process of changing habitats. Birds can be used as indicators of the condition of an environment. In addition, as an ecological function, birds can be seed dispersal agents and natural pollinators. Birds are also used by humans as pets and food, and play a role in various cultures of society. This study aims to identify birds based on dominant species, cosmopolite, endemic, and then make a comparison with the results of previous studies to see the shift in species that inhabit the UNS. Collecting data using Line transect and point count methods for identification, followed by qualitative. The results showed that 55 species were found, with the dynamics of adding new bird species and disappearing birds from old data. Birds are identified in various statuses with habitat adjustments that are currently developing.

Keywords: Avifauna, UNS, new report, dynamics

Diversity of stingless bees (Apidae: Meliponini) at vegetated habitats in Aul Tungganai Meliponiculture, Lubuk Minturun, Padang, West Sumatra

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Abstract. The diversity of stingless bees (Apidae: Meliponini) in Lubuk Minturun, Koto Tangah, Padang, West Sumatra had been investigated from November to December 2021. This study aimed to determine species and diversity of stingless bees among three vegetated habitats within the Aul Tungganai Meliponiculture. The fieldwork was located at anthropogenic area, forest edge, and forested area; each represented by three sites. The stingless bees were sampled using insect net and bait trap. A total of six stingless bee species from four genera were recorded. *Lepidotrigona* and *Tetragonula* were with two species collected, while *Geniotrigona* and *Heterotrigona* were only represented by a single species. The diversity of stingless bee was assessed as low (H' = 1.07), while the studied habitats were moderately similar in term of species diversity (E = 0.66) which also indicated the instability of stingless bee communities among habitats.

Keywords: diversity, Lubuk Minturun, Meliponini, stingless bee, vegetated habitat

Utilization of Birds (Aves) in Traditional Medicine at West Sumatra

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Abstract. Ethnobiological utilization of birds includes the representation of birds in art, usage patterns, language, messengers, and interactions in everyday life. The use of birds (Aves) in traditional medicine in West Sumatra had been investigated in January 2022. It aimed to identify bird species and utilization procedure of birds as traditional remedy West Sumatra, which in this study represented with Padang, Bukittinggi, Pesisir Selatan, Payakumbuh and Sijunjung. The information regarding this matter was explored through scrutinizing the local wisdom applied by people in those localities in West Sumatra. This study used survey method through interview and questionnaire. Five bird species were recorded used as part of tradition remedy in West Sumatra i.e., *Centropus* spp (Cuculidae), *Collocalia* spp. (Apodidae), an unidentified eagle (Acciptridae), *Buceros rhinoceros* (Bucerotidae), and *Capsychus saularis* (Muscicapidae). Feathers, overall body, beak, feet, and saliva from these bird species were specifically used as ingredients in the remedy, either by cooking it with spices or just in raw condition. The processing method of tradition medicine that use birds (or bird parts) was passed down from generation to generation.

Keywords: interviews, surveys, traditional medicine, utilization, West Sumatra

Fish Monitoring in Singkarak Lake, West Sumatra using the eDNA method with the next generation sequencing (NGS) technique

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Abstract. The largest lake in West Sumatra is Singkarak lake which has experienced a decline in species. Hydroelectric Power Plant, fish traps that are not environmentally friendly, degradation, and invasive species become the main factors. Fish monitoring with non-invasive methods is needed to detect species. A study using the eDNA method with the NGS technique was conducted to detect fish in Singkarak Lake. Water samples were taken as much as one L with two replications. Amplification of eDNA with universal primers. The results identified 12 species from 8 genera, 6 families, and 5 orders. These species have been previously reported in Singkarak lake. Besides, also detected species that are present in other lakes and rivers in West Sumatra (15 species), species in other Islands in Indonesia (30 species), and species in other countries, which have not been reported in Indonesia (50 species). Some native species; rinuak, jabuih, sasau, and gariang, were not detected suggest due to not being captured DNA in water samples, low DNA concentration, or no available sequences in the NCBI database. The submitted sequences to NCBI and used the specific primer recommended detecting the species that were difficult to find directly.

Growth and flowering of asian pigeonwing (*Clitorea ternatea* L.) treated with salicylic acid

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Abstract. Asian Pigeonwing (*Clitorea ternatea* L.) has been cultivated in many countries. The flower of this species contains anthocyanins that is important as a source of antioxidant. The content of antioxidant and other secondary metabolites can be manipulated by hormonal treatments. Salicylic acid (SA) is known to be able to alter growth and induced flowering in several plant species. This experiment was aimed to evaluate the effects of salicylic acid on growth, flowering and the anthocyanins content. Seeds were germinated and seedling of 2 weeks' old were replanted in a polybag containing growth medium, one seedling per polybag and then placed in an open field. Salicylic acid of 0 ppm (control), 25 ppm, 50 ppm or 100 ppm were applied at 6 weeks after planting. Eight replicates were prepared for each treatment. The results showed that SA application of 75 ppm increased plant height, number of compound leaf, chlorophyll content and anthocyanin content, whereas plants treated with SA of 100 ppm produced more flowers and siliques. SA application tends to decrease stomatal density but the leaf area and time to flowering were not affected by SA treatment. It was concluded that SA application of 75 ppm is appropriate to increase growth, flower number and anthocyanin content in Asian pigeonwing.

Keywords: asian pigeonwing, salicylic acid, anthocyanin

Combination of Mung Bean and Ginger Extracts as Functional Foods for Treatment of Type-2 Diabetes Mellitus

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Abstract. Mung bean is a nutrient-rich food and low glycemic index, that is generally consumed as a drink combined with various flavours. This study aims to examine the effectiveness of mung beans that was combined of ginger extract as a source of anti-inflammatory agent and improve of flavour too. This experimental study used of rats (*Rattus norvegicus*) model of type-2 diabetes mellitus (T2DM). The model animals were grouped into 3 groups, i.e. normal control, treatment with mung bean and ginger extracts, and positive control using commercial drinks for the T2DM diet. The results showed that the combination of mung bean and ginger extract drink was able to slow down spikes in blood glucose levels, the same as commercial drink of T2DM-diet.

Keywords: mung bean, ginger, functional food, Type-2 Diabetes Mellitus

Effect of Gamal Leaf Extract (*Gliricidia sepium*) in Artificial Feed on Growth Rate and Feed Conversion Ratio of Bileh Fish (*Rasbora* sp.)

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Abstract. This study aims to determine the effect of adding gamal leaf extract in artificial feeds on the growth rate and feed conversion ratio of Bileh (*Rasbora* sp). The research method is experimental and uses a completely randomized design (CRD), consisting of 4 treatments (P) with 3 replications. The treatment given was the addition of gamal leaf extract with different doses in artificial feed, namely: 0 ml/kg (control/P1), 10 ml/kg (P2), 20 ml/kg (P3) and 30 ml/kg feed (P4). The research phase includes preparation of containers, experimental feed, fish rearing, and data collection. Parameters taken and evaluated include: specific growth rate (SGR), absolute length growth (ALG), feed conversion ratio (FCR), survival (SR) and water quality parameters. The data were processed and analyzed with statistics (Anova). The results of statistical analysis showed that the addition of gamal leaf extract in artificial feed had a significant effect on SGR, ALG, and FCR ($P<0.05$), but had no significant effect on survival ($P>0.05$).

Keywords: Gamal leaves, feed, growth, bileh fish

Seagrass Distribution in the Waters of Kemujan Island, Karimunjawa Archipelago National Park Center

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Abstract. Seagrass is a plant can be distinguished between stems, leaves, also roots. Seagrass ecosystems can support the life of various types of living things because of their ecological functions, but are vulnerable to threats of damage both due to human and natural factors. This research aims to determine the types of seagrass found, the area of the seagrass beds, value of the cover percent, value of the ecological index, and environmental factors on Kemujan Island, Karimunjawa Islands. The research was conducted in September 2021 at Mrican Beach, Batulawang Beach, and Laendra Beach, Kemujan Island, Karimunjawa Islands. The seagrass monitoring guidebook published by LIPI in 2017 was used as a reference for the seagrass data collection method. The results showed that in the waters of Kemujan Island, Karimunjawa Archipelago, three species of seagrass were found, namely E. acoroides, T. hemprichii, and C. Rotundata with the dominant marine sediments being muddy sand and gravel sand. Species of T. hemprichii were found in all observation stations. The waters of Kemujan Island are included in the poor category because it has a seagrass cover value of 27.24%. The Seagrass area of beds in the waters of Kemujan Island is estimated at 303,099.90 m^2.

PARALLEL SESSION BIOLOGY EDUCATION

Analysis of Critical Thinking Skills for XII Class Students on Biotechnology Materials

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Abstract. Critical thinking skills can be developed through the learning process. Biotechnology material requires students' critical thinking skills in the learning process. SMAN 1 Payakumbuh has done critical thinking skills in the learning process but it is still not optimal, and data on critical thinking skills are still unknown. This study aims to analyze the level of Critical Thinking Skills of Class XII Students of SMAN 1 Payakumbuh about Biotechnology Materials. This type of research is descriptive research with simple random sampling technique. The instrument used in this study was a test of students' critical thinking skills, and a validity test questionnaire. The data analysis technique used is quantitative descriptive analysis and qualitative descriptive analysis. Based on the results of the research that has been carried out, the data obtained that the results of the critical thinking skills of class XII students of SMAN 1 Payakumbuh were analyzed per indicator. The conclusion of this study is the level of critical thinking skills of each indicator of class XII students of SMAN 1 Payakumbuh at low qualification qualifications with an average of 50.59%.

Analysis of digital book integrated local culture as the internalization of character education during pandemic

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Abstract. Digital books are one of the learning media that provide innovation in distance learning during the pandemic because they can be accessed easily. The digital book experience that is equipped with pictures, audio and video makes learning more interesting. Based on the results of the study it is known that the integration of local culture in digital books can realize the noble character of students in harmony with national education. This research was conducted using a literature review method by analyzing a number of articles and books relevant to this topic. This research is important to do to strengthen the national identity through characters that are sourced from local wisdom through digital books. The teacher's role is very much needed in the development of digital books that are integrated into local culture so that learning during the pandemic becomes more interesting and student attitude competence can be achieved.

HOTS-Based Student Worksheets: Preservice Biology Teachers' View Regarding Early Conditions of Curriculum and Learning Design Lectures

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Abstract. The aim of this research was to describe the views of prospective biology teachers on the initial conditions of curriculum and learning design lectures in the context of developing HOTS-based student worksheets in curriculum and learning design courses. This research is the early stage of research and development (R&D) using a 4D model, namely at the definition stage. The instrument used to collect data in this study is a questionnaire given to preservice biology teacher students who take curriculum and learning design courses in the January-June 2022 semester. The results of this study are 1) Learning resources in curriculum and learning design courses are still limited to handouts given by lecturers, PPT, literature from the internet and regulations from the Ministry of Education and Culture related to curriculum and learning design, 2) Structured assignments given by lecturers every week are in accordance with the Module Handbook and discussed during lectures, but not in accordance with students' thinking skills, 3) The lecture material provided is in accordance with the Module Handbook, useful for students, easy to understand and presented from simple to complex concepts but still abstract, 4) Implementation of blended learning for curriculum and learning design lectures provided the teaching materials in e-learning benefits for students, learning methods are relevant to the structure of the lecture but need variations, 5) The peer assessment and portfolio in curriculum and learning design lectures are beneficial for students, 6) Biology teacher candidates need student worksheets that contain introductory material and examples of doing assignments such as calculating effective and ineffective weeks in making annual programs. The conclusion of this study is the importance of developing HOTS-based student worksheets in curriculum and learning design courses.

Marine environmental care attitude through integrated science learning of junior high school students in Tanjungpinang

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Abstract. Indonesia, which is the largest maritime country in the world, has many marine environmental issues. One of the factors causing marine environmental issues is human activity. This indicates a lack of marine environmental care attitude of humans. The Riau islands is a province in Indonesia whose sea area is much wider than its land area. Students in the Riau Islands must have marine environtmental care attitude to make Indonesia's marine environment better in the future. Internalizing marine environmental care attitude can be implemented through integrated science learning whose the study field is about the environment. This study aimed to find out how the role of integrated science learning in internalizing marine environmental care attitude in junior high school students in Tanjungpinang City. This research was quantitative descriptive. Data were collected using a questionnaire with statements developed through 4 main indicators. The indicators were students' knowledge of the sea, students' attitudes in preserving the marine environment, students' attitudes in preventing damage to the marine environment, and students' attitudes in repairing damage to the marine environment. Students' marine environmental care attitude could be seen from the students' respons to the statements developed from indicators.

Validity of STEMS-Based Project Learning Model to Enhance Creativity in the 21st Century

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Abstract. It is the teacher's responsibility in paying serious attention to highlighting the 21st century way of learning in transforming the education system, focusing on equipping students with creativity. This 21st century learning requires suitable learning model to achieve the learning objectives. STEMS-based project learning model is one of the new strategies, which can raise students' creativity. This study develops STEMS-based project learning model by adding social element to the STEM learning approach so that it becomes science, technology, engineering, mathematics, and social (STEMS). This study aimed to develop a valid STEMS-based project learning model to enhance students' creativity in the biology learning. This study uses Plomp development research design. Instrument used were questionnaires and data were analyzed descriptively based on the score sheet of validation. A pedagogy expert, biology education expert, instructional technology expert, and language expert validated the model. The result of validity showed that STEMS-based project learning model was valid criteria. Hence, the findings of this study are expected to encourage teachers to integrate STEMS-based project learning model in learning biology to enhance the students' creativity. This is in line with the needs of the current pedagogy that further stimulates the atmosphere of active learning in the classroom leading towards the revolution industry 4.0 and the 21st century learning.cant effect on SGR, ALG, and FCR (P<0.05), but had no significant effect on survival (P>0.05).

Implementation of Problem-Based Learning Model (PBL) Based on Lesson Study on Student's Critical Thinking Skills in Animal and Human Physiology Courses

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Abstract. This study aims to describe the improvement of students' critical thinking skills as a result of implementing a problem-based learning model based on lesson study in Animal and Human Physiology courses. The subjects in this study were students of Biology, State University of Malang, amounting to 33 students. This type of research is Classroom Action Research. This study uses a descriptive qualitative approach based on lesson study in the form of plan, do, and see stages. The research model used is Kemmis and Mc. Taggart, consists of planning, action, observation and reflection activities with two cycles. Data was collected using instruments in the form of an observation sheet for the implementation of learning syntax, an observation sheet for the implementation of lesson study, and an assessment sheet for critical thinking skills. The data collected in this study include: critical thinking skills as measured by post-test and student worksheets, as well as the success of the implementation of syntax and lesson study obtained from observation sheets of action implementation and lesson study. The conclusion of this study is that the application of the problem-based learning model lesson study can improve students' critical thinking skills in animal and human physiology courses.

Current Trend of Blended Learning Research in Biology Education: A Review of Literature From 2015 to 2022

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Abstract. The problems of face-to-face meetings in Biology classrooms are the lack of flexibility and materials that cannot be accessed anytime and anywhere. Therefore, it needs to be combined with online learning or called blended learning. The purpose of this review is to describe the implementation of online and blended learning in the context of Biology education in research published from 2015 to 2021. The method used is a literature study of 15 articles by searching databases such as ERIC, Google Scholar, Scopus, and Emerald. The results of the analysis are then synthesized into several themes. Research themes regarding blended learning of Biology education in the last 5 years can be categorized into 4 themes including the effectiveness of BL (60%), challenges of implementing BL (60%), strategies to implement BL (60%), and perceptions towards BL (53%). Most of the article state that blended learning is effectively applied, but it also has challenges or obstacles. The strategies used in the implementation of blended learning are the use of quizzes, reflection, the use of interesting videos and pictures in the LMS, increasing student interest in online learning, and implementing feedback from the teacher to the student's work. Teachers and students have both positive and negative perceptions of various aspects of blended learning. The recommendation is that there is a need for further research on blended learning in various contexts, for example in developing countries because most of the research has been carried out in developed countries.

Development e-module based on android using adobe flash professional CS6 on materials of animal circulation systems for students in class XI mipa of SMAN 3 Padang

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Abstract. Technology that continues to develop in the era of globalization makes learning models change. Learning that was originally equipped with printed learning materials, for now, adapts to 21st century learning, namely the system e-learning, materials have also been transformed into electronic formats. The learning material can be found on student smartphones, so that with this learning material students can learn anytime and anywhere. Another concrete thing with the electronic learning material is that it can overcome the dependency and maximize the role of the smartphone for students as users. Electronic learning materials that are focused on in this study are e-module combined with the system android. The purpose of this development research is to produce an e-module based on android using Adobe Flash Professional CS6 on Animal Circulation Systems for valid, practical, and effective class XI MIPA students. This type of research is development research. The object of the research consisted of biology teachers and students of class XI MIPA at SMAN 3 Padang. The method used in this research development is to use the Plomp model. Based on the development that has been done, the results of this study are the production of e-module based on android on the Animal Circulation System which has very valid validity based on validator assessment, practicality is very practical based on the assessment of teachers and students of class XI MIPA at SMAN 3 Padang, and very effective through assessing learning activities and student learning outcomes in the cognitive, affective, and psychomotor domains.

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Development of problem based learning (PBL) biology modules to improve learning competence and students' critical thinking skills class VIII junior high school (SMPN 1) Patamuan

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Abstract. Abstract.This study aims to produce a valid, practical and effective excretory system biology module to improve students' competence and critical thinking skills. The type of research carried out is development research (R&D) with the Plomp design which consists of 3 stages, namely preliminary research, prototyping and assessment phase. The module validation uses an instrument in the form of a questionnaire. The results of the validation of the PBL-based module are categorized as very valid. The next stage will be the practicality and effectiveness assessment. The results of the practicality assessment by teachers and students showed that the module was very practical to use. The effectiveness of problem-based learning modules using test instruments and observation sheets. The results showed that the module effectively improve the competence and critical thinking skills of students which can be seen from the significant difference in learning outcomes of competence and critical thinking skills between students in the experimental class with the control class. Based on the results of data analysis, the PBL-based module on the developed excretion system material can be declared valid, practical and effective.

The influence of contextual teaching and learning (ctl) learning models and different initial abilities on students' critical thinking skills in science subjects class vii mtsn 2 kerinci

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Abstract. Observation results show that students' critical thinking skills are low. The causes are low learning activities, lack of teacher innovation in the learning process, teachers do not pay attention to initial abilities and learning is still conventional. Efforts that can be made are the contextual teaching and learning (CTL) learning model. The purpose of this study was to see the effect of the CTL model and initial ability on students' critical thinking skills. This type of research is a quasi-experimental. The population is class VII MTsN 2 Kerinci. Samples were taken by purposive sampling. Data analysis on hypothesis testing using two-way ANOVA. The results obtained are the average value of critical thinking skills in the experimental class is higher than the control class. The value of critical thinking ability of students with high initial ability in the experimental class is higher than the value of students with high initial ability in the control class. The value of critical thinking skills of students with low initial ability in the experimental class is higher than the control class with low initial ability. There is no interaction between the CTL learning model and students' initial ability to influence students' critical thinking skills.

Interactive multimedia development using adobe flash cs6 to improve critical and creative thinking skills of class VIII junior high school students.

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Abstract. Education has a huge impact on the existence of the 21st century. Improving the quality of human resources through education, from primary and secondary education to higher education is the key to being able to follow the development of the Industrial Revolution 4.0. This 21st century learning applies creativity, critical thinking, cooperation, problem solving, communication skills, community skills and character. The education system needs a new movement to apply skills in the era of the industrial revolution 4.0. One of the movements designed by the government is the new literacy movement in the form of digital literacy and technology. Interactive multimedia is a new literacy movement based on digital and technology in learning that can improve students' critical and creative thinking skills. The purpose of this research is to produce interactive multimedia for the respiratory system and excretory system material in humans that can improve critical and creative thinking skills of VIII grade students of junior high school.

Citizen science project to improve creative thinking skills of high schools students on environmental change subject

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Abstract. The citizen science project is an activity of collecting data or information by students in groups to solve problems around them by providing solutions to the problems. Along with the times, to create solutions must be creative because the problems encountered have a high level of complexity. Therefore, this study applies a citizen science project in high school biology learning to improve students' creative thinking skills in solving a problem around them, such as environmental changes. The research method was pre-experimental with a single-group-pretest-posttest design and the research subjects were 26 students in grade 10. The instruments used were the student creative thinking skills test, students' response questionnaire, and students' response interview guidelines. The average value of students' creative thinking skills before using the citizen science project was 57.31 in the poor category, while the average value of creative thinking skills after that was 71.51 in the good category. The result of the N-Gain value is 0.32 with moderate criteria. This shows an increase in creative thinking skills by using citizen science projects. Based on the results of the questionnaire analysis and interviews, were overall the students get various benefits from this learning that can help them think more creatively.

Development of Android-Based Interactive Learning Media on Invertebrate Materials for Class X SMA

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Abstract. Learning media is a tool that can convey information effectively and efficiently to students during the learning process. The purpose of this research is to produce an android-based interactive learning media on invertebrate material for class X SMA that is valid and practical. This research is a research and development research using 4D models, which consists of four stages, namely define, design, develop, and disseminate. In practice, the disseminate stage was not carried out due to time and cost constraints. The research subjects consisted of two UNP biology lecturers, one biology teacher at SMAN 1 Lembang Jaya, and 45 X MIPA students at SMAN 1 Lembang Jaya. This research data is primary data, with research instruments in the form of validity and practicality test sheets. Data analysis techniques in this study are qualitative and quantitative. From the results of the product validity test, obtained a validity value of 93.5% (very valid). The results of the product practicality test by teachers are 91.2% (very practical) and by students 97% (very practical), with an average practicality of teachers and students of 94.1% (very practical). So it can be concluded that the resulting product is very valid and very practical.

Development of an Offline Virtual Laboratory for Biology Learning Genetic Materials for SMA/MA

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Abstract. In education era 4.0 ,teachers are needed in skills designing various learning tools and technology facilities to achieve learning objectives. One of the learning who need technology is biology because science subjects that has difficult and abstract concepts. Then, one of the biological materials that is very important to do is genetic material, because the material is related to life and phenomena that occur in people's lives, for example skin color, hair color and others. Genetic practicum activitie need to be carried out to provide students with experience and knowledge. Virtual laboratory media is one of the learning media that can be used by teachers to replace practicum activities in the laboratory. The research objective is to produce a virtual laboratory. This type of research is development research using the Plomp model. The Plomp model development phase consists of a primary research phase, a development or prototyping phase, and an assessment phase. The subjects of this study were students of class XI MIPA at SMA Negeri 7 Jambi in the 2021/2022 academic year. The instruments used are validity assessment sheets, practicality assessment sheets and essay questions to assess their effectiveness. Hypothesis testing was carried out with the Independent sample T-Test using SPSS 17. The results showed that the Virtual Laboratory Media obtained very valid criteria according to validation experts with a value of 89.21%. Practical criteria for practical teacher responses with a score of 77.15% test results and practical student response criteria with scores in small groups obtained an average of 77.78%. The results of the effectiveness test showed that based on the T-Test and U-Test scores, the aspects of attitudes, knowledge and skills of students scored high in the experimental class compared to the control class. The results of the Independent Sample t-test show the value of tcount > ttable. Based on the effectiveness test conducted, it is known that the use of an offline virtual laboratory for learning the developed biology material is valid, practical and effective.

Development of video learning model Problem Based Learning

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Abstract. Based on observation data in the Biology Learning course, it was found that basic teaching skills and student motivation to learn were still low. For this reason, students need learning media that can improve teaching skills and learning motivation. This study aims to produce a video model of problem based learning that is valid, practical, and effective. This type of research is development research with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The instruments used were validity questionnaires filled out by lecturers, lecturer practicality questionnaires and student practicality questionnaires, student learning motivation questionnaire sheets, and student teaching skills assessment observation sheets. The data analysis technique used is the assessment of validity, practicality and effectiveness (teaching skills and learning motivation). After doing the research, the results of the validation carried out by material, media and learning experts showed very valid criteria, then the results of the practicality assessment by lecturers and students were very practical. The results of the effectiveness test using N-Gain students' teaching skills have increased and students' learning motivation has increased. It can be concluded that the Video Problem Based Learning model developed is valid, practical and effective.

Validity of The Integrated Booklet of Local Potential of the Kawasan Mandeh Pesisir Selatan Regency in the Material Animalia Class X SMA

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Abstract. Biology learning is learning that can not only be learned textually, but can also be carried out contextually. Learning biology contextually can motivate learners to be more active and learning can be more meaningful, because contextual learning comes from these learners. Pesisir Selatan is one of the regencies in West Sumatra that is rich in natural resources (Natural Resources), one of which is the Kawasan Mandeh. This is a great opportunity to link contextual teaching materials with the living environment, namely the cultivation of local potential in teaching materials. This study aims to produce a valid local potential integrated booklet product consisting of several aspects, namely aspects of content feasibility, language, presentation, graphicness. This research is a type of development research using the ADDIE model. This model consists of five stages, namely: analysis, design, development, implementation and evaluation. Due to time constraints, this study was only carried out validity tests. Data analysis in this study used qualitative and quantitative anlysis, while the Data collection techniques of research data used observation methods, documentation and statistical tenics. Based on the results of the assessment of the validity test of the local potential integration booklet, a value of 86.26% was obtained with valid criteria. So it can be concluded that the Integrated Booklet of Local Potential of the Kawasan Mandeh Pesisir Selatan Regency in the Material Animalia Class X SMA is valid.

Keywords: *Animalia Material, Booklet, Local otential*

Development of *Booklet* with Encyclopaedia Integrated Local Potential Of West Pasaman Regency On Biodiversity Material For Class X SMA

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Abstract. One of the innovations in the learning process is to make local potential a source of teaching materials. The integration of this local potential in learning will show that there is a correlation between the existing local potential and the material studied by students so that it can increase students' understanding and involvement in biology learning. The purpose of this study was to produce a *Booklet* with Encyclopedia Integrated Local Potential of West Pasaman Regency on Biodiversity Materials for Class X SMA. This research is a research and development (R & D) with a 4-D development model (Four-D Models). The data obtained in this study are in the form of validity and reliability data. This research produces a *Booklet* with Encyclopedia Integrated Local Potential of West Pasaman Regency on Biodiversity Materials for Class X SMA with very valid and very good criteria. These criteria are obtained from the validity value of 92.57% meeting the very valid criteria and the readability value by the teacher of 94.64 meeting the very good criteria and the readability value by students of 91.84% meeting the very good criteria.

Keywords: *Booklet,* Encyclopaedia, Local Potential, West Pasaman, Biodiversity

Development development of a digital book based on the integrated randai model of West Sumatra's local potential on animalia material

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Abstract. This study aims to develop a digital book based on the RANDAI model on animalia material for class X SMA / MA. This research is a research and revelopment research using the Plomp development model. The Plomp development model has three main stages, namely preleminary research, prototyping phase and assessment phase. The digital book was validated by 2 lecturers of Padang State University. Practicality test by 1 biology teacher of SMAN 1 Lubuk Basung and 28 students of SMAN 1 Lubuk Basung who have studied Animalia material. The data collection technique uses the Likert scale with validation and practicality criteria adapted from Purwanto. The average validation score obtained was 91.15% with very valid criteria. The average value of practicality by teachers is 94% with criteria. The average value of practicality by learners is 97.5% with very practical criteria. This research resulted in a digital book based on the RANDAI model integrated with sumatran local potential in this animalia material is very valid and very practical to be used as a medium and teaching material in learning

Development of digital books based on the randai model integrated with West Sumatra's local potential on plantae materials

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Abstract. This study aims to produce a product in the form of a digital book based on the RANDAI model integrated with the local potential of West Sumatra on valid and practical plantae material. The development of digital books uses a group development model, which consists of 3 stages, namely the preliminary research stage, the development or prototype development stage (development or prototyping phase) and the final assessment stage (assessment phase). The subjects of this study were 2 biology lecturers, 1 biology teacher and 28 students. The data obtained from this study is in the form of validity and practicality data. This research resulted in a Digital Book Based on the RANDAI Model Integrated with West Sumatra Local Potential on Plantae Material that is valid and practical. The validity value of 91.9% meets the criteria of being very valid and the practicality value by the teacher with a score of 96.02% meets the very practical criteria and the practicality value by students with a value of 97.48% meets the criteria of being very practical.

Urgency analysis of development of integrated biology teaching materials local potential in ecosystem material for class X SMA/MA

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Abstract. This study aims to determine the urgency of developing local potential integrated teaching materials in class X SMA/MA ecosystem materials. Biology as a branch of science examines issues related to living things from the level of organization of life to their interactions with environmental factors. Each region has a specific environment or resource that includes natural, human, technological and cultural resources called local potential. The local potential of each region can be used as a contextual learning resource so that learning becomes more meaningful. This type of research is descriptive qualitative research. The subjects of this study were students of class XI MIPA 1 SMA Pertiwi 1 Padang and biology teachers at SMA Pertiwi 1 Padang. Data was collected by distributing questionnaires to students and biology subject teachers. The data analysis used in this research is descriptive analysis. Based on the results of research that has been carried out, the development of integrated teaching materials for local potential in class X SMA/MA ecosystem materials is very necessary so that learning can be more effective and can improve student learning outcomes.

Development Of Interactive Multimedia Virtual Laboratory Assistant

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Abstract. The 21st century learning summarizes students' thinking skills in four competencies, namely critical thinking skills, creative thinking, collaboration, and good communication. Teaching materials in schools should be able to help students in practicing thinking skills. This study aims to produce interactive multimedia assisted by a virtual laboratory for respiratory and excretory system materials in humans that can improve the critical and creative thinking skills of class XI students that are valid, practical, and effective. This type of research is development research with the Plomp model. The instrument in this study is a questionnaire of validity and practicality as well as a matter of effectiveness. The data analysis technique was validity, practicality using a Likert scale scoring and effectiveness using ANOVA using SPSS 21. The results showed interactive multimedia assisted by a virtual laboratory obtained very valid criteria according to expert review with a value of 81.26%. The practicality of the teacher is very practical with a value of 96.66% and the student response criteria are very practical with a value of 95.71%. The effectiveness test of interactive multimedia assisted by a virtual laboratory is effective because the experimental class shows an increase in critical thinking skills. Based on these results, it can be concluded that the interactive multimedia assisted by a virtual laboratory on the respiratory and excretory system materials developed in humans is valid, practical and effective.

Keyword. Interactive Multimedia, Virtual Laboratory, Critical and Creative

Development of E-Module Based *Problem-Based Learning*

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Abstract. Based on the data from the initial investigation conducted by interviewing one of the science teachers at SMPN 22 Padang, it is known that in the learning process students still tend to be passive and the activities of students are still lack. The teaching materials used are printed books and student worksheets. Therefore, e-modules are needed that can help students visualize learning materials. This study aims to produce e-modules based on problem-based learning on the material of the respiratory system and excretory system for students of class VIII SMP that are valid, practical, and effective. This type of research is development research using the Plomp model. The instrument in this study was a validity questionnaire filled out by lecturers, and a practicality questionnaire for teachers and students. The data analysis technique used is the assessment of validity, practicality, and effectiveness (the results of student learning competencies from aspects of the cognitive, affective and psychomotor domains as well as student learning activities. The results obtained that the e-module based on problem-based learning criteria is very valid, and the results of the validation by the validator are valid. with a value of 84.24%. Practicality by teachers shows a value of 90.68% very practical criteria and practicality by students gets a score of 87.72% very practical criteria. Test the effectiveness of e-modules based on problem-based learning from aspects of the cognitive, affective, and psychomotor domains as well as student learning activities shows an increase in student learning outcomes. Based on the results obtained, it can be concluded that the problem-based learning-based e-module developed is very valid, practical, and effective.

Keyword. Development Research, E-Module, Problem Based Learning

The Implementation of WE-ARe Model on the Critical Thinking of Pre-service Biology Teachers

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Abstract. By implementing a learning model that cultivates 21st century skills, students' critical thinking skills can be enhanced. One of the alternative learning models that can be used to accommodate this is the WE-ARe model. This study is a quasi-experimental, with a pretest-post-test control group design. All biology education students from IAIN Ternate and STKIP Kie Raha in Ternate City, North Maluku, Indonesia were included in the study. The research sample consisted of sixty biology education students. Essay test questions were used to evaluate participants' critical thinking skills. The significance level for the covariate analysis (ANACOVA) was set at 5%. The analysis revealed that the WE-ARe model positively influenced the critical thinking skills of pre-service biology teachers, where the experimental group obtained a higher mean score (81.714) than the positive (66.9995) or negative control (33.858) groups. Future use of the WE-ARe model as an alternative learning model to prepare students with 21st century skills and life skills is anticipated at both the secondary and undergraduate levels.

Keywords: WE-ARe Model, critical thinking skills, pre-service biology teachers, 21st century skills.

Implementation of a new paradigm curriculum using citizen science projects to improve students' critical thinking skills

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Abstract. The new paradigm curriculum requires teaching units to provide project activities in student learning. The project aims to strengthen the profile of Pancasila students, one of which is critical thinking. This study is to analyze the implementation of the citizen science project, Weather-It, as part of project activities in the new paradigm curriculum to improve students' critical thinking skills. This study uses a pre-experimental with a research design of one-group pretest–posttest. Forty-two grade 7 junior high school students in Bandung participated in this study. Validated pre-test and post-test questions were created and used to analyze the improvement of students' critical thinking skills. This increase can be seen from the change in the average value of the pre-test and post-test as well as by calculating the N-Gain score. The results showed an increase in the mean value of students' critical thinking from 48.75 (pre-test) to 70.41 (post-test). The N-Gain score indicates the effectiveness of the citizen science project where 57.1% of students are in the medium category, 28.6% in the high category and 14.3% in the low category. Similarly, the results reflect how the citizen science project, Weather-It, can be implemented as part of a new paradigm curriculum.

THE EFFECT OF THE USE OF THINK PARE SHARE (TPS) COOPERATIVE LEARNING MODEL ON THE COGNITIVE OF CLASS X STUDENTS AT SMAN 1 SULIKI

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Abstract. This type of research is a quasi-experimental (quasi-experimental). The design that will be used in this study is The randomized posttest only control group. The experimental group was subjected to treatment. The sample in this study used two sample groups, namely experimental class students and control class students who were observed from members of the population who were taken by purposive sampling technique, namely the sampling technique was carried out by considering the need that the number of students was the same and the average value of students was almost the same. The results showed that the average value of the cognitive domain of the experimental class students was 74.93 while the average value of the control class students was 65.40. The value of tcount is 2.45 and ttable is 2.00. This shows that tcount > t table so that the hypothesis is accepted, that is, there is an influence of cognitive competence of students who follow the cooperative learning model. It is known that students' cognitive domain learning competencies following the TPS type cooperative learning model are better than students' cognitive domain learning competencies following conventional learning.

Keywords: Think Pare Share, Cognitive, Students

Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis *Science, Technology, Engineering, Mathematics* (STEM) Tentang Materi Ekosistem Untuk Kelas X SMA/MA

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Abstract. Penerapan Kurikulum 2013 menuntut peserta didik memiliki kreativitas, inovasi, kemampuan berpikir kritis dan kemampuan menyelesaikan masalah melalui media pembelajaran yang berkualitas. Dalam proses pembelajaran guru sudah menerapkan Kurikulum 2013 dengan pendekatan STEM. Media pembelajaran yang sering digunakan guru biologi di SMA Negeri 4 Pariaman yaitu: Lembar Kerja Peserta Didik (LKPD), namun LKPD yang digunakan oleh guru belum berbasis STEM. Oleh sebab itu, dengan penggunaan LKPD diharapkan mampu berkomunikasi, berkolaborasi, dan memberikan kreativitas serta mengembangkan keterampilan melalui media pembelajaran dengan pendekatan *Science, Technology, Engineering, Mathematics* (STEM). Dari hasil wawancara dan observasi pada peserta didik kemampuan peserta didik dalam pemahaman materi ekosistem serta kreativitas masih sangat rendah. Oleh karena itu, dikembangkan LKPD berbasis STEM tentang materi ekosistem. Penelitian adalah penelitian pengembangan. Penelitian ini menggunakan *Four-D Models* yang terdiri dari 4 tahap yaitu tahap *define* (pendefinisian), *design* (perancangan), *develop* (pengembangan), dan *disseminate* (penyebaran). Penelitian ini dilaksanakan sampai tahap pengembangan, sedangkan tahap penyebaran tidak dilakukan karena keterbatasan waktu dan biaya dalam penyebaran produk secara komersial. Instrumen penelitian yang digunakan dalam penelitian ini berupa lembar wawancara untuk guru, angket observasi peserta didik, angket uji validitas dan angket uji praktikalitas. Pada tahap pendefinisian dilakukan pengumpulan data dengan mewawancarai satu orang guru biologi dan menyebarkan angket observasi peserta didik kepada 30 peserta didik kelas X MIPA SMA Negeri 4 Pariaman. Pada tahap perancangan didapat hasil 60% peserta didik menyukai warna Hijau. Pada tahap pengembangan dilakukan uji validitas dan praktikalitas. Teknik analisis yang digunakan pada penelitian ini adalah teknik analisis kualitatif dan kuantitatif. Berdasarkan hasil analisis awal-akhir, maka LKPD yang dikembangkan adalah LKPD berbasis STEM pada materi ekosistem. Bahan ajar dikembangkan sesuai dengan karakteristik peserta didik. Sebanyak 98% peserta didik menyukai bahan ajar yang memiliki gambar, berwarna, dan materi pelajaran singkat, padat, dan jelas. Peserta didik menyatakan bahwa materi ekosistem termasuk materi yang sulit. Hasil validitas LKPD berbasis STEM adalah 90,91% (sangat valid) dan hasil uji praktikalitas oleh guru 87,91% (sangat praktis) serta nilai praktikalitas oleh peserta didik 89,85% (sangat praktis).

Kata kunci: LKPD, STEM, Ekosistem

ANALYSIS ITEM ABOUT PSYCHOTROPIC MATERIAL CLASS XI SMAN 5 TEBO IN 2021/2022

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Abstract. Evaluation of learning is important to measure the success rate of students in understanding the learning provided by the teacher, in addition to the evaluation of learning is also used in measuring the achievement of learning implementation plans. Item analysis is important in evaluating learning. This study aims to analyze the item *of posttest* psychotropic material Class XI SMAN 5 Tebo academic year 2021/2022 including validity, reliability, differentiating power, and difficulty level of the problem.Based on the results of the analysis of the item about which is done with the help of Anates Ver. 4.0.9. it can be seen that the validity of the problem has been good, because it is in the range of valid to very valid. The reliability of the question is at a very reliable level, the differentiating power of the question is at a good to very good level, and the difficulty level of the question is at medium criteria. So it can be seen that *posttest*the posttest matter of psychotropic material Class XI SMAN 5 Tebo academic year 2021/2022 is in the good category

ANALYSIS ITEM ABOUT PSYCHOTROPIC MATERIAL CLASS XI SMAN 9 PADANG IN 2021/2022

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Abstract. The purpose of this study was to determine the characteristics of psychotropic material items in Class XI Semester 2 of the 2021/2022 Academic Year using the anates program. This study used a quantitative approach and data collection techniques were carried out by purposive sampling technique. The instrument in this study was in the form of 10 questions. It can be seen from the validity of the 10 test items that were found to have high criteria, namely 0.597 to 0.749 so that the questions can be used properly. In terms of discriminatory power, it has poor to very good criteria, namely 0.00 to 3.20, so it is necessary to improve on poor discriminatory power. In difficulty, the questions have moderate to difficult criteria, namely 48.00 to 25.00 so that the questions can be used properly because they are not so difficult and not so easy.

Keywords: Psychotropic Material, Anates, Essay

The Implementation of WE-ARe Learning Model toward the Critical Thinking of Pre-service Biology Teachers

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ABSTRACT

By implementing a learning model that cultivates 21st-century skills, students' critical thinking skills can be enhanced. One of the alternative learning models that can be used to accommodate this is the WE-ARe learning model. This study is quasi-experimental, with a pretest-post-test control group design. The participants consisted of all biology education students from IAIN Ternate and STKIP Kie Raha in Ternate City, North Maluku, Indonesia. The research sample consisted of sixty biology education students. Essay test questions were used to evaluate participants' critical thinking skills. The significance level for the covariate analysis (ANCOVA) was set at 5%. The analysis revealed that the WE-ARe learning model positively influenced the critical thinking skills of pre-service biology teachers, where the experimental group obtained a higher mean score (81.714) than the positive (66.9995) or negative control (33.858) groups. Future use of the WE-ARe learning model as an alternative learning model to prepare students with 21st-century skills and life skills is anticipated at both the secondary and undergraduate levels.

Keywords: Critical thinking skills, WE-ARe Learning Model, pre-service biology teachers, 21st-century skills.

1. INTRODUKCTION

Meaningful learning will have a positive impact on students' thinking abilities. Critical thinking helps an individual face the challenges of a globalized world [1]. Critical thinking is defined as a person's ability to examine an event or a condition, analyze an opinion, and decide based on prior knowledge [2].

Critical thinking refers to the ability to access, analyze, and synthesize information [3]. This ability is also related to communication and information skills. The digital literacy era with diverse sources of information presents a challenge for students to be able to select relevant and appropriate sources and information based on their needs, locate quality sources, and provide evaluations on aspects of objectivity, reliability, and data updating. To become successful lifelong learners in the 21st century, students must have strong critical thinking and literacy skills [4], [5]. Critical thinking enables students to rationally process information and prepare for independent study [6]. Students with critical thinking skills can distinguish information based on its importance and relevance [7], [8].

Critical thinking basically involves the process of identifying and analyzing sources of information for credibility. Critical thinking demonstrates the capacity to utilize prior knowledge and draw connections and conclusions [9]. Enhancing logical reasoning skills can enhance critical thinking skills. Paul & Elder describes several roles and functions of critical thinking skills, where each function represents an important part of the quality of thinking and overall outcomes. These roles and functions include: (1) questioning problems; (2) goals;

(3) information in the form of data, facts, observations, experiences or other sources that can help someone solve their problems; (4) a concept in the form of a mindset that becomes a framework for thinking and acting; (5) assumptions that describe the rationale; (6) point of view in reasoning and thinking which involves the process of interpreting and understanding something; (7) interpretation and inference which serves to understand the data and draw conclusions; and (8) implications and consequences in the form of readiness to face the implications and consequences of the thinking process [10]. The application of critical thinking in biology classes can provide students with opportunities to develop analytical, inductive, and deductive thinking skills to solve fundamental everyday problems [11]. In a learning environment, students with strong critical thinking skills demonstrate greater self-assurance by viewing themselves as individuals who can actively contribute to the learning process.

According to previous research, university students score poorly on every indicator of critical thinking ability [12]–[15]. Surveys indicate that students' critical thinking skills remain underdeveloped because the materials and learning strategies employed in the classroom are not conducive to the development of students' critical thinking abilities [16], [17]. The critical thinking and critical analysis skills of aspiring biology teachers continue to be underdeveloped [18]. Students' higher order thinking skills are still in the low range, with self-regulated thinking at 59%, critical thinking at 58%, and self-regulated thinking at 57% [19]. The ability of biology department students to ask and consider questions remains low [20], [21]. These findings suggest the need for the application of active and innovative learning models in the classroom to strengthen students' critical thinking skills. The syntax of a learning model provides students with a unique and distinct experience and influence an individual's cognitive capacity [22].

Critical thinking skills do not develop by itself as people age and grow. This cognitive ability will flourish if it is stimulated and purposefully enhanced [23]. Critical thinking is a domain of higher-order thinking that must be taught to students continuously through the selection of suitable learning models [7], [24]–[26]. Enhancing critical thinking requires a learning model that can facilitate student learning activities, where they can produce logical and rational arguments, make reflective decisions, and evaluate what they should do or believe [27]. Finding the ideal learning model to develop students' critical thinking skills is a challenging task for most educators [19], [28].

The WE-ARe learning model is a constructivist-based active learning model that consists of warm-up, exploring, argumentation, and resume phases [29]. The learning model has been shown to increase pre-service biology teachers' learning motivation and critical thinking skills [30]. The WE-ARe learning model enhances self-assurance and generates positive energy in the learning environment, thereby promoting students' learning progress because they have a positive outlook on their academic success. The stages of the WE-ARe learning model (Warm-up, Exploring, Argumentation, Resume) increase biology students' self-efficacy [29]. WE-ARe is believed to have the potential to promote pre-service biology teachers' critical thinking skills in Ternate, North Maluku.

The problem statement of this study is "Does the WE-Are learning model have an effect on pre-service biology teachers in Ternate, North Maluku?" The purpose of the study was to identify the effect of the WE-Are learning model on the critical thinking skills of pre-service biology teachers in Ternate, North Maluku. It is anticipated that the findings of this study will assist educators and lecturers in designing learning that can stimulate students' critical thinking, thereby increasing the competence of the biology teachers, particularly in facing the challenges of the 21st century.

2. METHODS

This study was a quasi-experimental study, using WE-ARe learning model as the independent variable and critical thinking skills as the dependent variable. A pretest-posttest control group design was used (Sugiyono, 2009).

Table 1. The Pretest-Posttest Control Group Design

Group	Pre-test	Treatment	Post-test
Experimental	O_1	WE-ARe	O_2
Control Positive	O_3	STAD	O_4
Control Negative	O_5	Conventional	O_6

Notes:
O_1 = Pretest score of the experimental group (implementing the WE-Are learning model)
O_2 = Post-test score of the experimental group (implementing the WE-ARe learning model)
O_3 = Pretest score of the positive control group (implementing STAD)
O_4 = Post-test score of the positive control group (implementing STAD)
O_5 = Pretest score of the negative control group (implementing conventional learning)
O_6 = Post-test score of the negative control group (implementing conventional learning)
X = Treatment (implementing the WE-Are learning model)

The research population contained all students from the Department of Tadris Biology at IAIN Ternate and STKIP Kie Raha, Ternate, North Maluku. The research sample consisted of 60 four-semester students from the Department of Tadris Biology. These students were assigned into three treatment classes. The study was conducted during the even semester of the 2021/2022 academic year. Prior to determining the sample, equivalence test was conducted to the students. The test was done by distributing a placement test.

The research instrument consisted of a critical thinking test. The test underwent validity testing and empirical testing. The results of the validity tests showed that the instrument was valid and reliable for use in the research. Data on the participants' critical thinking skills were gathered using an essay test. The participants' answers were evaluated using a critical thinking rubric developed by Zubaidah, Corebima, & Mistianah as an adaptation from the Critical Thinking Essay Test and Guidelines for Scoring Illinois Critical Thinking Essay Test. The rubric used a 0-5 scale [31].

The research data were collected using a pretest, observation, and a post-test. The data were analyzed using descriptive and inferential statistics. The descriptive analysis resulted in the students' critical thinking profile, while the inferential statistics was used to test the effect of the WE-ARe learning model on the students' critical thinking skills. The research hypothesis "The WE-Are learning model has an effect on pre-service teachers' critical thinking skills in Ternate, North Maluku" was analyzed using ANCOVA at the significance level of 5%. ANCOVA was run in SPSS. Prior to analyzing the data with ANCOVA, One-Sample Kolmogrov-Smirnov test and Levene's Test of Equality of Error Variances were performed to examine the normality and homogeneity of the data.

3. RESULTS

3.1 Descriptive Analysis of the Research Data

Descriptive analysis was done to examine the students' pre and post-test scores on critical thinking skills. Table 2 displays the minimum, maximum, and mean scores as well as the standard deviation obtained by the experimental and control groups.

Table 2. The Results of the Descriptive Analysis on the Experimental, Positive Control, and Negative Control Groups' Pretest and Post-test Scores

Descriptive Statistics	Experimental Group WE-ARe		Positive Control Group STAD		Negative Control Group Conventional	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	20	20	20	20	20	20
Minimum	14.29	77.14	14.29	60	17.14	28.57
Maximum	31.43	88.57	31.43	77.14	28.57	42.86
Mean	22.285	81.714	23.428	66.999	22.570	33.858
Std.Deviation	4.86896	3.51791	4.20629	4.39413	3.19685	4.56785

Table 2 explains that on the pretest, the experimental group obtained a mean score of 22.285 with a standard deviation of 4.86896, meanwhile the positive control obtained a mean score of 23.428 with a standard deviation of 4.20629, and the negative control got a mean score of 22.570 with a standard deviation of 3.19685. These figures suggest that prior to the treatment, all participating groups had equivalent critical thinking skills, indicated by their similar mean scores on the pretest.

However, on the posttest, the experimental group obtained a mean score of 81.714 with a standard deviation of 3.51791, meanwhile the positive control obtained a mean score of 66.999 with a standard deviation of 4.39413, and the negative control got a mean score of 33.858 with a standard deviation of 4.56785.
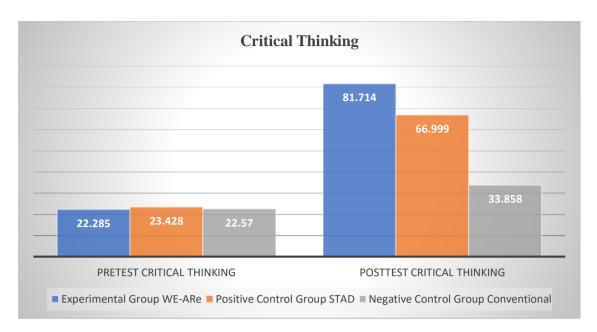
Figure 1. The Students' Pretest and Post-test Scores of Critical Thinking Skills

3.2 The Assumption Tests

Before conducting the covariance analysis, data normality and homogeneity of the variance were examined. The data normality was tested using the *Kolmogorov-Smirnov* method with α=0.05, where significance level (p) >0.05 showed that data had normal distribution and p<0.05 showed that data did not have normal distribution. Data that had normal distribution were then analyzed using parametric analysis, while data that did not have normal distribution were examined using non-parametric analysis. The homogeneity of the variance was tested using the Levene's test, where significance level (p) >0.05 was considered homogeneous and p<0.05 was considered non-homogeneous.

3.2.1 Test of Normality

The results of the normality test of the experimental and control groups' data using Kolmogrov-Smirnov are presented in Table 3.

Table 3. Results of the Normality Test

Score	Groups	Kolmogorov-Smirnova	Sig.	Remarks
Critical Thinking Skills-Pretest	The experimental group (WE-Are)	0.181	0.086	Normal Distribution
	The positive control group (STAD)	0.154	.200*	Normal Distribution
	The negative control group (conventional)	0.189	0.058	Normal Distribution
Critical Thinking Skills-Posttest	The experimental group (WE-Are)	0.187	0.065	Normal Distribution
	The positive control group (STAD)	0.14	.200*	Normal Distribution
	The negative control group (conventional)	0.162	0.176	Normal Distribution

Table 3 shows that, on the pretest and post-test, the significance level (p-value) of each treatment group was bigger than 0.05 (p>0.05); hence, it was concluded that the research data were distributed normally.

3.2.2 Test of Homogeneity

The results of the homogeneity test of the experimental and control groups' data using Levene's test are presented in Table

Table 3. Results of the Normality Test

Variables	Levene's Statistics	Sig.	Remarks
Critical Thinking Skills-Pretest	1.728	0.187	Homogeneous variance
Critical Thinking Skills-Posttest	0.647	0.528	Homogeneous variance

Table 4 shows that, on the pretest and post-test, the significance level (p-value) of each treatment group was bigger than 0.05 (p>0.05); hence, it was concluded that

the research data (pretest and post-test data of all treatment groups) had homogeneous variance.

3.2.3 *Hypothesis Testing*

The research hypothesis was examined using analysis of covariance (ANCOVA). The analysis of covariance was done to investigate the effect of the WE-ARe learning model on the participants' critical thinking skills, with the pretest score as the covariance. The results of the ANCOVA conducted in this study are summarized in Table 5.

Table 5. The Results of ANCOVA

Tests of Between-Subjects Effects

Dependent Variable: Posttest Critical Thinking

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	24035.327[a]	3	8011.776	450.044	.000
Intercept	6997.796	1	6997.796	393.086	.000
Pretest_Critical_Thinking	1.512	1	1.512	.085	.772
Group	24032.610	2	12016.305	674.989	.000
Error	996.924	56	17.802		
Total	247247.935	60			
Corrected Total	25032.251	59			

a. R Squared = .960 (Adjusted R Squared = .958)

Table 5 explains the difference in critical thinking skills between the experimental and control groups following the research treatment. It was found that the F-calculated was 674.989 and the significance value was 0.000. Since the significance value was smaller than the alpha 5% or 0.05, it was concluded that there was a difference in critical thinking skills between the experimental and control groups. In short, it can be said that the research treatment, namely the implementation of the WE-Are model, had a significant effect on students' critical thinking skills.

Among the treatment groups, the experimental group achieved the highest mean score (81.714), followed by the positive control group (66.9995), and the negative control group (33.858). Based on the analysis, it can be said that the implementation of the WE-Are learning model was effective in enhancing pre-service biology teachers' critical thinking skills, compared to STAD and conventional learning. It has been demonstrated that the stages of the WE-Are learning model can stimulate the development of critical thinking skills in university students. The research participants initially had difficulty asking questions. They were

typically passive in argumentative discussions. However, as the lecturer provided scaffolding, the students gradually gained the confidence to actively participate in class discussions and were even able to provide feedback during the learning process. The lecturer shared website links to lecture-related materials, allowing students to easily access learning materials. In addition, students were also provided with e-book files related to the learning material. This was intended to increase students' interest in reading, particularly during the WE-ARe learning model's warm-up phase.

Next, the lecturer provided scaffolding to build the students' confidence in asking questions by having them compose questions in their notebooks. The lecturer then instructed the students to take turns reading the previously written questions. This learning activity taught students to ask questions with confidence. During this phase, the lecturer could identify and observe the level of questions posed by students, i.e., whether these questions required lower or higher order thinking skills. The lecturer then provided the same opportunity for students to submit their questions. This activity also had a positive effect on the behavior of students in subsequent

meetings, as they became accustomed to formulating questions and eventually became more willing to ask questions without the lecturer prompting them.

The warm-up phase allowed students to read literature so that they were better prepared to participate in learning, were more active in asking questions, had the courage to respond to questions and arguments, and possessed critical reading skills. In this phase, students' readiness to participate in the learning process was enhanced. The students were instructed to utilize their existing knowledge so that they could demonstrate their learning with greater assurance. This phase made learning not only dominated by students with exceptional academic skills, but also by all students in the class. Students who were prepared to learn during the warm-up phase were more likely to be engaged during the exploring phase. Typically, learners who are trained to think critically have rational and reflective thinking processes that are centered on deciding what to believe or do. Strong critical thinking skills can be advantageous in all facets of life, including in achieving better learning outcomes [3].

The exploring phase offered students opportunities to exercise critical thinking when conducting scientific investigations. In this phase, students were taught how to gather the necessary information for the problem-solving process. The students were instructed to be able to link the knowledge gained from reading activities to exploration activities. In order for students to meet the course's learning objectives, they were also instructed to hone their reasoning skills and develop their analytical thinking in the construction of knowledge and comprehension. In the problem-solving process, students were also trained to build skills and social relationships with their peers. To maximize each other's potential in meeting learning requirements, the ability to work together, collaborate, and elaborate is essential.

During the exploring phase, the lecturer also provided scaffolding to students who have difficulty in doing scientific investigations and problem-solving, both individually and in groups. Critical thinking can facilitate the learning process and students' thinking. Higher order thinking skills play an important role in the cognitive development of learners [32], [33] conclude that the critical and creative character of students is reflected in the components of critical thinking and critical thinking skills that integrate four abilities, namely the ability to construct ideas, conduct reflective assessments, self-regulate, and recognize traits and behaviors.

At the outset of its implementation in the classroom, the exploring phase posed a challenge for the lecturer because students lacked sufficient learning independence. Therefore, the lecturer gave students clear instructions and explanations. The instructor also instructed the students to use their smartphones to access the internet if they encountered any difficulties. Problem-solving-related material was designed to be easier to comprehend if students engaged in more discussion with their classmates. During the exploring phase, students were trained to develop reasoning, critical-creative thinking, and collaboration skills to achieve group learning success. Critical thinking enables individuals to effectively address diverse social, scientific, and practical issues [34].

The argumentation phase of the WE-Are learning model trained students' critical thinking skills in analyzing environmental problems. In the argumentation phase, the comprehension of the knowledge-concepts acquired in the exploration phase was discussed and presented. According to the observations, students needed more time to contribute to argumentative production. Students needed time to research the pertinent theoretical foundations to bolster their arguments. At the outset of the implementation of the WE-ARe model, students struggled to generate quality arguments. In general, the generated arguments lacked solid and supportive data backings. Occasionally, the presented arguments were lengthy but of poor quality. Therefore, the lecturer taught students how to construct persuasive arguments. The students were required to read extensively and critically and to take notes on significant things that could be used to support their arguments. They were instructed to bolster their arguments by citing relevant e-books and research articles. This activity was conducted to stimulate the students' capacity for assimilation and accommodation so that they may gradually develop higher order thinking skills. Critical thinking involves a variety of intellectual qualities, such as clarity, relevance, sufficiency, and consistency, among others [25]. They were required to read extensively and critically and to take notes on significant things that could be used to support their arguments. Students were instructed to bolster their arguments by citing relevant e-books and research articles. This activity was conducted to stimulate the students' capacity for assimilation and accommodation so that they may gradually develop higher order thinking skills. Critical thinking involves a variety of intellectual qualities, such as clarity, relevance, sufficiency, and consistency, among others (Fisher, 2001). Critical thinking also involves higher-order cognitive processes in analyzing information to generate new ideas [35].

Students practiced their critical analysis skills by summarizing lessons during the resume phase. Students were taught a variety of cognitive strategies to enhance their reasoning abilities, such as critical analysis of related research articles, highlighting important points in

reading, noting the essence of learning, creating concept maps to facilitate comprehension, and other techniques. In practice, the lecturer examined student learning difficulties by analyzing the results of the collected resumes. If there were still students who had trouble capturing information or writing the resume, the lecturer instructed them to record the learning process, including the argumentation phase, on their smartphones or laptops using a voice recording application. Students were able to build resumes with the help of recordings because they can be listened to repeatedly based on their learning needs. The phases of WE-Are learning model can stimulate the critical thinking skills of preservice biology teachers.

The ability to think critically is a fundamental skill that university students must possess in order to solve problems. Students who can think critically tend to perform well on learning tasks. Critical thinking is essential for comprehending and studying abstract scientific concepts, particularly in biology. The ability to think critically also helps students complete their assignments [36]. They can discover how learning concepts apply to real-world situations and how to apply prior knowledge in novel contexts [37]. External factors that can influence the critical thinking skills of students include educational paradigms, teaching approaches and methods, the nature of assessment, educator feedback, an emotionally supportive environment, and positive attitudes [38], [39].

Critical thinking enables individuals to effectively address diverse social, scientific, and practical issues [34]. Students' critical thinking skills are important because students with strong critical thinking skills can become critical consumers of science in responding to and following various scientific developments [40]. At the test of critical thinking skills, students were required to examine a variety of information and use it to solve problems. They were also required to identify a pattern or procedure whose truth value they determined [41]. When life problems become increasingly complex, each person must adapt and make the best decisions to deal with the circumstance [42].

Graduates who possess 21st century competencies must be equipped with higher order thinking skills, including critical thinking skills. Critical thinking can shape competitive human resources for the 21st century [43]. Critical and creative thinking is important to cultivate because it can improve the quality of human resources and help students develop a growth mindset, particularly in everyday life [44]. Developing critical thinking and problem-solving skills is the foundation of all necessary 21st century skills [45], [46].

CONCLUSION

Based on the research findings and data analysis, it was concluded that the WE-Are learning model had an effect on preservice biology teachers' critical thinking skills. The highest mean score on post-test was obtained by the experimental group (81.714), followed by the positive control group (66.9995), and the negative control group (33.858). It is anticipated that the results of this study will serve as a reference for biology education lecturers and other subject lecturers who wish to implement the WE-ARe learning model in the classroom to improve students' critical thinking skills. In addition, future research can try to implement the WE-ARe learning model at various educational levels.

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