

## **Report of the 29th AABE Biennial Conference (AABE2024) and Abstracts of the Papers Presented at the Conference**

The 29th AABE Biennial Conference (AABE 2024) was held at the Faculty of Education, Ehime University, in Matsuyama City, Shikoku, Japan, from October 12 to 14, 2024. The conference was organized under the direction of Professor Heiwa Muko, the conference executive director from the same university. This year's theme was *Perspectives for global well-being: biology education in integrated learning*. A total of 199 participants, including volunteers, attended the conference, with representatives from Japan (90), Korea (21), Taiwan (1), the Philippines (40), Thailand (2), Malaysia (5), Indonesia (6), India (5), and Australia (2).

On October 12, registration began in the afternoon, and from 3 to 6 PM, approximately 90 attendees enjoyed an ex-cursion to Matsuyama Castle, located near the university. They were accompanied by 27 volunteers, including students from Ehime University and schoolteachers, who served as guides.

On October 13, the conference began at 9:00 AM with an opening address by Professor Kiyoyuki Ohshika, Chair of the AABE Executive Committee. This was followed by greetings from Professor Shigeyoshi Watanabe, President of the Society of Biological Science Education of Japan, a co-sponsoring organization, and Professor Heiwa Muko. The first keynote address was delivered by Professor Manabu Sumida from the Faculty of Education, Ehime University, titled *Transforming Science Education in the Society 5.0 Era: Diversity, Sustainability, and AI*. Afterward, from 10 AM, parallel oral sessions took place in four rooms, where participants presented their research and engaged in discussions. Following a lunch break with distributed bento boxes, the second keynote

address was delivered by Dr. Aki Katoh from Ehime University, titled *Developing an innovative community-based science and technology program focusing on local regional issues incorporating entrepreneur-ship training*. The parallel sessions then resumed. A total of 51 oral presentations were delivered on this day.

In the evening, from 6 PM, a banquet was held in the university cafeteria, attended by 120 people. Professor Ohshika, Professor Muko, and Dr. Nobuyasu Katayama gave speeches, and Dr. Robert Wallis offered a toast. Attendees enjoyed local Ehime cuisine while deepening international exchanges. During the banquet, traditional Japanese songs and dances were performed, and the traditional game *Yakyuken* added excitement, with representatives from various countries competing in *janken* (rock-paper-scissors). The evening ended with a speech by Dr. Shigeki Mayama, Editor-in-Chief of AJBE, encouraging attendees to submit their presentations to the journal. The banquet concluded successfully.

On October 14, the third keynote address was delivered at 9 AM by Professor Kew-Cheol Shim from the Department of Biology Education, Kongju National University, Korea, titled *Biology Education in the Big Transformation Age*. Starting at 10 AM, 20 research posters were presented by junior and senior high school students (40 students), along with 48 general poster presentations and 7 workshops. Vigorous discussions and exchanges took place. After lunch, the fourth keynote address was given by Mr. Hideki Fujieda, Government School Inspector at the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan, titled *About Biology Education in Japan*. From 3 PM, country reports were

presented by Dr. Robert Wallis (Australia), Dr. Narendra Deshmukh (India), Dr. Muruni Ramli (Indonesia), Dr. Kwan Siew Wai (Malaysia), and Dr. Maricar S. Prudente (Philippines), providing updates on recent educational developments in their countries. Since the representative from Malaysia was unable to attend, the report was presented as a video message.

At the General Assembly (Closing Ceremony), held from 4:40 PM, reports on the activities of AABE over the past two years, financial reports, and publication updates were presented. The title of *Emeritus Editor-in-Chief* was conferred upon Dr. Nobuyasu Katayama, the former Editor-in-Chief of AJBE, with unanimous applause, and a certificate was presented to him. The Best Presentation Awards were then announced for both oral and poster presentations, and the awardees were presented with certificates on stage. Finally, Professor Jun Euy Hong from Seowon University, Korea, gave an invitation speech for the 30th AABE Conference to be held in Korea in 2026, accompanied by a video introducing the location. The ceremony concluded after 6 PM with wishes for a reunion in two years' time.

On October 15, an optional post-conference excursion was held, with 60 participants. The group departed at 8 AM to visit Ehime University Junior High School and Senior High School by bus, where they observed classes. At the junior high school, students dissected squid to compare the anatomy of vertebrates and invertebrates. At the high school, participants observed the dissection of dried anchovies using tweezers, studying the nervous system, digestive system, and circulatory system, including the brain. After a lunch of coconut curry and salad at the Ehime Prefectural Cultural Center, the group visited Tobe Zoo.

The excursion was a private event for AABE participants, who had the opportunity to learn from zookeepers about the animals' behavior and habits, with a special behind-the-scenes tour. Participants also enjoyed shopping at a Tobe pottery shop before concluding the day at the university at 5 PM.

The lectures, posters, and workshops presented at this conference are recorded here as part of the conference proceedings (note: these are not formally published, and submitting the research presented here as a journal article is not restricted by this record).

#### <Convention Theme & Rationale>

#### **Perspectives for global well-being: biology education in the integrated learning**

Large-scale natural disasters including the global spread of the novel coronavirus disease (COVID-19) and regional conflicts have forced us to make major restrictions and changes in societal activities. In addition to these social disruptions, the rapid development of cutting-edge science and technology is expected to bring about more uncertainty and complexity in our daily lives. This is not a temporary thing, but a characteristic of the with/after-corona society that we are about to enter. Developing next-generation human resources who can respond to the major changes in society and daily life called the VUCA era (Volatility, Uncertainty, Complexity, Ambiguity) is an urgent issue. In recent years, many have promoted STEM/STEAM education as one solution to this need.

This trend indicates that solutions to the difficult issues of modern society are not achieved within a single subject area, but rather with transdisciplinary efforts. An increasing number of schools today address one of the 17 goals established in the UN Sustainable Development Goals (SDGs) as a problem-

solving theme, but needless to say, achieving this requires learning in collaboration with diverse disciplines. While inquiry is at problem-solving's core, the introduction of new concepts such as resilience and diversity into the school education has become essential in recent years. In order to build a harmonious world where everyone can live in health, vitality, and peace; and achieve SDG's pledge to "leave no one behind", we need to challenge ourselves to

conduct research to discover the essence of a new kind of biology education.

In light of this situation, the organizing committee set the theme of the conference as "Perspectives for global well-being: biology education in the integrated learning." We hope that AABE 2024 will be an opportunity to lead to new proposals through presentations of participants' innovative research and heated discussions.



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<Keynote Address>

**Transforming Science Education in the Society 5.0 Era: Diversity, Sustainability and AI**

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Today, the world is facing challenges not only from the pandemic, but also from the ongoing and ever accelerating pace of global warming, loss of biodiversity, demographic change,

increasing inequity, social fragmentation, and threats to human well-being. Added to these are issues with fake news and scepticism regarding science and society. The significance and impact of education have been recognised, with quality science education being considered a right for everyone in the global context. This presentation extracts keywords for science education in the 21st century from an analysis of the works of Nobel laureates, including a case from Japan. The centres of

science have shifted over time, becoming more diverse and transnational. Instances of collaboration among researchers in geographically distant and disparate field-sharing roles are increasing. Science is expected not only to provide new knowledge, but also contribute increasingly to national development and society. In view of this trend, we would like to discuss, from the perspective of science education, the need to discover gifted and talented students in the region, the necessity of providing educational opportunities that transcend disparities, and the importance of international collaboration.

**Developing an innovative communitybased science and technology program focusing on local regional issues:**

**Incorporating entrepreneurship training**

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The Japan Science and Technology Agency (JST) provides support to universities to develop advanced educational programs in Japan. Ehime University was granted funding by JST in 2023 for a second high school student project. We built systematic training programs during our first JST project. In this second project, the program is being enhanced and expanded throughout the island of Shikoku. We recognized the urgent needs for fostering well-trained, innovative leaders of for the next generation who will be active in the region while understanding their connection to the world. The major concept of this project is to start with junior and senior high school students in providing scientific and entrepreneurship training. Universities and local communities are working together through university-level classes and individual research projects and instruction in entrepreneurship, and to provide cross-cultural adaptability through exchange with foreign researchers. In the field of biology, as our students conduct research various regions, they also learn how to

communicate what they learn to the local community. From the perspective of integrated learning, it is necessary to develop highly motivated students through topical research in local biology education. We will introduce our three areas of focus: independent research, involving the local community, and entrepreneurship activities.

**Biology Education in the Big Transformation Age**

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The future society will have been influenced increasingly by digital technology and climate change. Also, future society will be volatile, uncertain, complex and ambiguous (VUCA) or turbulent, uncertain, novel, and ambiguous (TUNA). Digital transformation driven by digital technology is having a huge impact on the economy, culture, and even education. We need transformational approach to the changes in the fundamental attributes of a socioecological system in anticipation of climate change and its impacts. In biology education, learning contents have the science of climate change well established, and an objective source of scientific information on climate change or crisis. Thus, the future society can be called big transformation age. The transformative competency is needed for students in response to future society, and teaching & learning tools for biology education have been rapidly transforming in big transformation age: Using sensors, digital inquiry tools, VR/AR, etc. We need to develop the educational capabilities necessary for future society and provide education for future generations preparing the big transformation age.

**Japan country report: About Biology Education in Japan**

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The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has established curriculum standards for elementary, junior high, and high schools in Japan to ensure that

all schools throughout the country provide a consistent level of education. These curriculum standards are called the “Courses of Study”. Schools are not separate from society, but are part of it. Therefore, the “Courses of Study” are revised approximately every 10 years, in order to review the competencies required to deal with modern issues such as globalization, rapid informatization, and technological innovation. The most recent revisions were carried out in 2017-18. The “Courses of Study” define considerations for the curriculum in general and the treatment of the number of class hours, as well as the general objectives, contents, and treatment of content for each subject, etc. The creation of textbooks and lesson timetabling are based on these guidelines. The curriculum emphasizes scientific

inquiry into natural objects and phenomena, as well as helping pupils to make connections between the subject and their daily lives. In elementary and junior high schools, there are 4 domains in the subject area of “Science” : energy, particles, life, and the earth, and biology is covered in the life domain. In senior high schools, biology comes under the subject area of “Science”, and is taught in “Basic Biology” or “Advanced Biology” classes. In addition, the progression of content from elementary school to high school is taken into consideration, as well as the effective implementation of learning activities to cultivate pupils’ competencies. For reference, here is the website of the “Courses of Study” (tentative translation) for elementary school science.

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<Parallel Lecture Seminars>

**Ectoparasites of Avian Species Visiting Selected Fruit Orchards of Davao City, Mindanao Island, Philippines**

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Ectoparasites are essential in disease transmission in several hosts, including avian species. Studies on ectoparasites of birds in various habitats are substantial, but there is minimal information about bird ectoparasites from fruit orchards, thus the conduct of this study. Birds were captured via mist netting in two preselected fruit orchards and dusted afterward for ectoparasite collection before release. Ectoparasites were identified based on their morphological features. Twenty-eight avian species (N=468 individuals) were identified in the surveyed fruit orchards, of which 32% were Philippine endemic. Nine species (N=24

individuals) were captured, all of which are known to occur in areas near human settlements. Ectoparasites were collected from feather dustings of 13 captured non-breeding individuals representing five of the nine bird species. The abundance, as well as the type of ectoparasites among captured birds, varied among bird species. One *Todiramphus chloris* individual had a heavy infestation. A total of 1630 ectoparasites were collected, belonging to 24 taxa: 14 feather mites, one flea, and nine lice. Most ectoparasites collected were feather mites (Order Acari, Suborder Astigmata, Family Analgoidea) and chewing lice (Order Phthiraptera). Data revealed that despite a high degree of disturbance, fruit orchards do harbor and allow the existence of several birds, including endemic species. Despite the low capture rate, most bird individuals were infested with ectoparasites. This data reiterates previous reports that wild birds are important hosts of several ectoparasites including those found in fruit orchards.

**Introduction of ‘Biology Karuta’: To draw out an attitude of proactive engagement and to consolidate knowledge**

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The current courses of study in Japan assess students' "attitude towards independent learning", "knowledge and skills" and "ability to think, judge and express". Allowing students to engage in a variety of activities and expressions will lead to the retention of knowledge while drawing out students' independence. Therefore, in high school biology classes, 'Biology Research' and 'Biology Karuta' have been implemented. The specific activities are: report writing, report presentation and Q&A session based on the biology research; creation of picture cards and songs for the Biology Karuta; voting; and the Biology Karuta competition. This time, we would like to introduce 'Bio-Karuta'. Karuta is a traditional Japanese game played mainly during the New Year. We have been playing 'Biology Karuta' in analogy with it. In a post-implementation questionnaire, more than 90% of the students said: 'I enjoyed playing Karuta'. 'My knowledge of the classification of organisms has increased'. 'My knowledge of the characteristics of living organisms has increased'. As per the aim, the students were able to work on their own initiative, have fun with their friends and consolidate their knowledge of biological classification and the characteristics of organisms. The relevant parts of this content in the courses of study are chapter 1: Biological diversity in 'Basic biology' and chapter 1: Biological evolution and systematic taxonomy in 'Biology'.

### **PROBES: PROblem-Based Explorations in Science**

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The Philippines' Matatag Science Curriculum prioritizes a learner-centered approach, emphasizing inquiry, collaboration, innovation, and scientific exploration. This focus aligns perfectly with the national emphasis on Science, Technology, Engineering, and Mathematics (STEM) education, aiming to cultivate critical thinkers and problem solvers who contribute to national progress. Building upon this foundation, this paper introduces PROBES

(Problem-based Explorations in Science), an innovative framework presented during a nationwide training for high school science teachers. PROBES leverages the inquiry-based and problem-solving strengths of the Matatag curriculum and integrates them with the Engineering Design Process (EDP) to create a dynamic learning environment. The EDP, a cyclical process used by engineers, provides a structured approach to problem-solving within PROBES. This process involves defining problems, researching possibilities, brainstorming solutions, building prototypes, testing, and refining based on results. By integrating the EDP, PROBES fosters active investigators by encouraging students to drive their own learning journey through contextual problem-solving activities. They delve into research, experiment with solutions, and analyze findings, leading to a deeper understanding of scientific concepts and their real-world applications. The session will walkthrough participants through the PROBES framework, designed to promote active learning, contextual understanding, and a more engaging classroom experience. Ultimately, PROBES empowers science learners to become future-ready scientists who can address societal issues with science and make a positive impact on the world.

### **Perception of Science Gifted Children on the Value of Ecological Transformation Education in Discussion and Debate Activities Using Documentary Films**

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To confront climate change and global crisis, ecological transformation education in the Republic of Korea does not only focus on the coexistence of the environment and humans but also sustainability based on ecology changeovers in an extensive range of fields. This study aims to analyze science-gifted children's discourse in discussion and debate activities using environmental documentary films and examine their epistemic value on ecological transformation education, such as life respect, sustainability, and ecological environmental sensitivity. Using epistemic

network analysis, I analyzed the discourse of twelve elementary school students from a university-affiliated science gifted education center to reveal the co-occurrence pattern of the subject's perspectives on ecological issues, problems, and solutions. As a result, the three epistemic network models were generated as the relationship between ecology and humanity, inquiry into the ecological problems, and practice and participation in ecological transformation. The first epistemic network model showed two different stances regarding the vegetarian diets of humans and their utterance types and connections. In the second module, the ENA model embodied the science-gifted students' perception reflected in their description of inevitable ecological problems in the future per periods. Lastly, the third model represented the discourse collected from the discussion on solving prospects in energy, sea, and agriculture. To improve science-gifted students' epistemic value on ecological transformation education, it needs to support them in breaking the stereotype that humans are superior to other living organisms and possessing the willingness and responsibility to live harmoniously as members of the earth's biosphere.

### **Teachers' Perceptions of Higher Secondary School Biology Topics: A Case Study**

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It is well known that the quality and extent of learners' achievements are determined primarily by teachers' competence, subject matter knowledge, sensitivity to teaching and teachers' motivation. The paper presents a case of teachers' perceptions & experience of teaching topics either easy or difficult in Biology in higher secondary schools (Grades 11 & 12). This case study is important because it is observed that these teachers' have to teach a complete syllabus in an academic year while they may not be comfortable teaching each topic in the syllabus. In this study, eight experienced biology teachers from eight

different higher secondary schools participated and data collected through questionnaires, interviews, classroom observations, and analysis of instructional materials. The teachers' questionnaire focused on morphology, physiology, the topics of the syllabus, such as: classification, cytology, genetics, evolution, animal systems, ecology, biotechnology, and plant anatomy. The data was qualitatively analysed to describe the teachers' perceptions & experience of teaching topics either easy or difficult in biological sciences provided by the teachers in questionnaires & interviews. Topics such as, morphology, physiology, plant anatomy, ecology, etc. were found interesting to teach and can be made concrete by using diagrams, examples, specimens, etc. However, classification, cytology, genetics, evolution, and biotechnology topics were found difficult in memorizing due to scientific names and technical terminology. The findings reveal that students' active participation, explanations with examples and use of technology and combining theory with related practical play a significant role in handling the situation. It is also found that teachers face difficulties in comprehending and teaching complex biology concepts because of the historical character of biology and high content levels in textbooks. It is recommended that elements of the classroom techniques include teachers' intentions, knowledge of textbook content, pedagogical knowledge, students' curiosity and level of interest, teachers' autonomy, and time constraints. These findings may help to create the teaching and learning materials. This study has implications for both pre-service and in-service teachers' education and also for policy makers.

### **Creating The Ideal Fish: A program placing "life history" into perspective**

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The fundamental difference between living resources we utilize as food, such as vegetables and fish, and non-living resources

such as petroleum and coal, is that the former reproduce and regenerate as part of a natural process. So, in theory, mankind should be able to use living resources for generations to come, so long as they are utilized and managed properly. In order to do so, it is relevant that life history of each and every organism is understood as a member of intertwined ecosystem. But, is the concept of life history or life cycle truly understood by the mass? To enhance understanding of life history, a lecture program was created. In outreach programs and lectures at various levels, from middle school to graduate school, students create the ideal fish based on what they have learned from through the lectures and their imagination. Descriptions on morphology, ecology, reproduction, relationship with humans must be provided. Each student present their ideal fish in a show and tell form or as a paper report depending on the occasion. By creating their ideal fish, the whole life history of that species comes into student's perspective, from eggs, larva, juvenile, young and adults and how they survive and reproduce, guaranteeing the presence of the next generation. Examples of ideal and unique creations will be shown at this presentation.

### **Adaptive, Innovative and Effective Practices in Teaching Biology: Experiences from the Philippines**

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Quasi-experimental studies that showcase adaptive, innovative and effective experiences in teaching Science in the Philippines are presented. Firstly, a study that dealt with the effective use of Metacognitive Argument Driven Inquiry (MADI) approach in developing students' conceptual understanding and argumentation skills is described. In the MADI approach, several metacognitive strategies were explicitly embedded in the biology lessons. The impact of the MADI approach on students' conceptual understanding resulted in an effect size of  $d=0.600$ , indicative

of large positive effect on students' conceptual understanding. After exposure to MADI approach, students made high-quality arguments consisting of accurate and complete claim, appropriate and sufficient evidence, and appropriate and sufficient reasoning that link evidence to the claim. In another study, innovative instructional practices for online education using Home-based Biology Experiments (HBEs) were investigated. The study aimed to determine the effects of home-based biology experiments on students' knowledge gains, self-efficacy, and perceived levels of engagement. Students' knowledge gains were determined by comparing the results of the pre- and post-test questionnaires. While the self-efficacy, engagement, and perceptions of all participants ( $N=839$ ) were investigated using the post-test questionnaire results only. Moreover, students' and teachers' feedback were gathered during focus group discussions. Findings revealed significant increase in knowledge gains after doing the HBEs. Students' self-efficacy and perceived level of engagement were likewise significantly improved. Collectively, these studies underscored the integration of metacognition and experiential learning in the design and implementation of adaptive and innovative instructional materials and practices to ensure effective and meaningful learning experiences for the students.

### **Diatom-based STEM education for problem solving in global river environmental issue**

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We have been conducting educational activities for over decade in multiple countries, using diatoms as indicator organisms of river water quality, to understand river environments globally from a scientific perspective and to think about solutions to problems independently. In the practices and surveys conducted before the COVID-19 pandemic, Indian students expressed concrete opinions on improving the river environment after the classes, while Japanese students only suggested abstract improvement methods. To address this, we introduced STEM methods and conducted classes in Japan that combined diatom specimens from various countries in the past and present, ecosystem simulators, videos and photos, statistical data related to water quality, and internet searches. During the COVID-19 pandemic, we conducted classes in three schools in Japan. The results showed that even with different lesson plans, students' final thoughts were similar. Last year, we conducted classes in both Indian and Japanese schools and surveyed students' thoughts on rivers before and after the classes. Indian students showed similar results to past surveys, while Japanese students initially had similar reactions to the past, but after the classes, they began to refer to improvement and maintenance through collective efforts. After conducting classes in both countries, we held an interactive session using Zoom. Indian students asked various questions to the Japanese students, and Japanese students responded to all of them. Indian students could learn about the experiences of improving river environments in Japan, and Japanese students could broaden their international perspectives, both of which left a positive impression of the interactive session.

**Assessment of Genetic Determinism Beliefs: Development and Validation of a Culturally Adapted Tool for Korean Society**

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This study aims to develop and validate a culturally adapted version of the Public Understanding and Attitudes towards Genetics and Genomics (PUGGS) tool to assess genetic determinism beliefs among Korean university students. Genetic determinism is the view that individual characteristics, behaviors, and diseases are primarily determined by genes. Such beliefs can lead to essentialist thinking and cognitive biases, reinforcing stereotypes and prejudices against certain groups, potentially leading to discrimination and justifying inequalities. To address this, key factors of genetic determinism beliefs were extracted from prominent discussions in Korean online communities. These factors include intelligence, social class, talent, and physical traits. New items reflecting these factors were developed and integrated into the existing PUGGS tool. Pilot tests and expert reviews were conducted to ensure cultural appropriateness and comprehensibility. The revised tool was then administered to Korean university students. This study investigates (1) attitudes towards genetic determinism beliefs among Korean university students, (2) the effectiveness of the culturally adapted PUGGS tool, and (3) the socio-demographic factors influencing these beliefs. Data analysis includes reliability and validity tests and factor analysis to identify key influencers of genetic determinism beliefs. The findings aim to provide a comprehensive understanding of genetic determinism beliefs among Korean university students and offer foundational data for educational strategies and policy-making to mitigate the negative impacts of these beliefs. This study underscores the importance of culturally sensitive tools in accurately assessing and addressing genetic determinism.

**Integrating Philippine Endemic Species in Biology Lessons**

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Filipino students are more familiar with foreign species such as lions, tigers, and giraffes and

are less familiar with Philippine endemic species. The low awareness might be due to foreign references used in school and to foreign mainstream movies/videos which are more popular than their local counterparts. Integrating Philippine endemic species in Biology lessons might help increase student awareness and promote higher concern towards the welfare of such species. There are different ways of promoting endemic species in the classroom. One is by using recitation stickers with pictures and local names of these species. Another is by using endemic species as examples in lessons. The most effective way of getting to know the Philippine endemic species, according to students, is by researching about these species as part of their requirements/assessments. Integrating the endemic species helped students appreciate and care more for what species we have in the country, and hopefully translate to more active participation in promoting the welfare of these species.

#### **Interdisciplinary Learning in Biology: Bridging Disciplinary Boundaries for Enhanced Learning and Retention in Middle and Senior Secondary Schools**

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Interdisciplinary learning represents an innovative approach that merges the objectives and methodologies of two or more disciplines as opposed to a traditional monodisciplinary approach which is inadequate for solving the multifaceted challenges of the modern world. This paper aims to assess the effectiveness of interdisciplinary teaching of Biology across Middle, Secondary, and Senior Secondary schools, correlating it with enhanced student knowledge and increased retention. The study was carried out to broadly connect Biology learning with other disciplines like Physics, Chemistry, Geography, and Art. A pedagogical study was carried out assessing the lesson plans of Biology teachers and their effectiveness through the lens of an interdisciplinary approach. The study involved 1200 students from grades 7-12 and a set of formative assessments designed

to evaluate the broad integrated understanding were administered. Results indicate a strong correlation between the interdisciplinary approach and its significance in improvement in both comprehension and practical application of concepts and better retention of concepts as evident in the marks scored in the formative assessment. The study advocates for the widespread adoption of interdisciplinary teaching methodologies across the Middle and Senior & Senior Secondary schools in Biology elevating student engagement and academic attainment. The interdisciplinary approach helps students develop lifelong learning skills essential for their future education.

#### **Effect of treatment with a microscale pressurizer on the germination rate of plant seeds**

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This study investigated the effect of pressurization (0.2-1.0 MPa, 600 s, 20 °C) using a microscale pressurizer on the germination of plant seeds. The plant seeds used in this study were five species (crown daisy, tomato, carrot, parsley and Japanese parsley) that were selected mainly from plant seeds with low germination rates, as indicated by the Japanese Ministry of Agriculture, Forestry and Fisheries. The control population underwent pressurization of 0.1 MPa for comparison. The germination rate of Japanese parsley tended to increase by 62.5% at 0.2 MPa and by 125% at 0.5 MPa. In contrast, the germination rate of crown daisy tended to decrease by 42.5% at 0.2 MPa. No significant differences were observed for other seeds or under other pressurized conditions. This study's results are of great significance because they show the effectiveness of the microscale pressurizer. The microscale pressurizer enables microscale physiological hydrostatic experiments on animals and plants and can be used for teaching in exploratory activities. It can also overcome problems related to seed germination that can hinder teaching in science classes in elementary and junior high schools. The ability to promote stable seed

germination through pressure treatment can ensure greater learning opportunities for students. The increased germination rate of plant seeds leads to sustainable management of forests, and this research is relevant to and contributes to the achievement of SDGs 4 and 15.

### **Comparing Science Curriculum Design of Thailand with Japan: A closer look at biology contents in middle school science curricula**

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The national science curriculum plays a crucial role in shaping science teachers' approaches to teaching science in actual classrooms. Conducting a cross-cultural comparison can allow us to identify similarities and differences in learning outcomes, content arrangement, and pedagogical approaches emphasized in different contexts. This can provide us with broader understandings and perspectives of how our science teachers should be supported to teach science more effectively and how our students can be encouraged to construct a more well-rounded and robust understanding of science. Hence, this study aims to compare Thailand's science curriculum design with Japan's, focusing on biology contents at the middle school level. This study is a descriptive research analysis of documentary analysis. To conduct a cross-cultural analysis, the Basic Education Core Curriculum (BECC) and IPST science textbooks were used to understand Thailand's middle school science curriculum. The Course of Study for Middle School (CSMS's English version on MEXT's official website) and Dai-Nippon science textbooks were used to understand those of Japan. A content analysis of the two countries' science curricula revealed notable similarities and crucial distinctions. For the goal of science education, cultivating students as scientifically literate citizens is seemingly emphasized in both science curricula since they display science learning processes commonly associated with scientific investigations and student-centered inquiry experiences. However, some characteristics of both curricula are different, such as the total times

used in teaching biology concepts, required biology concepts, and their arrangement in each lower secondary school grade level.

### **Which organisms live in aquarium water?: "Aquarium PCR": exploring DNA technologies via practical learning experiences**

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The need to better understand living creatures and the environment has become increasingly important due to environmental issues such as climate change and loss of biodiversity. Biology plays a crucial role in promoting a healthy lifestyle. Advances in molecular biology techniques such as recombinant DNA and DNA diagnosis, and more recently genome editing, have increased the need to understand the nature and application of these techniques. It is expected that individuals have a comprehensive understanding of these techniques, highlighting the increasing significance of biology education. Given this background, we focused on DNA-related techniques that facilitate the examination of biodiversity at the DNA level. To this end, we developed an experiment aimed at teaching these techniques through the practical application of environmental DNA detection, primarily for high school students. We named this experiment 'Aquarium PCR' (polymerase chain reaction), which comprises four steps, i.e., DNA isolation from aquarium water, PCR, electrophoresis of the PCR products, and DNA detection using a fluorescent stain. Several species of freshwater fish, including Japanese medaka, were kept together in the same aquarium. DNA was isolated from the aquarium water and selective primers were designed and used to detect DNA from specific freshwater species. In addition, universal primers developed for fishes by Miya et al. (2015) were also used to amplify DNA. The specificity of our primers for amplifying DNA was verified through restriction

analysis. This sequence of experiments provides high school students with an excellent opportunity to learn about DNA-related technologies.

### **An Earth and Life Science Course for the Rest of Us: Students' Conflicted Stories of Participation**

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The goal of scientific literacy has become crucial in conversations about school science reform to address complex and interdisciplinary sustainability issues confronting our communities. Redesigning our Earth and Life Science (EALS) course, which all senior high school students from various academic tracks other than STEM take, allowed us to begin reimagining science learning for all - from merely learning concepts to mobilizing scientific knowledge for engaging participation in socio-ecological issues. A focus group discussion and interview were used to elicit students' perceptions and experiences to gain a holistic understanding of the impact of the revamped EALS curriculum. Through inductive thematic data analysis, we surfaced the tensions in students experienced: (1) overwhelming study load vs foundational college preparation; (2) perceived irrelevance to their academic track vs meaningful real-life application; (3) communication struggles during the pandemic vs active collaboration and immersive learning. We reflect on tensions in student stories to articulate a pedagogical framework necessary for teachers' collective guidance in future course iterations. Restructuring the course based on these insights can foster a more inclusive and engaging learning environment, ultimately empowering students to develop a deeper appreciation for the sciences and their relevance to the lives of our communities.

### **Using *C. elegans* for Early Detection of Cancer in Dogs and Cats**

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In the United States in 2023, an estimated 65.1 million dogs and 46.5 million cats lived as pets. The annual incidence of cancer among these animals is estimated at 4 million cases, with mortality rates of 47% in dogs and 32% in cats. Dogs experience cancer incidence that is 2.5 times higher than that of humans, which may be linked to their shorter lifespan, genetics, and higher prevalence of diseases. Regular cancer screenings are recommended for pets, but advanced techniques like CT and MRI scans are limited by cost and anesthesia requirements. A new screening method called N-NOSE has been developed to detect cancer in pets using the chemotaxis behavior assays of *Caenorhabditis elegans* (*C. elegans*) to detect cancer in urine samples. Previous research has shown that *C. elegans* are strongly attracted to cancer urine while avoiding healthy urine samples. In this clinical study, N-NOSE was used to detect cancer in the urine of dogs and cats. The chemotaxis index values in cancerous and healthy animals differed significantly ( $p < 0.01$  for dogs and  $p < 0.04$  for cats). The N-NOSE method is highly accurate, with areas under the ROC curve of 0.8114 and 0.7851 for dogs and 0.7667 and 0.9000 for cats in different urine sample dilutions. The study suggests that N-NOSE could be a simple and convenient method for early-stage cancer screening in dogs and cats. Currently, N-NOSE is already a commercial success for dogs and cats cancer screening in Japan.

### **Understanding adolescents' knowledge and attitudes towards vaccinations and vaccine-preventable diseases: Perspectives from India**

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The Universal Immunization Program (UIP) in India has not adequately emphasized adolescent immunization with most government initiatives targeted towards early childhood vaccination. The study addresses the dearth of evidence in India on vaccination information needs of adolescents. An exploratory qualitative study was carried out with grade 9–12 students after COVID-19 vaccinations were introduced stagewise in India for children aged 12–18. Semi-structured interviews conducted between November 2022–February 2023 with 16 students across socioeconomic strata (SES) in Mumbai, India, to ascertain their knowledge and attitudes towards vaccines and vaccine-preventable diseases. Excluding chickenpox and COVID-19, students' awareness of diseases was limited to examples listed in the science textbooks. Lower SES students reported getting measles, mumps, cholera, and typhoid in childhood. Vaccine safety and sideeffects emerged as the top concerns among students. Parents, doctors, and teachers were viewed as reliable and trustworthy sources of vaccine information. Students felt that schools did not provide adequate vaccine information. Though unsure about its "truthfulness", the media was still a preferred source of information. Our observations provide insights into the COVID-19 experiences and concerns of adolescent students. Most students were unaware of the Human Papillomavirus (HPV) and showed low intent to get vaccinated, which is concerning, given the Indian government's plan to introduce it into the UIP. Hence, a study on their perspectives would be vital in achieving sustainable development goals of good health and well-being. Science education and teachers have a crucial role in fostering scientific literacy about vaccination among students, especially in this post-COVID-19 era.

**The practice of visiting lessons of observation and experiment using insects for elementary school life environmental studies by university students**

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The curriculum guidelines for Life Environmental Studies state the following goals: "Students should be able to think about their own relationship with nature, notice the goodness and splendor of these things and their relationship with themselves, and cherish nature. Through contact with and involvement in nature, they should be able to devise and enjoy them, realize the goodness and importance of activities, and improve their own play and life," etc. Given these facts, experiential learning is emphasized in life environment studies, and actually observing plants and animals in the outdoors is an important activity. In this study, we developed observation and experiment materials using live insects in order to learn about animals and plants to be aware of when observing nature in the field, and also to learn about insects' habitats and food, thereby cultivating a perspective when observing nature. The class will (1) classify insects and non-insects. (2) Learn about the relationship between insects' habitats and food sources. (3) To learn about dangerous plants and animals. In addition to basic content such as an explanation of insects prior to the third grade science class, the class also touched on more advanced content. Team-teaching classes were conducted by university students for first- and second-year elementary school students in the prefecture, and a questionnaire survey was conducted for students before and after classes. In this presentation, we will report our analysis of the developed teaching materials and the results obtained from the questionnaire survey.

**Exploring How Teachers Navigate Tensions When Developing Assessments in a Professional Learning**

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Educational assessments provide opportunities to evaluate and improve the effectiveness of curricula or teaching methods. In developing these assessments, educators often encounter tensions—moments of explicitly confronting competing demands or juxtaposed ideals about assessments or education. This study aimed to explore the tensions that arise when teachers

develop assessments within a professional learning community, how they manage the tensions, and how the tensions affect the assessment development process. To this end, we formed a professional learning community with four middle school science teachers in Korea. The teachers had eleven 90-minute meetings to collaborate on developing and reflecting on assessments. We recorded the teachers' discourse and gathered artifacts from the meetings. We transcribed and qualitatively analyzed the teachers' discussions about assessments. Our findings showed that the teachers identified and managed three main types of tensions while developing and implementing assessments. The tensions were between the goals of: 1) "eliciting diverse answers from students" and "scoring with fair criteria," 2) "focusing on the processes of learning to guide student growth" and "grading to measure learning outcomes," and 3) "using group assessments for efficiency" and "using individual assessments to evaluate each student's learning." These tensions emerged when the teachers discussed how to realize their goals for teaching and learning while considering institutional requirements. By addressing these tensions, the teachers developed concrete strategies for assessments focused on reform-oriented goals in science education. This study provides implications for supporting teachers' professional learning about assessments and collaboration.

### **Enhancing Critical Thinking Skills in High School Biology Education Through Real-Life Scenarios: An assessment of conceptual understanding**

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Critical thinking has become an important skill of the 21st century to cater for complex challenges. However, it also fosters allied life skills such as organizational skills, planning, open-mindedness, and communication skills among school students. The researchers used Scriven and Paul's definition of critical thinking as a guide and developed a framework adapted from Barnett's model: Think-Reflect-Act approach. The current study aimed to

identify the extent to which 42 grade six & 41 grade nine students demonstrated critical thinking through carefully crafted real-life scenarios. Qualitative data is gathered through real-life scenarios on biological concepts and analyzed by categorizing information to understand themes and insights. According to the findings of the study, the use of real-life scenarios teachers can help students to develop critical thinking and problem-solving abilities in various ways. It shows that localized and contextualized learning activities promote a better understanding of the lesson. The findings also emphasized that critical thinking is a crucial skill that has the potential to benefit students in solving complex real-life problems. Therefore, it is essential to prioritize the teaching and learning of critical thinking in biology education. The study recommends adopting real-life scenarios strategies in teaching school biological concepts, in addition to conducting conceptual understanding. Hence, future study is suggested to develop and produce localized and contextualized instructional materials such as modules and worksheets for other learning competencies in biological sciences.

### **Study on Observation Method of Microtubules by Microscope in High School -Effects of Microtubule Inhibitors and Potential for Inquiry Activity Materials-**

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Since 2013, pictures of the cytoskeleton have been included in all Japanese high school biology textbooks, as the Courses of Study state that "to deal with the structure and function of cytoskeletons". However, these pictures are taken by fluorescence microscopy

or confocal laser microscopy using the fluorescent antibody method, and students cannot observe the cytoskeleton because these instruments are not available in high schools. Therefore, we proposed the immunoenzyme technique that can be observed with an optical microscope for students in high schools at this conference in 2018, and introduced a method for observing the cytoskeleton using silkworm (*Bombyx mori*) blood cells, which are readily available in Japan, at this conference in 2022. In this conference, we will introduce a method for observing microtubules in A6 cells which are Frog (*Xenopus laevis*) cell line derived from kidney that can be easily cultured by high school students. Microtubule inhibitors have been used as anti-cancer drugs (paclitaxel), gout medications (colchicine), and pesticides (proprylamide). We will discuss the results of observations of microtubule behavior using these drugs and their potential as teaching materials for high school students' inquiry activities.

**Wetlands as Classrooms: Advocating for local ecosystems through collaborative classroom-based research: A preliminary biological survey of Sasmuan-Bangkung Malapad Critical Habitat and Ecotourism Area**

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Wetlands are ecosystems where land and water interact. The Sasmuan Bangkung Malapad Critical Habitat and Ecotourism Area (SBMCHEA) is a mangrove islet created through the deposition of volcanic sediments. It lies within the Sasmuan Pampanga Coastal Wetland (SPCW), which in 2021 was declared as the Philippines' 8<sup>th</sup> Wetland of International Importance. SPCW is composed of inter-connected mudflats, mangroves, and a river ecosystem. It is an important stopover for

migratory birds on the East Asian-Australasian Flyway. The river system is also of economic, historical, and cultural significance to municipalities along its banks. Despite these, there is a dearth in available data on its biological diversity. The main objective of this study is to fill that void. Specifically, it aimed to determine the status of the wetland by measuring select physico-chemical parameters of the water and conducting a preliminary survey of its biological diversity (plankton, mangrove and fish). The study was conducted as part of the requirements for the course Freshwater Ecology by BS Biology students. Results of the physico-chemical parameters show that total dissolved solids (TDS) and dissolved oxygen (DO) were slightly higher than those for class C waters as defined by DAO 2016-08 and DAO 2021-19. Diatoms made up majority of the phytoplankton identified, while nauplius larva were the most common zooplankton identified. Five mangrove species were also identified with their conservation status under IUCN also being identified. Of the fish samples collected, 15 species were identified. This includes the endemic *Leiopotherapon plumbeus*, which is listed as vulnerable by IUCN.

**Students' Procedural Understanding During Inquiry-Based Practical Work: Preliminary Findings of Fermentation Experimentation**

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During inquiry activities, students frequently fall into the habit of mechanically following textbook steps, which causes them to lose sight of the activity's purpose and prevents reflective engagement. This lack of student autonomy during practical work results in a poor grasp of procedural understanding and biology concepts. To address this problem, an in-depth qualitative study was conducted using a guided inquiry-based approach. The guided inquiry activities were framed around

questions related to fermentation concepts and measurement guidelines, without providing specific experimental procedures. This qualitative case study involved 17 upper secondary school students from two sites, who participated in a scientific investigation on 'Yeast Fermentation'. Data were collected through interviews and observation of classroom discussions and analysed using the constant comparative method of analysis. The findings reveal that students involved in guided inquiry practical work were able to design experiments and evaluate the investigative process logically. However, this procedural understanding was achieved only after overcoming uncertainties, making multiple attempts and failures, and seeking guidance from peers and teachers. These results provide valuable insights into the challenges and successes related to procedural understanding in biology education, emphasising the significance of practical work in fostering deeper learning and engagement among students.

### **Unveiling Robotics Technology in Biology Education**

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Robotics is a cutting-edge technology in science education that is becoming an essential part of modern curricula. Research findings indicate that incorporating robotics into the curriculum can greatly improve students' thinking and self-directed learning abilities. For biology teachers, it is crucial to find engaging and innovative ways to offer students authentic, unique, and relevant learning experiences. Studies have shown that robotics fosters skills vital for success in the Fourth Industrial Revolution, including creativity, critical thinking, decision-making, and complex information processing. Integrating robotics in biology education involves students working collaboratively on research projects addressing life science issues and

concerns. During the project-making tasks, students are guided by their science teachers, robotics coaches, and research experts. This research showcases three exemplary projects namely: 1. VERTIBOT - an automated vertical garden robot designed to tackle the issue of farming in urban areas; 2. MAGDRAUBOT - a robot employing hydroponics and magnetism to provide alternative farming techniques; and 3. SENTRY - a robot designed for pandemic safety measures, featuring temperature checking, disinfection, movement barriers, and notification processes. Narratives from students highlight how their problem-solving and creative thinking skills are manifested in the design and development of these robot projects. These projects demonstrate the potential of robotics to enrich biology education and equip students with essential skills for future challenges. By exploring these projects and their outcomes, this research underscores the transformative potential of robotics in education, fostering not only academic growth of the students but also essential life skills.

### **Effects of Students Planning and Managing Lessons in InquiryBased Biology Classes**

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The new course of study in Japan, which has been in effect since 2022, promotes the improvement of classes by incorporating the process of inquiry. Many teachers in Japan are trying to incorporate inquiry in their classes, but few teachers are conducting inquiry in their classes because they distinguish between inquiry activities and classes. At the same time, the curriculum of the new course evaluates students on three perspectives: "Fundamental knowledge and skills", "Ability to think, to judge, to express themselves" and "Attitude of proactive learning". It can be used not only to provide feedback to students on their evaluations and to further develop their qualities and abilities, but also to improve classes for student development. Therefore, it is necessary to integrate the classes and evaluation of inquirybased classes. I am working on improve my inquiry-based classes,



and on exploring evaluation methods to integrate the classes and evaluation. In this presentation, I will introduce inquiry-based biology class of the field of molecular biology that all 5th grade students of our secondary school take. While the students planned their objectives, hypotheses, and verification plans, the research plans that were most evaluated were conducted experimental classes in which students actually planned, prepared, and operated. The preparation and management of classes by the students improved the skills necessary for the students' inquiry. In particular, the assessment of lesson preparation led to an improvement in the verification plan, among other things.

### **Epistemic Cognition in Science Education Practices in Japan: Case of Biology Classrooms**

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Japan's strong PISA rankings have sparked renewed interest in global education. Understanding Japan's epistemic fluency in science education practices is essential for gaining insight into their consistent academic success. Epistemic fluency demonstrates justified beliefs, the "process," and "ways of knowing." Anchored on the epistemologies in practice framework, we aimed to examine the students' objectives for constructing knowledge and their awareness of how to engage in that process. Notably, we seek to answer the question: How do biology classrooms develop epistemic fluency in Japan? The study employed a grounded theory research design. Our research strategy integrated school immersion, examining the classroom environment and closely observing the teaching methods used by the teachers. The classroom immersion occurred in three schools, where we observed seven elementary, lower, and upper secondary classes. We meticulously documented our observations through field notes, video recordings, and photographs. We enhanced our data by conducting focused group discussions

and interviewing the teachers. Then, we coded our recordings and constantly compared them with our field notes. Our peers carefully reviewed the coded transcripts during the observation to ensure their accuracy and validity. We used Marrying's inductive content analysis to explicate epistemic fluency into themes. Our research findings indicate that biology classroom demonstrates epistemic fluency through practical and real-life learning experiences. The students were actively involved in scientific exploration and fully engaged in hands-on scientific skills. The design of the classrooms accommodated inquiry innovatively and interactively. In addition, studying biology promotes self-reflection, which helps foster a deeper understanding.

### **Empowering Curious Minds: Exploratory Teaching through Immersive Learning using the GLOBE Program Protocols**

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In pursuit of transcending the confines of the classroom, exploratory teaching embraces a dynamic approach as students delve with varied skills which prioritizes discovery, scientific inquiry, and active engagement within the learning process. In this study, GLOBE Program protocols were emphasized and explored. For a span of two weeks, students embarked on an immersive learning journey focused on exploring different Earth System protocols covered by the GLOBE Program. The main target of the program is to provide students with opportunities in making significant environmental observations and collecting environmental data using the GLOBE Program. New GLOBE student accounts were created to submit data to the GLOBE Observer app, the GLOBE Data Entry and checked using the GLOBE Visualization System. A total of 249 data submissions by the students were reported, including 88 data collected in Atmosphere Protocol – Clouds; 17 data collected in Hydrosphere Protocol - Mosquito Habitat Mapper; 108 data collected in Biosphere Protocols - Land Cover,

Biometry Tree Heights, and 36 data collected in Pedosphere Protocol - Vegetation Covers. Students have continuously worked together on case studies, engaged in hands-on GLOBE activities and fieldwork using the GLOBE Protocols. Evidently, the students have developed a greater understanding of the environment around them while gaining essential insights into scientific procedures through activities like observing cloud conditions, reporting mosquito breeding sites, measuring tree heights, and evaluating soil moisture and land covers. It was also imbibed to have a strong connection to the global environment which ignited a love for environmental stewardship and preservation.

### **Teaching materials for indicator species surveys**

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In Osaka, the survey of indicator species by high school students was conducted as a project for the 40th anniversary of the Osaka High School Biology Education Research Association, and has been conducted almost every five years since then. The main purpose of the survey is to encourage high school students to pay attention to the nature around them through the survey. In addition, teachers have analyzed the results of the surveys conducted by the high school students and published reports. Therefore, through the survey of indicator species, I have attempted to create teaching materials to foster qualities and abilities. The survey was conducted same items as the Osaka High School Biology Education Research Association's Survey of Indicator Species Method A. I used the Google Form to the survey, because it is easy to aggregate the survey items and export them as a spreadsheet for later analysis. In the first year, analysis groups were formed for each survey item in class before the summer vacation, each group analyzed the results during the summer vacation, and the analysis results were presented in class after the summer vacation. Next year, I improved so that individual research would be conducted.

Through these activities, the students' interest in nature around them, ability to analyze and utilize data, and presentation skills improved. In the future, we would also like to conduct this survey at each high school in Osaka and build a culture in which Osaka high school students survey and analyze the ecosystem of Osaka.

### **Exploring DNA experiments using rice crackers common in Asian countries**

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The Human Genome Project commenced in 1990 and concluded in 2003. The project yielded the complete nucleotide sequence of the human genome, a crucial component of human biology. Following this historical achievement, thousands of genes were identified that are responsible for our physical and mental health. This knowledge has facilitated the development of genetic diagnostic methods that can be used to predict the onset of disease and the effects of treatments. Genetic diagnosis has the potential to contribute significantly to our well-being. However, knowledge of DNA-related technologies is not yet widespread. The importance of biological education is becoming increasingly evident. Here, we propose a new DNA experiment using rice crackers to facilitate learning about DNA technologies. Rice crackers, or rice cakes, are commonly eaten in Asian countries, particularly in Japan. Two kinds of rice cultivars are used to make rice crackers: glutinous rice and non-glutinous rice. In each glutinous rice cultivar, one of two types of DNA mutations in the waxy gene that encodes a granule-bound starch synthase was identified. Glutinous rice and non-glutinous rice can be distinguished by

examining the waxy gene. Furthermore, DNA isolation from rice crackers was successful despite the ultra-processed nature of the food. Based on these findings, we have developed an experimental procedure to determine which type of rice is used in rice cracker production. This educational exercise offers junior and senior high school students a valuable opportunity to gain firsthand experience with DNA-related technologies. Details will be reported in the presentation.

**Community-based Micro-watershed  
Resource Conservation: Impact  
Assessment of Anthropogenic Activities on  
the Water Quality of Barangay Irisan  
Watershed in Baguio City Biology Project-  
based Learning Approach**

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Irisan, the largest barangay in Baguio City, Philippines, is fortunate to have local water

springs that serve as a primary source for household water in at least 6 out of 28 zones despite the city confronting a myriad of water security challenges. However, there is a lack of data regarding the status of these local water springs and the absence of a comprehensive conservation plan. This study addressed this knowledge gap by conducting an assessment of the water quality, biodiversity and microclimate of the watershed in Purok 9 in collaboration with local stakeholders. Employing standard methods, the study evaluated water quality particularly, dissolved oxygen, total suspended solids, pH, temperature and fecal coliforms over four months to capture temporal variations. The results of the study revealed the presence of *E. coli* in both source and household water samples, indicating potential fecal contamination. Biodiversity assessments revealed a rich array of flora and fauna species, highlighting the ecological significance of the area. Meanwhile, microclimate analysis unveiled distinctive temperature patterns, with Purok 9 exhibiting a lower temperature of up to 5 degrees Celsius difference compared to neighboring areas, alongside a reduced UV index. Such insights offer valuable inputs for ecosystem management and conservation efforts in the city. The results of this project-based learning and collaborative study approach were presented to the local government as basis for policy formulation and future projects.

**One practical example of agriculture-based  
inquiry learning from its treatment in  
biology education**

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With future population growth in the world, a number of issues related to the environment and energy are receiving renewed attention. Among these, those related to food are the most pressing: the SDGs and other global initiatives to solve food problems are gaining momentum around the world. In Japan, there are many issues that need to be faced, such as a decrease in the number of bearers due to the ageing of the farming population and the large amount of food waste. We believe that it is

worthwhile to address these social issues once again in school education. Against this background, we introduce a practical case study from our school in which an inquiry-based study centred on agriculture was conducted in a science (biology) class. The school does not have an agriculture department and does not have any agricultural know-how, so the exploratory learning was done by hand. For example, the exploratory learning was conducted by setting issues based on soil analysis and ecological observations of the fields ploughed by the students. Continued practice is needed in the future, so we report on the current practice and results, and then describe future prospects.

### **Instructional Supports and Contexts for Facilitating Elementary School Students' Scientific Argumentation**

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The study aimed to explore instructional supports and contexts that influence the level and patterns of small-group argumentation activities among elementary students. To achieve this, a 9-lesson unit was developed focusing on constructing an explanatory model and argumentation about "What will happen to the ecosystem if bees disappear?" The unit was implemented over 5 weeks in two 5th-grade classes. Video recordings of the entire classroom, small-group activities, and class outputs were collected and qualitatively analyzed. The results revealed that instructional contexts and supports that enhanced students' argumentation activities were as follows. First, students engaged in higher levels of argumentation when provided with a space to freely discuss ideas, especially when: 1) recognizing the inadequacy of ideas, 2) attempting to express ideas in scientific terms rather than everyday language, 3) selecting ideas for presentation, and 4) discussing the ways to express ideas. Second, students' argumentation levels increased when teachers and researchers showed interest in students' thoughts through guided facilitation or supported logical step-by-step thinking. Lastly, students' argumentation levels increased when they acknowledged and attempted to reach consensus on the differences in their claims.

These findings provide insights that can support students' scientific practices and agentic learning.

### **Perspectives for global well-being: The perception of TVET graduate students about chat-GPT integration in science-biology learning**

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Science-biology learning is still an issue for some students at various levels of study. The integration of chat-GPT in learning can affect the learning landscape of students more positively based on the good acceptance of this artificial intelligence (AI) technology at the global level. Accordingly, this study was conducted to examine the perception of TVET graduate students about the integration of chat-GPT in science-biology learning. The online survey was answered by 60 respondents. Cronbach's alpha was calculated to be greater than 0.8. Data were analyzed using descriptive and statistical analysis including t-tests. The findings of the study show that most respondents have a very positive perception towards the integration of chat-GPT in sciencebiology learning. This findings show that science-biology learning problems among students especially at higher levels can be minimized through chat-GPT integration, in addition to its very flexible implementation.

### **Microplastics Detection in Water Samples from Sumaguig Cave in Sagada, Philippines: An Emerging Threat?**

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Microplastic pollution poses a significant environmental threat, contaminating diverse ecosystems, including subterranean environments. This study aims to detect and characterize microplastics in water samples from Sumaguing Cave in Sagada, Philippines. Water samples were collected from three natural pools inside the cave to assess the extent of microplastic contamination. The samples underwent a filtration process using alpha-cellulose filters to isolate potential microplastics. The retained particles were then subjected to a chemical digestion process through wet peroxide oxidation (WPO) to remove organic matter, facilitating the clear identification of microplastics. Stereo-microscopy was employed to examine the filtered residues, allowing for the identification and quantification of microplastics based on their morphological characteristics. The analysis showed varying concentrations of microfibrils across different sampling sites, which may be made of polyester and nylon. The findings of this study indicate that microfiber plastics have permeated subterranean water systems, suggesting widespread environmental dispersal and highlighting the vulnerability of the Sumaguing cave ecosystems to anthropogenic pollution, which may be brought on by tourism activities in the Sagada. The presence of microfibrils in seemingly pristine cave environments implies the need for comprehensive monitoring and targeted mitigation strategies to address microplastic contamination. This study also recommends further research to increase understanding of the pathways through which microfibrils infiltrate subterranean water in Sumaguing cave, and their potential impacts on cave-dwelling organisms.

**Evaluation of the Effectiveness of Environmental Education: Activities on Plant Dyeing for Indigenous Elementary School Students in Taiwan**

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This project adopts the action research method

to evaluate the effectiveness of environmental education activities focused on plant dyeing for indigenous elementary school students in Taiwan. Through site planning, instructional design, and course execution, the project involves in-depth observation and understanding of student behavior and responses during classes, with continuous adjustments for teaching methods. The project uses the Atayal Living Museum as the teaching site and collaborates with the local Lunpi Community Development Association and the nearby Datong Elementary School. We establish an environmental education facility based in the Lunpi community and develop suitable environmental education courses. In addition, we applied qualitative research methods such as data collection, analysis, and participant observation, along with quantitative methods like environmental education-related questionnaires to conduct this study. We focus on senior students at Datong Elementary School. The objective is to explore the effectiveness of environmental education courses in enhancing environmental literacy and to understand the students' thoughts and feelings during the course instruction. The action research at the Atayal Living Museum focuses on the Atayal tribe's plant dyeing techniques, complemented by instruction from handicraft teachers to highlight the museum's "Art and Humanities" features. During the implementation of the action plan courses, student behavior is observed, followed by another round of environmental literacy questionnaires and student feedback forms. The analysis includes research diaries, student learning worksheets, and feedback presentations, ultimately discussing the relationship between environmental education courses and environmental literacy.

**Aiming to advance genetic literacy in high school students Focusing on the relationship between genetic analysis technology and society**

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Molecular biology has recently become the center of learning contents in high school biology. In modern society such molecular biology techniques are used for clinical diagnosis and personal identification tools for victims in various disasters and in criminal investigations. Therefore, the Ministry of Education in Japan has made a major revision in order to make high school biology directly connect to modern biology based on molecular science, (2009). Moreover, High School Science Curriculum Guideline (2018) has put emphasis on inquiry-based learning and the importance of relevance to society and daily life. Here we developed a two-day novel teaching material to help high school students understand molecular biology by performing a lesson on genetic diagnosis based on the DNA experiment and then analyzing changes found in the students' pre- and post-questionnaires and -tests. The experiment lesson was given on the first day. On the second day lectures on genetic diagnosis, pregnancy, childbirth and women's life planning were given by three medical staff. And then a presentation on hereditary breast and ovarian cancer was given by a patient. After that, students were divided into several groups and discussed two case studies related to whether or not they would undergo genetic diagnosis. As a result, we could clarify the following; 1. The students recognized the benefits and the limitations of genetic diagnosis and realized the importance of DNA analysis in the society. 2. They could realize diverse viewpoints through group discussions. 3. These lessons led to enhance genetic literacy in high school students.

#### **Effects of Temperature on the Antibigram, Biofilm, and Biopigment Production in *Pseudomonas aeruginosa* Clinical Isolates**

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*Pseudomonas aeruginosa* is a notorious nosocomial pathogen owing to its resistance to multiple antibiotics and biofilm formation. This study investigated the effects of one week exposure at different temperatures on the antibiogram and biofilm-formation in *Pseudomonas aeruginosa*. A total of 30 isolates from clinical specimens were collected from a tertiary hospital. The preexposure minimum inhibitory concentration (MIC) was determined against the eight antibiotics: Amikacin (30µg), Gentamicin (10µg), Ciprofloxacin (5µg), Piperacillin Tazobactam (100/10µg), Ceftazidime (30µg), Cefepime (30µg), Imipenem (10µg), and Meropenem (10µg). About 80% of the isolates were found to be multiple drug resistant mostly to the beta lactam antibiotics. One isolate was resistant to all the test antibiotics. One isolate was resistant to all the test antibiotics. The post exposure MIC was taken after one week exposure at 24°C, 37°C, and 42°C. The biofilmforming activities after 48 hours were determined using the crystal violet assay. Results showed that increasing the temperature from 24°C to 42°C did not significantly affect the MIC ( $p>0.05$ ) but has a significant effect on the biofilm formation, with lower temperature (24°C) favoring increased biofilm compared 37°C and 42°C. In addition, pigment production was observed at 24°C, and became more pronounced at 37°C, but inhibited at 42°C. In conclusion, the ability of *Pseudomonas* to produce biopigment and biofilm was found to be temperature-dependent. This study underscores the importance of routine antibiotic surveillance for a directed and more efficacious treatment of *Pseudomonas* infection.

#### **Creating Evaluation Criteria for High School Students' International Collaborative Research Results and discussion descriptions in the field of biology through peer assessment with explicit evaluation criteria**

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In order to solve social issues on a global scale, there is a need to promote international collaborative research together with like-minded countries and regions. Therefore, it is important for high school students to experience international collaborative research at the high school level. However, there are few studies on the evaluation criteria necessary for students to reflect on each other's research in international collaborative research. Therefore, we conducted international collaborative research with High School A in Thailand and Nara Prefectural High School B in Japan to develop evaluation criteria for peer assessment in the result/ discussion writing phase and to clarify students' improvements. Evaluation criteria were created based on Goto (2013) and the criteria of the peer assessment table at Nara Prefectural Seisho High School, and peer assessment was conducted on the task of "describing the results and discussion of the group's research". As a result, more students fulfilled the criteria for the revised draft in the evaluation criteria of "Conducts multifaceted studies and discussions," "Interprets the data obtained from the results," and "Describes the method of statistical analysis conducted in the research." These results suggest that the creation of evaluation criteria and the implementation of peer assessment with clearly stated evaluation criteria in the international collaborative research allowed students to set up situations in which they collaborated with each other, and improved their scientific literacy.

**Square peg in a round hole? Investigating biology education for sustainable development curriculum practices of selected Filipino teachers**

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Considerable effort has been dedicated to

integrating Education for Sustainable Development (ESD) into formal curricula through extensive research. A significant body of research has delved into integrating education for sustainable development into the intended, formal curriculum, with a focus on curriculum integration audits. In the Philippines, environmental literacy is one of the goals of the biology curriculum. However, despite this, the integration of education for sustainable development remains localized to social studies, with unclear integration procedures in the biology curriculum. Hence, there is a pressing need to investigate how other subjects, particularly science and biology, integrate ESD into the formal taught curricula. This qualitative inquiry, which underscores the urgency of the situation, delves into how Filipino biology teachers integrate ESD into their classrooms. Practices of integrating ESD are explored through a two-pronged approach: focus group discussions with selected K-12 teachers and document analysis of lesson plans and curriculum documents. Thematic analysis was utilized to analyze focus group data, while content analysis was employed to scrutinize the curriculum documents. Findings reveal the absence of formal procedures to integrate ESD in biology lesson plans, leading to variation and occasional confusion in the integration of ESD. Moreover, this study discovered that ESD, while familiar, is not fully comprehended by biology teachers. Factors influencing this include the misalignment of pre-service biology teacher training and induction programs, as well as the lack of relevant inservice training. Recommendations include looking at ESD integration beyond formalistic procedures and focusing on the intersections of ESD and the hidden curriculum.

**Virus Education's Current Status and Issues in Japanese Elementary and Junior High Schools**

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This study is a basic research aimed at systematizing modern Japan's virus education. To elucidate the current characteristics of

virus education, this study analyzed the curriculum guidelines written by the Ministry of Education, Culture, Sports, Science and Technology as well as the textbooks for all compulsory courses (all grades, subjects, and publishers) approved by the Ministry. The curriculum's current status and issues were then derived. The analysis revealed no descriptions of viruses in the elementary school curriculum guidelines, but the supplementary explanation section of junior high school health and physical education did contain a description of viruses. Furthermore, the analysis of textbooks revealed publishers' descriptions of viruses, as follows: some in 5th-grade math; some in 6th-grade social studies; all in 6th-grade physical education; all in 7–9th-grade health and physical education, home economics, social studies, and technology; in 8th-grade science; in 8–9th-grade moral education; and some in 9th-grade Japanese. The following information will be presented at the conference: details of the curriculum guidelines and textbooks' content, analytic results in terms of grade ladders and aspects of content systematics, differences in characteristics between subjects, and discussion points obtained through the study.

### **The Development and Evaluation of Virtual Laboratory Modules in Human Anatomy and Physiology**

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The development of technologies had transformed the way we delivery of instruction and one aspect is through virtual laboratory activities. This article aims to developed virtual laboratory and its effects on BS Nursing student achievement at the University of San Agustin, Iloilo City. The developed virtual laboratory was incorporated in the university learning management system and was used in their HAP laboratory. Teachers and students evaluated the developed virtual

laboratory using adopt questionnaires from study of Dadiz et.al, (2014) using the Likert Scale. The teachers and the students both strongly agree that the developed virtual laboratory is effective in terms of objectives and content (X=4.34; X=4.66), clarity (X=4.4; X = 4.7), presentation (X= 4.42; X =4.64), relevance (X=4.2; X=4.64) and technical characteristics (X = 4.72; X = 4.38). To find out how developed virtual laboratory affects student performance, a one group pre-test posttest design was been conducted. Student achievement scores were compared before and after using the developed virtual laboratory. For that purpose, a set of 60 items quiz was developed. To determine the difference in pretest and posttest scores T-test for dependent sample was used. The pretest mean score of was 36.88 while posttest mean score was 53.51. Data showed that mean test scores increased after administering the developed virtual laboratory. Further, students' motivation using the developed virtual laboratory was measured using ARCS model. Results showed that fvalue of 0.8578 using one-way anova indicates no significant difference among means of ARCS model.

### **The level of awareness about the integration of artificial intelligence technology (AI) in basic science-biology learning among huffaz students**

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Academic exposure in basic science-biology may be less in-depth in most Huffaz Centers because the main target is mastering the memorization of the Quran. This study aims to identify the level of awareness about the integration of artificial intelligence (AI) technology in learning related to basic science-biology among students at Huffaz Center. A total of 67 students at one of the Huffaz Centers



were involved in answering the questionnaire online. Data were analyzed descriptively and statistically including t-test. Overall, the study found that some students have a relatively high level of awareness while others have a moderate level of awareness. The majority of students understand about AI in the development of today's technology world. The findings of this study show that students should be exposed to AI as often as possible to increase their level of awareness. The use of AI in Hufaz Centers in the future should be encouraged not only in academic learning but also in memorizing the Quran, so that the learning interaction is always resistant to global changes.

#### **Four teachers' differences in classroom management approaches (CMA): A case study in the Philippines**

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This case study determined whether four teachers' CMA varies based on years of teaching. Specifically, it compared two Grade 8 teachers from each set of beginning and experienced teachers with respect to facilitating skills, personality construct and metacognitive techniques dimensions. Data obtained from observations and interview on cell division and Mendelian genetics was qualitatively analyzed. The beginning teachers and one experienced teacher had stronger CMA than the other experienced teacher. Specifically, the other experienced teacher showed not much facilitating skills, less metacognitive techniques and failed to project a strong personality. The experienced teacher should be encouraged to retool and upgrade skills by attending trainings and workshops. This case study serves as a basis for school heads' planning of programs for continuous professional development on classroom management. For a more generalized conclusion, it is recommended to consider a greater population size as well as apply a specific statistical tool.

#### **Basic research on the contents related to explain scientific phenomena in arithmetic**

#### **and Japanese language textbooks for elementary school in Japan: Focusing on biological matters**

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In elementary school, the concepts related to living things might be constructed through not only science learning but also other subjects' learning. This study examined the contents about living organisms in arithmetic and Japanese language textbooks for elementary school in Japan. The approved textbooks that were most used in public primary schools of Tokyo were analyzed. The arithmetic textbooks used multiple species of animals in a variety of situations and contained the basic contents necessary for explaining living things from a scientific perspective, such as classification and tabulation. In Japanese language textbooks, several biological contents were included in the characters in the stories and in the events described in the explanatory texts. It was suggested that the understanding about the contents in the texts construct the basic images about the living things which would be learned in science, such as lives of insects and/or plants. On the other hand, there were disconnection parts between the contents in science and other subjects. For example, *Bacillus natto* was in the Japanese language text of the third grade but it was not the content of the science of the same grade and fermentation is not the science curriculum in elementary school. It was found that fundamental scientific explanation of biological phenomena and images of lives would be constructed through the learning in arithmetic and Japanese language classes. This work was supported by JSPS KAKENHI Grant Number JP23K20749 and JP24K00465.

#### **AI-Driven Science Teaching: Insights, Challenges, and Opportunities**

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This paper explores the potential of Artificial Intelligence (AI) to revolutionize science education drawing on insights from a workshop on AI in Education held during a national conference in the Philippines. Teacher participants emphasized the myriad of AI tools available for teaching and recognized their potential to enhance creativity, efficiency, and student engagement in science education. Both the workshop and the broader study emphasize the need for AI as an integral part of innovative science education, highlighting its capacity to transform teaching and learning practices. The study acknowledges challenges specific to science teachers, such as ensuring equitable access to technology for conducting experiments, accessing scientific databases, and utilizing advanced analytical tools, which were identified. Ethical considerations regarding the use of AI in scientific research and the importance of maintaining data integrity and privacy in laboratory settings were also emphasized. The study underscores the transformative potential of AI in science education while emphasizing the need for thoughtful implementation strategies, collaboration among educators and technology experts, and ongoing teacher professional development, which are essential to maximizing the benefits of integrating AI into the science curriculum. Overall, the findings envision a future where AI significantly improves science education by creating a more engaging and accessible learning environment for the next generation of scientists.

**Development of Teaching Materials for Enhancing to Understand of Biodiversity in Collaboration with Aquarium and Zoo: About SDGs Worksheets and Virtual Specimens Using ICT**

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Currently, human, and industrial development is having a serious impact on the world's biodiversity. Many species are extinct or on the verge of extinction, and the survival of various ecosystems is at risk. Therefore, teaching materials for thinking about biodiversity are necessary in biology education. On the other hand, in modern education, digitalization of education is progressing rapidly due to the development of ICT. Along with this, there is an urgent need to develop digital teaching materials that take advantage of the characteristics of ICT. Therefore, in this research, in order to solve the above social and educational issues, we had collaborated with aquariums and zoos and have developed teaching materials that utilized their resources. Two teaching materials we have developed are as below: 1. SDGs worksheets for marine ecosystem, 2. Virtual Skelton specimens for understanding mammals mainly. The SDGs worksheets were developed in collaboration with an aquarium. The aim was to understand the issues that microplastics have on living things and think about marine biodiversity through observing aquatic life in an aquarium. The virtual skeletal specimens were developed in collaboration with zoos. We have developed a virtual specimen that can be moved in three dimensions based on skeleton specimens from more than 10 animals including monkeys and elephants. These specimens can be viewed on tablets and other devices at schools. Through detailed and comparative observations, they can be used to understand animal structures and learn about animal evolution.

**Opportunities for Internationalization of Biology Research during the Pandemic and Beyond: the Microbiology Curriculum Perspective**

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The rationale for internationalization has been the subject of discussions and debates in Philippine academic institutions, especially in relation to changing academic calendar and

shifting paradigms in designing curriculum considering global standards and demands. In addition, the recent pandemic experience has taught us to rethink and adjust our ways of doing Biology in order to adapt to the dynamics of diverse cultures, systems, and practices at the international level. The advancement of global standards and outcomes for Biology education also means we need to facilitate complex thinking that goes beyond basic recall of facts, to enable our students, who would become Biologists, to apply problem-solving solutions to real-world biological problems, as has been shown by the response of Biologists in dealing with COVID-19. It is in this viewpoint that I will present case studies for internationalization, as experienced in the field of Microbiology, using (1) online resources for in silico analyses (e.g., MiGA, KBase), (2) available data for analyses from local and international databases (e.g., NCBI), (3) protocols for analyzing available data (e.g., scoping review, molecular docking for finding viral inhibitors) and platforms for remote mentoring and learning. Based on these case studies, there are many prospects for the revision of the Microbiology curriculum.

#### **Game Based Learning Approach on Strategic Thinking Skill and Understanding Concepts of Virus Material of Senior High School Student**

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This study aims to develop media puzzles with a game based learning approach to improve Strategic Thinking Skill and Understanding Concepts of Virus Material of Senior High School Student. The types of tests to determine the influence of puzzle game media on students' understanding of concepts are pre-test and post-test which are structured based on indicators of students' conceptual understanding, namely: 1) translation, 2) interpretation, 4) extrapolation. Observations were carried out by giving questionnaires to determine the influence of Strategic Thinking Skills on

students and then analyzing the data that had been obtained in the form of pretest, post-test and questionnaire scores. After obtaining the final value, analysis was carried out as a Normality Test, Homogeneity Test and Independent Sample t-Test. The linearity test is carried out to test whether there is a relationship between variables control (puzzle game) on students' conceptual understanding is linear or significant. if the resulting significance value more than 0.05, it can be said that there is no significant influence on students' conceptual understanding between the control class and the experimental class. If the resulting significance value is less than 0.05 then there is a significant influence on students' conceptual understanding between the control class and the experimental class. Based on these researches, it can be expected that puzzle media with a game based learning approach is feasible and effective for use in High School Students.

#### **Application of the online teaching material for biological course to secondary education and construction of the English version**

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We have developed an online teaching material simulating field biological course, VRinkai (V for "virtual" and Rinkai meaning "marine biological course" in Japanese) since 2021, due to limited usability of marine biological stations during the COVID-19 pandemic. VRinkai contains over 400 photos of marine organisms collected in marine biological courses in the past decade. In addition, the terrestrial version of VRinkai was established with over 200 more photos of

insects, amphibians, and reptiles. Students can enjoy learning classification of species at each taxonomic rank by catching randomly emerging animals in a game-like way. We have been demonstrating the educational effect of VRinkai in our university courses and it was expected to be applicable for secondary education as well. Also, English version was expected for global use. In this study, we updated VRinkai by adding new functions that allow teachers to create their original database and manage students in each class or group. Students can upload photos of local animals/plants taken in their field training. The updated version of VRinkai was applied to the class practices in junior and senior high schools. Registered data were automatically introduced in the biological classification games and in the hierarchical view which are used to compare the differences of multiple biotas. A questionnaire survey demonstrated that VRinkai is an effective teaching material for enhancing interest and active learning in biological classification, evolution, and biodiversity in secondary education. We currently making an English version, thus VRinkai is now expected for applying to global education courses.

**Diagnosing and remediating elementary students' misconceptions about 'Growth of Plants' through drawing Unveiling misconceptions using drawing and crafting solutions for conceptual change**

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This study identified misconceptions held by elementary-grade students about the "Growth of Plants". It investigated the reasons behind the misconceptions about a government Hindi Medium School in the suburban area of Mumbai, Maharashtra, India. The drawing method was used to identify the misconceptions, followed by interviews with ten Grade 3 and Grade 5 students to understand their underlying

reasons. After diagnosing the misconceptions, four sessions were prepared and planned accordingly to remediate the students' misconceptions. A thematic analysis for a holistic understanding of parts of plants and plant growth, including the drawing and interview analysis, was adopted for the study. Two main research questions guided this study: to diagnose students' misconceptions about plant growth and to assess the effectiveness of the "Hands-on Constructivist Pedagogical Approach" in remediating these misconceptions. The study employed convenience sampling to select 51 elementary students from mixed-grade classes (Grades 3 and 5) for practicality and accessibility. Data was collected using pre- and post-drawing tests, interviews, and classroom observations while taking the sessions as a participant observant. This study revealed the effectiveness of drawing methods to diagnose misconceptions; some were similar to those in previous studies, such as the fact that seeds are not alive and attributing anthropomorphic explanations for the growth of plants. The hands-on constructivist pedagogical approach involving collaborative learning led to conceptual change, evidenced by the post-tests (drawings and interviews) conducted.

**A dragonfly population survey based on the number of its nymph exuviae observed in a school biotope: Usefulness of exuviae in biology and environmental education**

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In recent years, there has been growing global concern about the impact of pesticide use and climate change on biodiversity and ecosystem. Particularly in Asian countries such as Japan, where paddy rice is widely grown, there is deep concern about the negative impact on aquatic animals. For example, a drastic decline in dragonflies has been reported, although the causes are not fully understood, and continuous monitoring surveys are still needed. In this study, we simply estimated the change in dragonfly population by counting the number of their nymph exuviae over four years in a small artificial pond at a teacher training college in Japan. The number of the exuviae

counted there decreased continuously throughout the four years, and the results were consistent with many previous reports indicating a decline in dragonflies. Immobile exuviae can be easily collected and counted by anyone, including students, while rapidly moving adult

dragonflies are technically difficult to count visually. In this presentation, we report the results of this monitoring study and propose the usefulness of exuviae as teaching materials in biology and environmental education, including other educational applications.

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<Poster Session>

### **How biodiversity is taught in upper secondary school biology in Japan**

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In the current Japanese Upper Secondary School National Curriculum Standard, biodiversity is one of the main learning topics in biology. To find out how biodiversity is taught in upper secondary school biology classes, we examined the treatment of biodiversity and related content in ten Basic Biology textbooks and five Advanced Biology textbooks which are currently used. There were considerable differences in content, its amount, and terms used by textbooks. In Basic Biology textbooks, 7 - 16% of the 150 - 240 text pages were devoted to biodiversity and related content. The number of terms on biodiversity and related content in each textbook ranged from 40 - 66, of which 19 - 44 were listed in the index, and 8 - 18 were key terms. Key terms common to most textbooks were biodiversity, species diversity, alien species, endangered species, extinction, ecosystem services, and environmental impact assessment. In the Advanced Biology textbooks, the pages allotted to biodiversity and related content was only 2 - 5% of the 270 - 428 text pages. The number of terms on biodiversity and related content in each textbook ranged from 33 - 48, of which 14 - 27 were listed in the index, and 7 - 13 were key terms. Examples of major key terms include biodiversity, genetic diversity, species diversity, ecosystem diversity, disturbance, Allee's effect, inbreeding depression, vortex of extinction, and ecosystem services. The survey results indicate that the content, terminology, and learning methods should be considered for students to recognize the importance of biodiversity conservation.

### **Learning to recognize the importance of biodiversity and the danger of its loss**

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According to the National Curriculum Standard, students should discover and understand the diversity of species in ecosystems through conducting observations and experiments in the unit "Biodiversity and Ecosystems" of Basic Biology. However, since this unit is placed at the end of the course, due to time limitation, it often ends up conveyed through "knowledge-based teaching". Instead of a teacher-centered approach, "Proactive, interactive, and authentic learning" is recommended to students for recognizing the importance of biodiversity and taking action to solve related issues. To help students find problems to investigate, we propose introducing the Planetary Boundaries concept which indicates that the loss of biodiversity is one of the key issues of concern. Planetary Boundaries' diagrams provide a visual framework for considering several other key issues, such as the nitrogen cycle and climate change, at the same time. This will encourage students to consider integrated inquiry on global issues, to become more aware of them, and to contemplate how to respond to them. Thus, the introduction of the Planetary Boundaries concept into Basic Biology classes could be a seed for further learning about biodiversity. Furthermore, it is desirable for students to conduct their own investigations not only within a particular subject but also across subjects. For this purpose, "Period for Inquiry-Based Cross-Disciplinary Study", which is newly established in the upper secondary school curriculum to aim to cultivate the qualities and abilities that

will enable students to discover and solve problems on their own, is applicable for studying further.

**Potential of *Pseudomonas* sp. from Mindanao endemic frog (*Limnonectes magnus*) in degrading polymer wastes in a micro-scale set-up**

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The study investigated the capacity of cutaneous bacterial isolates: *Pseudomonas* sp., *Enterobacter* sp., *Bacillus* sp., and *Streptomyces* sp. from three Mindanao endemic frog species for the biodegradation of polymer wastes in a micro-scale set-up. The isolates were identified based on morpho-cultural features, biochemical tests, and 16srRNA gene sequencing results. The polymer wastes tested were shampoo packets, surgical gloves, facemasks, and rubber shoe soles, which were prepared as cut and uncut and of varying sizes (5x5 and 1x1 cm), washed and subjected to moist heat sterilization before inoculation of bacterial isolates. Biodegradation capacity was measured as a change in mass, appearance, and density 60 days after bacterial inoculation. Results reveal no significant difference in the mass and appearance of all treatments based on polymer type, form, and size. However, a significant change in the density of polymer wastes of 1x1 cm size treated with *Pseudomonas* sp. was noted. The findings suggest that *Pseudomonas* sp. from the skin of *Limnonectes magnus*, a Mindanao endemic frog, can potentially degrade polymer wastes. Additional studies are necessary to verify this initial finding.

**Development and Validation of Empathy-S Instrument**

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The pandemic has brought a radical shift from face-to-face to remote learning modalities. The students' learning situation through synchronous and asynchronous science learning are faced with the challenge of learning concepts individually and collaboratively. This paper developed the Empathy-S instrument, measuring student's empathy while learning in the new normal. In this case, the researchers initially drafted the instrument, pilot tested for content and construct validation by six experts and 426 students in the municipality of Muntinlupa. The final instrument consisted of 14 items out of the original 38-item 5-point Likert scale instrument with a content validity index (CVI) = .84. Four components were accepted with considerable Eigenvalues and scree plot inflexions using principal factorial analysis (PCA) with orthogonal rotation using Varimax with Kaiser normalization. After reliability analysis, two components (1 and 2) were retained with Cronbach's  $\alpha = .83$  and  $.71$ , respectively.

**Antioxidant and Antimitotic Activity of Propolis Ethanolic Extract (PEE) from Philippine Stingless Bee (*Tetragonula biroi* Friese)**

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Natural products like bee propolis have drawn attention to their possible therapeutic potential in the search for alternative cancer treatments that target cell division and counteract reactive oxygen species (ROS). The present investigation aims to explore the antimitotic and antioxidant properties of Propolis Ethanolic Extract (PEE) obtained from *Tetragonula biroi* Friese Propolis from *T. biroi* Friese was extracted with 96% ethanol to produce the propolis ethanolic extract (PEE), then the DPPH radical scavenging assay was used to evaluate its antioxidant activity. The results showed a 100% inhibition rate that was comparable to

positive control, gallic acid. The *Allium cepa* test was used to assess the antimutagenic activity of PEE, and the results showed a strong association ( $r=0.923$ ) between higher PEE concentrations and a lower mitotic index. Microscopic examination showed that most of the cells were in prophase, indicating that PEE may be able to stop mitosis early on like that of several anti-tumor medications. The results highlight PEE's potential to counteract unchecked cell division and hinder ROS activity, which can be associated with its potential as a cancer treatment.

### **The Role of Metacognitive Skills in Developing Communicative Proficiency in Higher Education RFDT Instruction**

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This study aims to investigate the correlation between metacognitive skills and communicative proficiency at the implementation of Reading, Finding, Discussing & Talking (RFDT) instruction. Metacognitive skills, which encompass individual's awareness and control over their own thinking processes, are examined in relation to enhancing students' communicative skills, particularly in the context of RFDT-based learning in the Educational Profession course. Employing a quantitative approach with a correlational design, this study used 123 second-semester students undertaking the Educational Profession course as the research samples. The research instruments included essay questions to measure the levels of metacognitive skills and a validated communicative proficiency questionnaire. The data were analyzed using Pearson correlation statistical techniques to test the research hypotheses. The results show a significant positive correlation between metacognitive skills and communicative proficiency in RFDT instruction ( $r = 0.56$ ,  $p < 0.01$ ), indicating that students with higher metacognitive skills tend to have better communicative proficiency. The implications of this research highlight the importance of integrating metacognitive skill development strategies into the educational curricula, especially in higher education, to enhance students' communication effectiveness.

Further recommendations include the implementation of teaching methods that encourage self-reflection and control over thinking processes as an effort to improve the quality of learning and students' communication skills.

### **The Effect of AI-based Carbon Neutrality Education in Korea**

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This study aimed to investigate the impact on elementary school students' environmental sensitivity and creative problem-solving ability after conducting experiential and activity-based carbon neutral education based on AI tools for elementary school students. We analyzed the results of a pre- and post-survey on environmental sensitivity and creative problem-solving ability by applying AI-based carbon neutral education program to 25 sixth-grade elementary school students. The results of this study were as follows. First, the AI-based carbon neutral education program was effective in improving the environmental sensitivity of elementary school students. Significant changes appeared in the overall areas of sensitivity, aesthetic and emotional stability, and sympathy and compassion after the class. Second, AI-based carbon neutral education programs was effective in improving elementary school students' creative problem-solving ability. It can be seen that AI tool-based carbon-neutral education has had a positive impact on elementary school students' creative problem-solving ability. Third, the AI-based carbon neutral education program has a significant impact on changes in elementary school students' perception of the environment. As a result of analyzing interviews with students, it was found that this program has a meaningful effect on elementary school students, such as improving their interest in environmental pollution and behavioral practice. As described above, the AI-based carbon neutral education program was effective in improving elementary school students' environmental sensitivity and creative problem-solving ability and is believed to have a positive impact on changes in their

perception of the environment.

### **The Effect of Forensic Science Project Classes on Elementary Students' Science Inquiry Skills and Science Interest**

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In this study, we sought to determine the effect of forensic project classes on elementary school students' science inquiry skills and science interest. For this purpose, a forensic project class (7 sessions) was developed, and 26 students from one class at an elementary school in Metropolitan City B were formed as a single experimental group and the forensic project class was conducted. To conduct this study, we conducted a pre- and post-survey on scientific inquiry skills and science interest and analyzed the results. The results of this study are as follows. First, forensic project classes had an overall positive effect on improving elementary school students' science inquiry skills. There was a significant improvement in the post-test average compared to the pre-test. Significant changes were observed in both basic inquiry skills and integrated inquiry skills, which are sub-categories of science inquiry skills. Second, forensic project classes had an overall positive effect on improving elementary school students' science interest. There was a significant improvement in the post-test average compared to the pre-test. Significant changes were observed in all sub-categories of science interest: interest in science-related activities, interest in science related occupations, and science anxiety. In conclusion, the forensic project class had a positive effect on elementary school students' science inquiry skills and science interest, so it is expected that it can be used as a class to improve students' science inquiry skills and science interest in elementary school science education in the future.

### **Using Board Games to teach Carbon Neutrality in Korea**

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This study aims to develop students' environmental awareness and self-efficacy by using a board game as a teaching tool for carbon neutrality education, and to increase their ability to solve environmental problems related to carbon footprint and take action in their daily lives. In the course of the game, participants must connect the wooden fence tiles to create a forest to trap carbon. Students must also utilize carbon neutral action tiles to earn extra points or avoid carbon neutral obstruction tiles, which adds a strategic element to the game related to environmental literacy. Through the game, students learn about interaction with nature, social responsibility, the importance of economic decisions, and the need to be carbon neutral. Students explore how to use different strategies to most efficiently trap carbon and contribute to environmental protection by taking carbon neutral actions. Choices made in the game can inspire students to take sustainable actions in real life, which is a key goal of carbon neutrality education. Students used the board game in class for a total of two periods. The improvement of students' environmental literacy and self-efficacy toward carbon neutrality was evaluated before and after the board game class. The results showed that the environmental literacy and understanding of elementary school students were significantly improved. The students who participated in the interviews were able to think about the importance of carbon neutrality and express various opinions on the effectiveness of environmental literacy and carbon neutrality education.

### **Equipping Tomorrow's Educators: The Impact of Research-Infuse Learning on ESD Competencies in Biology Learning, Indonesian cases**

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This research-driven inquiry delves into the profound influence pre-service teachers wield as catalysts for ESD competencies. Our study aims to illuminate the transformative potential of research in molding these budding educators into impassioned advocates for sustainable practices and unwavering ESD champions. Our exploration is driven by a deep desire to uncover the intricate connections between research-infused learning experiences and the acquisition of ESD competencies. Preliminary findings have unveiled a compelling narrative: research experiences empower pre-service teachers to cultivate a profound understanding of sustainability concepts, as well as the intricate interplay between social, environmental, and economic dimensions. Through these experiences, they not only acquire knowledge but also harness the power to envision innovative teaching practices that seamlessly integrate ESD principles into their future classrooms. Furthermore, our research underscores the incredible potential of research-driven ESD education to nurture a profound sense of agency and a steadfast commitment to sustainability within preservice teachers. These empowered individuals are motivated to step forward as change agents, not just within the confines of their classrooms but also within their communities and broader educational settings. This research, beyond its contribution to the ever-evolving landscape of ESD competencies, offers profound insights into the pedagogical strategies and curricular enhancements that can empower pre-service teachers to drive sustainable change.

**Evaluation of the effectiveness of environmental education using environmental DNA analysis: Is it effective even for people who hesitate to touch living things?**

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Biota survey is used as one of the methods of environmental education, but it has several challenges. The difficulty in identifying multiple species cannot fully exploit the diversity of species. Moreover, education that involves direct contact with organisms can have a negative effect on people who hesitate to touch them. It is therefore necessary to develop a new environmental education tool that overcomes these challenges. Environmental DNA (eDNA) analysis, a novel method of surveying biota by analyzing the DNA of organisms present in the environment, has the potential to address these problems. Multiple species can be detected by eDNA analysis without specialized morphological knowledge. In addition, as the field process of this analysis only involves water sampling, it can be carried out by amateurs, including those unfamiliar with organisms. In this study, we investigated whether a survey of local biota using eDNA analysis could be used as an environmental education tool. An educational program using eDNA analysis was designed in three parts: a preliminary explanation of ecology and eDNA, sampling of river water, and a workshop lecture using an eDNA analysis result. We implemented this program during class time in three Japanese high schools. The results of questionnaire surveys suggested that students' interest in biodiversity and ecosystem services increased through the program. Some questions about interest in biodiversity improved more for students who said they were not good at organisms. This study is the first to show that environmental education using eDNA analysis can be effective when implemented during school hours.

**Learning for Science & Society in Primary School and Middle School Science, Korea**

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Learning for Science & Society are introduced in New Revised Version of National Science Curriculum, Korea. The new science curriculum consists of a total of five areas, with Science & Society added to the existing four areas of Movement and Energy, Matter, Life, Earth & Space. The Science & Society area focuses the role of science in individuals and the sustainable development of society. Learning contents of the Science & Society area have 'science & safety', 'science & sustainable society', and 'science & careers' in primary school science and middle school science (from 3<sup>rd</sup> to 9<sup>th</sup> grades). The Science & Society area has three core ideas on the following: Science and technology acquired through scientific inquiry contribute to human welfare and to be used for overcoming disaster situations. Science and technology contribute to a sustainable society by providing ways to efficiently use resources and energy. The development of science and technology affects the shape of future society and jobs, and individuals prepare for their lives by exploring the shape of future society and career paths. We expected students understand the interrelationship between science, technology, and society, and develop the ability to participate and practice as democratic citizens in solving individual and social problems through learning Science & Society area.

**Practice of visiting lesson for 6th grade elementary school students on the material cycle in ecosystems using LEGO blocks as molecular models**

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In sixth grade elementary school science, students learn about the cycle of carbon dioxide, water, and other substances through

photosynthesis and respiration, and learn about the food-eat-eat relationship between organisms. Nakamatsu et al. (2023) and Matsutani et al. (2023) developed educational materials on the mechanisms of photosynthesis and respiration using molecular models made with LEGO blocks from the LEGO Corporation, as well as materials for observing the food-eating relationship among organisms using live insects. In this study, we practiced a 90minute delivery lecture at an elementary school using those teaching materials. This class used a team-teaching method, with the participating university students divided into three roles: facilitator, assistant for observations and experiments, and coordinator. Questionnaires were administered before and after the class to examine changes in the children's knowledge and understanding, interest, and motivation for learning. As a result, the children's knowledge and understanding of material cycles and food chains among organisms improved from before to after the class. In addition, the inclusion of observations and experiments on the food chain using live insects is thought to have increased the children's interest in insects and the food chain.

**Potential of Mobile Microscopes as Tools for Citizen Science Promotion**

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Mobile microscopes are used by attaching single lens to the camera hole of smartphones or tablet PCs. These microscopes have been developed by Kuniaki Nagayama et al., based on Löwenhoek's monocular microscope, (Nagayama et al. 2013). The features of these microscope are as follows. 1) It is compact and convenient to carry around. 2) Observed images can be recorded on smartphones and other devices and shared over the Internet. With these microscopes, anyone can enjoy the microscopic world at home or outdoors. "Life is small Projects (LISP)" (launched on Facebook in 2015) is a voluntary group that aims to promote citizen science by giving workshops etc. using mobile microscopes. The

following examples show the advantages of mobile microscopes in school education. 1) Group discussions were easily held while viewing images of blood flow in fish fins on tablet PC (Yamanoi et al., 2023). 2) Using tablet PC for each student in a special-needs class enabled continuous observation of killifish development. 3) In a Cambodian high school biology class where microscopes are poorly available, exploratory cell observation became possible (Tsuzuki et al., 2021). LISP intends to develop and practice methods of utilizing the mobile microscopes and to compile collection of case studies of observations using them in the kitchen and other familiar places in order to promote citizen science. We would like to exchange opinions on what kinds of observation targets are appropriate, and what kind of utilization methods are possible and effective for school education and citizen science. <https://www.facebook.com/groups/life.is.small>

#### **Integration Post-Harvest Processing Technology of Java Long Pepper (*Piper retrofractum* Vahl.) for Curriculum Development in Vocational Schools**

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This research aims at analyzing the post-harvest handling and processing of Java long pepper (*Piper retrofractum* Vahl.) in Java as information for farmers and agricultural counseling workers, as well as to develop learning material on post-harvest learning for vocational school students. The methods used in this research were a survey supported by an interview with farmers of *P. retrofractum* in Java Island, Indonesia, regarding the handling of *P. retrofractum* post-harvesting. The results of the analysis of post-harvest *P. retrofractum* handling were used to develop learning material for vocational students in the Plantation Plant Agribusiness program. The best stages of post-harvest *P. retrofractum* handling which follow the standard process are initial sorting, washing, weighing, blanching, final sorting (grading), packaging or labeling, and storage. The results of the

learning material development indicate that the learning material is valid and can be applied in the learning process of vocational schools related to the necessary competencies of analyzing and evaluating post-harvest plantation plants.

#### **Integrating Local Wisdom of Traditional Dance into Biological Science Module in Plantation Area School**

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One of well-known plantation area is Kalibaru plantation, involving in remote area. The Kalibaru plantation community has local wisdom specifically on traditional dance. This study aims to develop a biological science module based on traditional dance in plantation areas. This research is development research. Data collection techniques using a questionnaire assessment or student responses to the module, needs analysis questionnaire and expert validation questionnaire. This traditional dance-based module development research design uses the four-D model proposed by Thiagarajan and Semmel. The results of the development research show that the validity level of the traditional dance-based module that has been developed reaches 84% in terms of material experts, 83.4% in terms of media experts, 77.5% in terms of linguists, 88.85% in terms of teachers (users), this indicates that the validity level of the traditional dance-based biological science module is feasible and can be continued in the next test. Based on the trial, the results of the questionnaire assessment or response of junior high school students are included in the agreed category with a score of 773 which means that students understand the material, understand the language used in the module and are interested in the appearance of the module.

#### **Collaborative Curriculum-Based Water Quality Research: Integrating Chemistry and Biology in the Study of Irisan Watershed, Baguio City. Biology and Chemistry education in the integrated learning**

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This study showcases a collaborative, curriculum-based approach to water quality research, integrating chemistry and biology disciplines within an educational framework. Conducted by students from Philippine Science High School- Cordillera Administrative Region, the research focuses on the Irisan Watershed in Purok 9, Irisan, Baguio City, classified as Class AA. The project aimed to evaluate the water's suitability for agricultural and household use through both physicochemical and microbiological analyses. Chemistry students assessed temperature, total suspended solids, pH, dissolved oxygen, and biochemical oxygen demand, concluding that the water is generally safe for use, though they recommend further routine testing. Biology students investigated the presence of *Escherichia coli* as an indicator of fecal contamination. Using membrane filtration and Eosin-methylene blue (EMB) agar, they analyzed samples from the main source, a storage tank, and a household faucet. While no bacterial growth was found in the main source, contamination was detected in the storage tank and faucet, suggesting issues with sanitation or environmental factors like animal waste. This interdisciplinary project underscores the importance of integrating chemistry and biology education to tackle real-world environmental and health issues. It highlights the necessity for regular water quality monitoring and maintenance of storage facilities to ensure safe water for local residents. Recommendations include routine cleaning of storage tanks and monthly water assessments to identify and mitigate contamination sources, promoting the community's health and safety through an educational lens.

#### **Development of Teaching Materials Using Resources in Zoo Practice with 4th Grade Elementary School Students Using ThreeDimensional Teaching Materials**

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Zoo have variety of effective resources in biology education where many animals are kept and exhibited. It is promoted to use of educational facilities like a zoo for school science by the Course of Study in Japan. However, it is educational issue that many school could not visit zoo as the place of field trips. So, in this study, we have developed ICT teaching materials that can be used online using animal skeletal specimens of the various educational resources zoo have. We have developed 11 materials of mammals, with most of them being monkeys. By posting the teaching material platform as 3D data on the web, Students can observe these skeletons from all directions, including enlarging, reducing, and rotating. A class practice using this teaching material was conducted with fourth grade elementary school students. As a result of the practice, over 90% of the students responded that they were interested in the skeleton. Additionally, over 90% of the students responded that the 3D data was very realistic. Furthermore, over 90% of students responded that they would like to go to the zoo and learn science more. Based on this research, we believe that we have been able to develop useful biological teaching materials.

#### **Development of Scientific Concept Assessment Based on Understanding by Design Curriculum**

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Understanding by Design aims for conceptual understanding, which involves transferring concepts to new situations or problem-solving scenarios, leading to enduring understanding. In this process also known as deep learning, learners develop practically applicable knowledge. In science education, deep learning is a significant goal. This study aims to develop an assessment model to achieve this goal and to

understand students' ability. To make this assessment model, we first refer to the achievement standards within the curriculum to identify key questions that confirm these standards. Familiar materials from textbooks are selected to pose these key questions, and problems are created using these materials along with the related scientific theories or conceptual content. The problem items are designed to start from a low-level explanation stage and progressively evaluate higher-level competencies through stages of interpretation, application, perspective, empathy, and self-knowledge. Additionally, the items are developed in a process-oriented manner, so that earlier items help in understanding and solving subsequent items. This approach will promote a deep understanding of scientific concepts and assess students' thinking skills and competencies.

### **Rethinking of Mendelian Genetics Curriculum: Critical Discussion-Based Education on Students' Genetic Determinism**

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Emphasis on certain knowledge in biology, especially in genetics, may inadvertently or intentionally contribute to biases and discrimination that could potentially divide individuals. Therefore, carefully selecting which biological concepts to emphasize in education is crucial and comes with responsibilities. Conventional introductory genetics education, based on Mendelian genetics, can perpetuate a deterministic view that genes are destiny, even after students learn otherwise. Research indicates that middle school students who focus heavily on single-gene traits in Mendelian genetics might start to develop or strengthen a belief in genetic essentialism. In response, we suggest a shift from the current Mendelian genetics curriculum to a revised approach that prioritizes interactions and phenotypic diversity, thereby mitigating genetic determinism among students. In the current context, where snippets of genetic determinism blend seamlessly with scientific discourse, it is essential that education does more than just convey genetic

concepts accurately; it should also promote genetic literacy, equipping students to critically assess the portrayal of genetics in the media. Critique creates space to explore alternatives and is particularly effective in educational activities that focus on collaborative construction of knowledge. Thus, encouraging students to critically discuss Mendelian genetics can effectively reduce genetic determinist thinking, enhancing the role of science education in fostering a more equitable and inclusive society.

### **Analysis of free inquiry activities of college freshmen major in Biology Education**

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Inquiry generally refers to the process of acquiring new knowledge that a person did not know before, or the activity of reproducing such a process. In other words, it simply refers to the pursuit of truth, information, and knowledge, and it is established as an important educational goal in the 2022 revised science curriculum in Korea. Inquiry learning does not mean that students should discover new knowledge or create new theories, but rather that they should reproduce as faithfully as possible the thinking process or method that the first researcher (scholar) went through when discovering the knowledge or theory. This study analyzed a task in which students enrolled in the biology education department of a college of education were given radish seeds and were asked to grow them for at least two weeks and submit the results. Ten radish seeds were distributed to all students, and they were asked to set their own variables and observe the radish seeds sprouting and growing. In this study, 23 freshmen enrolled in the Department of Biology Education at the College of Education were given guidance on the inquiry in the first week of March 2024, had them design an inquiry, and begin their own inquiry. The report was to be submitted by the end of May. . If students did not sprout or failed in their

quest, they were given radish seeds and were allowed to experiment again. Since this study was an experiment targeting students enrolled in the biology education department of a college of education, it can be said to have the meaning of examining the inquiry activities they have learned up to high school.

### **Environmental Talks with Future Generations Global science communication program as project-based learning**

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Environmental Talks with Future Generations is a global science communication program. Its purpose is to enhance the will to solve environmental problems as well as internationalism by having high school students talk about global environmental issues with other school students, students from overseas, graduate students, etc. In FY2023, in addition to students from Japan, high school students from Bangladesh also participated. The graduate students participated as a facilitator were from Bangladesh studying at Hokkaido University. 12 sessions were held in total from July to February, using both online and onsite. These sessions included four online lectures by foreign researchers and one beach-based plastic sampling. In the second half, we focused on the issue of marine plastics and explored what high school students can. Applicants were given the opportunity to work with Bangladeshi students who will visit Japan to create a panel discussion and to present their suggestion in front of large audience. Finally, eight applicants created effective materials and proposed solutions. The students who participated in the project increased their confidence in communicating in English, became more familiar with environmental issues, and realized the importance of not only researching but also taking action. According to the students' self-evaluations, they felt that their ability to expand their ideas and metacognitive abilities had improved. However, only students who participated in the panel discussion were able to improve their ability to plan, execute, and reflect. It is necessary to

examine what elements comprise the competency of internationalism and how it can be evaluated.

### **An Analysis of Peer Evaluations on Scientific Inquiry Exploring Students' Evaluation Levels and Patterns**

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This study aimed to analyze peer evaluations conducted to assess students' scientific inquiry abilities. Students' hypotheses and experimental designs were evaluated through the peer evaluation system 'Peer Evaluation Encouraging Reflection (PEER).' The analysis focused on assessing the quality of peer evaluations and understanding students' evaluation behavior patterns. It is expected that PEER will improve students' ability to critically evaluate their scientific work and promote a deeper understanding of scientific methods.

### **Environmental Consciousness of Senior High School Students: Basis for Innovative Environmental Education (EE) Approaches**

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This study investigated the level of awareness of environmental principles and issues among senior high school students, as well as the impact of gender, academic strand, grade level, and school type on their environmental sustainability initiatives and practices. Majority of the 770 respondents were female, enrolled in STEM strand in public schools. Results revealed that the respondents demonstrated significant awareness of sustainability principles and current environmental issues (Mean=3.33; SD=0.749). However, when it comes to practicing sustainability, responses indicated that these principles were only "often" practiced (Mean=2.93; SD=0.546). Notably, the level of awareness and practices

varied significantly across academic strands. The results unveiled a low positive correlation ( $r=0.296$ ) between the respondents' level of awareness and their practices. While students exhibited awareness of environmental principles and issues, they expressed a need for guidance on how to translate this awareness into meaningful action for the environment. Hence, there is a clear need for environmental initiatives that motivate students to actively engage in protecting and preserving the environment. Integrating "Education of, in and for the Environment" teaching learning activities will enhance students' environmental awareness and practices. This approach aims to cultivate environmental consciousness among students and empower them to contribute positively to environmental sustainability efforts.

**Practical use of experimental teaching materials using glowing lichen: Focusing on the lichen substance lichexanthone**

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The purpose of this study is to develop a learning program by combining experimental teaching materials of lichen. Lichen is a symbiont of fungi and algae. Although it has some features related to the contents of biology textbooks in Japanese high schools, there is a small number of teaching materials using lichens. In this study, we focused *Hypotrachyna osseoalba* (Vain.) Y.S.Park & Hale, a species of the foliose lichens. This species contains lichexanthone, one of the secondary metabolites of lichens (lichen substances). Because of this substance, the thallus of this species exhibits yellow fluorescence by ultraviolet light. The following experiments were examined. First, the crystals of lichen substances were observed by using microcrystal tests. These crystals showed different morphologies. Second, TLC was carried out to isolate lichexanthone. Consequently, one spot showing yellow fluorescence was identified as lichexanthone based on the R<sub>f</sub> value. Thirdly, the lichen substance was extracted from the TLC spot and crystallized. The crystals showed the same morphologies as lichexanthone. Furthermore, the crystals

exhibited yellow fluorescence by ultraviolet light. These results demonstrated that the yellow fluorescence of the lichen thallus is due to lichexanthone. From these experimental processes, an inquiry-based learning program was proposed, and evaluated practicality by implementing it in the actual class.

**Examination of experimental and observational teaching materials regarding nitrogen fixation using cyanobacteria (*Nostoc commune*)**

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Nitrogen fixation in ecosystem is covered in high school biology courses such as "Life phenomena and materials" and agricultural subjects "Agriculture and environment", and gives students deeply understanding of the interactions between living things in ecosystems and adaptive evolution. However, there are not many opportunities for learning through experiments and observations in actual classes, because it takes a lot of time to select the optimal target organism and their cultivation. Therefore, this research aims to create teaching materials for observation and experimentation on the subject related to nitrogen fixation using a method for simple and appropriate evaluation of nitrogen fixation ability through microscopic observation and analysis of metabolic activity of cyanobacteria (*Nostoc commune*). In general, nitrogen fixation of cyanobacteria is affected by the moisture and nitrogen condition of the habitat, so in this research, we evaluated the nitrogen fixation ability (such as ammonia content and nitrogenase activity) of them under culture conditions with high and low nitrogen concentration and moisture. As a result, it was found that the nitrogen fixation ability of them is positively affected by dry and low nitrogen conditions, and in this condition, it is appropriate to measure nitrogen fixation ability and observe nitrogen-fixing sites (heterogeneous cells). Thus, we conclude that it is possible to treat *Nostoc commune* as a target organism for teaching materials through

the evaluation of nitrogen fixation ability under optimal moisture and nitrogen conditions.

**Effect of deposition as a phosphorus source:  
Empirical study at the early stage of  
primary succession in volcanic soil**

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Phosphorus is an important plant nutrient for plant growth during the early stages of primary succession in volcanic soils. In immature volcanic soils, *Fallopia japonica* seedlings absorb inorganic nitrogen from wet deposition to colonize. The effect of deposition as a source of phosphorus was not well understood, so we investigated it. We tested the effects of deposition by treating *F. japonica* seedlings with wet deposition or distilled water in volcanic soils. The experiment was conducted at the Nikko Botanical Garden, and the deposition collected there was confirmed to contain phosphorus. *F. japonica* grown on volcanic soils with wet deposition exhibited higher phosphorus contents and growth rates than those grown with distilled water. These findings suggest that *F. japonica* grows gradually during primary succession and builds up phosphorus cycle, absorbing a very small amount of phosphorus from deposition. The remaining question is how the phosphorus came to be included in deposition. We hypothesized that plant matter (pollen and fallen leaves from nearby forests) could be blown away by the wind and included in deposition, providing phosphorus. As a result of verification, very small amounts of plant-derived components were confirmed in the deposition. It is unclear whether very small amounts of plant-derived components are the source of phosphorus in deposition, and this is an issue for the future.

**Plan for a biology class that fosters  
“hometown pride”**

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As globalization progresses, lifestyles and values diversify, and the inheritance of our

country's culture and traditions is at stake. In order to ensure that we carry on our culture and traditions to the next generation, I believe that now is the time for education that fosters “hometown pride (patriotism)”. This is fostered primarily in moral education, as indicated in Japanese Courses of Study. However, I examined whether students could develop hometown pride by strongly engaging with local organisms in biology classes and in integrated studies. Italians are historically and traditionally known for their strong hometown pride (Campanilismo). So to get a better understanding of the way hometown pride is fostered, I have been conducting surveys and interviews with Italians and people involved in the Italian food industry since 2018 regarding hometown pride. Based on these results, I also asked the students to plan lessons and events aimed at fostering hometown pride, which made me and the students reaffirm the importance of hometown pride and gave me many ideas for practices that would foster hometown pride. Furthermore, I have been involved in several practices related to be fostering hometown pride under the SGH (2015-2019) and WWL (2020-2024) programs for the development of global human resources at my school. I will present these practices as well. I hope that in the future there will be even one more global human resource who is proud of their hometown.

**Development of teaching materials about  
tidal flat ecosystem**

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Tidal flats formed at river mouth are important natural environments that provide an ecosystem for biological diversity. Currently, conservation of tidal flats is an urgent issue, because more than 40% of Japan's tidal flats have disappeared over the past 50 years due to land reclamation. So, it is important to learn about tidal flats in order to promote their conservation. However, it is difficult for children to visit the tidal flats in school education. Therefore, in this study, we have developed teaching materials to help



children to learn about tidal flats in school. We have developed the three teaching materials for learning about tidal flats, targeting Fujimae Tidal Flat, which is a representative example of the central area of Japan. The teaching materials are as below: 1. Online Video. 2. Resin specimens. 3. Role-playing activity. The on-line video allows children to understand the process of formation of tidal flats for 30 seconds, which takes about six hours from high tide to low tide. Resin specimens can help children understand the structures and characteristics of living things in tidal flats. In role-playing activity, children can play the roles of tidal flats creatures and help them to understand the tidal flat creatures and help them to understand the tidal flat ecosystem and food chain. We had practiced the class lessons using these teaching materials for elementary school children. As a result of the class practice, it was cleared that these teaching materials was good efforts for children to understand about tidal flats. 7

#### **Development of Teaching Materials for Resin Specimen of Insects to Understand of Body Structure and How They Grow**

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Insects are the living organisms that many children are most familiar with and most interested in, so they are suitable as a first living animals that children learn in elementary science classes. Through raising and observing insects, children learn about their body structures and how they grow. Recently, the number of children who dislike insects or unable to touch them is increasing. Therefore, in this study, we have developed teaching material of insect resin specimen that allows all children to learn about insects. Butterflies, dragonflies, and grasshoppers are introduced in Japanese elementary school science textbooks. We have developed resin specimen teaching materials for these three species. Three advantages of resin specimen teaching materials are as below: 1. Observable from all directions. 2. Observable at any time of the year. 3. Observable without touching the

insects directly. Through observation in all directions, they can understand the body structure of insects, such as the number of legs and shape of mouth. Children can observe various forms of insects at any time. And children who dislike insects can observe them because they don't touch insects directly. As a result of the class practice, all children were able to observe resin specimen teaching materials. And many children were able to understand insect structures and how they grow.

#### **Tracing flower visits of honeybees in an urban beekeeping hive A collaborative effort involving citizen science, inquiry-based learning, and biological research**

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The flower-visiting behavior of honeybees in urban beekeeping hives is of ecological interest and affects important features of honey products. The Okayama Honeybee Project 'Momotaro Honey Lab.' is an urban beekeeping project run by a private company. It provides a foundation for citizen science by disseminating environmental education among individuals through the cooperative efforts of local communities and educational institutions. As part of this project, a survey was conducted to identify plants visited by bees through microscopic observation of pollens to support inquiry-based learning among high school students. Pollen composition was found to vary with time of year, suggesting that bees visit the flowers of plant species with heterochronic blooming. To supplement these results, we performed DNA-based analyses in our university laboratory by utilizing our research equipment and expertise in plant molecular biology. We detected DNA sequences from cherry blossoms in honey collected in April, partially confirming high

school pollen analysis results. We are currently working to identify nectar and pollen source plants by DNA metabarcoding targeting the ITS2 region using Oxford Nanopore Technologies, a third-generation sequencing technology. This study identifies plants that play an important role in urban beekeeping through a collaborative approach and promotes understanding of the importance of biodiversity by revealing relationships between plants and insects and can contribute to education for sustainable development (ESD).

### **Class Practice to Improve Observation Skill for Junior High School Students**

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In this study, I had practiced the science lesson for junior high school students to improve observation skill, which is one of the process skills in scientific inquiry. In junior high school science classes in Japan, drawing is commonly used to record observations of objects. Additionally, mastery of drawing techniques is required by students. Therefore, when students do observations, they tend to pay more attention to the way of the drawing than observing the features of objects. So, as the aim of improving the significance and skills of observation, we have developed the program using sunflower seeds. As a result of the class practice, the first observation in the first half of the class, students had insufficient observation records because they were focusing on how to draw records. However, during the second observation in the second half of the class, they were able to capture the characteristics of the objects being observed and draw detailed observation records. Additionally, many students were able to understand the significance of observation, and learn about the importance of recording results.

### **A study on the cross-curricular learning of natural environment conservation in science and morality education**

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Issues related to natural environment conservation are often addressed in the context of trans-science. In order to tackle the issues, it is essential to balance scientific data with the development or protection of areas and the responsibility to conserve living organisms and nature. This study aims to identify the learning content regarding conservation of living things as explained in Japanese junior high school curriculum guideline and textbooks for science and morality education. Therefore, the purpose of this study is to clarify the current status and problems in cross-curricular conservation education. In science, the current Ministry's curriculum guideline for junior high school contains the mutual interrelationships among living things in the final unit of science section, and in a teaching guideline for the curriculum, it is described that human activities have made change to the balance of the natural world. The later also mentions climate change and alien species should be touched upon. On the other hand, in morality education, the same guideline contains reverence for life and a sense of awe, and a teaching guideline for the curriculum encourages students to humbly accept nature, perceive an emotional connection with nature, and become aware of nature conservation. Hence, morality textbooks contain learning contents related to these topics. Additionally, while elementary school students learn about the food-chain, most do not study ecosystems or other biodiversity conservation in science education. The gap indicates the possibility that many first grade junior high students might discuss conservation of living things without a scientific foundation.

### **Why do people hate insects? Elucidating Causes and Developing a Design for Learning Environments**

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It is becoming increasingly difficult to handle live insects in the third grade "Insect Morphology" unit at elementary school. One of the reasons

for this is that students and teachers "hate insects". Therefore, when there are many students and teachers who hate insects, classes are conducted using specimens and digital teaching materials. However, it has been pointed out that classes that do not deal with live insects do not provide a correct understanding of the body structure of insects. Teachers who teach in these classes also have a hate of insects. Why does this hate of insects arise? In a preliminary survey of elementary school teachers, the applicant revealed that they hate the "shape" and "movement" of insects. However, it is unclear what characteristics of insect shape and movement cause this hate. In this study, we clarified the characteristics of insect hate through a detailed investigation of the "shape" of insects.

**Cultivating a Sense of Attachment to Nature and Interest in Nature and Science through Experiential Agricultural Learning - Through a Questionnaire Survey of High School Agricultural and General Education Students-**

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In Japan, since the Meiji Era, when science was established, a rationalistic view of science based on Western science and a unique Japanese view of science that fosters a love of nature have coexisted (Ogawa, 2006). To nurture children in the age of VUCA, it is important to nurture the five human senses that cannot be replaced by AI. To this end, we conducted a questionnaire survey on the sense of attachment to nature and interest in nature and science among high school students in an agriculture course, focusing on the nature-loving sentiment unique to Japan. In this limited survey of agricultural high school students, a sense of attachment to nature and animals was fostered through hands-on agricultural learning. The results also suggest that the students' interest in nature and science has increased, and that they may have a positive attitude toward newly discovered scientific findings, rather than a bias toward nature worship in solving global problems.

**Microscopic observation method using side illumination to promote three-dimensional images**

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Optical microscopes are extremely useful teaching tools, and are frequently used in Japanese science education from elementary school to high school to study biological observation, but in most cases, observations are made using transmitted light. When observing through transmitted light, the image obtained from the sample is generally flat, and it is not possible to obtain a three-dimensional image like with a binocular stereomicroscope or an electron microscope. However, binocular stereomicroscopes are limited to low magnification, and unfortunately cannot provide images as high as optical microscopes. Originally, biological cells are assembled in a three-dimensional manner, and the inability to assemble a three-dimensional image using only two-dimensional images, as in the past, may encourage misconceptions about biological cells. In a questionnaire survey conducted on second-year university students, most students were unable to describe the stomata of plants as a three-dimensional image. Therefore, the purpose of this research was to make it possible to obtain three-dimensional images by devising side illumination, thereby making it possible to reproduce the image of biological cells three-dimensionally. Taking as an example the observation of stomata in leaves, which is common in biological observation, by adjusting the illumination brightness and incidence angle of side illumination using LEDs, it was observed that the guard cells had a convex shape and the stomata had a concave shape. In this presentation, observation methods while comparing images obtained with transmitted light and images taken with side illumination will be reported and discussed.

**Development of observation and experiment teaching materials for sixth grade elementary school science class. -Observation and experiment of the material cycle in an**

### **ecosystem using LEGO blocks as molecular models-**

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In the sixth grade science unit “Organisms and the Environment,” students learn that there is a food-eat-eat relationship between organisms and that organisms interact with the surrounding environment through respiration, photosynthesis, and transpiration, and through oxygen, carbon dioxide, and water. To understand chemical transformation, the concept of particles such as molecules and atoms is necessary. This concept formation is difficult not only for elementary school students but also for junior high school students, and it’s reported that it’s important to introduce particle images from elementary school in order to solve the problem. In also Based on these facts, this study developed educational materials to learn about the material cycle and energy transfer in ecosystems through photosynthesis in plants and respiration in living organisms by building molecular models using LEGO blocks. We also developed educational materials to observe the food chain using the corn’s young leaves (producer), *Mythimna separata* (phytophagous), and *Andrallus spinidens* (zoophagous). In nature, food webs are almost always formed by several interlocking food chains. Food webs are maintained when populations of various organisms are connected and biodiversity is maintained. We developed a teaching material in which each Jenga is represented as a population of an organism, and the relationship between populations in an ecosystem is represented by a pyramid of stacked Jengas. This teaching material teaches that high biodiversity leads to the maintenance of ecosystems.

### **Development and practice of teaching materials utilizing sea animals in aquariums in Japan**

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It was emphasized the use of social educational facilities like zoo and aquarium in the new Course of Study for Japanese elementary school issued in 2017. In the Course of Study, it is important that students think of the perspectives of commonality and diversity in the life science. Therefore, zoos and aquariums that keep and exhibit many various animals are suitable facilities for learning about the commonalities and diversity of life for students. There are many educational materials developed in which elementary and junior high schools and zoos collaborated with. However, there are only a few cases in which elementary and junior high schools and aquariums did. So, we have developed the teaching materials to make better use of aquariums in biology education for elementary school science. We have developed worksheets that allows elementary school students to study about animal behavior and ecosystem by observing animals at aquariums. In order to verify the validity of the developed teaching materials, we have conducted a class practice for 2nd and 4th grade elementary school students. By using these worksheets at the aquarium, many students were able to become familiar with sea animals and learn about the sea environment.

### **Developing teaching materials for high school biology to understand environmental viruses: PCR methods to detect viruses in aquatic environments**

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Understanding “environmental viruses,” which are the viruses that are part of the global ecosystem, is crucial for gaining a deep understanding of viruses. Viruses have a significant impact on ecosystems and the evolution of living organisms through their interactions with them and other viruses. However, it is difficult for high school students to focus on and research viruses. We developed teaching materials for high school students which focuses on environmental viruses. It familiarizes the students with the viruses, and helps them confirm their existence through experiments. We targeted T4-like phages that exist in many aquatic environments for the experiments. We used two types of filters to collect viruses from water samples. We extracted DNA from the sample using a simple extraction method, and then amplified specific sequences of T4-like phages using PCR. The participants were third-year high school students, and a descriptive survey was conducted after class, which revealed that it was focused on the relationship between viruses and the entire ecosystem and it could be an opportunity for them to feel connected to viruses. Additionally, we found that by changing the combination of the two types of filters, giant viruses, such as Mimivirus, could be detected. We hope that the existence of environmental viruses will be widely recognized in the future through lesson plans and practices utilizing the experimental teaching materials developed in this study.

#### **Implementing Online Classes Combined with the Observation of Animal Derivatives**

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Adventure World is a theme park in Wakayama Prefecture, home to 120 species and 1,600 animals, including giant pandas. The park also emphasizes educational outreach, offering 70 programs annually to 2,000 children. Since COVID-19, online classes have increased, providing more opportunities for distant children. However, these often became lecture-based due to the lack of close animal

interactions. To address this, Adventure World developed online learning content in collaboration with Benesse Science Class, an extracurricular science workshop provider. The content included observing animal feces and skull specimens sent to the classes in advance. These animal derivatives classes were conducted on December 26 and 27, 2023, with 23 primary school students. The keepers gave lectures and guided observations via Zoom. In the "feces class", the students classified the feces of giraffes, zebras, rabbits, and lions. However, 90% of the students confused giraffe and zebra feces. This was likely due to the misconception that the size of the animal correlates with the size of its feces. We will utilize this gap in future introductions to digestion to motivate students. In the "skull specimens class", the students classified the skull specimens of zebras, lions, and brown bears. However, some students mistook a lion's skull for a brown bear's, suggesting that adding feeding videos can help learn the relationship between tooth shape and diet more exploratory. Overall, students engaged in the exploration more actively than usual, resulting in high satisfaction. Therefore, combining online classes with animal derivatives was considered useful in motivating students to explore.

#### **Basic research for developing teaching materials on “ecology and the environment”: Focusing on the diversity of photobionts in the lichen family Cladoniaceae**

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The aim of this study is the development of teaching materials using features of lichens. Lichens are symbiotic organisms belonging to fungi. The lichen body consists of fungal hyphae and algal cells. Algae called "photobionts" provide photosynthetic products to fungi called "mycobionts", and fungi provide water, inorganic matter, and a stable habitat to algae. Therefore, this symbiotic relationship is considered mutualistic. *Asterochloris* (Trebouxio-phyceae, Chlorophyta) is a genus commonly found in many lichens, for example, *Cladonia* and *Pilophorus* of the Cladoniaceae, *Stereocaulon*

and *Lepraria* of the Stereocaulaceae, and others. Although *Asterochloris* is widely distributed across the world, research on its species diversity has been insufficient in Asia, Africa, and the Neotropics. In this study, we examined the photobiont diversity of the Cladoniaceae in Japan. As a result, five clades of *Asterochloris* were recognized as the photobionts of Japanese Cladoniaceae by genetic analysis. In the global distribution of each clade, three clades were widely distributed, and two clades were found only in Japan. The widely distributed three clades were classified into two types: one type was distributed in the temperate to subarctic regions of the Northern Hemisphere, and the other was found in the tropical to temperate regions of both the Northern and Southern Hemispheres. This genetic diversity and the distribution differences of photobionts suggested that each photobiont occupied its niche relative to temperature. This lichenological topic would be useful for learning about the relationship between living things and the environment.

**Development of teaching materials to verify the laws of inheritance using Japanese rice fish “Medaka” (*Oryzias latipes*)**

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“Medaka” (*Oryzias latipes*) is a small freshwater fish commonly found in rice field and streams in Japan. The body color of Medaka varies depending on the expression, size, and distribution of melanophores, xanthophores, and leucophores present in the epidermis. The expression of melanophores is determined by the combination of the B and b alleles, and it has been revealed that the black-brown body color is a dominant trait. In this study, basic research was conducted on crossbreeding experiments using commercially available Medaka in order to utilize their body color genetics in secondary science and biology. Three types of medaka with different body colors (black, orange, and white type) were prepared. The genotypes related to melanophores were BB or Bb for the black type, and bb for the orange and white types. In crossbreeding

experiments between black and orange types, or black and white types, all F1 generations were black-brown in color. Therefore, it is inferred that the genotype of the black type used in the experiments is BB. Next, crossbreeding experiments were conducted between F1 individuals, and the expression of melanophores in developing eggs was examined. In the experiment conducted in 2023, from one pair of F1 generations obtained by crossing a black type with an orange type, 315 eggs with melanophore and 122 eggs without melanophore were obtained, with a segregation ratio of 2.58:1. In my presentation, data from ongoing experiments will be reported and a comprehensive discussion will be provided.

**Observation of phagocytosis by lepidopteran larvae hemocytes using fluorescent ink as a foreign substance**

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In the basic biology of high school, the observation of phagocytosis by hemocytes can be easily observed by using lepidopteran larvae and india ink as foreign substances following the method of Sawa and Nakamatsu (2014). However, in the class, 42.9% of students could not find the phagocytosed hemocytes by themselves without the assistance of university students. In this study, we aimed to develop a foreign substance and an observation method to allow students to find phagocytosed hemocytes independently. We focused on materials that emit fluorescence, and examined the types of foreign substances and experimental conditions that are suitable. As a result, the most suitable experimental condition for teaching was using *Mythimna separata* larvae belonging to the family Lepidoptera and yellow fluorescent ink diluted 500 times with physiological saline and a reaction time of 15 minutes. In addition, hemocytes that showed phagocytosis to fluorescent ink could be easily observed by

installing a flashlight-type UV light in the microscope. It is thought that students can easily observe the blood cells that show phagocytosis by finding fluorescent foreign substances in the dark field using only UV light and then recognizing the outline of blood cells in the light and dark fields using both halogen light and UV light.

### **Development and implementation of teaching materials for phytoremediation: Aiming to understand the importance of biodiversity**

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The issue of lead contamination in water and soil, resulting in poisoning, is a major global concern. Phytoremediation refers to the method of using plants to purify the environment, which is expected to have a negligible impact on the environment. Furthermore, it is being evaluated for its potential use in effectively dealing with lead contamination. Conveniently, lead compounds, such as lead nitrate, are used in middle and high school curricula in Japan. We expected that incorporating experiential learning on phytoremediation could enhance students' comprehension of the utility of plants and the importance of biodiversity. Additionally, we anticipated that this approach would stimulate their interest in ecosystem conservation and facilitate accessibility to related technologies. Therefore, we developed teaching materials for conducting lead purification experiments using plants and conducted practical lessons, achieving the following results: 1) We developed a colorimetric method using rhodizonate appropriate for the quantification of Pb<sup>2+</sup> in high school settings. 2) We established a simple culture system for the protonema of *Funaria hygrometrica*, which has been demonstrated to have potential for use in phytoremediation. 3) We devised an experimental system to assess and contrast the lead purification capabilities of different plant materials within 5–10 min. 4) With the aid of these experimental systems, we conducted four distinct types of practical lessons. As a

result, most students favorably viewed the lessons, highly evaluated the plants' ability to purify the environment, and demonstrated heightened awareness of biodiversity and natural environment conservation.

### **The effects of cross-disciplinary inquiry-based learning: Enhancing self-efficacy and growth mindset through the integration of science research and biology education**

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Inquiry-based learning is being introduced worldwide to achieve efficient knowledge acquisition and develop 21st-century skills. At our school, we offer an inquiry-based science research class where students set their research themes and engage in two years of inquiry activities, including hypothesis formulation, experimentation, data analysis, and discussion. Similarly, biology classes incorporate these inquiry steps, allowing students considerable freedom in their experiments. This presentation examines the synergistic interaction between the inquiry-based science research class and biology education. Results show that data analysis and graphing skills acquired in the inquiry program significantly enhanced the quality of biology experiment reports, facilitating high-quality discussions. Conversely, the knowledge and skills gained from biology experiments fostered the development of new hypotheses and deepened inquiry activities in the science research program, creating a synergistic effect. Through two years of inquiry activities, students also improved their presentation skills, including poster presentations. According to a survey, more than 90% of the students reported that they "gained perseverance, grit and self-confidence through inquiry-based science research class," demonstrating the benefits of sustained work on a single theme. The synergistic interaction between subjects enhanced students' critical thinking, problem-solving skills, and self-efficacy, contributing to an improved growth mindset. Enhanced self-efficacy is crucial for fostering students' belief in their

abilities and independence in tackling tasks, underscoring the positive impact of integrating inquiry-based learning with biology education.

### **Designing STEAM Instructional Plans for Remote Online Learning: Teachers' Insights and Hindsight**

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Science, technology, engineering, arts, and mathematics (STEAM) education equips students to address real-world problems. It is an educational model that develops the creative, The COVID19 pandemic prompted the Philippine education to shift to remote learning mode. This challenging time called for teachers' creativity and resourcefulness especially in their Science classes. This descriptive study presents stories of public and private school Science teachers on the design of STEAM instructional plans for remote learning. The study examines the opportunities and challenges they experienced as well as the strategies they employed in their attempt to innovate and enhance the learning experiences of their students. The teachers highlighted the following as essential to successful design and implementation of STEAM instructional plans: (1) extensive and reasonable teacher training; (2) justifiable standards and expectations during implementation; (3) proper allocation of resources; (4) enhanced parent and student awareness; and (5) intensive industry partnership. Inequality should also be addressed for full realization of STEAM curriculum in the Philippines. Findings and recommendations guide designers, implementors, and instructional supervisors in crafting teacher trainings and establishing support systems to optimize the use of STEAM curriculum design in remote learning.

### **Learning Related to Climate Change in High School Science, Korea**

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Learning contents related to climate change have been introduced in National Science Curriculum, Korea. Inquiry activities related to climate change of Environment & Energy area in Integrated Science subject are on the following: Explore changes in the Earth's heat balance due to global warming, and Design future scenarios for ecosystems and the Earth system. New subject has been developed according to new revised national science curriculum for climate change education: Climate Change & Environmental Ecology for high school students, which has contents of characteristics of climate and environmental ecology, climate crisis and environmental ecological changes, and our efforts to respond to the climate crisis. The subject is aimed at understanding the seriousness of environmental and ecological changes due to climate change, and exploring the efforts of humanity and society to respond to the climate crisis, creatively and actively solving various social problems based on interest and curiosity in natural phenomena and scientific experiences in everyday life. We expected that these learning contents related to climate change should contribute to learning for climate change education and education for sustainability.

### **Development of a Generative AI-based Chatbot Service for Life Science Education**

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This study aims to develop an artificial intelligence chatbot service that can be utilized in science subjects' teaching and learning processes, offering a practical and effective solution. The goal is to design a life science education program using the developed chatbot, demonstrating its realworld application. Through prompt engineering on generative artificial intelligence based on large language models (LLMs), modules applicable to various teaching-learning contexts in science classes



were developed, and the educational applicability was explored. The chatbot-based educational model was applied to the 5th-grade unit "Various Living Things and Our Lives." For each lesson of the selected unit, prompts aligned with the learning objectives were developed and applied to the chatbot. The interactions between students and the chatbot were analyzed to investigate the usability. The results showed that the developed chatbot could be a handy teaching-learning tool for generating questions and responses tailored to learners' responses and levels, facilitating discussions, suggesting search content, and summarizing, evaluating, and providing feedback on learners' responses. In lessons

aimed at researching and understanding scientific knowledge or concepts, the chatbot demonstrated its ability to excel as a teaching assistant. In lessons focused on students' understanding and application of learning content, it was confirmed that activities such as self-evaluation, discussion, and unit summary could be carried out through interactions with the chatbot. In particular, the chatbot has shown that it can interact with students whenever and wherever they need it, without time and space constraints. This feature is expected to make personalized and adaptive learning more feasible as it can provide timely feedback that matches the student's level.

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<Poster Presentations by Junior High and High School Students >

**The Evaluation of the biodiversity of Atsubetsu  
Minami Forest Park for conservation:  
Consideration of economic value based  
on biomass estimation**

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Every tree measurement is one of the vegetation survey. Following this method, we identified the species of tree living in that area and measured circumference at breast height. This method allows us to obtain basic data to clarify the characteristics of the vegetation and its changes over time. Atsubetsu Minami Forest Park (Atsubetsu Ward, Sapporo City, Hokkaido) is a nature park located near our school. We set up three plots in Atsubetsu Minami Forest Park, and have conducted surveys for two years, and attempted analyzes the data obtained in our survey using a variety of methods. The results showed that although this forest is a park near a residential area, it has significant biomass comparable to that of a natural forest and has great economic value. We will continue to observe the ecological characteristics of this space by conducting continuous observations in conjunction with other surveys, for example Environmental DNA analysis. In addition, we will make some suggestions for forest conservation based on our research. On the day of the

announcement, we will also report on the results of the third survey conducted in April 2024.

**Comparison of firefly habitat and research  
pond environment and study of firefly  
induction methods**

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In Japan, there are many events to observe fireflies. The light emitted by fireflies attracts not only Japanese people but also tourists. However, firefly habitats have been declining, and become a problem in recent years. The cause of this problem is said to be the deterioration of their habitat environment. We are interested in this issue, and we wondered that the cause of this issue might be the lack of conditions which fireflies can live, as the environment they inhabit becomes increasingly polluted. In Japan, it is well known that it is important that rivers must be clean and that the habitat must be inhabited by organisms that are food for fireflies. However, we believe that there are other conditions that are essential for fireflies to inhabit, and that these unknown conditions may be a factor in this study. The purpose of this study was to clarify the conditions for fireflies to inhabit. Our school has a research pond. Since fireflies have been

observed in the area where our school is located, we used the research pond for this study. The content of the experiment is to use the research pond as a habitat for fireflies, and to make the pond environment more suitable for fireflies to live in. To conduct this experiment, we first conducted a survey of the environment of firefly habitats in the nearby area to identify their species that live there. Later, we will conduct a separate survey of the environment inhabited by fireflies of a different species found in this study, and make comparisons. In addition, we will conduct preliminary research in order to create an environment that will allow fireflies to inhabit the research pond in a few years.

#### **Allelopathic effects of *Papaver dubium* on other plants in the field**

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Currently I am researching with the aim to find out which plants are affected by the allelopathy of *Papaver dubium*, and how it affects them. I observed the species of plants that grows around *Papaver dubium* in the field. And noticed that only few specific species of plants were growing in that area. From this, I speculated that in the field the Allelopathy of *Papaver dubium* would have a small effect on these specific plants. To research this, I focused my attention on one of the species of plants often seen growing around *Papaver dubium*, *Oxalis corniculata*. Therefore, I am researching the allelopathic effects of *Papaver dubium* on *Oxalis corniculata*. I will present the results of this research. Additionally, from prior research, growth of *Raphanus sativus* var. *sativus* that were planted in soil where *Papaver dubium* had died had been reduced, compared to *Raphanus sativus* var. *sativus* that weren't planted in the soil where *Papaver dubium* had died. I built a hypothesis that dead *Papaver dubium* remaining in the soil contain allelochemicals and have an allelopathic effect on the plants that grow there. To study this, I am comparing the growth of plants in agar medium with and without *Papaver dubium*.

#### **Findings of the Exotic Species *Sagra femorata* (Coleoptera: Chrysomelidae) on *Pueraria Lobata* (Fabaceae) around the Isuzu River in Ise**

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It is important to evaluate the effects of exotic species on native species and on the environment. *Sagra femorata* (Drury) (Chryso-melidae) is originally distributed in Southeast Asia. Adults of *S. femorata* are among the best fascinated leaf beetles because they are about 20mm long, often brilliantly colored and metallic, and males of this species have greatly enlarged hind legs. Despite the enlarged femora, they do not jump. On account of this, *S. femorata* are collected mercilessly and sold for jewelry or trinkets or to collectors worldwide. In the same way, adults of *S. femorata* had been sold as pet insects in Matsusaka City, Mie prefecture. Then, in 2006, individuals of this species were found in fields in Matsusaka and were confirmed by the establishment in the same regions in 2009. On July 2021, I was found a dead body of *S. femorata* adult on the bank of the Isuzu river in Ise City, Mie prefecture, about 30 km away from Matsusaka. *Sagra femorata* lay their eggs on the stem of *Pueraria lobata* (Willd.) Ohwe (Fabaceae). Larvae cause galls in the stem of *P. lobata*. Galls caused by *S. femorata* were found in plants on the bank along the Isuzu river. In this study, some of the galls collected were dissected to determine the developmental stages and monitored periodically to confirm the emergence of adult *S. femorata*. In addition to these data, the sex ratio of *S. femorata* and biological information based on the observations were recorded.

#### **Investigating the habitat of *Aphelocheirus nawai* using environmental DNA analysis**

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*Aphelocheirus nawai* is a rare aquatic insect living in Japanese streams. And, the abundance is decreasing because the water

quality is worse than before. They are listed as vulnerable in the red list of Japan, and need to be protected. To protect their habitat, much information about the species is needed; however, to obtain enough information is difficult by directly taking method. The goal of this study was to search the habitat of them. Because using conventional method is difficult to take and find them, and the surveys should cover a wide range of areas, we used environmental DNA (eDNA) survey for this species, which has the advantage of being fast and searching in wide areas. The eDNA survey can provide the information on habitats of target organisms by only taking a little of water in an aquatic environment. First, we have successfully developed an analytical system specific to them. Second, I sampled water at 49 locations of streams in Hyogo, Kyoto, and Okayama prefectures and examined eDNA using our new system. In the result, we could find it in 5 points. They also responded at previously reported locations. The study shows Creating a tool to easily examine their habitats and suggesting new habitats for them.

#### **Possible serious effects of the sunscreen ingredient benzophenone on freshwater ecosystems: Assessing environmental impacts with euglena**

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Benzophenone, hereafter referred to as BP, is widely used as a UV absorber in various everyday products such as sunscreen worldwide. BP has been detected in 95% of the world's wastewater, raising significant environmental concerns in recent years. Although we depend on freshwater area in various ways, the precise impacts of BP on freshwater ecosystems remain insufficiently explored. This study aims to clarify the effects of BP on freshwater ecosystems. To this end, we conducted experiments using euglena, a keystone organism supporting freshwater ecosystems, and several crops as representative species. Our findings reveal that even at concentrations onetenth of those found in Japanese freshwater and seawater area, BP reduced euglena production by 40%. Furthermore, observations of crops

exposed to BP indicated a decrease in cell division and growth suppression. Given the foundational role of producers in ecosystems, the harmful effects observed on euglena suggest potential cascading effects throughout the ecosystem, potentially leading to species extinctions at higher trophic levels. Our results highlight the serious implications of BP contamination for freshwater ecosystems. Importantly, the introduction of activated carbon to euglena cultures, simultaneously with BP, mitigated its negative effects, resulting in a 30% increase in euglena production. This highlights the potential efficacy of activated carbon in reducing the effects of BP in freshwater ecosystems.

#### **Enhancing Butyric Acid Bacteria Content in Traditional Japanese Nukazuke Pickles**

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*Clostridium butyricum* is a type of intestinal bacterium that produces butyric acid. Butyric acid produced by *Clostridium butyricum* is absorbed into the intestine and is known to suppress allergic and inflammatory reactions by stimulating the immune system and increasing regulatory T cells. Although butyric acid bacteria are rarely found in food, nukazuke (pickles made in a rice bran bed), a traditional Japanese food, is one of the few foods that contain butyric acid bacteria. The flora contained in nukazuke is thought to change depending on the vegetables pickled in it and what is added to the rice bran bed, but the vegetables and pickling methods that increase butyric acid bacteria in nukazuke have not yet been investigated. Therefore, we aimed to clarify what kind of things increase butyric acid bacteria in pickles by pickling various vegetables and dietary fibers in the rice bran bed. If we could establish a method of making pickles with high butyric acid bacteria content, people would be able to easily prepare and consume this beneficial food at home, thereby improving intestinal health.

#### **Isolation of Benzophenone-Degrading Microorganisms from Soil**

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Benzophenone is a UV absorber widely used in sunscreens. It has been detected in wastewater globally, leading to the contamination of rivers and seawater. Benzophenone is known to have adverse effects on aquatic organisms, such as causing coral bleaching and affecting the spawning behavior of fish. Additionally, it inhibits cell division in algae and plants, which are primary producers in ecosystems, thereby halving their productivity. The widespread presence of benzophenone in the environment poses a serious threat to ecosystems. Identifying organisms that can degrade benzophenone may help mitigate these negative effects. Previous studies suggest that benzophenone in soil can be degraded by certain organisms. Therefore, we hypothesize that soil microorganisms capable of degrading benzophenone exist. This study aims to isolate such microorganisms. We will cultivate microorganisms from soil samples containing high concentrations of benzophenone and screen for those capable of degrading benzophenone.

### **Electrical Stimulation-Induced Pharyngeal Protrusion and Its Associated Body Regions in Planaria**

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Planarian feeding behavior involves navigating towards food, protruding the pharynx from the ventral side, and ingesting food through the pharynx. While pharyngeal protrusion is a critical component of this process, the underlying mechanisms governing feeding behavior and pharyngeal control remain poorly understood. In our study on planarian contraction responses to electrical stimulation, we observed pharyngeal protrusion in planaria which had their head cut off. This contradicts the previous study that the central nervous system controls pharyngeal protrusion. We hypothesize that investigating the pharyngeal protrusion response to electrical stimulation can shed light on the mechanisms of pharyngeal control. We aimed to identify the specific body region responsible

for pharyngeal protrusion in response to electrical stimulation by examining individuals with only the head, abdomen, tail with pharynx, and intact bodies. Our findings revealed that pharyngeal protrusion occurred in the head, abdomen, and tail regions but not in the whole-body. Further experiments are planned to elucidate the mechanisms controlling pharyngeal protrusion.

### **Oviposition behavior and ovarian development of “tongtonging” *Cotesia kariyai* female adults that do not oviposit**

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Parasitization rate does not reach 100% when 10 *Mythimna separata* larvae and 50 *Cotesia kariyai* (Ck) larvae are placed in the same small space and left for a certain period of time. As a factor, a female Ck wasp was found that repeatedly pierced the ovipositor tube against unparasitized *M. separata* larvae and injected venom but did not oviposit (Tong-tonging) (Kawahara, 2021). Tongtongued *M. separata* larvae are not oviposited by other Ck, allowing them to develop into pupae and adults. This suggests that the oviposition behavior of tongtonging Ck may be responsible for maintaining the population of *M. separata* in the field when the parasitization rate of Ck is high. However, if the tong-tonging Ck does not oviposit to *M. separata* larvae until it dies, then the tongtonging Ck cannot produce any progeny of its own. Kawahara (2021) showed that tong-tonging Ck have delayed ovarian development compared to Ck that show normal oviposition behavior. Based on this, we observed and experimented with tong-tonging Ck, predicting that their ovaries would develop over time and they would become capable of ovipositing. The results showed that the ovaries of tongtonging Ck developed over time, with about 90% of tong-tonging Ck ovipositing. The tong-tonging Ck is thought to maintain unparasitized *M. separata* larvae by delaying the time of oviposition compared to other Ck, and to produce its own progeny.

### **The Spot Roles for the Seven-Spotted Ladybird (*Coccinella septempunctata*)**

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The seven-spotted ladybird *Coccinella septempunctata* has spots on its elytra, which may vary in proportion from one individual to another. The aim of this study is to estimate the effect of varying temperatures on the size of the spots among the breeding conditions of the ladybird and to discuss the basis for this. In addition, image analysis using the database Global Biodiversity Information Facility (GBIF) was used to consider the significance of the spots on the ladybird's elytra to the ladybird themselves. In these studies, pupal spot changes were observed to be remarkable, although changes in adult spots were not observed to a great extent. Furthermore, differences were found in the proportion of seven-spotted ladybird spots between those found in East Asia and those found in other regions of the world. The study indicated that factors such as subspecies of the seven-spotted ladybird and their activities were related to the size of their spots. The study concludes that the spots have a role in maintaining body temperature and create a pattern that composes its warning colouration.

**Awareness Activities on the Ecology and Conservation of Otters in Japan:  
Promoting a Correct Understanding of Environmental Conservation through Zoos and Aquariums**

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There are currently 13 species of otters in the world, 12 of which are declining in population, and 5 are listed as endangered on the IUCN Red List. In order to repeat the tragedy like the tragedy of the extinction of the Japanese otter, we are conducting research with the aim of promoting a correct understanding of coexistence with otters. Currently, the 140 zoos and aquariums that are members of JAZA, as many as 45 have otters. In addition to the frequent posting of otter-related photos and videos on social media. Their popularity as pets since the late 2010s, and the existence of otter elections, tell us that otters are very popular in Japan.

The excessive popularity of otters has led to international problems, including smuggling. In this study, we considered the general perception and ideal image of otters from two aspects. First, we used data mining technology to quantitatively analyze people's level of understanding using articles from the Yomiuri Shimbun. Second, we explored the ideal state of otters through interviews with otter keepers, focusing on the problems and sense of crisis caused by the gap between ideals and reality. Furthermore, to evaluate the improving of people's awareness and educational approaches to this problem, we created a poster summarizing the environment surrounding otters and displayed it at Tobe Zoo for a while we conducted interviews with visitors and considered about the effects.

**Applying Genome Editing Technology to the Breeding of Dwarf Blue Jabba Banana (Ice Cream Banana)**

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I have been cultivating ice cream bananas in my garden for the past six years. This cold-tolerant variety can thrive in Japanese temperatures. However, despite their adaptability to the climate, ice cream bananas often suffer damage from strong typhoon winds, leading to stem breakage. To address this issue, I aim to develop a typhoon-resistant variety of ice cream banana by utilizing genome editing technology to reduce their height. Prior to initiating genome editing, I investigated genes associated with dwarfism in ice cream bananas. Concurrently, we attempted to induce callus formation from ice cream banana tissues. Successful callus induction and identification of dwarfism-related genes will enable us to introduce mutations using the Agrobacterium method, ultimately isolating dwarf plants with shorter stature. Our initial step involved identifying genes influencing the height of ice cream bananas. Using the amino acid sequences of D11 and SD1 from rice, a monocot species similar to ice cream bananas, we searched the ice cream banana genome database and identified several candidate genes. Future plans include sequencing PCR

products derived from the ice cream banana genome to design guide RNAs for genome editing. For callus induction, various tissues, including roots, petals, pistils, stamens, and ovule, were cultured on callus induction medium. Callus formation was observed exclusively in tissue containing ovule. I believe that this study will contribute to the future of banana breeding.

#### **Establishment of Conservation Methods Based on the Luminescence Cycle of *Luciola cruciata* and its Habitat**

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We have been studying the luminescence cycle of fireflies named *Luciola cruciata*. Although most fireflies in Kyushu region are of the 2-second type, the luminescence cycle of fireflies living in Amakusa was found to be of the 3-second type. Also, the luminescence cycle was found to be shorten at higher temperature. It was also found that the luminescence cycles became longer as the moonlight became brighter. Since we humans seem to have a negative impact on fireflies' growth, we are trying to make the best shelter where fireflies can glow in normal luminescence cycles. We are to build green curtains with a plant called *Momordica charantia*, which would keep the shelter cool enough for fireflies.

#### **Relationship between *Aspergillus oryzae* (Koji) and light in Japanese traditional fermented foods**

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My grandfather makes amazake and miso, Japanese traditional fermented foods. Amazake is a sweet, non-alcoholic drink made by breaking down rice starch and converting it into glucose. In contrast, Miso, especially barley miso, is a

specialty of Ehime Prefecture, and is a flavorful seasoning paste made by breaking down barley protein into amino acids. These are important foods in Japanese cuisine, and fermentation by Koji is indispensable for making them. I focused on the fact that my grandfather's traditional brewery that produce fermented foods has a very dark environment. The purpose of this research was to determine the relationship between Koji (*A. oryzae*) and light. The target strains were those used by my grandfather. Further, the experimental technique was conducted at home, without resorting to university facilities. Koji was cultivated under five different light environments (light through red, blue, and green underlays, bright and dark places). Rice-Koji for making amazake and Barley-Koji for making miso were compared under these various light conditions. The results showed that Rice-Koji activity decreased in bright light, and the effect of red light was less compared to blue and green. On the other hand, Barley-Koji activity also decreased in bright light. The details of the effect of light color on Barley-Koji are currently under investigation. Based on these results, the use of red light is the most effective way to create a safe environment for breweries. This research has the potential to enhance the manufacturing environment for Japanese traditional fermented foods.

#### **Beetles intestinal bacteria IV**

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The Japanese rhinoceros beetle (*Trypoxylus dichotoma septentrionalis*) inhabits regions south of Honshu in Japan. During its larval stage, it uses woody material as a nutrient source. The decomposition of the woody material is carried out by intestinal bacteria (derived from the soil), which establishes a mutualistic relationship between the larvae and the intestinal bacteria. The decomposed humus is excreted as feces. This study investigates the soil improvement capability of the rhinoceros beetle through humus decomposition. We hypothesized that if the intestinal bacteria were activated, the ability of the rhinoceros beetle to decompose humus

would naturally improve. Therefore, we conducted an experiment to investigate the conditions that activate the intestinal bacteria. From our experiments and previous studies, it was found that the intestinal bacteria are activated by three environmental factors in the current conditions. First, an anaerobic environment is necessary. However, since the soil is already anaerobic, its importance is considered low. Second, pH levels play a role; the intestinal bacteria are activated in an alkaline environment. Third, temperature affects activation; a range of 25-30°C is optimal for activation. Since the rhinoceros beetle is ectothermic, the temperature inside its intestinal is significantly influenced by the external environment.

### **Environmental DNA analysis for understanding the dynamics of wild fish in Sozu River, Japan**

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For sustainable use of fish resources, it is important to continuously investigate the distribution of fish and their dynamics. However, existing survey methods based on fish sampling are not easy to implement because they require a great deal of labor. On the other hand, in recent year, survey method using “environmental DNA (eDNA)” released from aquatic organism have been developed. In this study, to evaluate the validity of eDNA analysis in fish resources research, we investigated the seasonal dynamics of ayu (*Plecoglossus altivelis*) and other wild fish in Sozu River in Ehime prefecture, Japan, using eDNA analysis. We analyzed the eDNA samples collected from April 2020 to November 2021 at 9 sites in the Sozu River. These samples had been obtained by filtration of the river water using a membrane filter, and been frozen at -30°C. We extracted total DNA from the samples using a commercial DNA extraction kit, and quantified fish eDNA by real-time PCR. In the analysis of ayu eDNA, relatively low concentration of the eDNA were detected in March to early April. After that, the

eDNA concentrations increased by July, and eDNA was also detected at the most upstream site. Furthermore, although ayu eDNA concentration decreased in October to November, the concentration was relatively higher in lower reach. These eDNA dynamics were similar to known life cycle of ayu, so we thought that eDNA analysis is effective tool for understanding the dynamics of wild fish in a river.

### **Hemostatic effects of *Portulaca oleracea* and *Chamaesyce maculatani* II**

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The hemostatic effects of *Portulaca oleracea* and *Chamaesyce maculata* are known, but the mechanism has not been elucidated. The purpose of this study was to show that these plants transform fibrinogen into fibrin. These plants were added to a fibrinogen solution and the absorbance value for each plant was measured. The absorbance values of the experimental plots were defined by samples containing distilled water and either *Portulaca oleracea* or *Chamaesyce maculata* with fibrinogen subtracted from blank samples without fibrinogen. The results showed that the absorbance values of the experimental plots were significantly greater than those of the control when *Portulaca oleracea* was added (t-test  $p < 0.05$ ), while there was no significant difference for *Chamaesyce maculata* (t-test  $p > 0.05$ ). This data suggests that *Portulaca oleracea* converted fibrinogen into fibrin. It is known that thrombin cleaves fibrinogen, exposing polymerization sites and resulting in fibrin monomers. These monomers then polymerize to form fibrin polymers, which are stabilized by transglutaminase (factor XIIIa), leading to hemostasis (Takeo et al. 2013). Transglutaminase is also known to be present in plants. From previous research and these results, it is suggested that the transglutaminase in *Portulaca oleracea* converted fibrinogen into fibrin. Experiments are currently ongoing to clarify the enzymatic activity responsible for the transformation of fibrinogen into fibrin. The results of these experiments will also be presented at the seminar.

### **The relationship between butterfly flight and physical characteristics**

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We became interested in the mechanism of flapping the wings of insects. When we examined the studies conducted in the past, it was reported that *Prantica sita* (Asagi Madara in Japanese), flies in an energy-saving way compared to other butterflies in a study by Toyooka et al. Therefore, we decided to investigate the relationship between the weight and wing area of butterflies and the flap count of butterflies of different families. To begin with, we collected these types of butterflies in the open field. Then, used your smartphone to take a picture. Then, based on the footage, we counted the number of times the butterflies flapped their wings. Next, the collected butterflies are wrapped in medicine wrappers and weighed using an electronic balance. Then, Image J was used to measure the area of the wing. A exponential approximation was found between flap count and body weight (coefficient of determination  $R^2 = 0.525$ ), flap count as well as between the flap count and wing area (coefficient of determination  $R^2 = 0.9231$ ). A linear approximation was observed between wing area and body weight (coefficient of determination  $R^2 = 0.792$ ). Therefore, it can be seen that there is a correlation between these relationships. I would like to add data on long-term migration of Asagi Madara and compare

them with general butterflies. In addition, I would like to look for other butterfly species with different specific characteristics excluding Asagi Madara.

### **Regeneration process and survival rate of the *Dugesia japonica* from head fragments**

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The *Dugesia japonica*, a species of planarian a kind of flatworm native to Japan, has a very high regenerative ability, but when it is cut, it has been confirmed by Ogami et al. that individuals regenerating from head fragments do so more slowly than other fragments. Based on this, we will investigate the process of regeneration of head fragments, the changes in survival rate and regeneration speed when changing the environment, and the differences seen in individuals after regeneration. As an experimental method, the *Dugesia japonica* were made to fast for 10 days. The heads were cut off and the rest were discarded. After that, all head pieces were reared side-by-side in a tank. The number of days required for regeneration and the number of days that survived were plotted on a graph. Next, we will conduct the same experiment by changing various aspects of the water temperature. If there are some changes in the manner of regeneration, we will conduct further experiments to clarify their causes. Through these experiments, we will investigate in detail the regeneration of head fragments of the planarian.

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<Workshop>

### **Let's try VRinkai!! –online teaching material for field biological course–**

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We have developed an online teaching material



simulating field biological course, VRinkai (V for "virtual" and Rinkai meaning "marine biological course" in Japanese) since 2021. VRinkai contains over 600 photos of marine and terrestrial organisms collected in field biological courses in Keio University and other academic field research. Students can upload photos of local animals/plants taken in their field training. Uploaded data were automatically introduced in the biological classification games, which students can enjoy learning classification of species at each taxonomic rank by catching randomly emerging animals. Also, VRinkai allow teachers to create their original database and manage students in each class or group. According to these groups, biological hierarchy view is generated which are used to compare the differences of multiple biotas. VRinkai is an effective teaching material for enhancing interest and active learning in biological classification, evolution, and biodiversity. Today, we'll show demonstration of VRinkai. You will need only your smartphones, tablets, or PC. Photos of animals/plants are optional. Let's enjoy!!

**Development of Natural Science Books for International: Students from English—Speaking Areas and Kanji (Chinese Characters) Using Aareas II**

Tomoko Kaga

*Ritsumeikan University (Until March 2022)*

An electronic poster was presented at the 28th Asian Biological Education Association Biennial Conference in the Philippines, held online on April 28-30, 2022. Because the conference was not held face-to-face due to the COVID-19 pandemic, we were unable to provide a printed booklet to participants. This time, we would like to ask participants to read it and help us improve it. The purpose of this research is to develop bilingual teaching materials in both English and Japanese that are easy to understand for students who wish to study natural sciences using either Japanese or English. As a first step, we have produced a bilingual Japanese-English book by Professor Emeritus Osamu Mitamura entitled "Looking at the world's lakes can help us understand how people live: A proposal for comparative limnology." This book is a compilation of the

results of Professor Emeritus Mitamura's research on lakes around the world together with local researchers. It is intended to help international students learn about lakes around the world and become interested in environmental conservation. It includes many photos of lakes and other things. This time, ruby text has been added to the Japanese text, and the English text is displayed alternating every few lines. We would like to ask those who have received the Japanese-English bilingual book to fill in a questionnaire. Please send the answer to Kaga's address (aureliakaga1143☆gmail.com). Please change ☆ to @.

**Teaching materials to taste the mechanism of flow of genetic information, "Transcription and Translation", based on the wheat germ cell-free protein synthesis system in vitro**

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The wheat germ cell-free protein synthesis system is a practical method for synthesizing recombinant proteins in test tubes, developed by Professor Emeritus Yaeta Endo of Ehime University. Since the system is prepared from wheat embryos, it is less susceptible to codon bias thus does not require codon optimization of the template, and produce quality of high molecular eukaryotic proteins in a large amount beside the system solved the bio-hazardous issues. In Basic Biology in Japanese high schools, the Courses of Study states that "An overview of transcription and translation deals with the genetic information flow from DNA base sequences to mRNA base sequences for transcription and from mRNA base sequences to amino acid sequences via tRNAs for translation". In high school, protein expression experiments have been performed by transformation of *Escherichia coli*, but because these were genetic recombination experiments, aseptic manipulation and measures to prevent spreading were necessary.

Therefore, we developed an experimental teaching material kit utilizing a wheat germ cell-free protein synthesis system. In this kit, mRNA of the target protein is first expressed, and transcription can be confirmed by checking mRNA expression with an RNA-specific visualization reagent. Then, translation is confirmed by expressing a protein using the produced mRNA and showing the presence of the protein. In this workshop, you will be able to experience the expression of GFP based on GFP mRNA. This kit is expandable, so we would appreciate your feedback after the experience. For more information on the “Transcription and Translation Experiment Kit,” please see below.

<http://www.cfsciences.com/jp/CFS-EDU.html>.

#### **Development of experimental materials using insects for kindergartens and nurseries, elementary schools, junior high schools, and high schools**

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The Biology Laboratory and the Science Education Laboratory in the Faculty of Education at Kogakkan University are developing teaching materials for observation and experiments using insects according to the curricula of kindergartens and nursery schools, elementary schools, junior high schools, and high schools. The materials used are *Mythimna separata*, a butterfly order, Parasitoid wasps that parasitize it, and stinkbugs that feed on it. *M. separata* is a primary consumer of corn leaves and is a holometabolous insect. In the laboratory, *M. separata* is reared successively on artificial diet. *M. separata* larvae also have a large fluid volume and hemocyte count, making them suitable for hemocyte observation and immunization experiments. *M. separata* larvae have several parasitoid wasps. Among them, *Cotesia kariyai* (Ck) is an endoparasitoid that oviposits about 100 eggs at a time, and its larvae grow and develop by feeding on the blood plasma and fat bodies of *M. separata* larvae. Female Ck adults have a high urge to spawn at any time, so oviposition behavior can

be easily observed. *Andrallus spinidens*, which is zoophagous, is a hemimetabolous insect that grows and develops by feeding on butterfly insects such as *M. separata* larvae. We are using these insects to develop educational materials that enable students to learn about insect growth and development, the food chain, the origins of ecosystems, the concept of parasitism, and immunity. The materials for first and sixth grade elementary school students and high school students will be discussed in detail in oral and poster presentations.

#### **Development of Virtual Observation Materials for Vegetation Succession Utilizing the Metaverse and 360-degree Images**

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Virtual reality (VR) technology is used in many fields. In addition, a virtual space called the “Metaverse” has been constructed on the Internet. And the Metaverse is used as a place for games and communication using VR technology. So far, many teaching materials have been developed for the educational use of VR technology, such as spatial understanding of geological formations using Google Earth. However, most of these teaching materials are designed to be viewed by individuals and are not intended for discussion by multiple students. Therefore, by placing digital content, e.g., 3D models and so on, in the Metaverse, students can participate in learning activities in the same space, and cooperative learning may be possible. In science education, field observations are effective in enhancing a learning attitude. However, it is hard to implement such experiences in schools due to various restrictions. In the present study, we focused on VR technology to solve this problem. And we constructed a teaching material in the Metaverse that deals with the content of vegetation successions. And we place 360-degree photos of vegetation at different stages in the Metaverse space. That space is created in “DOOR.” “DOOR” is a web-based VR platform supplied by NTT QONQ. This service is no app installation

required. Access is available via the browser of a smartphone or tablet device. In this workshop, we will demonstrate the virtual observation materials we have created. Through the workshop, we would like to discuss the possibilities and utilization of VR content.

**Learn ancient techniques by making a replica bronze mirror! Educational activities  
Archaeological Museum at Matsuyama City**

Akiko Kodama

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The Archaeological Museum at Matsuyama City and its associated facilities were opened in Matsuyama General Park on October 31, 1989, as part of the Matsuyama City 100th anniversary project. The Archaeological Museum at Matsuyama City is an affiliated facility of the Buried Cultural Properties Center. The museum is not only a specialized institution for researchers but also a place where the general public and tourists can relax and where children and students can go on field trips. Therefore, the museum engages in exhibitions, education, public relations, publications, and the collection and storage of artifacts through a series of excavation surveys. Knowledge of science and biology is also important in archaeology. Various items such as pollen, plant fragments, animal bones, etc., contained in excavated materials can provide valuable information. For example, at the Hasaike Kofun site, the type of fly discovered revealed details about ancient life. In this workshop, you will learn about ancient technology by making a replica bronze mirror. A replica bronze mirror polished with compound will make a beautiful souvenir.

**Introduction of some handmade teaching**

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<Country Report>

**Teaching sustainability in Australian schools**

Robert L. Wallis

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**materials and tools used in biology classes**

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In the field of biology education, various teaching materials and tools are used, whether commercially available or handmade. The reasons why teachers make their own teaching materials or tools, even though there are many convenient commercially products, are that they are expensive (not given the budget to purchase them), but it may also be because they do not match their classes or teacher's requests. In fact, many teachers may have used teaching materials made by themselves in their classes. The speaker has teacher trainee students work on developing teaching materials as their assignment. The reason is that developing teaching materials requires a deep understanding of the purpose and content of the learning, knowledge and skills in manufacturing, and ideas, and it will be useful for students who will become teachers in the future. In this workshop, some of the teaching materials and tools that the speaker has devised or that students has devised in classes will be introduced, for example, paper crafts of flowers, musclebone models, eyeball model, handmade microscopes, adapter of microscope-smartphone, and etc. All of these are inexpensive, easy to make and fully practical. Some of them would be provided as easy making kits, and instructed on how to make them. We would like to have you actually hold them in your hands, and discuss your impressions with us.

cross-curriculum priorities that include Sustainability. Thus, Sustainability is not taught as a separate discipline, but is integrated into the key learning areas wherever possible. There are three Organizing Areas relevant in the curriculum for teaching about Sustainability: Systems, World Views and Futures. Teachers have access to an array of resources to help in their teaching, including lesson plans, field work suggestions and work samples. In the senior secondary school curriculum (levels 11 and 12), Sustainability is again taught through established disciplines and subjects, including Biology, Geography and Earth & Environmental Science. The latter field may be taught under different titles – in New South Wales, for example, Earth & Environmental Science is a distinct Subject in levels 11 and 12, while in Victoria there are two so called Study Designs that cover the key learning area: Environmental Science and Outdoor and Environmental Studies. This presentation will include examples of how Sustainability is taught in Australian primary and secondary schools. Keywords: Sustainability education, Australian schools, cross-curriculum teaching.

**Country Report from AABE India Chapter:  
Biological Sciences & Environmental  
Education for Sustainability**

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India is a megadiverse country with high biological diversity and contain many species exclusively indigenous, or endemic, to them. India also contains four of the world's 34 biodiversity hotspots or regions that display significant habitat loss in the presence of high endemism. In India Biology Education in Schools across the primary, middle, and secondary levels has been scrutinized to match the standards prescribed by the New Education Policy (NEP) 2020. This policy has significant implications for biology teaching, including experiential learning, higher-order assessment methods, and the integration of environmental education. This intends to bring the teaching of Biology across the Indian curriculum on par

with the international curriculum. The NEP emphasizes a holistic approach & multi-disciplinary approach covering climate change, sustainable development, conservation and management of biological resources and biodiversity etc. The health and well-being of individuals remains a key aspect for success in all other aspects of life. Under the umbrella of the Asian Association for Biology Education (AABE), India Chapter has been working actively in biology education from kindergarten to college level. Apart from research in the area of biology education, health education & environmental sustainability, various teacher training workshops, conferences & seminars, competition & exhibition has been organized to, promotes biology & environmental education & awareness that leads to action for sustainable development. Climate Change programs of India focus on climate literacy, knowledge exchange and public awareness as well as participation, using interactive educational methodologies.

**Biology Education in Indonesia: The New  
Curriculum Setting**

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As a large archipelagic country ranked the 2<sup>nd</sup> in biodiversity index in the world, Indonesia faces many issues in biology education and preparing biology teachers who will serve all high schools around the country. There are about 39,052 high schools spread over 34 provinces in the country. Standardizing the educational quality in all schools is a big challenge for the country. The new curriculum focuses on giving more autonomy to teachers to design learning based on the culturally responsive pedagogical approach and giving more chances for students to do independent learning. New approaches are introduced, i.e. the interdisciplinary and integrated biology with chemistry and physics, reducing the content of learning to the essential one (i.e. for grade 10: biodiversity, virus, innovation in biology technology, ecosystem, and climate change), adopting the understanding by design approach in constructing the lesson, more

project-based activities, focusing the learning outcomes on demonstrating the understanding of the biology concepts to solve local, national, and global problems, and facilitating differentiated learning. Moreover, six science practices must be nurtured to understand biological phenomena (a. observing, b. asking questions, c. planning and carrying out investigation, d. analyzing and interpreting data, e. evaluating and reflecting, and f. communicating the results).

### **Refined Malaysia's Pre-University Biology Syllabus With A Focus On Sustainable Development And STEM**

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As the global community increasingly emphasizes the importance of sustainability, education systems must align with these values. Recent PISA results highlight the challenges faced by Malaysian students in mastering STEM techniques, revealing gaps in critical thinking and problem-solving skills. In response, it is crucial for Malaysia to reorient its education system towards sustainable development and the integration of STEM principles. This manuscript reports on the Malaysian government's effort to enhance sustainable development and STEM education by refining pre-university programs, specifically the Sijil Tinggi Persekolahan Malaysia (STPM) Biology syllabus to integrate sustainability education and foster a deeper understanding of STEM. This revision aimed to equip students with not only theoretical knowledge but also practical skills relevant to addressing real-world environmental challenges. By embedding sustainability concepts within the syllabus, the initiative seeks to cultivate critical thinking, problem-solving abilities, and ethical decision-making in students. Furthermore, the updated syllabus encourages collaboration and innovation, preparing students to involve in sustainability and scientific research. This restructuring reflects the government's commitment to developing a workforce equipped for the challenges of a rapidly changing global economy, especially

in green technologies and sustainable industries. Ultimately, the refined STPM Biology syllabus ensures that students are prepared for further education or the workforce with relevant skills and knowledge.

### **Immersive Technologies in Teaching Biology in the Philippines: Transforming Distance Learning Experience and Outcomes**

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The use of immersive technologies such as Augmented Reality (AR) in biology education offers a substantial advantage in improving student performance, especially for senior high school students in the post-pandemic educational contexts. These findings were revealed in a systematic review of published studies on the impact of AR in teaching and learning of biology, which yielded a moderate overall effect size at 0.62. While, a group of science teachers in the Philippines developed AR modules to teach complex cell biology topics. These AR-based lessons were perceived to be useful and effective in promoting learning gains ( $t = 2.268$ ;  $n = 32$ ;  $p = 0.030$ ). In another study, using the remote learning setup, Improvised Insect Traps (IITs) were used to provide an authentic learning experiences in teaching and learning insect taxonomy at home. Results revealed that IITs effectively improved students' self-efficacy beliefs ( $Z = 0.033$ ,  $p\text{-value} = 0.022$ ,  $g = 0.68$ ). In an effort to provide a proper forum for discussion and further exchange about relevant technologies in biology education and research, the Biology Teachers Association of the Philippines (BIOTA Phils. Inc.) had Immersive Technologies for its theme during its 58th Annual Conference last April 18-20, 2024, in Boracay Island, Aklan, Philippines. Plenary talks and discussions underscored the need to focus future research in exploring the use of other immersive technologies and investigate its long-term impacts. Integration with other emerging educational technologies to further enhance student learning and engagement was also emphasized during the convention.