"promoting GeoScience education worldwide"

GeoSciEd IX 2022

Shimane, Japan

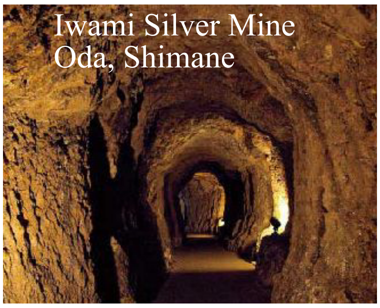
Proceedings


Neogene sedimentary rock, Izumo, Shimane


Hii River, Izumo Shimane


Tottori Sand Dunes, Tottori


Itsukushima Shrine, Hiroshima


Iwami Silver Mine Oda, Shimane


Rosoku–Jima Island Oki, Shimane


Lake Shinji and Yomegashima Island, Matsue, Shimane

Main Theme：Geoscience Education for Sustainability

& the 76th JSESE Annual Assembly

21-24 August 2022

Kunibiki Messe (Shimane Prefectural Convention Center) “promoting GeoScience education worldwide”

GeoSciEd IX 2022

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Proceedings

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& the 76th JSESE Annual Assembly

Organizer / International GeoScience Organization (IGEO)
Promoter / Japan Society of Earth Science Education (JSESE)
Japan Earth Science Olympiad Committee

Support / Ministry of Education, Culture, Sports, Science and Technology (MEXT) / Shimane University / Shimane prefectural board of Education / Tottori prefectural board of Education / National Association of Upper Secondary School Principals / All Japan Junior high school Principals’ Association / Japan Federation of Primary School Principals Association / JAPAN PRIVATE HIGH SCHOOL FEDERATION / Matsue city board of Education / Izumo city board of Education / Okinoshima-Town bord of Education / Oda City bord of Education / All Japan NATURAL SCIENCE Department, Senior High School Culture Clubs Federation / Japan Junior high schools Science Education Society / Japan Primary School Council of Science Study / Shimane Prefecture Senior High School Council of Science Education / Shimane Prefecture Junior high school and Primary School Science Education Society / Shimane Peninsula and Shinjiko Nakaumi Estuary Geopark / Oki Islands UNESCO Global Geopark / San’in Kaigan UNESCO Global Geopark / The Shimane Nature Museum of Mt. Sanbe / MONUMENT MUSEUM KIMACHI STONE / Geological Society of Japan / Volcanological Society of Japan / Meteorological Society of Japan / Japan Geoscience Union / Tokyo Geographical Society / Society of Japan Science Teaching / Japan Society of Physics and Chemistry Education

21-24 August 2022

Kunibiki Messe (Shimane Prefectural Convention Center)

Contents

Greetings

Dear participants of the IX GeoSciEd conference,

Our common passion for geoscience education brings all of us here to attend this conference, both virtually and in-person. We are here to share and discuss our research, best practices, and insights. To do so in an international environment with so many differents social and cultural backgrounds is an enrichment experience for all of us in and of itself.

Our theme this year is Geoscience Education for Sustainability. Global challenges like climate change, energy and food security, and plastic pollution call for urgent action by humanity, and geoscience education is a fundamental actor in that process.

We are all aware of the importance of geoscience education for facing our many global challenges. We are also equally aware of the large challenge of bringing geoscience education into our national school curricula and educational systems. How do we impact the stakeholders who make key decisions for national and global education? With a coordinated and joint global effort of many researchers and educators, such as all of you, we can positively impact these curricular decisions. I hope that this conference is an opportunity to create and strengthen professional and scientific collaborations, and even international freindships, that can bring this goal to fruition over the next half decade.

All of what we are doing this week is possible because of the people who started the International Geoscience Education Organization (IGEO) more than 20 years ago and have been successful in recruiting talented new people to help spread our message. Sadly, in the last few months, some of the people who founded IGEO have passed away. We gladly remember and celebrate during this conference the memory of Chris King, the first IGEO Chair, and Ian Mckay who gave a great contribution to the organization of the VI GeoScied in 2010.

I'd like to extend a special thanks to the Japanese organizing comittee for the great effort that they have made in organizing this event, especially during such trying times as we've seen over the past few years as a result of the pandemic. We really appreciate all our participants, including our online participants connecting from all over the world. We have great expectations for our conference activities and field trips and I hope that all of you, no matter where you are, learn from and enjoy this conference.

Campinas, 29/07/2022

IGEO Chair 2018-2022
Roberto Greco

Welcome note

Since the first pilot meeting at Southampton, UK in 1990, the 2022 GeoSciEdIX in Matsue, Japan is a first GeoSciEd in Eastern Asia. I would like to extend my sincere welcome to all participants in such a COVID global infection situation as a chairperson of GeoScieEdIX LOC.
This time, GeoSciEd IX was co-sponsored by the Japan Society of Earth Science Education, which was established in 1948. The Japan Society of Earth Science Education has nearly 500 members, publishes the academic journal "Education of Earth Science" four times a year, and holds a national convention once a year in the summer. It is no exaggeration to say that it is the only academic organization related to earth science education in Japan.

GeoSciEdVIII was held in Campinas, about 50 km away from Sao Paulo, Brazil. The Japanese team, which had previously planned to "invite GeoSciEd to Japan," formed an invitation team with the support of the Matsue Convention Bureau and participated in the Brazilian congress. When GeoSciEd was held, I was thinking of holding the Japan Society of Earth Science Education at the same time, so it was a great opportunity for me. However, to be honest, I was worried that communication with people from overseas would be successful because the conference of the Japan Society of Earth Science Education will be announced in Japanese. However, that worry turned out to be useless.

As you all know, it was a conference where the presentations of geoscience educators in Brazil and the presentations of GeoSciEdVIII were held in the next classroom. The domestic presentation was only in Portuguese, and I could only guess by looking at the presentation slides because I don't understand Portuguese, but I could feel the passion of Brazilian educators for geoscience education. This is possible, and I am convinced of the success of the joint holding of GeoSciEdIX and the Japan Society of Earth Science Education. In addition, Japan held the 10th IESO Mie in 2016, and after the Earth Science Olympiad, it received high praise from home and abroad. It is one of the supporting organizations for GeoSciEdIX.

Sanin, centered on Matsue, has many scenic spots and is a mysterious place for Japanese people. Because Sanin is also the stage of Japanese mythology that tells the beginning of the country. In this era when it began to be called the Anthropocene, earth science education that can be spoken from a global perspective is becoming more and more important. We hope that all the participants will understand the current situation and development of earth science education in Japan and feel the heart of the Japanese people who are the basis of it.

Chairperson of Local Organizing Committee
Dr. Ken-ichiro Hisada

Greetings from the Host

From August 21st to 24th, 2022, the 9th International Conference on Geoscience Education (GeoSciEd IX) by IGEO is held in Matsue City, Shimane JAPAN. At the same day, different time, same place, the 76th Annual Assembly of Japan Society of Earth Science Education will be held. We would like to express my heartfelt gratitude to all participants in the above Conference.

Shimane Prefecture is a place in Japanese history where you can feel the romance of eternity for a long time of the human and the earth, as told in the Izumo myth. Shimane Prefecture consists of the Izumo, Iwami, and Oki regions. GeoSciEd IX will be held at "Kunibiki Messe" located in Matsue City, that is, in the Izumo region. In addition, the Iwami region (World Heritage Iwami Ginzan Silver Mine) and the Oki region (Oki Dogo Island, the UNESCO Global Geopark) will be added as field excursion sites, and all Shimane will welcome you. And more, we have prepared geological excursions related to disaster prevention at many sites, including Miyajima, a World Cultural Heritage Site, in Hiroshima Prefecture, and geological excursions in the San'in Kaigan UNESCO Global Geopark, including the Tottori Sand Dunes, in Tottori Prefecture.

We have set "Geoscience Education for Sustainability" as the theme of this conference. This is the same as the theme of the annual Assembly of Japan Society of Earth Science Education. There are two reasons for choosing this theme. One is, as climate change progresses rapidly, the frequency of weather disasters and landslide disasters is increasing. With the addition of earthquake disasters, volcanic disasters, and the other related geological disasters, disaster prevention and mitigation education is extremely important as part of geoscience education. Another one is, there is a problem of lack or absence of teachers who teach earth science in high schools in Japan. We would appreciate it if the participants could be aware of the theme of the conference, share information, and have discussions during the oral and poster presentations and geological field excursions during the conference.
We hope that this conference will greatly contribute to the development of "Geoscience Education for Sustainability".

Thank you for all the organizations and individuals who have sponsored and supported this conference.

General Coordinator
Ichiro Matsumoto

IX GeoSciEd 2022 – the 9th International Conference on Geoscience Education
– Geoscience Education for Sustainability –
Matsue – Shimane – Japan, August 2022

Schedule of GeoSciEd IX

MH: Multipurpose Hall, SH: Small Hall

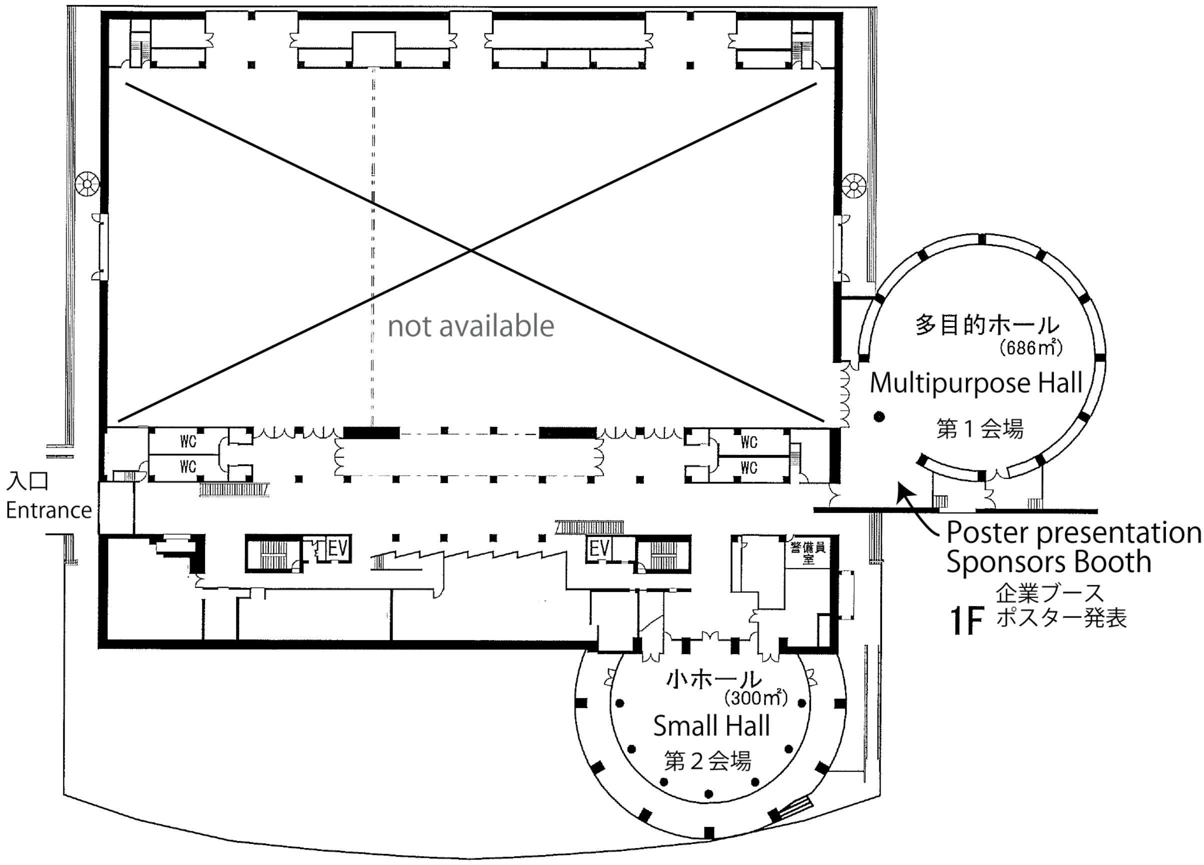
JST	UTC/ GMT	BRT	19-20 August	21 August (Sunday)	22 August (Monday)	23 August (Tuesday)	24 August (Wednesday)	25 August (Thursday)
8:00	23:00	20:00	Pre-Conference Field Excursions ・San'in Geopark ・Hiroshima World Heritage					Post-Conference Field Excursions ・Oki Geopark(25-27 Aug) ・Iwami Silver mine World Heritage
9:00	0:00	21:00			JSESE Registration（地学教育学会島根大会受付）	Poster Presentation (inc. High school students) MH ポスター発表 高校生ジュニアポスター発表	Symposium on Disaster Prevention MH	
10:00	1:00	22:00			JSESE Oral Presentations（口頭発表：16件）MH, SH			
11:00	2:00	23:00						
12:00	3:00	0:00			Lunch（昼食）	Lunch（昼食）	Lunch（昼食）	
13:00	4:00	1:00					During Conference Field Excursion (Shimane Geopark)	
14:00	5:00	2:00		GeoSciEd9 on-site Registration	JSESE Oral Presentations（口頭発表：32件）MH, SH	JSESE Annual General Meeting（総会） MH		
15:00	6:00	3:00		JSESE Council meeting（地学教育学会評議員会） MH		Keynote Presentation（基調講演） MH		
16:00	7:00	4:00						
17:00	8:00	5:00			Icebreaker Party（ミニ懇親会）MH 17:00~18:30	閉会行事		
18:00	9:00	6:00			(18:30~)Greeting from the Mayer of Matsue City 松江市長挨拶	(18:40~) Oral Presentations (13 persons / 20m each) MH/SH		
19:00	10:00	7:00		Opening Ceremony (30m) MH Keynote Presentation (45m) MH	Oral Presentations (6 persons / 20m each) MH/SH		Conference Dinner at Matsue Vogel Park	
20:00	11:00	8:00			IGEO/IESO Assembly			
21:00	12:00	9:00		Oral Presentations (10 persons / 20m each) MH/SH	Oral Presentations (6 persons / 20m each) MH/SH	21:30~ Closing Ceremony (30m) MH		IESO 2022 Online (Italy), Opening Ceremony
22:00	13:00	10:00						

Orange: GeoSciEd9 (onsite-online hybrid conference)
Green: JSESE (Japan Society of Earth Science Education) Annual Meetings in Japanse language
Yellow: GeoSciEd9 / JSESE Joint Program
Blue: Symposium on Disaster Prevention

Venue

Kunibiki Messe (Shimane Prefectural Convention Center)

- Main room: Multipurpose Hall (MH) (200 seats)
- Sub room: Small Hall (SH) (120 seats)
- Poster session: near the entrance of the Multipurpose Hall
- Sponsors Booth: near the entrance of the Multipurpose Hall



Abstract format description

Title of abstract

Author names (A. B. Last name[1]*; C. D. Last name[2]) * Corresponding author

Address of the Institution ([1]EEE, [2]FFF)
E-mail of corresponding author

The main text. ……………

Keywords:
References:

Keynote presentation abstract

19:30~20:15, Sunday, 21st August.
Keynote speaker Prof. HAYASHI Shintaro

Multipurpose Hall (Zoom)

IX GeoSciEd 2022 – the 9th International Conference on Geoscience Education
– Geoscience Education for Sustainability –
Matsue – Shimane – Japan, August 2022

Kitchen Volcano Experiment

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There are 111 active volcanoes in Japan. Numerous disasters have occurred because of their eruptions, which is why the Japan Meteorological Agency continuously monitors fifty of these active volcanoes. In the 2014 eruption of Mt. Ontake, located on the border of Nagano and Gifu prefectures (approximately 210 km west of Tokyo), fifty-eight people died and five were reported missing due to scattered high-speed rock impacts from the phreatic eruption[1].

Volcanic phenomena are infrequent and large-scale; thus, it is difficult to observe volcanic eruptions in classrooms. Furthermore, visual materials and verbal explanations are not sufficient for children to understand the eruptive phenomena of volcanoes.

The kitchen volcano experiment, which is a model volcanic eruption experiment that uses familiar materials found in the kitchen, was developed to overcome this difficulty. In kitchen volcano experiments, various model volcanic eruptions are created using common kitchen ingredients such as chocolate, cocoa, and mayonnaise. This allows eruptive phenomena including lava flows, pyroclastic flows, plume columns, debris avalanches, and volcanic mudflows to be observed, facilitating children's understanding of volcanic phenomena through observation of realistic models.

Effectiveness of the Kitchen Volcano Experiment

The kitchen volcano experiment allows children to experience volcanic phenomena. Children can easily visualize volcanic eruptions by performing in person model experiments. The use of food items in the kitchen volcano experiment was unexpected for the children and easily captured their interest. Kitchen volcano experiments are safe because they use food items, although consideration should be given to children with allergies to certain foods.

Various kitchen volcano experiments

Mentos cola experiment: Highly viscous magma often causes explosive eruptions. This is caused by the fuming of volcanic gases (mainly water vapor) dissolved in the magma, which increases the magma's apparent volume and causes it to erupt vigorously as fragments from the crater. This mechanism is similar to that of Mentos in cola. When Mentos are added to a carbonated beverage, such as cola, carbon dioxide bubbles are generated. This causes the volume of the cola to increase, and the cola and gas droplets gush out of the mouth of the bottle. The experiment with carbonated beverages, such as beer and cola, is a classic kitchen volcano experiment in volcanology[1].

Eruption column experiment: When magma erupts explosively, it produces large amounts of pumice, ash, and volcanic gas. The plumes of these aggregates are hot. The high-temperature plume rises and draws in the surrounding air. The air expands, the plume becomes less dense than the surrounding air, and the plume rises through the air due to buoyancy. The eruption column experiment was conducted in water. The water tank was filled with water, and a volcano model was placed at the bottom of the tank. The volcano model was connected to a container outside the tank using a tube. The liquid in the container could be ejected from the top of the volcano model. The experiment was conducted by placing a fatty oil bath additive diluted with water into the container and shooting it out from the volcano model[2]. There is also an experiment using chalk powder instead of bath oil [3]. The liquid ejected from the volcano model had a lower density than the surrounding water. The appearance of the rising liquid is similar to that of a rising volcanic plume during an explosive eruption. However, the high-temperature conditions of an actual eruption cannot be reproduced.

Volcanic ash experiment with "fu": In this experiment, students think about how pumice and volcanic ash spread. When an explosive eruption occurs, pumice and volcanic ash rise together with volcanic gases to form an eruption column. The eruption column is moved by the wind above the volcano, and the pumice and ash fall on the leeward side.
A volcano model was created with paper clay and pipes. The horizontal and vertical pipes from the crater were connected inside, and the air injected from the horizontal pipe was released vertically from the crater. A bicycle tube was connected to the horizontal pipe of the volcano model. When the bicycle tube was filled with air, and the air was discharged, it ejected from the crater of the volcano model with great force[1][4][5]. In this experiment, "fu" was used instead of pumice stones or volcanic ash. "Fu" is an ingredient used in Japanese cooking, made from wheat flour gluten. It has a low apparent density, is full of air bubbles, and is often used in miso soup or other dishes. The fu was then crushed into small pieces and placed in the crater. When air was blown out at high speed, a column of fine fu was ejected into the air at a height of approximately 2 m, similar to the column of an eruption. A fan was set up in advance to provide a weak breeze. The fu was then swept downwind. In this experiment, students were asked to consider the direction in which volcanic ash falls when a volcano erupts, the size of the ash particles, and the distance from the volcano.

Model experiment of ballisitic rocks: Rocks are ejected from a crater at a high velocity during a phreatic explosion of Ontake 2014 eruption[6][7]. This explosion scattered rocks around the crater at high velocity. The ejection velocity was estimated to be approximately 145–185 m/s [7]. The apparatus used in the "fu volcanic ash experiment" was used. Dozens of light lumps made of paper clay (instead of rocks) were placed in the crater, and air was vigorously blown out[8]. The lumps of paper clay were expelled in various directions and followed a ballistic trajectory. After showing the children this experiment, they discussed how they can protect themselves from fast-moving rocks.

Condensed milk and cocoa lava: Lava is a flow of hot molten rock. Heat is released from the surface, which quickly cools and becomes rock. Meanwhile, the interior of the lava remains hot and fluid. As the inner lava flows, the hardened rocky surface fractures. Lava moves similar to a caterpillar causing the fractured rocks to fall from the front of the lava. In the condensed milk lava experiment[9], condensed milk was used to represent the molten rock interior, and cocoa was used to represent the solidified lava surface. We observed the cocoa layer fracturing and falling from the front section to assist in understanding the structure and movement of lava.

Keywords: Eruptin, Kitchen volcano experiment, education, model experiment
References: [1] Hayashi, S.(2006)The most delicious volcano book in the world. Komine Shoten, pp127.(in Japanese)
[2] Volcanological Society of Japan (2017) 24th Open Lecture Text, pp.10(in Japanese).
[3] Kasama,T. et al.(2011) Education of earth science, 64, 1-12.
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[5] Hayashi, S.(2015)Let's go to the Geopark, a trip to meet volcanoes and dinosaurs. Komine Shoten, pp175(in Japanese).
[6] Kaneko T. et al. (2016) EARTH PLANETS AND SPACE, 68, 72.
[7] Tsunematsu K. et al. (2016) EARTH PLANETS AND SPACE, 68, 88.
[8] Shintaro Hayashi (2015)　SABO,no.117,　pp.8-12(in Japanese).
[9] Hayashi, S.(2012) Abst. 5th International UNESCO Conference on Geoparks, 4-P-12.

Oral presentation abstract

Multipurpose Hall (Zoom)

21st August 2022

TIME (JST)	ID	Page No.	Authors	Title	On-site / Online	Chairperson
19:00-20:00				**Opening Ceremony**		
20:00	MH_01	11	R. Greco; L. Horodyskyj	Could Earth Science education contribute to a culture of Peace?	On-site	I.Matsumoto
20:20	MH_02	12	K. Hisada	Future Earth Science Education in Japan: The Treatment of Humankind in Prehistoric Times	On-site	
20:40	MH_03	13	→Poster Presentation	→Poster Presentation	-	
21:00				(Short break)		
21:20	MH_04	14	→Poster Presentation	→Poster Presentation	-	R.Greco
21:40	MH_05	15	I. Matsumoto	Practical research on sustainable earth science education in kindergarten	On-site	

22nd August 2022

TIME (JST)	ID	Page No.	Authors	Title	On-site / Online	Chairperson
19:00	MH_06	16	C.J.B. Landicho; P.L. Zipagan; G.J.C. Ang	The Use of Filipino in an Online Performance Task in Senior High School Earth Science	Online	C-Y. Chang
19:20	MH_07	17	C. Zabini; F. de Oliveira	Teaching Paleontology: motivating future teachers	Online	
19:40	MH_08	18	Pawan Kumar Acharya; Aneeta Thapa; Kabi Raj Paudyal	Status of Geology in Geoscience Education at School Level Nepal: A Case Study from the district of Kathmandu Valley.	Online	
20:00-21:00				**IGEO/IESO Assembly**		
21:00	MH_09	19	P. W. Gonçalves; H. Assis Jr; M. L. Brino	John Casper Branner (1850-1922): an American geologist with Brazilian students in mind and his pedagogical approach	Online	Y.Kumano
21:20	MH_10	20	R. Serrano-Agila; J. Manrique-Carreño	Geology report: A problem based learning study of Loja churches, Ecuador	Online	
21:40	MH_11	21	D.M. da Costa; E. R. de Souza	From Thermal Contraction to Plate Tectonics: the internal dynamics of Earth in Geography textbooks from 1932 to 2016.	Online	

23rd August 2022

TIME (JST)	ID	Page No.	Authors	Title	On-site / Online	Chairperson
18:40	MH_12	22	S. N. Vaddadi; N. S. Vaddadi; D.D. Jain; A. N. Ghole; S. S. Virdi	Geotrails - Outreach Program for Geoscience education	On-site	N.Matsubara
19:00	MH_13	23	Yong Il Lee	The national geopark system of Korea and the role of geoscientists for its development	Online	
19:20	MH_14	24	S. Udomsak; N. Choowong; M. Choowong; V. Chutakositkanon	Thousands of Potholes in the Mekong River and Giant Pedestal Rock from North-eastern Thailand: Introduction to a Future Geological Heritage Site	On-site	
19:40	MH_15	25	P. Charusiri; R. Jitrattana; N. Thungprue; A. Saadsud	Satun Global Geopark, Southern Thailand: Past, Present, and Future	On-site	
20:00-20:20				(Short break)		
20:20	MH_16	26	K. Kashiwai	Shimane Peninsula and Shinjiko Nakaumi Estuary Geopark; The land where you can experience the rich nature and the deep history of Izumo Fudoki	On-site	K.Sano
20:40	MH_17	27	K. Bentana; N. Zouros; I. Valiakos	Lesvos Island UNESCO Global Geopark: Training earthquake behaviour	Online	
21:00	MH_18	28	S. Sato; T. Fujioka	Significance and Challenges of Utilizing Geoparks in Learning about Natural Disasters: Expectations for School Education to Create Leaders of a Sustainable Society	On-site	
21:30-22:00				**Closing Ceremony**		

MH_01

IX GeoSciEd 2022 – the 9th International Conference on Geoscience Education
– Geoscience Education for Sustainability –
Matsue – Shimane – Japan, August 2022

Could Earth Science education contribute to a culture of Peace?

R. Greco[1]*; L. Horodyskyj[1,2]

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[2]Science Voices, Tempe, USA
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The world is facing global challenges due to climate change, loss of biodiversity, and finite resources that may not meet the needs of a growing population. However, our educational approaches often do not prepare people for addressing these challenges. *Cooperation* and its associated skills will be the key to finding sustainable solutions. Yet many of our informal learning environments, such as the International Earth Science Olympiad (IESO), focus on *competition* as a way of motivating students to learn. This is no longer appropriate for a world that is rife with conflict and in which large cooperative teams are required to complete breakthrough research. Additionally, not all students learn well in competitive environments, resulting in inequitable outcomes for different genders, cultures, and physical abilities.

From the IESO Statutes, we learn that the main aims of IESO include:

- ✓ □ raising student interest in and public awareness of Earth science,
- ✓ □ enhancing Earth science learning of school students,
- ✓ □ improving the teaching of Earth science in schools,
- ✓ □ promoting international cooperation in exchanging ideas and materials about Earth science and Earth science education, and
- ✓ □ encouraging friendly relationships among young learners from different countries, and promoting talented and gifted students in earth science

Whether these lofty ambitions are met is questionable, as competition is an external driver. Not all students are motivated by external motivation, with many requiring internal motivation to become engaged with Earth sciences and develop Earth science identities.

In this work, we would like to propose alternative formats for international Earth science student events that are developed within a Peace education theory framework. We will present and discuss some possible future models that will not only advance the peaceful ambitions of international science research, but will also lead to more equitable outcomes for students interested in the Earth sciences.

Keywords: Earth science education, peace education, cooperation, global challenges.

IX GeoSciEd 2022 – the 9th International Conference on Geoscience Education
– Geoscience Education for Sustainability –
Matsue – Shimane – Japan, August 2022

Future Earth Science Education in Japan: The Treatment of Humankind in Prehistoric Times

K. Hisada

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In the 21st century, understanding of the evolution of the earth and space has made remarkable progress. These achievements have now allowed us to treat 13.8 billion years of Big History, which integrates the universe, the Earth, and life, as a new and fascinating text of earth science in the 21st century[1]. Through such universe, earth, and life histories, we should deal with issues such as the dispersal of modern humankind and the adaptation of humankind to the environment as future geoscience education. Until now, "origins" such as the birth of the universe, the birth of the earth, and the birth of life have attracted attention in geoscience education. However, as the SDGs show, we have reached an era where "sustainability" must be taken seriously. I would like here to emphasize that Japan has been a tailwind in treating such a "period of humankind" firmly and deeply as geoscience education. It is due to contribution from the setting of the Chibanian (Middle Pleistocene) and the theorizing of global warming.

Chibanian is one of an international geological ages name with a Japanese place name established in January 2020, meaning the period from 774,000 years ago to 129,000 years ago. It is said that Homo sapiens, which was born in East Africa 200,000 to 100,000 years ago, which is the latter half of the Chibanian Age, has begun to spread to the world [2]. In the Chibanian Age, the 100,000-year cycle of glacial and interglacial periods is predominant. The Late Pleistocene (GSSP not set) corresponds to almost the last interglacial and glacial periods, and the present (Holocene) is the interglacial period. In other words, it can be said that Homo sapiens was able to spread humankind to the world by utilizing the landing of the strait due to sea-level changes over a 100,000-year cycle. Thus, the Chibanian Age corresponds to an important period in understanding humankind diffusion. Also, Dr. Syukuro Manabe's Nobel Prize in Physics in 2021is highly evaluated. He established “Combined Ocean-Atmosphere Model” in 1969 [3], and he proposed the world's first predictive model that an increase in carbon dioxide concentration affects global warming. Global warming is causing long-lasting changes to our climate system, which threatens irreversible consequences if we do not act, and its prevention is taken up as one of the action goals, that is, “13. CLIMATE ACTION” in the SDGs. Thus, the period from the Chibanian Age to the present age of Homo sapiens is an important subject that links the modern society of geoscience education, and geoscience education is an important subject that considers the future of Homo sapiens.

For the 21st generation, Japan's geoscience education must take into consideration the universe and earth, life, and humankind histories covering 13.8 billion years, and even sustainability. Until now, geoscience education has tended to focus on pre-humanity in Japan. From now on, starting with the big bang, going through the solar system, the earth, and the birth of life, until just before the formation of civilization, it is necessary to deal with the so-called prehistory and devise ways to connect it to the history of civilization. We have finally reached the point where we can develop a story-like earth science education with such a time axis.

Keywords: Universe-Earth history, Life history, Chibanian, World diffusion of humankind, Future geoscience education in Japan

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IX GeoSciEd 2022 – the 9th International Conference on Geoscience Education
– *Geoscience Education for Sustainability* –
Matsue – Shimane – Japan, August 2022

Key Role of International Geoscience Education Organization in Unifying and Standardizing Global Geoscience Education Policies and Activities around the World

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International Geoscience Education Organization (IGEO) was established to promote geoscientific educational activities via accepting active IGEO council members around the world. However, one of the main activities of the members is knowledge sharing both for the public and geologists, through performing geoscience educational activities for their nations, because it has a significant impact on the advancement of geoscience and achieving sustainable development goals in the world. The current research study is a survey-analytical-descriptive type adopting a scientific approach based on the special IGEO report published in April, 2020. It has tried to contribute to IGEO policy-makers, and their council members' understanding regarding the dynamics of geoscience educational activities performed by 34 out of 46 members, active around the world. Research results showed that the member reports were prepared informally and unacceptable for reporting in an international level. Additionally, they do not adopt standard formats for reporting their activities to IGEO and other global organizations. Preparing scientometrics knowledge map of the member activities showed that the performed activities are classified into 100 activity types but classified in 14 profile groups irrespective of their detailed activity information, representative of professional experience and geological features of countries. The members have been performing their activities in the different fields of geoscience education so that analyzing the report and modelling the activity types of the performed activities by the members showed that they have possibly been performed without following a certain global roadmap from the past decades to present. And furthermore, it seems that most of the activities are performed based on representative professional experience and geological issues and features of countries. the activities were heterogenic and insufficient in terms of activity types and global needs respectively, except for some activities such as holding international Olympiads, or an international conference. The research showed that there are not existing roadmaps, standards and possibly unified policies for performing geoscience educational activities by each member in national and international scales. It is therefore suggested to the IGEO to prepare a standard format for reporting the member activities. Preparing a national to global roadmap for the members need to consider the Strengths, Weaknesses, Opportunities, and Threats (SWOT) of the members based on their activities with concise statistics and scientometrics studies. The members do not have a certain organizational structure and enough experts to pursue their duties in the global scale, as a result, they fail to successfully demonstrate the dynamics of geoscience education for their national and international purposes. As well, it is suggested to United Nations Educational, Scientific and Cultural Organization (UNESCO), International Union of Geological Sciences (IUGS), and the IGEO decision makers that it is essential to create national organizational structures for the members by requesting support through their national organizations which are active in their respective countries, and also allocate domestic and foreign budgets to them where the activities need to be conducted and presented in scientific, unified, and standardized formats for all geologists around the world.

Keywords: IGEO; Geoscience Education Activity standards, Research Activity guidelines, Research Activity regulations, Scientometrics studies, Road map

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Role of Geosciences Education Training Policies and Activities in Promoting Sustainable Development Goals of the United Nations

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This is a desktop research study which has proposed some suggestions to International Union of Geological Sciences (IUGS) and International Geosciences Education Organisation (IGEO) for developing a new generation of education systems around the world. As it is clear, the world has experienced many natural events over time, like occurrences of various natural hazards, pandemics, etc. in the local to global scale. Such events have influenced on the activities and life styles of societies in all levels across the world. For instance, the world has been faced with other global issues, such as earthquakes, volcanic eruptions, and recently climate change and global warming, supplying of green energy, water and mineral resource management insofar as it has affected the world in many ways and affected economic growth of countries, global commodities prices, governmental dependency, and even formation of new cultural behaviour among societies. Additionally, recently, Covid-19 pandemic has spread the world over starting from 2019 and continues to this day. It has promptly intensified those changes as mentioned earlier and been associated with some pros and cons. One of most beneficial of these changes around the world was developing new education training systems known as online education training systems across the internet based on IT infrastructure and platform, although it was developed in advanced countries many years ago. One of most important part of these benefits was knowledge sharing between all scientists within the internet, which was not otherwise possible in face to face education methods, due to the distance, travel costs, or existence of restriction or sanctions for some countries such as Iran, among many others. Also, the Covid-19 pandemic offered to the educational system some lessons in many aspects. It has shown, for instance, that we were not prepared for these new global changes, and most of education training system was not prepared to face global problems. Now, considering these cases, the United Nations (UN) is trying to raise public awareness of current global risks in all its dimensions. At the same time, the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a specialized agency of the UN aimed to promote the UN sustainable development goals through the development and increasing of international cooperation via education, art, sciences, and culture. In the other hand, IGEO, as an affiliated member of IUGS, recently published an international standardized geoscience textbook for teachers and students under the UNESCO educational policies, as a good occasion to improve public understandings related to different types of global challenges and methods to identify them. Considering these cases, we are suggesting that it is essential to develop global frameworks and Knowledge sharing for geoscience education training network via the internet and Metaverse. knowledge Sharing and data, accessing e-learning resources stored in the IGEO's network, facilitating collaboration between students and teachers, and budget allocation, specially to developing countries (in the form of collaborations), are key educational factors to approach the UN's goals. It seems that we cannot achieve sustainable development goals without preparing or updating geo-standards, guidelines, regulations, and alternative policies for geoscience training activities which may be affected by future natural geological events. we suggest to adopt robots in geoscience training based on multidimensional databases and artificial intelligence.

Keywords: Geosciences Education Training, IGEO, IUGS, UNESCO, United Nations.

Practical research on sustainable earth science education in kindergarten

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Making mud Ball (dumpling) is one of the "plays" that many early childhood children have done. It is a scientifically valuable experience of interacting with the soil and the earth. In other words, the mud and sand used to make mud dumplings are the earth itself, and there is a deep scientific and scientific learning, which is considered to play a major role in fostering children's literacy for the earth.

"Play" in early childhood is learning itself, and I think that the experience of this ages has a great influence on the subsequent growth. In addition, the houses, towns, kindergartens, schools, etc. where children live and play have something to do with "land creation and formation". In areas where geoparks and world heritage sites exist in San-in area (Shimane and Tottori Prefectures), there is a connection with the natural environment and the history, industry, and culture that develop based on it.

In this study, I show that it is important for children to come into direct contact with nature (original experience), touch it, smell it, taste it, see it, and hear it. In addition, through this, it becomes possible to develop a rich sensibility for nature and a feeling of valuing the environment. In particular, this presentation will focus on childcare using mud dumplings from early childhood and the utilization of Geoparks.

It also organizes the relationship with SDGs (Sustainable Development Goals) and discusses the sustainability of Earth Science Education.

The photos show mud balls made from several types of soil with various colors and textures.

Keywords: Mud Ball, Soil Sciences Education, Earth Science Education, Kindergarten, SDGs

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The Use of Filipino in an Online Performance Task in Senior High School Earth Science

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Language assumes a critical role in any human endeavor. For teachers and students alike, the medium of instruction affects the successful delivery of lessons and attainment of curricular goals. In the Philippines, English and Filipino are used separately as the medium of instruction in specific learning areas [1]. One of the subjects being taught in English is Earth science, a senior high school core curriculum subject in the Science, Technology, Engineering, and Mathematics (STEM) strand. While current language guidelines provide for the use of English in Science [1], the feasibility of using Filipino and/or regional languages in teaching the subject has remained the focus of earlier studies and discourses (e.g., [2], [3], [4], [5]). In this paper, we present an online performance task in senior high school Earth science developed and implemented in collaboration with the Filipino subject area. Insights gleaned from this project are also discussed.

Keywords: Earth Science, Filipino, Performance Task, Philippines

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Teaching Paleontology: motivating future teachers

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This work is about an application of an active methodology teaching for a Paleontology class at UNICAMP Biological Sciences undergraduate course (Campinas, SP, Brazil). The objective was to develop course materials about some main topics in Paleontology for teachers and students of elementary school level. These topics are usually sparse and scarce in Brazil's Geoscience education, despite their great potential among young scholars; they are also fundamental to improve citizens' relationship with urban and natural environments. In general, teachers' background lacks a deep understanding about the complex Geosciences relations and concepts, which reflects in their future inabilities to work with these concepts based on their own students' interests. The texts written target the teaching of those geoscientific concepts to the undergraduate linking them with Biology, Chemistry, and Mathematics. Moreover, they will become available to these future teachers and to other professionals to use in their classes. The course began with the presentation of two methodologies. Students should vote and the majority of the class opted for active learning. They were then organized within 10 groups, to work on the following themes: taphonomy; paleobotany; vertebrates; fossil records of São Paulo´s State; extinctions and climate changes. In total, 16 classes were organized in 4 main blocks: a) theory presentations with specialists, b) text construction and discussion within the groups and the teacher, c) reading and evaluation of other's group work and d) final presentations. The first block was based on concept's presentations performed by specialists and further use of synchronous meetings to elaborate texts which should include the following items: 1) title suggestion, 2) image description that illustrated the subject, 3) introduction and concept's approach for the theme, 4) importance of teaching and learning the chosen concepts allied to competences conferred by the governamental document that guides the national curriculum - *Base Nacional Comum Curricular* (BNCC)-, 5) suggested methodology for the teacher and 6) bibliographical references. At the second block, each couple of groups erected one of the 5 themes and read and evaluated all the works from other groups. At the third block, the chapters developed during the course were presented to the whole class; these needed to have the same criteria previously mentioned (1 to 6), plus a lesson plan. Groups could also work to add additional concepts and activities, based on what were proposed by others. At the final block, students shared their thoughts and personal experiences. Students: acknowledged the high potential in Geoscience and Paleontology at the Elementary school level; recognized a broad range of methodologies that can be used in such classes; mentioned the importance of specialists lectures to better comprehend subjects; cited difficulties (such as prolonged time and lack of texts in their language) in elaborating course material; and acknowledged that it was probably more demanding than a common methodology, but the effort was valid once the material will be useful in their careers as teachers.

Key-words: active methodology, undergraduation level, Geoscience

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Status of Geology in Geoscience Education at School Level Nepal: A Case Study from the district of Kathmandu Valley.

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At the school level of Nepal, the geoscience portion is included in the Geology, Astronomy and Environment section of the textbook Science from Grade 2 to Grade 8 at the school level. Earlier, the curriculum of geoscience was included up to grade 10 while the recently revised curriculum limits its existence up to grade 8. The curriculum of Geoscience at the school level is insufficient in the context of Nepal. Many portions of this subject are not included in Grade 11 and 12 of the secondary school levels in the science stream.

The teachers and students faced more difficulties in understanding geology (the main foundation of geoscience), as compared to other portions (environmental science, soil science and the study of solar systems). This subject is included only in the school level curriculum of science and is taught as a major subject at bachelor's and master's levels. In many schools, this subject is not taught by teachers. Very few teachers are from geology backgrounds. Based on the portion, they study at the school level, they teach to their students, which makes them very difficult to deliver the core concept of Geology, its application and its scope for the prosperity and development of the nations. Some teachers still skip teaching the major portion of geology. Besides this, the technical terminology, and the requirement of a practical and field-based approach to understanding the subject further add difficulties to them. The curriculum is not well organized and is not prepared by the related experts. The textbook is also not written by related experts which leads to the existence of errors that become difficult to be pointed out by the teachers. As a result, the flow of misinformation occurred as a major problem. This type of problem is comparatively lower in the other portions of geoscience.

In this regard, the questionnaire survey was carried out to school level science teachers representing the different schools of Kathmandu, Lalitpur and Bhaktapur districts of Kathmandu Valley. The survey comprised 20 questions which were focused on the information about the background of teachers, their familiarities and knowledge related to geology, the existing problems, and possible solutions at the school level. The survey result shows that less than 5% of school-level teachers are from geology backgrounds and about only 10% of teachers are familiar with Geology related contexts. Few teachers skip the geology portion while teaching and most of the teachers only cover the curriculum from an exam point of view. Many teachers admitted that the lack of practical and theoretical knowledge they could not help their students to identify the mineral, ore and rock types. The majority of teachers do not take their students on geological field excursions. Many teachers even do not know the scope of Geology in Nepal. Most teachers feel easier to teach the natural disaster portion of Geology. This result shows the status of Geology in Geoscience Education is poor.

However, many teachers suggested revising and adding the relevant content of Geology in the curriculum and science textbooks according to the needs of the nation. From the viewpoint of many teachers, interactive and observatory activities through different means for the teachers and students are an urgent requirement. Almost all teachers expect training on the theoretical part, identification of rock and minerals and geological field excursion from the geoscience-related organizations and professionals. So, the training for teachers including the field excursion is a must for the school level science teachers which will help them to enhance their skills and knowledge. It, in turn, helps to deliver the accurate and core concept of geology, its scope and application and develops an interest in the subject in students. It will be a base for extending the horizon and advancement of geoscience education in the upcoming days in Nepal.

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John Casper Branner (1850-1922): an American geologist with Brazilian students in mind and his pedagogical approach

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John C. Branner the known American geologist was born in Tennessee (USA). His professional training was begun in Brazil before to complete his university studies in geology. He got a job at Brazilian Imperial Geological Survey as assistant of his teacher Charles F. Hartt (1840-1878). Together Hartt visited Amazon region as part of survey. Back to US, had got a job in mining company of Boston and returned to Brazil (mineral prospecting and research of diamonds in Minas Gerais State). After some years, he finished his geological studies in Cornell University. His successful carrier involved important issues in US (creation of Pennsylvania Geological Survey; prospection of coal, bauxite and other ores; the earthquake of San Francisco). He was teacher of geology at Indiana University and after at Stanford University, this was President of University. During his life always had involved with geological studies in Brazil: did long expeditions mainly in Brazilian northern and, at the same time, kept interrelationship with the main scientists that time: Orville A. Derby (1851-1915), Miguel Arrojado Ribeiro Lisboa (1872-1932), Luiz Felipe Gonzaga Campos (1856-1925), Francisco Homem de Mello (1837-1918) and, his assistant Roderic Crandall (who remained in Brazil and worked mainly in north and northern of Brazil). In Brazil, Branner was a geologist of field: collected samples, helped to classify fossils, did survey and maps, collaborated with scientists in different institutions. On the Brazil, published several works. The pedagogical Branner`s approach manifests itself in his interest to prepare Brazilian students: he published a text book in Portuguese to students. In 1906 apparated the first text book done with Brazilian geology [1] and in 1915 the second and actualized edition [2], few years after in 1920 the Branner's geologic map of Brazil in big scale (1:5.000.000) - sheet and book in Portuguese [3]. Branner defends that to learn geology is necessary to know place and landform, specimens (kinds of rocks and fossils) and their distribution and organization. This approach is connected with the Branner`s field experience and his capacity to associate 3D models of body of rocks in surface with landforms. This appears in visual language used in the two-text books and mainly in sheet of geological map. The Branner`s approach to teach brings to pedagogy based on the field and the place.

Keywords: teaching of geology; history of science; pedagogy based on place.

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Geology report: A problem based learning study of Loja churches, Ecuador

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During COVID-19 pandemic, education activities were still working in other modalities such as e-learning [1]. E-learning involves the use of a computer or electronic device [2]. In this teaching modality, teachers have to do synchronously or asynchronously activities. Problem Based Learning (PBL) is a methodology allows to plan various activities. PBL analyse problem scenarios, students plan, collect and synthesize information from multiple sources, generate questions and hypothesis, and communicate their ideas [3]. Case study and on-line communication increases student's learning skills. This paper describes briefly the activities and results of PBL model applied in Universidad Técnica Particular de Loja, Ecuador [4]. PBL was executed in Practicum I course of 3th year Geology program. Six course student's groups were formed to research six different churches. During 10 weeks, Practicum I students faced different scenarios related to field data collection. The study had three phases, (a) church information: date construction, building material, quarry location, neighbour people and priest interviews; (b) geochemical test: geological sample collection, X-ray fluorescence test; and, (c) communicative abilities: results analysis, technical report, conclusions. PBL reveals students' positive attitudes to field work.

Keywords: Problem based learning; online teaching; undergraduate course, geology, Ecuador

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From Thermal Contraction to Plate Tectonics: the internal dynamics of Earth in Geography textbooks from 1932 to 2016.

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This research is a summary of a master's dissertation defended in January 2020 that aimed to understand how the discursive changes on tectonism and mountain formation occurred in the textbooks of the sixth year of Elementary School II, published in Brazil between the 1932s and the 2016s. In other words, we investigated how these books treated the origins of the folds or uplifts of the relief and displacements of the earth's crust, movements linked to tectonism, seeking to understand the conditions of production of these discourses. For the investigation, we gathered and analyzed a *Corpus* of 28 textbooks on Geography, resulting in reflections that help us to understand the trajectory of Earth Science teaching and history in Brazilian basic education from the theoretical-methodological framework of Discourse Analysis, of the French Line. We consider in our analyzes the contexts, the conditions of production and the interdiscourse, fundamental elements of Discourse Analysis and which will be discussed throughout the research. In general, we realized that between the 1930s and the 1980s, most of the Geography textbooks and their authors still presented speeches related to the theory of Thermal Contraction, which came from the 19th century, as responsible for the folding and creation of mountains. This perspective did not change even with the proposal of Alfred Wegener's theory of Continental Drift, disseminated in the early twentieth century, and which only began to be considered more seriously by the scientific community during the second half of that same century, since the mapping of the ocean floor provided new discoveries for Geosciences, culminating in the theory of the expansion of the sea floor and also in a new paradigm: the Plate Tectonics theory, formulated in the late 1960s. We found that only from the decades from 1980 to 1990, with the creation, development and implementation of the PNLD - National Textbook Program in Brazil, the authors of these materials started to incorporate Plates Tectonics once and for all to explain the internal dynamics of the Earth. In this sense, we will highlight the importance that the program PNLD has in the continuous improvement of these materials. Today, for example, all textbooks have varied resources when addressing the tectonism. Reading these books and analyzing them allowed us to understand what were the scientific, editorial and discursive changes in relation to the formation of mountains or folds and displacements of the crust.

Keywords: Geography – Study and teaching; Geosciences; Plate tectonics; Textbooks; National Textbook Program – PNLD.

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Geotrails - Outreach Program for Geoscience education

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Geoscience as a subject is not very popular. Most of the schools in India teach Geoscience or Earth science as a part of social sciences and not as science. Moreover, the pedagogy in geosciences in India is majorly didactic, lecture driven and lacking enough outdoor exposure. Not surprisingly, there is a huge lack of awareness of the importance of Earth Sciences and its importance in daily life. To bridge this knowledge gap, Centre for Education and Research in Geosciences (CERG), organizes various outreach activities to increase awareness and understanding of Geosciences. The activities are run by team of enthusiastic volunteers, many of whom are professional qualified geologists.

One such outreach activity is the **'Geotrail'.** Various Geotrail have been organized annually since the inception of CERG in 2017. A Geotrail comprises of day long guided field trip to easily accessible outcrops, in and around Pune district, Western Maharashtra. As the entire area is covered by ~64-66 Mya Deccan Volcanics, the Geotrail is designed in such a way that it highlights the morphological features of the different lava flows, other physical volcanological features like lava tubes, lava caves, lava channels and various geomorphic features carved in the volcanics such as natural Arch/bridge, potholes (Geomorphosites), etc.

The traverses of Geotrail are planned in such a way that in addition to the geological features, ancient heritage sites (historical and archaeological) close to the field outcrop or enroute the field traverse are also included in the Geotrail. This enables to highlight the relationship of the local geology to architecture and history. Geotrails are an interesting & effective method for building awareness and dissemination of the importance of geosciences and its application, not only to the young students but also to the layman and help stimulate the much-needed respect and appreciation towards Mother Earth.

Based on the authors experience with the Geotrails, a proposal for a Geopark encompassing various Geosites, Geomorphosites, historical and archaeological sites covering parts of Pune and Ahmednagar district has been submitted for consideration. All the sites/spots included in the proposed Geopark is part of the trail.

To ensure the protection of these Geosites, the team at CERG has planned out community outreach programs for the local people in local language. The aim is to disseminate the significance and importance of the Geosites to the local people, especially children and youth, so that they not only feel proud of their area and but also take up the responsibility of protecting them.

Keywords：Geoscience Education, Outreach, Deccan Volcanics, Geotrail.

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The national geopark system of Korea and the role of geoscientists for its development

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The national geopark system of Korea joined the international trend of conservation and wise use of geoheritage as the Jeju Geopark was certified as the Korea's first Global Geopark at the 4th Global Geoparks Network Conference in 2010. With this as an opportunity, in 2011 the Natural Parks Act was amended to include geoparks in natural parks, and the legal system of geoparks was established. Since Jeju Island and Ulleung–Dok Islands Geoparks were first certified as the two national geoparks in 2012, the number of national geoparks has steadily increased, and as of March 2022, a total of 13 national geoparks are in operation. In addition, three or four places are preparing to be designated as a national geopark. At present, there are four UNESCO Global Geoparks (UGGps)(the Jeju UGGp, Cheongsong UGGp, Mudeungsan UGGp, and Hantangang UGGp).

Since Korea does not have a large territory, it was expected that 5 to 6 geoparks would be established at the time the legal system was implemented, but now it is far beyond that and is spreading across the country. There are various opinions as to the reason why the number of geoparks is steadily increasing in Korea. Perhaps two things are believed to have been accepted by local governments and local residents: the concept of a geopark is that the geopark preserves only important geoheritage, but there are relatively few restrictions on other activities, and that, if designated as a geopark, the sustainable development of the region can be promoted through geotourism.

There are various geoheritage and landscape in 13 national geoparks, from Precambrian strata forming the foundation of the Korean Peninsula to the modern geomorphic features. Each geopark is operating programs tailored to its geoheritage characteristics by utilizing "geo-brands" such as geotrails, geoactivities, geocultures, geovillages, geoinformation, geofoods, geofarms, and geogifts. In addition, by developing educational programs, the next-generation and local residents are being educated on the natural history, history, ecology, and culture to inspire pride in their local area.

The interest and participation of geoscientists with various perspectives on geoparks is in need. When reviewing applications for Global Geopark, geoscientists not only receive a request for international valuation of geoheritage from the International Union of Geological Sciences, but also participate as experts in national and global geopark applications, and act as evaluators. As geopark is one of the best places for Earth Science education, and geotourism requires rigorous professionalism/academic support for geology/earth science, so academic research on geoheritage, the core asset of geopark, must be continued to develop geostoryline.

Keywords: Korea, national geopark system, UNESCO Global Geopark, geo-brand

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Thousands of Potholes in the Mekong River and Giant Pedestal Rock from North-eastern Thailand: Introduction to a Future Geological Heritage Site

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A site with thousands of potholes, locally named "Samphunbok (SPB)," and a giant pedestal (mushroom) rock possess a very high geological value. The potholes are being formed on the riverbed of the Mekong River; whereas the giant pedestal rock is the largest on the Khorat Plateau, and is located in Ubon Ratchathani province, north-eastern Thailand. Based on detailed geological, geomorphological, and sedimentological perspectives, this paper presents the geological history of both erosional features for the future promotion of the Global Geopark Network. The giant pedestal rock is likely to be a remnant of degradation and weathering after a regional tectonic event. It is sculptured in the fracture zone of thick sandstone beds after uplifting and folding. No evidence of abrasion by wind was found. The formation of potholes is limited inside the Mekong River bankfull elevation. The appearance of potholes in different levels of the sandstone beds infers their formation in relation to the vertical evolution of the Mekong River. All geological data shown in this paper confirm the rareness of potholes and the giant pedestal rock in terms of how they were sculptured and preserved through time. These erosional features at SPB are discussed and introduced in this paper as a global geological heritage site.

Keywords: Pothole. Pedestal rock. Geoheritage. Mekong River. Samphunbok. Khorat Plateau
Reference: Udomsak, S. et al (2021) Geoheritage, 13, 5, 1-17

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Satun Global Geopark, Southern Thailand: Past, Present, and Future

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We selected the Satun geopark for our current study since the geopark has been certified as a member of UNESCO Global Geopark in 2018. The study aims to document the past and present activities related to the Global Geopark and to address the plan for sustainable development. The geopark, situating in the Andaman Sea coast of southern Thailand, commenced from the discovery of the Pleistocene Stegodon elephants in the 4 km - long cave by a fisherman in 2015. Subsequently, not only a geological investigation but also social and cultural analyses were performed in Satun Province for detailed evaluation in the establishment of the geopark. The result came out very well due to the co-operation of both government and non-government sectors. In term of natural environment, the geopark has been known as the peaceful place with great natural beauty. Furthermore, after the establishment of the Satun Global Geopark, several jobs and new careers have been generated. Good examples are batik fabricates, melon farms, and coffee shops. At present, the geopark is geologically famous for "Land of Palaeozoic fossils". Starting from the oldest sedimentary strata with Cambrian fossils, clastic rocks have been found as the Tarutao Group rocks. The Cambrian trilobite fossils of Tarutao Island are the oldest in the Thai-Malay Peninsula, and the overlying volcanic ash layers allow for absolute dating of the Cambrian - Ordovician biostratigraphy. A new genus and five species of Cambrian trilobites have been recently discovered here, as well as the fascinating red stromatolites. A significant amount of bio-geological evidence during Cambrian to Permian times in the Satun area supports the evolution of Shan Thai (or Sibumasu) formed as a part of peri-Gondwana terranes. Geomorphologically, "Prasat Hin Panyod" Permian-limestone tower karst is the outstanding geosite of the Satun Geopark characterised by the eminent pinnacle karst landform, including stunning sea caves and hidden lagoon, which tourists can visit by kayak. Nonetheless, one of the key future-research studies is the occurrence of thinly to thickly bedded volcanic tuffs which has been reported as well in several places in Thailand, such as Chiang Rai area in the north, Uthai Thani- Kanchanaburi and Prachuap Khiri Khan areas in the central, and Surat Thani area in the south. This widespread magmatism represents the tectono-magmatic episode related to Pan African mobile belt of Cambro-Ordovician ages. In Myanmar, this magmatic episode is also responsible for voluminous Pb-Zn mineralization in Baldwin of northern Shai State. Therefore, the result of age dating determination for the easily accessible volcanic tuff in the Satun Geopark is crucial for deciphering geologic/tectonic history of mainland Southeast Asia. It is therefore anticipated that the contact between Cambrian and Ordovician in some places within the Satun Geopark is unclear and need to be solved. The provenance of Stegodon related sediments need to be systematically proved and the most reliable ages of non-fossiliferous limestones need to be resolved. However, the key sustainable economy is also required in the future for the linkage between natural geopark and local villagers' societies, cultures, and communities.

Keywords: Satun, Global Geopark, Southern Thailand, Paleozoic, Fossils

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Shimane Peninsula and Shinjiko Nakaumi Estuary Geopark: The land where you can experience the rich nature and the deep history of the Izumo Fudoki

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A Geopark is a place where we can learn about and enjoy the relationship between "stories of the land", "ecology of plants and animals" and "local residents' daily lives, histories, cultures and industries". The purpose of Geoparks is to create sustainable societies by encouraging local people to learn about the above relationships, nurturing a sense of pride in the region, and promoting awareness about and enhancing understanding of climate changes and geological hazards. Shimane Peninsula and Shinjiko Nakaumi Estuary Geopark work closely with Shimane University, who participate in the Geopark Committee as the secretariat office. Shimane University works daily on education, dissemination and public awareness about the Geopark by holding Geopark study programs for the university students and workshops for citizens, and by serving as instructors in geopark classes at elementary schools and supervising the creation of support materials used in classes. The support materials are distributed to all elementary schools in Matsue City and Izumo City, and the Geopark Promotional Council provides bus fare subsidies for visiting the Geopark. About 40% of schools in Matsue City and Izumo City, 26 schools, used the subsidy during the fiscal year 2021.

Keywords: Shimane Peninsula and Shinjiko Nakaumi Estuary Geopark, Geopark study program, Support material

References: none

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Lesvos Island UNESCO Global Geopark: Training earthquake behaviour

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Lesvos Island UNESCO Global Geopark (Greece) is located in a very active seismic area. Thus it works continuously to raise awareness, inform and educate school students on issues related to seismic risk reduction.

In Lesvos the Natural History Museum of the Lesvos Petrified Forest realises the thematic educational programme entitled "Natural processes on our planet-Let us familiarize ourselves with the earthquakes".

The aim of the program is to educate school students on issues related to the protection against the seismic hazard. Learning through experiential activities, transformative learning and training is used as a methodology of education.

The geosites such as the faults of Lesvos, the earthquake simulator that has been installed in the Natural History Museum of the Lesvos Petrified Forest, educational material and the exhibition areas of the Museum are used as tools for the implementation of the programme.

In the earthquake simulator the school students have the opportunity to experience the simulation of earthquakes that happened in the past. The students get familiar with the consequences of an earthquake and implement the protection measures on how to react during an earthquake. The earthquake simulator is specially designed to represent a familiar place of the students such as a school classroom.

The experience of the seismic movement in the earthquake simulator and the acquaintance with the phenomenon of the earthquake helps to reduce the feeling of panic and meets the need for proper preparation for the confrontation of the seismic risk.

The Educational Program is addressed to students of Primary and Secondary school level Education, adapted respectively to their age.

Keywords: Geopark, UNESCO, Lesvos, education, earthquake

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Significance and Challenges of Utilizing Geoparks in Learning about Natural Disasters-Expectations for School Education to Create Leaders of a Sustainable Society

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The significance of using Geoparks in school education has been presented from various perspectives (contexts) at science education-related academic societies in Japan, etc. In 2017, the Courses of Study in Japan indicated that Geoparks should be used in science classes at junior high schools. However, the significance of using Geoparks in junior high school science classes in Japan has not yet been fully discussed and understood. Therefore, it is desirable to organize the significance of utilizing Geoparks in school education that has been discussed so far, and to clarify and explain the significance of utilizing Geoparks in the study of natural disasters in junior high school science classes. Therefore, in this study, we organized the significance of utilizing Geoparks in school education, and clarified the significance of utilizing Geoparks in learning about natural disasters in junior high school science classes. We also discussed issues related to the use of Geoparks, and aimed to promote the use of Geoparks and enhance the study of natural disasters in junior high school science classes.

As a result of the literature review, the following points can be considered as the significance of Geopark education in Japan in conjunction with disaster education.

The World Geoparks and the Japanese Geoparks differ in how disaster education was positioned as the significance of Geopark education. The World Geoparks were first regarded as a place for geoscience education, and then their value was recognized as a place for disaster education as well. On the other hand, Japan Geopark has been regarded as a place for disaster education since its inception. Therefore, there are many Geoparks in Japan that are suitable as sites for disaster education, and it can be said that Japan has the initiative in Geopark education linked to disaster education.

The relationship between disaster prevention/mitigation and reconstruction education in Geoparks and environmental education, ESD, and SDGs can be summarized as follows.

The significance of ESD and environmental education includes disaster prevention education from the perspective of "sustainability. And as a field to learn it effectively, there is a Geopark that is suitable as a place to learn about natural disasters. Disaster prevention education in a geopark enables students to understand the connections between humans and society, and between humans and nature, and to learn about the history of humans' confrontation with natural disasters, the dual nature of natural benefits and disasters, and the mechanisms of natural things and phenomena, from a multifaceted and multifaceted perspective through a combined humanities and science approach. In addition, the goals and targets of the SDGs can capture the specific role of Geoparks.

In order to enhance Geopark education based on disaster prevention education, ESD, and SDGs in junior high school science classes in Japan, it is necessary to take measures to effectively utilize Geopark education, such as the preparation and use of supplementary readers based on textbooks, the preparation of curriculum-based learning plans, and the use of instructors with specialized knowledge of Geoparks. He pointed out that in order to enhance Geopark education, it is necessary to take measures to effectively utilize Geopark education.

Keywords: Geoparks, Disaster risk education, natural disasters, Environment Education, ESD, SDGs

Oral presentation abstract

Small Hall (Zoom)

21st August 2022

TIME (JST)	ID	Page No.	Authors	Title	On-site / Online	Charperson
19:00-20:00				-		
20:00	SH_01	30	A. Tomita; P. S. Bretones	Astronomy Day in Schools project: practice on equinoxes and solstices	On-site	T.Sano
20:20	SH_02	31	K. KIMURA; M. Ishii; M. Sugaya; T.Satoh	Astronomy lessons which used Constellation Camera "i-CAN" that encourage the attitude of observing the night sky	On-site	
20:40	SH_03	32	H. Otsuji	The Moon in the Night of NIRVANA	On-site	
21:00-21:20				(Short break)		
21:20	SH_04	33	T. Satoh; M. Ishii; I. Matsumoto; K. Kaoru; H. Ueda	Use of the Remote Observing Tools for Astronomy Subjects under Pandemic	On-site	A.Tomita
21:40	SH_05	34	K. Sawada; M. Okyudo	Astrotourism and Sustainability: A case study of Yoron Island, Kagoshima Prefecture	On-site	

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TIME (JST)	ID	Page No.	Authors	Title	On-site / Online	Charperson
19:00	SH_06	35	S. Chawchai; J. Miocic; A. Baillan; P. Surakiatchai; S. Kongsen; M. Choowong; F. Preusser	Late Holocene Sea level change and hydrodynamic of Chanthaburi estuary in the eastern Gulf of Thailand	Online	M.Watarai
19:20	SH_07	36	H. Sun; Y. Duan	Research on the Disaster Education in Chinese Senior High School Geography Textbook	Online	
19:40	SH_08	37	N. Pajonpai; R. Bissen; S. Pumjan; A. Henk	Shape Design and Safety Evaluation of Salt Caverns for CO2 Storage in northeast Thailand	Online	
20:00-21:00				(IGEO/IESO Assembly @MH)		
21:00	SH_09	38	B. S. Emralino; F. M. Emralino	Narrative and Thematic Analysis of Natural Disaster Experiences of High School Science Students	Online	I. Takimoto
21:20	SH_10	39	Y. Sakakibara; H. Nagai	Development and Evaluation of a Lesson Program on a Storm Surge with a Typhoon passage	On-site	
21:40	SH_11	40	T. Fujioka; I. Matsumoto	Education for Disaster Risk Reduction in Japan from the Viewpoint of SDGs (Sustainable Development of Goals)	On-site	

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TIME (JST)	ID	Page No.	Authors	Title	On-site / Online	Charperson
18:40	SH_12	41	Young Shin Park, Kiyoung Lee, Hyeong Soo Kim, Hyonyonh Lee, James Green and Jiyeon Lee	Developing Global Energy Topic STEAM Program with a Focus on Democratic Citizenship	On-site	M.Cano
19:00	SH_13	42	Y. Kumano	The Model STEAM Education Challenges Using “Dagik Earth” for the Sustainability within the project of Shizuoka STEM Academy	On-site	
19:20	SH_14		→Poster Presentation	→Poster Presentation	-	
19:40	SH_15	43	S. Shoji; T. Sato; K. Kawai; K. Imai; Y. Kobayashi	Development of BYOD-style Horizontally and Vertically Movable Virtual Reality Field Trip Tool for Earth Science Education	On-site	
20:00-20:20				(Short break)		
20:20	SH_16	44	S.M. Locke; G. Bracey; S. Hu; T. Foster; C. Wilson	Outdoor Earth Science Learning Through Geocaching	On-site	Y-S. Park
20:40	SH_17	45	M. Matsubara; A. Nishizawa; S. Aoi; K. Takenouchi	‘NIED Quake map!’-Guide and education tool at geoparks-	On-site	
21:00	SH_18	46	L. Horodyskyj; B. Ilca; W. Parkhurst; A. Gazdac; J. Oribello	Agavi: A Digital-Analog Hybrid Platform for Science Education	On-site	

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Astronomy Day in Schools project: practice on equinoxes and solstices

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The sub WG of Astronomy Day in Schools, under the WG of Astronomy Education Research & Methods, the Commission C1 of the Astronomy Education and Development [1], the International Astronomical Union (IAU), has been calling schools around the world to share practices of astronomy education, especially in conjunction with the equinoxes, solstices, and other major astronomical phenomena. Equinoxes and solstices are not only astronomically significant around the world, but they are also important phenomena in the history of science and are connected to cultural events in various regions, making them suitable subjects for educational practice that combines science, history, culture, and STEAM education. The project website since 2021 [2] and has collected records of the practices. A collaboration led by the Iranian Teachers Astronomy Union and Students' International Network of Astronomy in Iran, has allowed this project to organize online exchange meetings on the occasion of the equinoxes and solstices. This has given students around the world an opportunity to introduce their school studies, daily life, and culture in their respective countries. We have shared various kinds of practice related to astronomy with links to local culture, daily life, and community. Through the above activities, we found that communication among teachers and students across borders promotes astronomy education, environmental and nature education, and astronomy education practices related to culture and daily life are good gateways to the world of astronomy and science for teachers regardless of their fields. The challenge of this project is that it is not yet sufficiently numerous as a repository of examples of practice, and not yet sufficiently broad in its scope as it relates to the field of geosciences in general. We would like to use this presentation to introduce the first results from the registration of practices on the website and the introduction of practices in the online communication meetings and hope to receive input from researchers and practitioners in geoscience education.

Keywords: astronomy education, international collaboration, equinoxes and solstices, astronomy and culture

References: [1] https://www.iau.org/science/scientific_bodies/commissions/C1/ [2] The website (https://adis.narit.or.th/) is hosted by the National Astronomical Research Institute of Thailand (NARIT).

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Astronomy lessons which used Constellation Camera "i-CAN" that encourage the attitude of observing the night sky

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One of the purposes of learning astronomy in elementary school is "to have many opportunities to observe the moon and stars, and to have many emotions and interests in the celestial bodies and many stars in the night sky." [1] Children need to have the opportunity to observe the stars. However, children cannot watch the stars during class hours during the day, and the teacher has difficulty gathering children at night and is not confident in teaching to observe the stars, so everyone has little opportunity to observe the stars together. Therefore, each child is forced to observe at home at night[2]. Previous studies have shown that it is not enough to teach how to observe the night sky in daytime lessons alone. And that it has been difficult for children to acquire accurate drawing skills.

From these issues, we investigated whether showing the real-time night sky image during class would motivate children to observe the night sky at home. Also, by checking in advance the night sky that children will see at night, we will make it possible for them to recognize that they have seen the same asterism later. This survey is for 4th-grade, we compared the lessons taught by the constellation camera i-CAN before the observation with the lessons taught by the planetarium software. Both children practice how to use a compass and observed the moon during the day and learned how to draw by the silhouette method. After that, the children observed the night sky and draw asterisms at each home.

As a result, children who learned using i-CAN began to actively observe at home. This increased the children's attitude towards observing the night sky. Furthermore, it became clear that the asterisms they perceived as the same stars were reproducible draw of not changing their arrangement over time. Thus, it was suggested that using i-CAN before observing the night sky at home is an effective teaching method for acquiring reproducible observation and recording skills.

Figure1. Night sky real-time observation using time difference. Everyone can use i-CAN to observe the stars/constellations in the classroom during the day.

Keywords: Astronomy Education, Constellation Camera i-CAN, Astronomy Teaching, Observation, Learning activities

References:

[1] Ministry of Education, Culture, Sports, Science and Technology. (2017) Elementary School Course of Study Commentary Science Edition, 60.
[2] Masayuki Ishii. et al. (2012) Society of Japan Science Teaching, Abstract #2H103,368.

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The Moon in the Night of Nirvana

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I have been focusing on the depictions of the moon in literary works. A famous *haiku* by Yosa Buson, featuring the moon, is a popular science teaching material for Grade 9 students in Japan to infer the moon's shape. Because he wrote the haiku when he left the Maya temple in Kobe and saw the beautiful scenery in front of him, I found that he might have been reminded of the "Nirvana" drawing (Figure 1). The *haiku* not only expresses the beauty of nature as claimed by Masaoka Shiki, but also embeds the impermanence of human life and death and the eternal transition of the natural world[2][3].

Figure 1. Nirvana [1]

In Japanese literature, the moon generally refers to autumn, but the full moon in spring seems to represent Nirvana. The disciples in the drawing must have thought of Buddha when they saw the rising moon after he died. How high did the moon go up? The moon occasionally rises unexpectedly high, sometimes at altitudes above 80 degrees in Japan.

Buddha died in Kushinagar, which is located 26.7 degrees north latitude, on the night of the full moon on February 15 in the lunar calendar. However, there are some theories regarding the year of his death that cannot be clarified; for example, Theravada Buddhism estimates it to be 544 BC, while Hajime Nakamura believed it was 383 BC.

Table 1. Moon of the Estimated Night of Nirvana

Estimated Year (BC) [4]	Altitude of the Moon [degree]	Time of Moonrise	Remarks
949	66.7	18:04	Shobo Genzo
544	69.2	16:38	Theravada
486	65.3	17:53	Shusho Tenki
386	66.7	16:56	Ui Hakuju
383	71.7	17:25	Nakamura H.

The observed altitude of the moon changes greatly depending on the latitude and its positional relation with the sun (moon age). In addition to the obliquity angle of 23.4 degrees, the angle of 5.1 degrees between the lunar orbit and the ecliptic planes must be considered. The moon orbits the barycenter and the lunar orbit plane, keeping its inclination, and rotates in the opposite direction to the orbit movement in a cycle of about 18.6 years (causing the earth to nutate). The National Astronomical Observatory Japan provides a website that instantly calculates the moon's altitude, rising time, and direction based on the observed place and date [5].

Table 1 shows the altitude and the time of moonrise for each theory. The altitude of the full moon of that night at Kushinagar, while not exceptionally high, was high enough. Figure 1 shows a drawing of the sunset time (moonrise time) of one of these. This calculation depends on the calendar and may be revised in the future.

Keywords: Moon Altitude, Nirvana, National Astronomical Observatory Japan.

References: [1] Daien-ji, Suginami, Tokyo [2] Otsuji H. (2020) What Buson Caught in the Canola? *Proceedings of JSSE 44*, G064. [3] Otsuji, H. (2021) The Philosophical Background of Art in STEAM Education, *EASE Conference 2021*, Shizuoka, Japan. [4] Wikipedia "Shaka." [5] National Astronomical Observatory of Japan. https://eco.mtk.nao.ac.jp/cgi-bin/koyomi/koyomiy.cgi

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Use of the Remote Observing Tools for Astronomy Subjects under the Pandemic

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Studying astronomy subjects is usually quite challenging as most of celestial bodies cannot be observed during the day when kids are at the schools. Remote observatories in different timezones (assume they are in the night) can therefore be useful to deliver the real-time view of target objects to the classrooms in the day. Our constellation camera i-CANs were developed to provide convenient access to the night sky based on an easy-to-use interface [1]. The best usage of i-CAN is to visualize the motion of stars (**Fig. 1**) which is in Japan's standard curriculum (Course of Study) for 4th grade. The night sky of an i-CAN site is projected to the screen and kids mark the positions of stars. In 5 or so minutes, undoubted motion of stars is noticed.

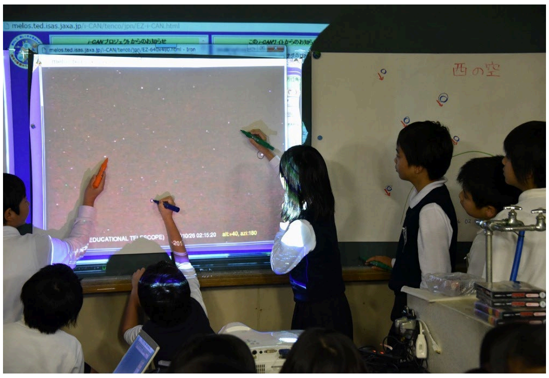

Fig. 1: Kids mark star positions on the screen (before the pandemic).

This pandemic has forced so many areas in our lives to change. At schools, remote classes are now common, and teachers/students get more and more familiar to remote tools (presentation, chat, etc.) than ever before. We have found that our remote observing tools, such as i-CANs, are almost as useful as they were before the pandemic, or even more useful now. "Projection of the sky to the screen" can easily be replaced by "sharing of the screen". "Marking star positions" can be done using "annotation function" of the meeting app (zoom, for instance). It should be noted that these are not only for remote class but the same can be done in the real classroom as each student is now given a tablet device. There is no need to call kids to the screen which may increase the risk of infection to each other.

After all, the pandemic has increased in general our ability of utilizing remote tools, and it has shed more light on our remote observing tools. We may probably be able to learn more from these (unintentional) experiences to make the once challenging astronomical subjects more fun to study things.

Keywords: Astronomy subjects; Remote tools; Constellation cameras; Motion of stars; Pandemic

References: [1] Satoh T. et al. (2008) Global Hands-On Universe 2007, 73-78.

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Astrotourism and Sustainability: A case study of Yoron Island, Kagoshima Prefecture

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In recent years, astrotourism (AT), which is defined as an activity where people travel from their place of residence in order to look up at beautiful starry sky and celestial bodies has started to attract an increasing number of tourists all over the world [1]. Also, AT is an innovative form of tourism that contributes to sustainable tourism development based on the triple bottom line (TBL) [2]. AT is expected to lead the creation of night-time economy that has been ignored in the past (Economic Bottom Line) [3], the promotion of educational activities to prevent light pollution based on environmental protection (Environmental Bottom Lone) [4], and the inheritance of star lore in the region (Socio-Cultural Bottom Line) [5]. Wakayama University is practicing sustainable tourism development centered on AT in Yoron Island, Kagoshima Prefecture. This report describes the activities we are engaging in on the Island.

Yoron Island, 20.8 km^2 in area, has a population of approximately 5,000 people, and the coast is surrounded by a coral reef. Yoron Island experienced a tourism boom in the 1970s, attracting more than 150,000 tourists a year, but the number is currently hovering around 70,000 [6]. We are practicing the following three major activities in the island. First, we offer "The Qualification System for the Astronomy Guide [7]" to train astro-tour guides. At present, more than 50 local residents have taken the course, and several of them are actually carrying out tours. Mr. A, who specializes in marine leisure guiding, talked to us, "Even if I get too old to go out to sea, I can continue to guide starry skies!". In Yoron Island, AT is becoming part of the economic income. Second, we are engaging to reduce light pollution. Town lights are the biggest natural enemy for AT. Therefore, we have switched streetlights in some areas of the island with an upward luminous flux ratio of 0. We also plan to survey the status of streetlights throughout the island and, in turn, replace them that can reduce light pollution. In the future, we aim to be certificated by International Dark-sky Places Program, which is carrying by International Dark-Sky Association [8]. We are committing to creating island where tourism and the rich environment can coexist. Third, we are conducting ethnographic research on star lore in the island. The ancient people lived by watching the movement of the stars and the moon when there were no clock and compasses. Also, they know a lot of folk songs, related to the stars and the moon. We hope that astro-tour guides can explain their wisdom of life. In order to realize, we have published several of our findings in a paper [9]. We will continue to engage on creating a sustainable tourism destination through AT on Yoron Island, focusing on these three pillars.

Keywords: astrotourism, sustainable tourism development, Yoron Island, astronomy education, light pollution

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Late Holocene Sea level change and hydrodynamic of Chanthaburi estuary in the eastern Gulf of Thailand

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Beach ridges are sea level-related deposition that can be used to infer former sea level positions and shoreline evolution. In this study, satellite images provide evidence of paleo-beach ridges in Chanthaburi province, the east coast of Thailand extending as far as 6 km inland with an orientation approximately northwest-southeast, comparable to the current coastline. Paleo-beach ridges in this area can be divided into two sets; inner ridges (5.3-6.0 km inland) and outer ridges (0.4-1.8 km inland). The Chanthaburi river estuary is currently situated between the inner and outer ridges. The sedimentary properties show that (1) the ridge sediments are fine to coarse sand, becoming finer inland; (2) the grain shapes are sub-round to sub-angular with low sphericity; and (3) the mineral composition is primarily quartz (> 90%), with a small amount of clay minerals, feldspar, and heavy minerals. Optically stimulated luminescence (OSL) dating of 26 sand samples from 12 pits of ridge profiles suggest that the oldest deposition occurred during the late Holocene (3,580±180 years ago). The inner set of paleo-beach ridges accumulated during ~3,800-2,500 years ago, while the outer set of ridges formed between ~2,000-1,000 years ago. In conclusion, the formation of paleo-beach ridges in this area indicates the sea-level regression ca. 2 m after the mid-Holocene Highstand. The sea level transgression triggered the formation of the beach barriers, and estuarine systems were likely active after the regression.

Keywords: Beach ridge, Sedimentology, OSL dating, Sea-level change, Gulf of Thailand

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Research on the Disaster Education in Chinese Senior High School Geography Textbook

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Abstract: In the process of sustainable development, education is one of the key ways to mitigate disasters and ensure safety. Education that teaches the basic knowledge and skills of disaster mitigation and prevention plays an extremely active role in disaster mitigation and risk control. The curriculum of geography contains rich resources for disaster education, and the content and characteristics of disaster education organized in geography textbook are the core elements for implementing the goals of disaster education.

This article analyse disaster education in compulsory Geography 1 textbook in Chinese senior high school which is published by Sinomap Press (Shanghai edition).The book is set up according to students' overall development needs, and all Chinese senior high school students will study it and be tested, which have universal educational significance.The topics of disaster education in Chinese senior high school geography textbook cover meteorological disaster, marine disaster, geological disaster, biological disaster, etc. The content of typhoon, flood, storm surge,algal bloom, earthquake, landslide and mudslide is organized in the textbook according to Chinese disaster situation and the national geography curriculum standards.They convey systematic and universal disaster knowledge, develop students' ability to obtain disaster information and argue disaster problems,enhance the consciousness and mobility to prevent disaster,and form the harmonious coexistence between human beings and nature.

The main features of disaster education in Chinese senior high school geography textbook are:(1)constructing the disaster knowledge framework,which is organized by "concept of disaster - causes of disaster - characteristics of spatial and temporal distribution of disaster - impact of disaster - measures for disaster prevention and mitigation"; (2)promoting students' literacy,and the activity tasks permeate the basic methods and ideas of geographic research and embrace core geographic literacy; (3)integrating information technology,and the textbook provides geographic tools such as Geographic Information System,Virtual Reality Technology, Remote Sensing, and online disaster databases to guide students to recognize and understand the application of information technology in disaster prediction and forecasting, data analysis, and disaster relief. Disaster education is logically organized, with the application of cutting-edge science and technology, and student-centered experiential activities.It gradually enriches students' disaster cognitive system by "what to know - why to know - how to do".It can enhance students' disaster prevention and mitigation ability, and establish a sustainable development concept of dialectical coordination between human and environment.

Keywords: Chinese senior high school geography textbook; disaster education; disaster prevention and mitigation

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Shape Design and Safety Evaluation of Salt Caverns for CO_2 Storage in northeast Thailand.

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In Thailand, greenhouse gas emissions, especially carbon dioxide (CO_2), have almost quadrupled since 1989. The energy producing industry is the main contributor by burning fossil fuels to generate electricity. Therefore, the energy sector has come under scrutiny and been pressed by society to take responsibility for CO_2 emissions which are one of the main reasons for global warming. Many methods have been developed to handle CO_2 emissions, one of which is Carbon Capture and Storage (CCS). Captured CO_2 can be stored in geological formations, e.g., rock salt deposits, which are found worldwide. Salt caverns are an intensively studied and adequate solution due to their large storage capacity, safety of storage operation and long operation time. Rock salt has a low permeability and self-healing capabilities, preventing the leakage of CO_2. Additionally, excavation of salt caverns by cost-efficient solution mining is economically beneficial as the overall cost for CCS are reduced. However, the designing process of salt caverns is still considered a complex issue despite progress in geotechnical, construction and exploration methods. Finding the optimal shape and dimensions of a salt cavern in given geological conditions is a difficult engineering problem in view of safety and stability requirements. In this paper, the stability of typical cavern shapes (spherical, cylindrical, teardrop, bulb, and pear) was evaluated. The analysis aimed to find the optimal cavern shape for salt deposits found in borehole K-89 at Ban Nong Plue, Borabue district, Maha Sarakham province, northeast Thailand. Sources of CO_2 are natural gas and biomass power plants. For local communities, the safety of CO_2 storage facilities is of utmost concern. The evaluation of cavern stability was based on the following criteria: displacement, von Mises stress, safety factor and volume change. The results of this evaluation can be useful in the design of an optimal cavern shape for planning new cavern fields for storing CO_2 (and other gases) in salt deposits.

Keywords: carbon dioxide sequestration, salt cavern, geomechanical modeling, cavern stability, safety, Maha Sarakham Formation

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Narrative and Thematic Analysis of Natural Disaster Experiences of High School Science Students

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A narrative and thematic analysis of the experiences of high school science students during the 2020 Taal Volcano eruption in the Philippines was conducted. A survey instrument was prepared as an in-class activity and was administered to the students (n = 218). The activity was a set of guided closed- and open-ended questions designed to obtain the specific experiences of the students during the actual Taal Volcano eruption and the subsequent actions of the students and their families immediately following the eruption. Recollection of the students on their specific activities and locations during the eruption varied primarily as it occurred on a weekend. Responses describing their subsequent actions were analyzed and were identified to fit under five different themes: 1) respondents become more cautious and were forced to establish their own emergency procedures (51%); 2) respondents become more cautious but did not make any specific emergency procedures (30%); 3) respondents did not do any action (10%); 4) respondents already have existing emergency procedures (7%); and 5) respondents did not provide any classifiable and clear answers (2%). The results can serve as basis for the conduct of a focus group discussion to further investigate the immediate factors which motivated the students and their families to arrive at those decisions. It is recommended that similar surveys be formatted also using the instrument employed in this study to get narratives from other natural disaster experiences.

Keywords: disaster education, science education

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Development and Evaluation of a Lesson Program on a Storm Surge with a Typhoon passage

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There are heavy rain, strong wind and storm surge (high tide) in meteorological disasters. Most of them are caused by typhoons. The typhoon Isewan had the most of victims in Japan 1959. The damage done by huge storm surge. The storm surge disaster induced by typhoon Yulanda caused several damages in Leyte and Samar island the Philippines. TV and a radio addressed inhabitants as storm surge attention. But many inhabitants let their guard down and failed to escape. Over 7700 people died or were missing. Understanding of the mechanism of storm surge is important for residents to judge the information about safety correctly and evacuate the safe place. The mechanism of storm surge, which tends to occur in the bays located on the right hand side of the typhoon passage, is not easy to understand.

We have developed a new course of study on storm surge disasters. We should teach high school students about storm surge since they can deliver serious damage, but the available teaching materials are poor and there are few classes covering this issue.

The reason storm surge can more easily cause flooding in some areas than other, and the factors that generate flooding may be hard for students to understand. To address those difficulties we have developed: (1) teaching material using a magnet bar and magnetic compass to simulate the wind direction on different sides of the typhoon passage (Figure 1) and (2) the lesson plan including an activity with a computer using AMeDAS observation data on historical typhoon movements and wind directions.

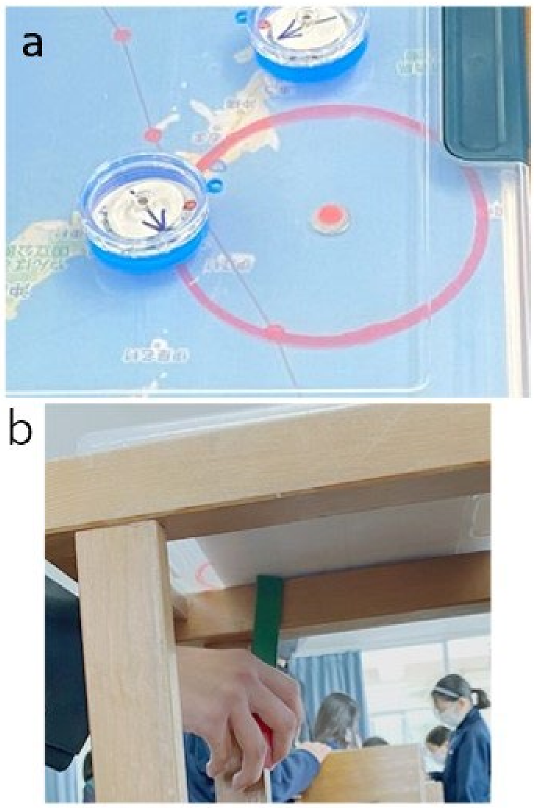

Figure 1: A teaching material for an activity with a magnet bar ***a****: wind direction compass model on the a clear box,* ***b****: S pole of a magnet bar is moved under the clear box*

We performed a trial lesson to study the effectiveness of the lesson plan and found the following:

1) The lesson increased student interest in studying typhoons.
2) Students found the lesson fun.
3) The lesson was successful in explaining the properties of the wind direction in typhoon movement patterns and how it helps us predict storm surge floods.

Keywords: typhoon, natural disaster, high school, storm surge, wind direction

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Education for Disaster Risk Reduction in Japan from the Viewpoint of SDGs (Sustainable Development of Goals)

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Today, efforts to achieve the SDGs are attracting attention both domestically and internationally. Responding to climate change and natural disasters is indispensable for building a sustainable society. Words related to natural disaster reduction are frequently used in the targets and goals of the SDGs. Especially, SDGs 4 have important implications for education that leaves no one behind in natural disasters. Education is indispensable for the realization of all 17 goals, and the importance of Geoscience education goes without saying. In this report, we intend to summarize the issues and prospects of Geoscience education in Japan, where natural disasters have occurred frequently from viewpoint of SDGs.

In the 2011 Great East Japan Earthquake and Tsunami, more than 600 children, students were killed. In Ishinomaki City and Higashimatsushima City, the predictability of disasters was disputed even by the Supreme Court. These discussions, the manual guidelines prepared by the government, and the Third Plan for the Promotion of School Safety have revealed the following:
(1) Principals need to understand the natural environment of the area at a higher level than citizens. (2) The Board of Education, which established it, has a great responsibility for guidance and advice. (3) Schools need to review safety manuals and require teacher training. (4) Hazard predictability as a duty of care is also applied to natural disasters

These issues present future challenges not only to school principals and boards of education, but also to the Japanese educational community. Specially, the need for Geoscience education in school management became clear.

1．School administrators need to learn the local nature, for example Geography or Geology
2．Faculty and staff are required to conduct school safety and evacuation drills based on their knowledge of Geoscience.
3．Curriculum management that transcends the framework of conventional subjects is indispensable for disaster prevention education from the perspective of SDGs.
4．By learning about the benefits of nature as well as regional and domestic natural disasters from the viewpoint of ESD, it is possible to educate people who are conscious of the harmony between nature and humans.

Keywords: Disaster Risk Reduction, SDGs/ ESD, Geoscience Education, School Safety

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Developing Global Energy Topic STEAM Program with a Focus on Democratic Citizenship

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This study explored democratic citizenship (DC) for students by developing eight different components of DC as a framework. We employed this framework to examine what and how much DC is included in activities that have the topic of energy in science lab books and textbooks from K to 12 in Korea. We found different DC components were included in lab books and textbooks at different grade levels and some components were not present at all. To help address the uneven distribution of these components, we developed four energy topic DC inclusive science, technology, engineering, arts, and mathematics (STEAM) books related to the topic of energy that were designed to foster rich DC learning experiences in school science. We engaged 13 teachers as consultants in a validation process when developing the DC inclusive STEAM books. This study describes the development and implementation of the DC framework for preparing supplemental science curriculum materials that can improve students' appreciation for DC.

Table 1. The Democratic Citizenship Frame (DCF)

	Component	Definition	Sub-Components
1	critical thinking	logically explain the given problems and information and judge from various perspectives	logical decision divergent thinking
2	communication and collaboration	process of reaching a compromise by exchanging opinions with colleagues and others during scientific exploration and problem solving	cooperative learning and discussion
3	information management	provide a way to collect, evaluate, and analyze the information	data collection/data analysis/data representation
4	Sympathy	share emotion together and increase our empathy for it	emotional empathy and ethics
5	social accountability	feel and express social responsibility closely in relation to students' lives	responsibility
6	science, technology, & society	explain explicitly the relationship between technological development and social change	STS
7	self-direction plan	plan, execute and evaluate what can be done on a personal level to solve the problem	self-directed planning, implementing, and evaluating
8	decision-making competency	enhance decision making after various alternatives are presented and discuss to compare them to decide which one is the most appropriate and concrete solution	exploring alternatives/making decisions

We developed four energy topic DC-inclusive STEAM books (on the subjects of nuclear energy, wind power energy, thermal energy, and solar energy) for citizens and students to experience rich DC. We believe that more training is needed for science educators to understand DC, to develop DC educational programs, and to be able to construct consensus about DC's definition for its usage in education. Science educators need to collaborate with teachers so that they can understand DC and implement their practices on the basis of their understanding.

Keywords: democratic citizenship, STEAM, energy, science education

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The Model STEAM Education Challenges Using "Dagik Earth" for the Sustainability within the project of Shizuoka STEM Academy

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The "Dagik Earth" is the 3 dimensional learning materials of the Earth and other planets of the Solar System. Most of the data were collected from many satellites which are moving around the Earth. It was supported by a governmental grant from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan between FY 2009 and FY 2011 to develop the system and educational programs. Kyoto University, National Institute of Information and Communications Technology, National Museum of Nature and Science, Shizuoka Science Museum, and Shizuoka University participate in this project.

Also, Shizuoka STEM Academy is the five year project of encouraging students' researches with STEM learning supported by the Japan Science and Technology Agency from 2018 to 20222. It is about 30 institutions are conducting similar projects in many locations in Japan. In the case of Shizuoka STEM academy, it has been conducting STEM learning in the morning and discussion on the individual research or group research within the contexts of informal education.

It is identified that "Dagik Earth" is one of the best STEM learning material in terms of main points that fit to project based learning and eight practices of Next Generation Science Standards developed in the US. At first, it is easy to develop guided PBL models which available for the teachers and then individual or group oriented development of forming questions by watching many DATA among 175 contents.

In this short paper, it is explained the contexts of STEM learning with project based learning using Dagik Earth from 2021. Also, descripted reactions of each student were analysed. Once participated students know how to manipulating 3D dimensional data, they concentrated to watch again and again those data to find their own solutions concerning to Global issues.

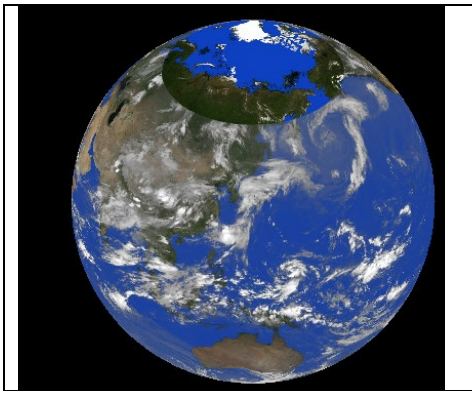

Figure 1.

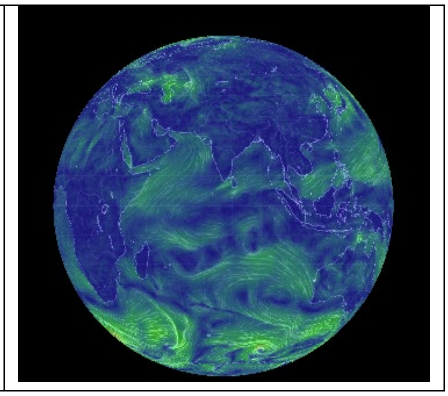

Figure 2.

Keywords: Model STEAM Learning Material, STEM education, Dagik Earth, Informal Science Education, Shizuoka STEM Academy.

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Development of BYOD-style Horizontally and Vertically Movable Virtual Reality Field Trip Tool for Earth Science Education

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In Earth Science, field trips that enable a deepening of geological understanding though in-situ, multi-angle observation have recently become more difficult for educational institutions to conduct for economic and safety reasons. In addition, the COVID-19 crisis has forced education systems to find alternatives to face-to-face instruction, and has stimulated the need for remotely accessible educational tools. As an alternative, virtual reality (VR) technology not only brings a virtual field trip experience into the classroom, but also enables users to browse difficult-to-reach views, such as a close-up 360 degree photograph of a highly located outcrop. While most VR learning tools only provide 360-degree images at certain static spots and with limited immersive experience, we developed a both horizontally and vertically movable VR field trip tool with a drone, focusing on two notable geological sites, the Large Outcrop of Torikata and the Yobake in Saitama Prefecture. We expect to clarify the utility of this VR field trip tool which could potentially supplement actual Earth Science field trips.

Fig. the Large Outcrop of Torikata captured with a drone

Keywords: Earth Science teaching material, VR, BYOD, field trip, the Large Outcrop of Torikata, the Yobake

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Outdoor Earth Science Learning through Geocaching

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Geocaching is a popular hobby that involves GPS navigation to a hidden "cache" or point of interest somewhere on Earth. The international geocaching website lists the latitude and longitude for sites all over the world, and many active geocachers try to log as many geocaches as possible. Additionally, a special type of geocache, called an EarthCache, focuses specifically on a site of geological significance. To complete an EarthCache, the cacher must answer a series of questions about the geological site and send answers to the owner of the EarthCache. The worldwide popularity of geocaching means this activity is an excellent opportunity to promote earth science awareness and learning among the public, teachers, and school children.

A team of scientists and educators at a public four-year university in the Midwestern United States designed a research project to introduce EarthCaching to pre-service elementary teachers. The goal was to increase preservice teacher interest and positive attitudes towards teaching earth science in the outdoors. We designed eight field EarthCaches and two virtual EarthCaches and integrated them into the curriculum of a science content course. Most of the sites were located on campus so that students could easily visit them even if they did not own a car. The geologic topics aligned with the course content and included the water cycle, soils, natural resources, and sedimentary rocks. Unlike the traditional earth science laboratories in this course, the EarthCaches were completed by students outside of regular class time. We administered pre-/post-surveys and then compared changes in earth science conceptual knowledge and attitudes towards teaching outdoors between the EarthCache participants and a control classroom. Over three semesters, there was no statistically significant difference in the conceptual earth science knowledge gains between the two groups, even when the EarthCaches were completed by the students independent from an instructor as an out-of-classroom activity. Follow-up interviews with the preservice teachers indicated that students perceived several benefits from the outdoor experience, including direct observation of natural processes described in the textbook and curiosity about their surroundings. Caches that included questions about the relationship between humans and their environment, including historical human impacts, were of particular interest to students. Students also mentioned challenging aspects of the experience, such as weather conditions and difficulty with navigation. The findings indicate that EarthCaching is a promising approach to introduce preservice teachers to outdoor earth science learning. Also, although most published EarthCaches focus on geologic features and processes, topics that relate to sustainability education were especially popular with the preservice teachers in this study. This suggests a potential to further sustainability education through geocaching. In addition to elementary preservice teachers, this project has had a broader impact on society by creating a new published EarthCache at a limestone bluff that is now visited regularly by members of the public.

Keywords: preservice teachers, geocaching, outdoor learning, elementary education

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'NIED Quake map!'-Guide and education tool at geoparks-

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1. Introduction

Geoparks are the single, unified, geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development. Familiarization of the local seismic activity in communities is one of our important missions since earthquakes are major natural and cultural heritages in Geoparks.

In July, 2018, National Research Institute for Earth Science and Disaster Resilience (NIED) has opened the web site named as 'NIED Quake map!' to visualize the local seismicity around the Itoigawa UNESCO Global Geopark (https://www.geopark.bosai.go.jp/itoigawa). It is user-friendly to explore the recent earthquake locations detected by Monitoring of Waves in Land and Seafloor (MOWLAS) and historical earthquakes in the same map. The 'NIED Quake map!' successfully shows the seismicity in the wide area around the Geopark. Visitors can access to it by scanning the QR code shown on the information board at the Fossa Magna Park.

2. 'NIED Quake map!'

The top page of the web shows a map of the local seismicity during recent one year. The color and size of circles show the depth and magnitude of earthquakes, respectively. The latest earthquake is shown with a large star. There are volcanoes, active faults, and rivers to grasp the location of the geosite. People can recognize the seismicity within the ground with seeing both memorable large earthquakes and unfelt micro-earthquakes.

3. Use in the guide at the Itoigawa Geopark

Now NIED provides web sites for 16 geoparks among 46 in Japan and plans to open web sites according to their requests by the geoparks through Japan Geopark Network (JGN) based on the Comprehensive Partnership Agreement between NIED and JGN.

The guides of the Geopark use the 'NIED Quake map!' to explain the geology and geophysics at the Geopark. Tourists and school children visiting the Fossa Magna Park access to the website through the QR code by using their smartphones to find both many earthquakes beneath the ground and many earthquakes near the active faults. We usually confirmed about 20-30 accesses every day and 50-60 accesses by the groups of the field trip at Fossa Magna Park.

NIED also provides the 'NIED Quake map!' for San'in Kaigan UNESCO Global Geopark in 2022. There are approximately 180 elementary, junior high, and high schools in it. They are planning to promote the 'NIED Quake map!' to be able to use for teaching and learning tools at schools.

Figure: 'NIED Quake map!' for San'in Kaigan Geopark Museum of the earth and sea. Purple lines denote the surface trace of active faults.

Keywords: 'NIED Quake map!', hypocenter map, geopark, guide, school class

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Agavi: A Digital-Analog Hybrid Platform for Science Education

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The COVID-19 pandemic was a genuine opportunity to transform science education for the 21st century. Instead, the opportunity has been mostly squandered, with the standard lecture-lab science classrooms migrating almost completely intact to the digital environment through the use of Zoom lectures and simulation labs. This underwhelming transition to online learning has negatively impacted students, instructors, and institutions, resulting in a global push for a return to in-person versions of the same. The format of this transition was necessitated due to the rapidity of the COVID-19 pandemic lockdowns, but was exacerbated by poor resources for offering quality online learning at reasonable cost. This includes not only digital platforms, but general internet and connectivity infrastructure as well.

We will be discussing the Agavi project that Science Voices (a US-based nonprofit organization focused on improving equity in digital science education) has been working on since the start of the pandemic. Informed by our experiences in poorly connected internet environments in Indonesia, Romania, and the US Virgin Islands, the Agavi project is designed to fill the gap between traditional 20th century digital tools (learning management systems, videos, multiple-choice quizzes, etc.) that most of the world works with and the 22nd century digital tools that Silicon Valley is obsessed with (virtual reality, augmented reality, metaverse, etc.).

The Agavi system is currently under development by a cadre of global volunteers working closely with science teachers in both formal (universities) and informal (observatories, museums, national parks, tourism) learning environments in multiple countries (Brazil, Indonesia, Romania, Ukraine, and US). It features a smartphone-native design with a focus on making the building and analysis of science activities simple through good user interface design. The system integrates various smartphone and external sensors as objects that can be used in activities to allow teachers to build active learning experiences that encourage students to interact with their environments, rather than simply consuming content through a portal. We are also constructing our databases to allow the application of bioinformatics analysis techniques so that we can better understand how teachers develop and modify materials, how they share them, and how shared content is modified and updated for its new environment. The goal of this research is to inform the design of an artificial intelligence system that can help teachers adopt and optimize international teaching materials for their classrooms more easily, essentially, allowing them to learn quickly from the experiences of their colleagues from around the globe.

We will demonstrate the Agavi system and show examples of its implementation in astrotourism projects in the US Virgin Islands, environmental public education in Indonesia, and completely off-grid digital lab classrooms in the Amazon River basin. We will also discuss application of the system in geoscience teaching environments, especially field courses.

Keywords: digital education, COVID-19, digital-analog systems, informal science education, smartphones

Poster presentation abstract

Poster sessions will be held via digital posters (ePoster) on the official website. All participants can discuss using the comment form set up beside the poster pdf file. There will be no core time for the poster session, but you can discuss with the presenters using the free online communication space (Spatial Chat) described below. ***Spatial Chat URL: https://spatial.chat/s/geoscied***

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How many students disbelieve in plate tectonics, who are majoring in the Training Program for Elementary School Teachers as undergraduate

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Ability of imagination is possibly important for science study. Understanding of the plate tectonics is one of the typical examples in imagination usage. Questionnaire investigation had held through the students attended a lecture of “Subject content of science in elementary school” as required subject in course of the Training Program for Elementary School Teachers. It is consisted of very simple questions such as “Do you think that plate tectonics is true?” I expected the only affirmative answer, but the result is wonderment that the 14 of 122 marked “NO” on it. Some of them answered additional reasonable phrases, for example “Continents are drifting? Never acceptable for me, such kind of idea!” These voices may be plain and naive words of the contemporary 2nd grade undergraduate students in our university. Plate tectonics is briefly explained in this lecture, and the questionnaire is done at a term end. This subject consist of physics, chemistry, biology, earth and space sciences and additional glossaries and notandum for every three weeks (totally 15 weeks). There are subsections of “geology including earthquake and volcano”, astronomy and paleontology in the section of earth and space sciences. Plate tectonics is not a must topic in elementary school science, however it is a must knowledge as Japanese citizen including elementary school teacher. Time allocations in the lecture are only 7 and 2 minutes for about plate and for plate tectonics, respectively. Are these 11.5% of students may just failed to hear as it happens? However, this subject was done as on demand remote lecture, and students could listen repeatedly on their needs. Is it some kind of confusion between scientific knowledge and naive conception, or simply caused by artless lecture done by the author? Julius Caesar said that “people see what they expect to see.” “People” in these words envisage lack of imagination abilities, however it is still unclear that the way to bring up the ability. Additionally, the result of another questionnaire “Who is the most respectable scientist or engineer?” is presented and open discussion is expected.

Keywords: naive conception, plate tectonics, on demand lecture, remote lecture, science in elementary school

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What should science education learn from the heavy rain in July 2020 in Japan and what should be improved?
-Relationship between science education and heavy rain disasters-

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Of the fatalities in the Kuma River due to the heavy rain in July 2020, 50 people are said to have been caused by the flooding of the Kuma River basin. The Kuma River is a first-class river with a total length of 115 km, but we will consider the damage in the Kuma River basin from the viewpoint of science education and propose science education linked to disaster prevention education.

Elementary School Curriculum Guidelines is clearly stated as follows: Depending on how it rains, the speed and amount of flowing water may change, and the appearance of the land may change significantly due to flooding. [1]

However, the textbook does not describe the amount of water at the time of the actual disaster and is not related to the actual damage.

Therefore, three points are mentioned in order to relate science education and disaster prevention education.

(1) Does the textbook mention damage assumptions when a large amount of water flows into a river?
(2) In the textbook, the undercut slope is mainly eroded, but did that really happen?
(3) In the textbook, a large amount of water erodes the straight part, but did that really happen?

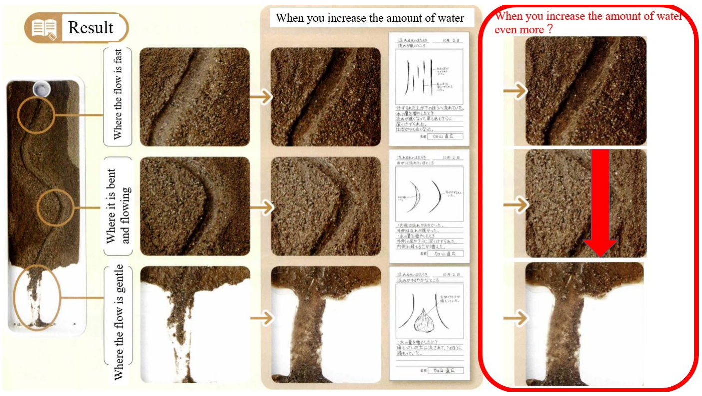

Fig.1 Science Textbook for 11years old in Japan[1]

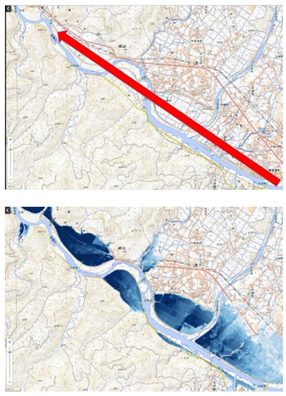

Fig.2 Flow path after flood [2] [3]

For (1), I propose to add a red frame in Fig.1. Discussions on (2) and (3) will proceed based on the actual damage situation.

Lastly the Grant-in-Aid for Scientific Research C (No. 20K02782) was used for the research. I would like to express our gratitude here.

Keywords: Disaster prevention education, The function of running water, Science textbook

References: [1] Author Ministry of Education.(2018) Elementary School Curriculum Guidelines (2017 Notification) Commentary Science Edition. [2] Author Arima.et al(2020)grade5,dainihontosyo,90. [3] Author Geospatial Information Authority of Japan(2015)NI52-12-7-2

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Online classes on various topics enforced by the COVID-19 pandemic - a introduction of geological sights in Japan -

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Geo-excursion is increasingly important to not only in the field of education but also in society due to the increase in extreme events caused by climate change and dilapidated social infrastructure. In Japan, synchronous online classes have been offered since the 1980s [1], and especially since the spring of 2020, the number of cases has increased due to the spread of coronavirus disease (COVID 19), and online field excursion have likewise increased and diversified. In this presentation, I will introduce on the importance of the "geo-excursion" as a tour in geosciences and geography, the evolution of online events, student responses, and comparisons with real excursions in pre-COVID-19 era. These were a total of nine online geo-excursions conducted during a 90-100 minute class at a university in three locations around the Tokyo, as well as in the Northern Alps, Kyoto, Okinawa Island, Mount Fuji, Kofu Basin, and the Hamadori region of Fukushima Prefecture (Table 1). All but two of these excursions were conducted by a single person using Zoom online meeting system from a smartphone, and the student reactions were favourable. Online excursions have some disadvantages compared to real tours, such as not being able to touch the actual objects and discuss directly with other students. On the other hand, online excursions have some advantages in terms of time and space, such as they can be joined in the evening and do not require travel. Furthermore, I will introduce some of the ways to make the excursions more realistic and stable, such as checking cell phone reception, using gimbals, assisting participants in locating their current position, using YouTube live streaming, and sharing measurements taken at the site with participants, while also introducing suitable geological sites in Japan.

Table 1. Overview of conducted field excursions

Broadcast location	Objective/Keyword	Travel device and distant (km)	Number of field staff
Ikuta park, Tama Hills (Kanagawa)	field work training, million-year time scale, sea-level change	0.6 on foot	1
Shirouma snow Valley (Nagano)	research introduction by a graduate student, perennial snow patch	–	1
Ado river – Kyoto Higashiyama	relationship between tourist attractions and active faults, The Hanaore fault	28 by car	1
Joga-shima island (Kanagawa)	coastal topography, marine sediment, deformation structures, field survey training	0.3 on foot	2
Tama river (Tokyo and Kanagawa)	fluvial geomorphology, flood in old river channel, natural tourist spots in the city	1.1 on foot /4.5 by car	1
Okinawa main island	plinian eruption, drifted pumice, domestic time difference, diversity of local products	0.1 on foot /15 by car	1
Eastern side of the Mt. Fuji (Shizuoka)	the Hoei eruption, sector collapse, debris and slash avalanche	1.1 on foot /4.4 by car	1
Kofu basin (Yamanashi)	the largest collapse event in Japan [2], hummock landforms and facies, land use	0.5 on foot /13 by car	1
Hamadori regeon (Fukushima)	current status of the 2011 Fukushima nuclear disaster, uninhabited residential area,	7 by car	3

Keywords: geo-excursion, online classes, geography, geoscience, Zoom
References: [1] Shimizu, Y. and Maesako, T. (1998) IEICE Transactions. J69-A, 1181-1189. [2] Inokuchi, T. (2006) Journal of the Japan Landslide Society, 42, 409-420.

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Radiation Learning Materials Using Natural Radioisotopes Contained in Mineral and Hot Springs

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Teaching materials that utilize local resources are effective in raising the interest of learners. In particular, radiation and radioactivity, which are often thought to be unrelated in daily life, are considered to have a great effect. This research aims to develop radiation teaching materials and learning contents using natural radioactivity that exists in the area.

The Ikeda mineral spring in Ooda City, Shimane Prefecture is a mineral spring with a high radon content, and the authors are developing teaching materials such as a cloud chamber experiment using the radon in the water for junior high school and high school students. It was found that 10 hot spring waters in Shimane prefecture, including the Ikeda mineral spring, could be used as the source of the cloud chamber experiment, and the experiments are being conducted in class at 5 junior high schools (fig. 1). Some hot spring water sources are natural micro hotspots, and students visit the site to measure radiation using survey meters (fig. 2).

Fig. 1 Cloud chamber experiment using hot spring water collected at nearby Chihara Onsen at Misato Municipal Daiwa Junior High School

Fig. 2 Students of Ooda Municipal Shigaku Junior High School measuring radiation dose at Ikeda mineral spring

In this research, the museum and the school collaborated, and the students experienced the contents such as the cloud chamber experiment and environmental radiation described in the textbook by conducting actual experiments and measurements while utilizing the resources of the local area. The students were interested and learned the correct knowledge, which was a good opportunity to become aware of radiation in their future lives.

Keywords: radiation learning, mineral springs, radon, utilization of local resources, erudition collaboration

Reusing a notebook as an occasion to raise awareness about sustainability in a democratic way

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This is an activity that gives students the ability to understand the relation between consuming in large scale, waste of natural resources and the dramatic climatic changes and natural disasters that can occur. This project begins in the start of the school year. After a short introductive discussion about consumption, waste of resources and further consequences such as climatic instability, students decide to take action [1]. Beginning from our school living, we set apart from other things objects, we all use in the classroom every day and we focus on notebooks. A large number of new notebooks every year are required, to be used for the learning procedures. Students are asked to calculate the amount of the notebooks that they and their schoolmates consume per year and find out how many trees are needed for, as well as the water and energy waste [2].
After this activity students realize that our consuming habits have an impact on our ecological footprint: that should be improved [3]. Therefore, students are encouraged to create their own notebooks to use in class, by taking an old notebook and making it reusable by transforming it in an artistic way. The rule is to transform it in accordance with the ecological standards of sustainability. The last part of the project consists of a contest procedure, where the students set the criteria and then they vote for the best notebook of the class. Criteria could be questions like "how many hours were needed before the notebook was finished", "is the product compatible with sustainability, are the materials used ecofriendly" e. t. c. This last step is very important to set up democratic procedures in experiential and participating way. By setting up criteria they realize their inner motives and after discussing them, they can be more conscious. But first of all, after the completion of this activity, they recognize that they can do more about their planet, in a pleasant creative and participating way. This activity is simple and can be implemented without a lot or expensive prerequisites. It is suitable for crowded classes, as well as small classes. It can be implemented from all students and no additional cost is required. This activity is suitable for all student ages because it can be easily adjusted to the needs of any educational level.

Key words: ethics, reuse, consumption, sustainability, democracy

References: [1] United Nation (2015): The 17 Sustainable Development Goals (SDGs). [2] Tushar Jain et al (2017): International Journal on Emerging Technologies (Special Issue NCETST) 8(1): 498-502.[3] Karin Jäger (2018): DW, Cradle to cradle: Living in a world without waste.

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Rock identification practice using a rock garden and rock teaching materials

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1. Introduction

In igneous rock learning, students observe rock samples to characterize each igneous rock. The students practiced rock identification by using rock gardens and igneous rock materials. The purpose of this exercise was to understand what the students pay attention to when identifying igneous rocks.

2. Rock garden and rock teaching materials used to practice rock identification

(1) Rock Teaching Material Garden in Junior High School of Yamagata University (JHSYU)
The rock garden contained 83 rocks. Students practiced igneous rock identification using 30 rocks, including andesite, granite, rhyolite, and other sedimentary and metamorphic rocks. (Fig.1)

Fig. 1. Rock Garden at JHSYU

(2) Igneous rock teaching materials consisting of locally collected igneous rocks
The authors created a set of igneous rocks from 20 rocks collected in the area. This rock set consisted of andesite, granite, and rhyolite with various lithologies, such as varying particle size and color. Sedimentary rocks were also included in this set. The aim of the exercise was to observe whether the igneous rock sample was distinguished from other rocks. (Fig. 2)

Fig. 2. Rock Sample

3. Students' view on igneous rock identification

In the rock garden practice, the outdoor rock sample surface was dirty or weathered, but the students looked for and observed what kind of place. The correct answer rate was high, with 70.7% for andesite, 88.8% for granite, and 70.9% for rhyolite. This is presumed to be due to the fact that igneous rock samples have the same lithology for each type of rock. In practice, when using igneous rock teaching materials, the correct answer rate was lower than that of the rock garden practice, with 63.6% andesite, 69.1% rhyolite, and 55.8% granite, because they were composed of rocks that had different lithologies for each rock type. The igneous rocks that were difficult to identify were andesite with large phenocrysts, as well as dark-colored granite and rhyolite. The students's viewpoint of igneous rock identification is influenced by color and particle size, as well as by texture.

Keywords: igneous rock, rock gardens

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[1] Naoko Domon and Yukiko Ohtomo (2019) Abstract of 73th JSESE National Convention, pp.147–148.
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Rock gardens in elementary and junior high school in Japan: evaluation of the current status and examples of utilization

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Some Japanese elementary and junior high schools have rock gardens (fig.1B &1D-F) that were installed in the 1960s and 1970s in an attempt to incorporate natural elements, such as rocks and plants, in the school setting. The Japanese Islands was formed by active orogeny between the Paleozoic and the Cenozoic, during which time a variety of rocks were formed. Most rocks in these rock gardens were collected in the area, as such domestic rocks were readily available.

At that time, there were many discussions about what kinds of rocks would best serve the purpose of the rock garden in schools.. However, these rock gardens are rarely used as teaching tools in today's schools.

For example, the rock garden in the Junior high school of Yamagata University (fig.1A&B), constructed in 1966, has been left unattended. We provided basic information (e.g., rock distribution maps, contour maps(fig.1C), and rock sample lists) about this rock garden so that it could be used for classes [1]. When the garden was used for hands-on learning about igneous rocks, it became clear that there was a difference in the teaching effectiveness of the various rocks. From these observations, we generated a visualization of the students' observational learning patterns, which allowed us identify potential improvements for future classes[2] [3] [4]. Rock gardens that remains in Japanese schools in today as testaments to the education of natural and Earth science about half a century ago. In future, It will be usefull for students to learn about local stones and geology, as a direct oppocunity,and as access points.

Fig.1 Rock gardens of elementary and junior high school in Yamagata city.
A-C: Junior high school of Yamagata Univ., D: Yamagata City Third Elementary School,
E: Yamagata City Fourth Elementary School, F: Yamagata City Fifth Elementary School

Keywords: rock garden in school, teaching material, local geology

References: [1] Ohtomo Y. et al.(2018) Bull. Yamagata Univ. (Education), 17, no.1,1-24. [2] Ohtomo Y. et al.(2019) Bull. Yamagata Univ. (Education), 17, no.2,35-46. [3] Ohtomo Y. et al.(2020) Bull. Yamagata Univ. (Education),17, no.3,149-159. [4] OhtomoY. (2021) Bull. Yamagata Univ. (Education), 17, no.4,133-145.

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Preparation of Rock Thin Sections and Polarized Light Observation at A Middle School

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The preparation of rock thin sections and their observation are significantly helpful for studying rocks and minerals. However, the practice is seldom offered in ordinary middle schools. This is because special tools are needed to make thin sections, cutting and grinding the rock tips. Also, polarizing microscopes are used to observe the samples, but the polarizing microscopes in their science room are not sufficient for the number of students.

Therefore, we tried to make rock thin sections by students themselves and observe them using simplified polarized units in our class. For this purpose, we prepared some rock tips for thin section making using commonly available DIY tools. The tools used are shown below. 1) Mini table saw and the Diamond blade (8inch 180mm, Fig.1). 2) A blade grinder for home use and the Diamond disc (6inch 150mm, #120, #400, #1200, Fig.2).
Before the student's practice, we did primary cutting of rocks, polishing them, gluing on slide glasses(28×48mm), and finally cutting the rock tips again to about 1.0mm thickness.

We planned three regular classes (150 minutes total) so that all students can complete the process of making their rock thin section in time and safely. Our study used Crystalline limestone (metamorphosed from Dolomite, Calcite), which is very cheap at DIY stores and has low hardness for sample making. Also, they show lovely interference colors in the polarized view. The student held their slide glass firmly with a suction cup and grind the samples with water-resistant sandpaper (#240, #400). This helped to keep their fingers from getting hurt. The final thickness of the samples is around 0.05mm or less.

We made a simple polarized light device made of craft papers and polarized films for polarized light observation (Fig.3). Students can rotate the sample within it and observe it in natural light or with a binocular stereo-microscope.

Our presentation will show the process of preparing the training materials, student practice, and polarized light observations.
We want to discuss improving our materials and the contribution to other schools.

Fig. 1 Mini table saw for cutting rocks

Fig. 2 A blade grinder for home use with a diamond disc

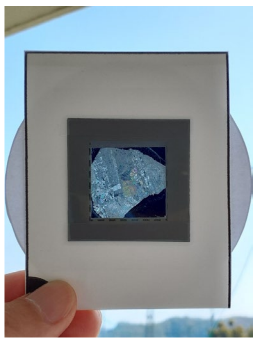

Fig. 3 A polarized unit made from polarized films

Keywords: Rock thin sections, Mini table saw, Blade grinder, Polarized film, Middle school.

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Development and Practices of Geoscience STEAM /SDGs Teaching Materials Utilising the Geology and Culture of Japan ; Examples of Teaching Materials for Schools and Museums

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This study presents a case study of the development of geoscience teaching materials using geological materials in Japan in line with the SDGs (Education for Sustainable Development (ESD) and STEM/STEAM education. In the geological education, the use of rocks and minerals is an essential part of the teaching materials, and these have been developed using rocks and minerals in both informal and formal education. For instance, in formal education, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Economy, Trade and Industry (METI) have started to work on STEAM education and ESD, and changes are beginning to take place in science education. Meanwhile, in informal education, the International Council of Museums (ICOM), which is held every three years, proposed the slogan 'Museums as Cultural Hubs: The Future of Tradition' was proposed in 2019 [1]. Furthermore, in the new definition of museums, 'education' temporarily disappeared, and it became a major issue. The importance of 'education' was highlighted. Therefore, even informal education is required to aim for a sustainable society. However, not many petrology teaching materials have been developed in Japan and Asia that integrate STEM/STEAM and the SDGs. In a survey of junior high school students (n=154) on whether learning about rocks and minerals was useful to society, 56% of children answered that it was not useful or they did not know [2].

In this study, we conducted a geological survey of rhyolite and basalt, white sand and black sand from Niijima, Tokyo, as well as a survey of traditional culture using local rocks. The results of the geological survey and petrological analysis showed that the rocks and sands had the same forming minerals and textures, and were deemed suitable as teaching materials to explain the change from rock to sand. Furthermore, it became clear that there was a glass craft (Art) on the island that made use of local rocks and that the relationship between people and rocks could be made explicit [3]. We used these samples to conduct informal and formal (junior high school) workshops in which students were asked to observe the rocks and sand in comparison to each other. The results of the questionnaires (informal) and worksheets (junior high school) showed that children were able to understand the relationship between rocks and sand and the use of rocks in crafts [4].

The novelty of this presentation is that it clearly shows the importance of focusing on local geology and culture when developing teaching materials using rocks and minerals in the sustainable society that is required in the future. Based on Japan as a case study of the development and practices of teaching materials focusing on local geology, it is proposed that this focus can be applied to other countries and regions to expand the possibilities for the development of geological teaching materials with STEAM and SDGs.

Keywords: Educational materials, Niijima island, Quartz, STEAM, sand

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A report of trial classes on diurnal and annual motions of stars at junior-high school using a self-made portable planetarium

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A portable planetarium could be a great tool in science classes to help students to understand motions of heavenly objects, since teachers can have science classes with planetariums without taking students outside schools [1]. When such planetarium classes are possible at own schools, it is important to discuss which topic can be taught most effectively with a portable planetarium.
In order to identify which topic should be selected when a portable planetarium can be used in a science class, we selected topics of diurnal and annual motions of stars for the first example. Students need to understand how differently stars are moving in the northern, eastern, southern, and western skies when they learn these topics. Therefore, we assumed that a planetarium is an ideal tool in a science class of these topics because all stars in the sky can be seen in the same manner of the real sky. In this study, we aim to confirm that topics of diurnal and annual motions of stars can be taught more effectively with a planetarium.
We have made a teaching plan on topics of diurnal and annual motions of stars to have trial classes at a junior-high school in Tokyo using a portable planetarium on 29 Nov, 2018. We had four same classes, each of which 35 students of third grade attended. Before the classes, we carried out a test to check how well the students understand diurnal and annual motions of stars and if students are interested in astronomy.
Each of the trial classes was 45-minute long. We had the first 10 minutes for an introduction before entering the dome, followed by 15-minute lecture on diurnal motions of stars watching projected stars inside the dome. We had another 15-minute lecture on annual motions of stars, where we projected scenery pictures of snow field and beach before showing stars to change their feeling of seasons. Finally, we had 5-minute wrap-up after getting off the dome. We again carried out a test to check their understanding after the trial class and compared results of the former and the latter tests.

Figure 1: A photo of the inside of the air-dome and the working projecting system.

Comparing results of the tests, we have found that more students correctly answered questions on diurnal and annual motions of stars after planetarium class. We also found that more students enjoyed the planetarium classes than normal classes. It was mentioned by students hat it was good to see all directions simultaneously and that projecting scenery pictures was good in learning annual motions of stars.
We can conclude that a portable planetarium is a good tool for science class of astronomy and that topics of diurnal and annual motions of stars can be taught effectively using a planetarium.

Keywords: Earth science education, junior-high school, diurnal motion, annual motion, planetarium

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Geolab – an innovative approach to building Earth Science awareness.

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In a world struggling to combat the crisis of global warming, ever rising sea-level and the problem of ever depleting natural resources (combined with an alarming population growth rate), the study of Earth Sciences and all its associated branches have become topics of utmost importance. Almost everywhere around the world, Earth Sciences is not taught as an independent subject in schools. Earth Science education at an early age, therefore, will ensure that majority of the future generations will be equipped with basic knowledge about the Earth and related processes, no matter what vocation they choose in the future. With future driven by the key term "sustainability", any efforts on Earth Science education at schools/early age will prepare the children for future challenges.

As part of its mission to build awareness towards the importance of Earth Science in daily life, the team at 'Centre for Education and Research in Geosciences' (CERG), India conducts various activities aimed at the layman and school children. One such program, dubbed "Geolab", has gained huge following among the local schools. Geolab is an interschool earth-science based project competition and exhibition, targeted towards middle school and high school children from 5th Grade to 12th Grade. Probably one of its kind, Geolab focuses solely on Earth Science related projects. Initiated as a part of CERG's annual Geoweek program, it was spun-off as an independent activity due to the overwhelming response and popularity it received.

Geolab is a platform for the young minds of India to demonstrate their creative and innovative talent, offering their perspective on solutions to Earth Science related problems faced by mankind today. Interestingly, though the project contest was based on Geosciences, many of the projects presented were of an interdisciplinary nature, with application of information technology, data-science, mathematics, physics, and biology in geology; thereby emphasizing the multidisciplinary aspect of the Earth Sciences. This event also provided an opportunity for young students to interact with eminent personalities in the field of Geosciences and other disciplines.

Besides the scientific pursuit, bringing Earth Science closer to the masses and explaining its benefits to humankind is an immediate need. Such initiatives, hence, provide a platform for dissemination of Science to the common man.

Keywords: Geolab, Earth Science projects, Earth Science education

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Practice and report on the improvement of color index teaching materials

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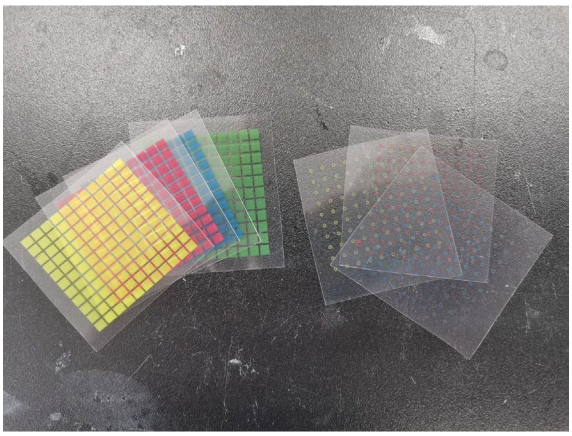
Objective, To improve color index materials for rock classification with those available at junior and senior high schools. We tried both tracing paper and OHP film methods described in Japanese textbooks. For the OHP film, there were few descriptions of detailed work methods. Therefore, we considered and practiced several methods for specific work.

Results, We prepared 6 kinds of deep metamorphic rocks and tried the method using tracing paper and OHP film for each of them. For tracing paper, tracing paper was applied to the rocks, colored minerals were painted black, and evenly spaced ruled lines were placed on top of the tracing paper.
The intersections of the ruled lines and the colored minerals were counted and the color index was obtained. For the OHP films, various colors were used "。 " mark and "the color of the ruled lines reversed" were printed in various colors and applied to the rocks. Each was then counted and the color index was obtained.
The effectiveness of the OHP film in the field was also tested.

Conclusion, "。 " mark and "the color of the ruled lines reversed" were both found to be valid. However, we also found that in some cases the color combinations were incompatible with each other. The validity of the film in the field was also verified. We believe that these methods may be effective when conducting experiments using color indices in junior high and high schools.



Keywords: color index, OHP film, plutonic rock, tracing paper,

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The Importance of Teaching Natural Resources By a Context-based Approach

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Science education in Japan has traditionally been taught from the perspective of *knowledge of/in science*. However, recently, some researchers argued that integration of both perspectives from *knowledge about science* and *knowledge of/in science* should be done for improving scientific literacy [1] [2]. The content of natural resources have the possibility to teach not only from the perspective of *knowledge of/in science* but also from the perspective of *knowledge about science*. Textbooks of upper secondary schools describe based on *knowledge of/in science*, such as what types of ore deposits are in the world and what kind of minerals are included in industrial products, without referring to the contexts. On the other hand, Nakanishi *et al.* (2020) clarified that textbooks of secondary school for boys published before WWII focused on how natural resources were used and their relationship in the social contexts. The purpose of natural resources education included social and cultural aspects [3]. However, there were little literature on concerning how natural resources were taught before WWII concretely.

We set the following research questions: What kinds of *knowledge about science* were included in mineralogy textbooks? ; What contexts were natural resources taught in? To solve these research questions, we analysed 88 mineralogy textbooks of secondary schools for boys published before WWII (1881-1941).

We found that the topics on copper, coal and clay minerals, such as feldspar had been written in the contexts on local/national and global issues, and current and historical perspectives, with aiming to understand science and technology. The contents of natural resources were described not only where natural resources were buried but also what were the sequences of producing industrial materials and products. Furthermore, the importance of teaching natural resources focused on understanding how natural resources were used and teaching natural resources in the contexts of import and export of natural resources related to the national development. So far, the importance of teaching natural resources enhanced the use of natural resources and the relationship between natural resources and the society.

From this research, we argued that the content of teaching natural resources through context-based approach should include the regional uniqueness, scarcity of resources, formation of resources and relationship with society and technology.

Keywords: Context-based approach, Natural resources, Mineralogy, Upper secondary school education

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Practice of Earth Science Education Leading to Logical Disaster Prevention Actions

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Science education in Japan is divided into four fields: physics, chemistry, biology, and geoscience. Among these, geoscience in particular has been designed to make students aware of how to understand complex natural phenomena. This educational activity is expected to help students develop the ability to make decisions that will help them take disaster-prevention actions. This educational activity leads to the development of abilities that will be useful in making decisions to take disaster prevention actions.

In this study will be introduced teaching materials and their presentation methods that can make students perceive earthquake phenomena scientifically on a regular basis. It would be liked to suggest that the educational practice can be expected to provide a behavior modification that leads to disaster prevention. The contents of this study include the observation of waveform records at the same time as or immediately after the occurrence of earthquake motion, and the experiential understanding that there are various patterns of earthquake motion caused by various factors. Let us describe this as "tasting seismic motion. This learning will help the participants to imagine disasters that may occur along with earthquake phenomena, which will lead them to prepare for disaster mitigation in advance and to evacuate based on accurate assessment of the situation in case of an emergency.

Observing earthquake waveforms in real time

Minamishima (2019)[1] provides an example of an educational environment in which geoscientific observations are constantly presented in the classroom, allowing students to compare sudden phenomena with data as well as experience them. Among others, a seismograph teaching material using an optical mouse and a personal computer was proposed by Minamishima (2017) [2]. Various possibilities of educational practices based on this are specifically presented.

Keywords: Seismograph, Disaster Prevention, ground motion

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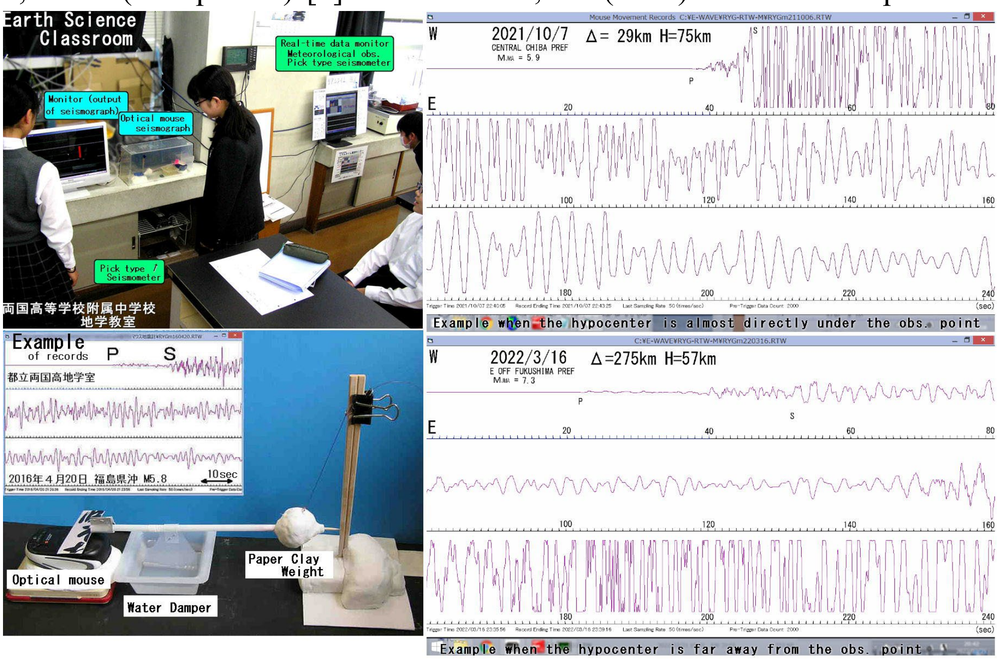

Earthquake and its disaster in earth science textbooks for upper secondary school published in 2022: Contents and problems

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The Ministry of Education, Culture, Sports, Science and Technology in Japan (hereafter called MEXT) announced the renewal of the national curricula standards for primary and lower secondary schools on 31 March, 2017. The 2017 curricula have been applied to primary schools since April 2020 introducing the 6 new types of RIKA textbooks, RIKA is roughly a subject of natural science, to each grade by 6 publishers. Moreover, the 2017 curricula for lower secondary schools were started in April 2021 introducing the 5 new types of RIKA textbooks by 5 publishers.

NEMOTO (2021) [1] and NEMOTO (2022) [2] report that the results of textbook analyses of contents to earthquake and its disaster, focusing on terminology, using a total of five lower secondary school RIKA textbooks based on the lower secondary school in the 2017 standard curricula. As a result, it is clarified that there is large differences among textbooks in the types and amounts of terms used in the content of earthquake disaster (Table 1).

On the other hand, MEXT announced the renewal of the national curricula standards for upper secondary schools on 30 March, 2018. The 2018 curricula have been applied to upper secondary schools since April 2022 introducing the 5 new types of CHIGAKU-KISO textbooks, CHIGAKU-KISO is roughly a subject of Basic Earth Science, by 5 publishers. It is interested to clarify what differences are analysis results between primary and lower secondary school textbooks and upper secondary school textbooks in the content of earthquake and its disaster. However, we cannot obtain these textbooks until April 2022. Therefore, I cannot write the results of analyses in this abstract because the deadline of it was the end of March, 2022.

In this presentation, I will report on the current status and issues of the earthquakes and its disaster in these textbooks, including the differences among school types of the contents in the textbooks.

Table1 Relationship between terms related to the earthquake other than those listed in all lower secondary school textbooks (5 types) and the number of textbooks in which they were listed

the number of appeared textbooks	terms
4	N/A
3	landslide
2	landslip, building collapse, hazard map, seismic reinforcement, earthquake warning, tsunami hazard map
1	soil avalanche, debris flow, crack in the ground, (geotechnical) ground, tsunami early warning, earthquake disaster, disaster prevention, lifeline, seismic hazard map, evacuation shelter, earthquake, major tsunami warning, tsunami advisory

(ref.: terms earthquake and related to the earthquake listed in the 5 textbooks: earthquake, fault, hypocentre, epicentre, seismometer, preliminary tremors, duration of preliminary tremors, principal shock, P-wave, S-wave, seismic intensity, magnitude, trench, plate, tsunami, active fault, uplift, subsidence, earthquake early warning, liquefaction)

Keywords: upper secondary school in Japan, CHIGAKU-KISO (Basic Earth Science), earthquake, earthquake disaster, natural disaster

The Evolution Of The Process of Selecting The Philippine Team For The International Earth Science Olympiad (IESO)

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The Philippines was one of the participating countries when the International Earth Science Olympiad (IESO) commenced in 2007 in Daegu, South Korea. The two top scorers of the Earth Science Quiz Contest facilitated by the Earth Science Teachers Association of the Philippines (ESTAP) constituted the "Philippine Team". Both students got bronze medals.

The inclusion of the International Team Field Investigation (ITFI) in IESO has prompted the Philippines to modify its selection process to include the assessment of hands-on practical skills. From the almost multiple-choice type of questions of ESTAP assessment, it became more open-ended and focused on problem-solving. Hands-on field experiences have become an integral part of the training.

Such reforms paid off when the Philippines started to garner a silver medal in 2009 (3rd IESO in Taiwan); and eventually, a gold medal in 2011 (5th IESO in Italy). Unfortunately, due to financial and political constraints, participation was discontinued from 2012 to 2016.

The long five-year hiatus of non-participation has engendered reflection as regards the goals and objectives of the Philippines ' engagement in the IESO. Contributory is the fact that one student who competed in the 3rd IESO in Taiwan pursued a course initially in Chemistry then later shifted to BS Geology inspired by his experience during the selection, training, and participation in IESO. He fished his degree with flying colors, topped the licensure exam for geologists, and currently pursuing his Ph.D.at Massachusettes Institute of Technology.

According to Nir Orion in his preface to the book, Earth Science Education: Global Perspectives (2016), the ultimate goal of participation in many countries in the IESO has been the medals. While the Philippines still gives a premium on getting medals, especially silver and gold, it has now become necessary to draw gifted students to pursue careers in Earth Sciences. To achieve this, exposure to "what geoscientists do" in a camp setting has become integral, even in the selection process.

The Philippines started participating in IESO again in the 11th IESO in France in 2017.
In the selection process, a week-long camp was introduced. After the written tests were given to participating students across the country, 10 students were selected to participate in a camp where they interacted with several Earth Scientists who would later assess them and rank them so that the final four would emerge. The four students then get to represent the Philippines in IESO. The goal of the inclusion of the camp is to have the 10 highly gifted students be exposed to what Earth scientists do so that they would have an appreciation of it and eventually pursue careers in the Earth Sciences even if they were not chosen to represent the country in the IESO.

Keywords: selection, medals, hands-on, IESO, ITFI

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Meteorite Study by High School Students- Activities in Japan, 2021–2022-

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Background: Placing the next generation of scientists in an environment nurturing further exploration can be inspirational. By engaging them in hands on, cutting edge research in their own classroom, can this be achieved. Various exploration missions to asteroids, comets, and satellites have been planned and executed in recent years. Engaging high school students in planetary science is essential for accelerating space exploration to future generations. For example, opportunities for students to learn about planetary materials are being provided by some museums and through public lectures [1, 2]. However, programs enabling students to study them at school have not been attempted or reported. To nurture future planetary scientists, we initiated an educational project on meteorites for high school students in the United Kingdom and Japan. Here, we introduce the activities performed in Japan during 2021–2022.

Outreach Program: Planetary materials research uses state of the art instrumentation and laboratories worldwide to analyse celestial samples. However, with the miniaturization of certain key instruments such as electron microscopes, high school students could be assisting cutting edge research in the school laboratory. As a case study, several carbonaceous chondrites were selected and prepared. A tabletop scanning electron microscope (SEM) Hitachi TM3030 was provided to Seiko Gakuin School by Hitachi High-tech.

Lectures for students: On June 21st, 2021, Dr. Hitesh Changela presented to students at St Pauls and Seiko Gakuin on meteorites and sample return missions. Participants in the lecture learned the latest achievements in planetary materials science and various techniques. On October 14th, an additional lecture was conducted at Seiko Gakuin High School, Japan. In the Japanese and UK school curriculum, planetary science, and especially planetary materials science, is less accessible. Students were therefore introduced to fundamental planetary science, such as the evolution of our solar system and the formation of meteoritic inclusions in the protoplanetary disk [3]. The theory of SEM observation was also explained. After the lecture, students observed some meteorite inclusions using an optical microscope.

SEM observations by high school students: High school students were able to study carbonaceous chondrites using the Tabletop SEM. They discovered features of interest for further exploration within the samples. The high school students in Japan reported their findings at a small international workshop (International Research for School, 2022).

Future work: With access to Table Top SEM, students can be engaged in a planetary materials research and education program. Furthermore, they could also be guided in using their SEMs to assist with major planetary materials research, empowering them to make discoveries in their own classroom. As well as meteorites, with success of JAXA's Hayabusa-2 mission, this opens up avenues for engaging students in the cutting edge of planetary materials research.

Keywords: exploration missions, tabletop scanning electron microscope, carbonaceous chondrite, meteorites, planetary materials

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Development of Educational Materials Using Lunar and Planetary 3D Models

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3D models are electronic data that can be used with 3D printing, 3DCG, virtual reality (VR), and augmented reality (AR). Educational materials that utilize 3D models can aid in our understanding of various objects' complex shapes. Many 3D models are available for download online, but they are often insufficient for educational purposes. Therefore, we have created our own lunar and planetary 3D models and used them for educational activities. Our models have also been used by several other museums. Moreover, we have made our 3D models public via the website "Thingiverse" so people around the world may access them.

Our method for creating lunar and planetary 3D models was as follows: to begin, point cloud data for the longitude, latitude, and elevation of terrestrial planets such as Earth were exported as text files from digital elevation models (DEMs) using QGIS. The text files were then converted to the rectangular coordinate system using Python before being exported as OBJ-format 3D models via Blender. Finally, surfaces were created on the resulting 3D models using MeshLab. By multiplying the elevation on a model by a desired factor, any elevational variations on the model's surface can be emphasized or de-emphasized through scaling. Additionally, by limiting the longitude and latitude, partial planetary 3D models can also be created using the method above (Fig.1). When creating 3D models of giant planets such as Jupiter, visible light images were used instead of DEMs. However, due to luminescence being represented by elevation in the final product, the resulting models do not represent the true shape of such planets (Fig.2).

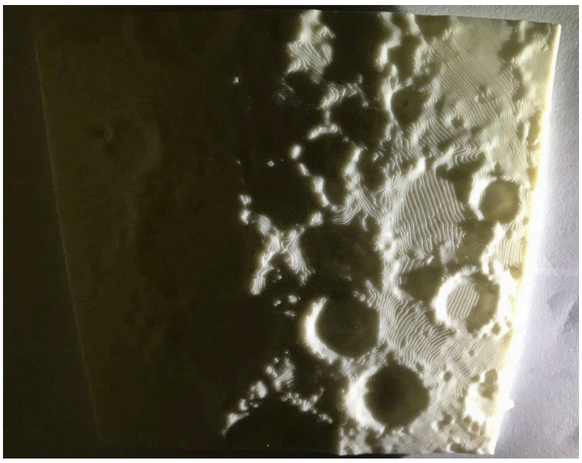

Figure 1: A 3D print of a partial lunar model. In this photo, a simulation of the phenomenon known as "Lunar X" is being demonstrated. The letter "X" appears as a clair-obscur effect in the center of the model when light and shadows mix on the lunar surface.

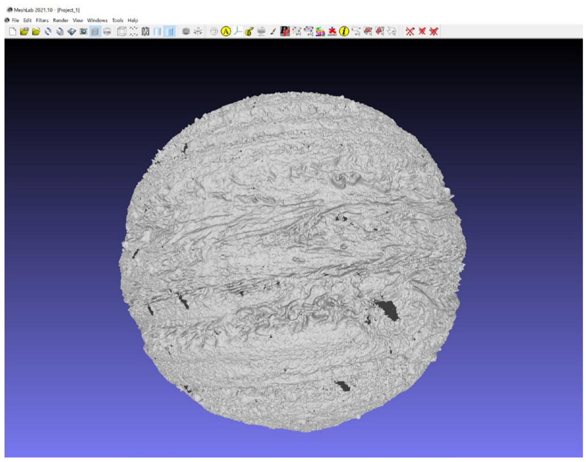

Figure 2: A resulting 3D model of Jupiter. In this model, the elevation is directly proportional to the luminance of Jupiter's visible light images.

Keywords: digital elevation model, Python, terrain, 3D printing, 3D software

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Exploring Global Challenges: Minority Girls' Perceptions of Energy

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With a growing population and a planet of limited resources, fourteen "Grand Challenges" have been identified by the U. S. National Academy of Engineering (NAE), including several that address concerns about energy. A deep understanding of energy by all learners is essential to the future of Earth, but is particularly critical to those living in low-income and underserved areas. As part of a National Science Foundation (NSF)-funded STEM and Computational Thinking (CT) out-of-school time program for underserved racial minority girls, we examined the perceptions of energy of 30 elementary girls (ages 8-11) who were participating in this program.

At the start of the program, two researchers conducted a semi-structured interview with each girl. The girls were asked to describe energy, give examples of energy, and to tell what they knew about energy changing forms. Interviews were audio-recorded and transcribed for analysis. A basic qualitative analysis method was then used by four researchers, employing open coding to identify an initial set of concepts, and then axial coding around concepts of energy, energy use, types of energy, and energy in the environment. These codes were examined by the researchers to find themes and relationships. Emerging themes included energy as an intangible quality of someone/something, energy as a cause of motion, and energy as a concrete quantity that can be possessed and transformed. The girls did not speak about the more general, integrated, or systemic aspects of energy—its scarcity, renewability, global use, and accessibility.

We present details from these findings and discuss impacts for STEM education, including how infusing computational thinking into existing curricula (a larger goal of this project) may support the development of a more systematic way of thinking about STEM. We also highlight a sample energy activity from our nearly-finalized STEM+CT curriculum.

Keywords: energy; STEM education; minority girls; computational thinking; systems thinking

The Role of University-based Regional Center for Science and Mathematics Education Devlopment (RCSMED) In The Enhancement of Earth Science Education in the Philippines

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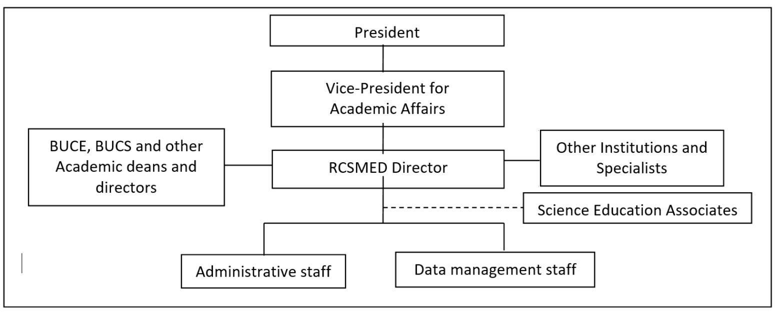
The Department of Science and Technology (DOST) created, as early as 1992, the Regional Science Teaching Center (RSTC) which aimed at training science and mathematics teachers in key regions in the Philippines. These Centers had their own building, facilites, and staff. Unfortunately, due to funding issues, the program was not sustained. Since RSTCs were situated inside state universities, they became integrated in the College of Education of the university in that region. The responsibility of funding and leadership had transferred from DOST to the respective Universities.

Bicol University had sustained RSTC to become facilator of programs by DOST and Department of Education in the training of science and mathematics teachers. However, under the direction of the new University president, RSTC evolved in 2016 into what is now the Regional Center for Science and Mathematics Education Development (RCSMED). It's niche is no longer only limited to teacher training but it has expanded to curriculum development and public awarenss of Science.

The Bicol region is home to the majestic perfect-cone Mayon Volcano. It is also next to the Pacific ocean in which more than 20 tropical cyclones were engendered annually. As such, natural disasters related to geohazards characterize the place. This was the reason why, the Bicol region and Bicol University became among the hosts of the 2nd International Earth Science Olympiad (IESO) in 2008 with a theme on addressing climate change.

The new niche of RCSMED is heavilty influenced by the richness of the the region in terms of themes in Earth Sciences (e.g Bicol region is a mining environemnt and with an active geothermal plants). As such, programs in teacher training in geohazards, disaster risk reduction, earth resources, astronomy among others were conducted in coordination with the local government and stakeholders such as mining and geothermal companies sicne 2016.

RCSMED also handles the selection of the Philippine Team for the IESO. They administer the exams even in other regions and facilitates the camp to further select the 4 students who will represent the Philippines in IESO. This is part of their mission of public awareness of Earth Sciences



Keywords: teacher-training, public-awareness-of-science, RSTC, RCSMED, IESO

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Misconceptions about Fundamentals of Climate Change Science among Pre-Service Teachers in Japan

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A deep understanding of the current state and causes of climate change is required for the teachers who carry out climate change education (Dolan, 2021) [1]. However, it is pointed out that there are various misconceptions about the fundamentals of climate change science (e.g., Choi et al., 2010) [2], and it is desirable to improve the teacher training curriculum so that pre-service teachers can adequately understand the fundamentals of climate change science. Therefore, this study aims to clarify the recognition of pre-service teachers in Japan on the fundamentals of climate change science and consider the contents of teaching and learning on them during teacher training.

A questionnaire on the fundamentals of climate change science was administered to 1st-year undergraduate students (n = 177) at a Japanese university of teacher education in April 2022. Of them, fifty-seven students belong to the science education course. When asked to select the greenhouse gases from eight gases, 94% of the students selected “carbon dioxide.” However, only 20% of the students selected “water vapor,” the most abundant greenhouse gas in the earth’s atmosphere. However, 64% of the students (n = 28) who took “Basic Earth Science” in upper secondary schools selected “water vapor.” On the current state of climate change in which anthropogenic greenhouse gas emissions are considered the main cause, in the question which selects the appropriate things from eighteen items, 75% of the students selected “ozone layer destruction,” which is a misconception about the current state of climate change. Even 68% of the students who took “Basic Earth Science” in upper secondary schools selected “ozone layer destruction.” Also, 68% of the students in the science education course selected it. Here, only 9% of the students in the science education course took “Basic Earth Science” in upper secondary schools. As a previous study (Monroe et al., 2019) [3] pointed out, many students confused climate change with ozone layer destruction.

These results suggest that the study of “Basic Earth Science” in upper secondary schools contributes to recognizing greenhouse gases but less to the resolution of misconceptions in the current state of climate change. It became clear that enhancing the teaching and learning that understand the current climate change was necessary for the teacher training curriculum, regardless of the study of “Basic Earth Science” in upper secondary schools.

Keywords: misconception, pre-service teacher, teacher training, climate change education, climate change

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Variations of Surface Ozone at the Cape Point Global Atmospheric Watch (GAW) Station, South Africa

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The surface ozone (O_3) is a major pollutant and a short-lived greenhouse gas and has therefore attracted much concern in recent years. It is a secondary atmospheric pollutant formed by reactions between oxides of nitrogen (NO_x=NO+NO_2) and volatile organic compounds (VOCs) or carbon monoxide (CO) in the presence of sunlight. At the boundary layer (below the troposphere) where we live and breathe, O_3 pollution has direct impacts on human health, agriculture and vegetation. It is therefore crucial to understand and monitor the long-term variability in O_3.

This study analysed the diurnal, seasonal, inter-annual cycles and trends of O_3 at Cape Point Global Atmosphere Watch (GAW) station. O_3 time series were obtained from South African Weather Service (SAWS) for the period 1990 to 2014 on daily basis from the 30m-air intake line, which were processed to diurnal, monthly, seasonal and annual scale. Furthermore, the Mann-Kendall (MK) Test for monotonic analysis of trend together with non-parametric Sen's Slope estimator were used to estimate the magnitude of trends for O_3 time series.

Over Cape Point, average O_3 exhibit a pronounced diurnal and seasonal cycle. O_3 concentration increases during the daytime following sunlight driven production processes. The diurnal patterns of average O_3 concentration initially builds up in the morning and peaks in the noon and gradually decreases through night. The peaks possibly were influenced by intense solar heating in the afternoon. Seasonal cycles of O_3 showed the existence of annual variability with maximum in winter and minimum in summer followed by autumn and spring. Overall, there is strong statistically significant increasing trend in both seasonal and annual average O_3 concentrations over Cape Point.

Keywords: Surface ozone; MAKESENS Model; Diurnal and Seasonal Cycles; Trends

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Special education program of Geopark for high school students - The case of Lesvos Island and San'in Kaigan UNESCO Global Geoparks collaboration

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Lesvos Island UNESCO Global Geopark (Lesvos Island UGGp) and San'in Kaigan UNESCO Global Geopark (San'in Kaigan UGGp) are two Geoparks that share many common features like spectacular volcanic and coastal landscapes, geothermal fields, protected areas, reach biodiversity and endemic species, reach cultural heritage, common approach in geotouristic and educational activities as well as innovative local development initiatives on food and handcrafts. On the 12th of February 2011 they have signed a sistering agreement, aiming to the close collaboration of the two territories in various fields of mutual interest like geotourism, educational program and networking.

Recently, a practicing education program is necessary in a high school education. The Japanese Ministry of Education, Culture, Sports, Science and Technology proposed that it was important to cooperate with a research institute and university in a high school education by education guidelines. But it is difficult to cooperate with a university and research institute for high school. The other hand, a school education is one of important programs in geopark activities. Geopark can offer various educational programs and act as an intermediary between high school and university.

As a result of the collaboration between Lesvos Island UGGp and San'in Kaigan UGGp, we could get some good results. One of the important results is Special education program of Lesvos Island UGGp for Toyooka High school. In 2014,2015 and 2019, students of the Toyooka High School which is a local high school, partner of San'in Kaigan UGGp, participated in educational programmes of Lesvos Island UGGp, and collaborated with a local high school, partner of Lesvos Island UGGp, both schools presented their home geopark and had the opportunity to get to know each other. We will discuss about how the students have changed after the participation of this educational program.

Keywords: Geopark, UNESCO, Education, Student, High school

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Ophiolite and hybrid mélange complex exposed along the western Kohat Basin, NW Pakistan and development of Indo-Afghan suture

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Patches of Neotethyan ophiolites and Kahi sedimentary mélange exposed along the western Kohat basin of NW Pakistan were studied in detail for delineating the tectonic history of emplacement over the western Indian continental margin. Ophiolites are characterized by the presence of serpentinites, peridotites, gabbro, basalt and chert exposed in parts and fragments. The base of the ophiolite complex is dominated with the metamorphosed and serpentinized peridotites and harzburgites. The whole rock suit forming ophiolite is mixed at places with the mixture of marine and outer shelf sediments (Kahi mélange). The Kahi sedimentary mélange is a mixture of accretionary sediments, turbidites radiolarites. Biostratigraphic analysis were conducted on the samples collected from the shale interbed and carbonate nodules in the turbidite facies. Late Cretaceous index planktonic foraminifera and radiolarians were studied in the collected samples and it implies age of the Kahi sedimentary mélange. The field relationships show the ophiolite suit structurally thrust over the Kahi sedimentary mélange. This information shows that the initiation of ophiolite emplacement on the Kahi sedimentary mélange first took place during late Cretaceous which also corelate with the onset of initial collision between Indian plate and Afghan plate. Faulted contact of the Kahi sedimentary mélange with the late Paleocene Lockhart Formation of Indian margin suggests late Paleocene age for the obduction of combined ophiolite and Kahi sedimentary mélange over the Indian margin. This is indicative of the final closure of the Tethys ocean and final collision event between the plates. Regional structural trends indicate the post collisional indentation of Indian plate into Eurasian plate, leading to conversion of the India–Afghan collisional boundary into a transform boundary. The strike slip component of the boundary dismembered and dislocated the main ophiolite and Kahi sedimentary mélange into patches and slivers of chaotic rock masses. These are the representative of the typical colored hybrid mélange complexes formed as result of the subduction–accretion processes that take place during continental suturing events. Our detailed field study and biostratigraphic results show that development and evolution of the ophiolites and mélange complex along the Indo–Afghan suture is a result of coeval tectonic and sedimentary processes in a subduction–accretion setting, and that the collision of Indian plate with Afghan block took place in at least two major tectonic events.

Keywords: Indo-Afghan suture, hybrid mélange complex, Waziristan ophiolites, Pakistan.

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Geomythology of the cave Ahunruparo, the entrance to the other world, in the Pon-ayoro coast, Shiraoi Town, Hokkaido, Japan

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Geomythology is the study of the oral and written traditions created by prescientific cultures to account for, often using poetic or mythological imagery, geological events and phenomena [1]. Vitaliano recognized two main categories of myths that contain geologic themes: those that are considered to be based on real events (euhemeristic myths), and those that can be interpreted as attempts to account for features of the environment (etiological or explanatory myths) [2].
The so-called Ainu myths can be divided into three main categories: mythic epics (kamuy yukar), heroic epics (yukar) and prose tales (uwepeker) [3]. Mythic epics and heroic epics are recited in rhythmic rhymes to short repetitive melodies. The texts of the stories that fall into the category of prose tales are recited in a relative monotone and in prosaic diction that is close to everyday conversation.
The Ahunruparo sea cave is located along the Pon-ayoro coast near Shiraoi Town, Hokkaido. Ahunruparo means "the entrance to the other world" in the Ainu language, and is a sacred site of the Ainu people in Hokkaido [4].
The Ahunruparo cave is composed of pyroclastic flow deposits, Kt3-pfl, from the Kuttara volcano in the Iburi region. The Kt3 tephra, including Kt3-pfl, has been assigned to eruptions that occurred ca. 49000 B.P. [5]. The deposits, which comprise rhyolitic welded tuff and are characterized by apparent columnar joints and abundant cracks, are used as building stones.
The Ahunruparo measures 2.5 × 6 × 5 m and is probably a natural sea cave created by weathering and erosion. Though the cave is not affected by sea water at present, sea water previously entered the cave at high tide. The surface of the cave is characterized by having tafoni, and marine flotsam, such as seaweeds, are deposited in the cave during the typhoon season. Field observations revealed that the cave was likely formed when the sea level was higher than it is at present.
Toponymical studies have revealed that many of the features along the Pon-ayoro coast have mythic Ainu names, such as kamui-mintar (God's garden), kamui-ekashi chasi (God's fort), and yaunkut-tomari (domestic mooring). According to prose tales about the Ahunruparo in the Iburi region, Ahunruparo was considered to represent a portal between the Ainu mosiri (present world) and the Pokuna mosiri (afterlife). Differences among prose tales are ascribed to local variations or the recited period. Ainu myths that contain geologic themes have not been studied extensively, and further examination of these myths is considered necessary from the viewpoint of geomythology.

Keywords: Ainu myth, geomythology, Hokkaido, Kuttara volcano, pyroclastic flow deposits
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Petrology of volcanic rocks from Mount Pinatubo, Philippines: Implication for magmatic crystallization

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Eruption of Mount Pinatubo in the Philippines in 1991 is the one of the recently erupted volcanos of the world. Mount Pinatubo erupted about five cubic kilometers of magma, so the rock and other products are newly formed. From field investigation, there are two rock types that are formed by the erupted magma with the composition ranges from andesite to rhyolite. Most of the products from Pinatubo are dacite or rhyodacite with high amounts of phenocrysts and andesite with poor phenocrysts. The rhyolite and dacite are composed of the same mineral assemblages which are hornblende, plagioclase, biotite, and opaque minerals (magnetite). The volcanic rocks typically exhibit the porphyritic texture of plagioclase and hornblende phenocrysts embedded in glass groundmass and fine volcanic ash. Crystallization P-T conditions determined by Al-in-Hornblende geobarometer and hornblende geothermometer are 2.02 – 3.89 kbar and 821 – 909 °C, respectively. The estimated crystallization depth is 8 – 12 km. Whole-rock geochemistry and mineral chemistry indicates that these rhyodacite and andesite are formed by calc-alkaline magma in the same magma suit related to subduction.

Keywords: Mount Pinatubo, Philippines, Petrology, Volcanic rock, Crystallization

Current status of beach sand and its significance for education

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Sand has been overexploited as industrial resource in economic development and modernization in various countries of the world. As a result, environmental destruction proceeds in rivers, beaches, tidal flats, and shallow seas [1]. Sandy beaches are vulnerable to the effects of rising sea levels due to global warming [2], resulting in the disappearance of sand-base environments worldwide. From these points of view, educational activities using sand, mainly beach sand as a resource, can serve as natural science and as an education material for thinking about a sustainable society.

Sand grains are composed of minerals, rock fragments and biological source particles. The beauty of sand under stereomicroscope fascinates observers (Fig.1). In addition, the observation of sand grains can estimate the provenance to provide educational teaching for understanding river and marine environments. Sand grains are ubiquitous, easy to obtain, easy to handle, and the amount collected can be adjusted. It is helpful for a material of natural science education in schools and museums.
The size of each sand grain is different, and a sea wave circularly polishes the sand grains. It is necessary to know in advance what characteristics the constituent minerals exhibit under stereomicroscope [3]. We qualitatively examined the mineral composition of beach sands from 41 locations on the Japanese Island [4]. These characteristics can be helpful for observing minerals in beach sands. From the perspective of natural science education, estimation of the provenance from beach sand helps develop scientific and geological thinking.

Fig. 1. The beautiful sand grains from the river mouth of Seki-river, southwestern

We can expect this education, research and sand sample collection activities will help us understand the global environment in the 21 century and lead us into the future.

Key words: beach sand, educational activities, global environment
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GIS approach using statistics and morphometric indicators to assess the tectonic signature in the hydrographic network.

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The analysis and interpretation of tectonic lineaments constitute an interesting approach in geological mapping and mineral exploration. In mountainous regions with difficult access, the identification and mapping of tectonic accidents sometimes remains difficult. The use of remote sensing and GIS can reduce the risk, time and cost of exploration.
The present study is an attempt to assess the tectonic signature on the drainage network using remote sensing data in a GIS environment.
The statistical study of the drainage network showed a direct interaction between tectonic activities and the hydrographic network. In fact, this network is mainly the result of inherited and current tectonic activity.
The results obtained provide valuable information on the identification of major tectonic directions in the Nefza region (North East of Tunisia). These results are comparable to tectonic data extracted from the geological map of the region.
Indeed, the study of some morphometric indicators extracted from the drainage network, revealed the existence of an E-W subsurface tectonic control covered by the Quaternary sedimentary series not indicated on the geological map of the region.

Keywords: Tectonic, drainage network, remote sensing, GIS, morphometry.

Poster_30

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Enhance Students' Learning Experience in Fieldwork by Using ArcGIS Online

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Using the ArcGIS Online application to conduct geological fieldwork provides an alternative method of teaching students. This study describes an educational innovation for geological fieldwork that uses the ArcGIS Online application to assess students' learning experiences. When compared to traditional classrooms, this teaching method allows students to better understand how geological structures and features connect through the mapping area. This observation suggests that students can consider structure and deformation events as spatial continuity while gathering acquisition data in the field. Independent t-test results between treated and untreated student groups show that the average post-test score of the treated students was significantly higher than pre-test scores at a $p = 0.05$ level after using ArcGIS Online in this study's fieldwork. As a result, the ArcGIS Online application is critical in changing and developing geological fieldwork in Thailand at the university level for students. This teaching method has the potential to benefit any science teaching as well as other disciplines requiring similar skills.

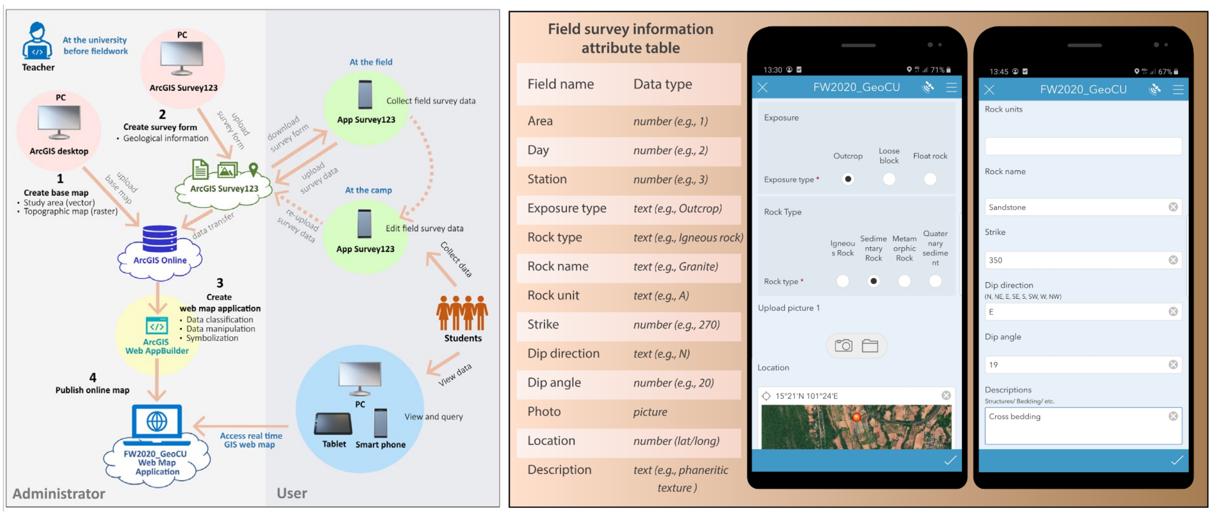

Figure 1 Schematic of workflow for constructing a fieldwork teaching with ArcGIS Online application (left) and Field survey information and data type for generating a survey form and image of the Survey123 application on the smartphone (right) [1].

Keywords: Geoscience; Smartphone; ArcGIS Online; Survey123; Fieldwork

References: Phantuwongraj S. et al. (2021) Geosciences, 11(9), 357.

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Dye Separation Properties of Various Rocks and Their Potential Applications

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1. Purpose
On science classes-in junior high school, students learn the origin, distribution, and composition of the landforms through observation of surrounding topography, strata, and rocks. Through those activities students are expected to classify rocks, which would lead to an understanding of disasters and underground resources in their surrounding area. In addition to the chemical and mineral compositions for classification of igneous rocks, color indices for plutonic rocks and color tones for volcanic rocks are introduced as important indicators for classification in school textbooks. However, classification by them is not always accurate, because of some exceptions have been pointed out, such as the existence of mottled gabbro with a low color index, rhyolitic obsidian with dark color, black andesite, and gray basalt (Takahashi, 2010). Previous research in our laboratory has confirmed that green food pigments can be separated by column chromatography using silica sand and river sand containing large amounts of quartz (Okada, 2020). It has been suggested that the ability to separate dyes may depend on the quartz content in the sample. The purpose of this study is to investigate the dye separation characteristics of various rocks and minerals by column chromatography, and to develop practical protocols for classifying rocks which can be used in educational activity.
2. Method
(1) Sample
Basalt, andesite, rhyolite, mottled rock, diorite, and granite, were used as carrier. Fresh granite and weathered granite were also used. Quartz, Microcline, Albite, Labradorite, and Anorthite were tesed as the majour rock-forming minerals. The carriers were aligned with a grain size of 0.06 mm ~ 0.2 mm.
(2) Experiment
The column consisted of plastic straw as cylindrical body, cotton, carrier, and non-woven fabric. The green solution solute was prepared by mixing 0.5 g of blue No. 1 and 0.5 g of yellow No. 4 with diluting 500 mL of ion exchanged water. Ion-exchanged water was passed through the column, and 0.5 mL of the dye solution was added after the water level had dropped to the level of the non-woven fabric which is put on the top of the carrier. When the water level dropped to the level of the non-woven fabric, ion-exchanged water was added again. The RGB values of the effluent were measured every minute from the time the dye flowed out using Digital Color Meter, a Macintosh software application, on the computer screen while the iPad was connected to the computer and the effluent was photographed with the iPad's camera.
3. Results and discussion
The pigment separation characteristics differed among the various rocks. Separation of yellow and blue was observed in rhyolite and weathered granite. Andesite did not discharge the yellow, but only the blue. Only Albite was found to separate pigments among rock-forming minerals. For Labradorite, only the blue flowed out. The different pigment separation characteristics of the various rocks suggest that this method may be useful in classifying igneous rocks. Separation was confirmed in igneous rocks containing Albite, suggesting that the mineral contributes to the separation. The separation characteristics differed depending on the degree of weathering of the granite, suggesting that the amount of Albite and the surface condition of the granite may also affect the separation. Issues to be addressed in this study include more quantitative measurements of runoff, investigation of separation factors, and quantification of the amount of Albite in the samples.

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Analysis of Board Games Applicable to Science Classes on Climate Change: Focusing on Citizenship Education

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Science in school education is used to cultivate the ability and attitude of students to understand the concept of science and to investigate scientifically, and to develop the competence to scientifically and creatively solve problems faced by individuals and society. In particular, many of the issues facing citizens of the world today, such as climate change, GMOs, denuclearization and health threats such as COVID-19 pandemic, appear to be related to science in large part. In this situation, students should be educated to develop a wide range of scientific knowledge and critical thinking to understand the various issues they face from a scientific point of view and evaluate the process of problem solving.
This flow of science education is connected with citizenship education as a part of preparing for adult life to participate in society building through active participation in decision-making.[1] In particular, the relationship between citizenship and science is more evident in some social debates where scientific knowledge, understanding, and characteristics must be clearly expressed.[2] Therefore, in this study, the issue of climate change was selected as a representative topic, considering that citizenship education is necessary in modern science classes. This is because the world faces the climate change problem, and it is necessary for citizens to make decisions in various aspects based on scientific understanding.
School citizenship education can be achieved by providing classroom participation, elections, decision-making opportunities, social action that benefits the community, and opportunities for students to feel that they are part of the wider community and that their contributions are valuable.[3] In this study, we collected board games that can be leveraged in science classes about climate change. Initially, we analyzed the general characteristics of the subject, play method, and target age. Next, we analyzed them from the perspective of citizenship education as an in-depth characteristic. Building on insight about the citizenship education perspective within the context of science classes, we analyzed to what extent the board games that we had collected included the degree of scientific understanding, decision-making opportunity, and practice on climate change issues.
As a result, we discovered that most of the climate change board games tended to focus on carbon emissions and average temperature rise on a global scale, allowing students to naturally enhance their understanding of these themes through playing the game. In addition, it provided an opportunity for group or individual decision-making processes, based on their scientific understanding of climate change learned through playing the board game. However, in general, the aspect of putting their knowledge into practice was not emphasized. Therefore, in order to cultivate students' citizenship in climate change science classes using board games, it is recommended that the approach to these games needs to be revised, to ensure that it fosters more individual and collective social action.

Keywords: citizenship education, science education, climate change, board game

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School-Use Seismographs Employing 3D-Printed Parts -Subsequent Developments and Practical Issues-

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We have developed a seismograph system for classrooms using mainly 3D printed parts[1]. This is a revised model of our previous version[2]. The system consists of i) Electromagnetic sensor with Neodymium magnets, ii) Integrated amplifier + Microcontroller (Arduino Uno), and iii) PC-based logging system using Arduino IDE and Processing software. Also, the mechanical design of pendulums (Free periods around 5 seconds) and their functions are similar to the 59type seismographs once operated by JMA(Japan Meteorological Agency) until the mid-1990s. This system is used for 1) Demonstrating seismographs in a classroom 2) Continuous recording for local and foreign earthquakes. The detecting limits of the Richter scale are around M6.5 for teleseismic and M>2 for regional. The details of our system were already presented at JpGU2022 May 2022[1]. In this conference, we will report some additional improvements and the issues for practical observation at school. Three sets of our system are already manufactured and installed at author's sites to ensure practical operation. 1)The first author's house, 2) Shinoda junior high school (Fig.1), and 3) Taisei Gakuin University campus (Fig.2). Also, another similar system is now developing at the fourth author's house.

They are similar settings, placed on the ordinary rooms (the first and second floors of school buildings or a wooden house) without any special settings for seismic observation. The 24 hours continuous recordings are operated with old-fashioned laptop PCs.

After several months of observation, we were vexed with vibration noises caused by soft ground bases and not rigid buildings. Such noises are particularly severe on cold, windy wintertime days because the strong sea waves hit the seashore and cause long period tremors (1 to 3 [sec]) invading land areas. Therefore, we can not distinguish the natural earthquake signals from these days' noises. Nevertheless, many seismograms (local and teleseismic) on mild weather days are recorded and now analyzed under such unsuitable conditions.

Our presentation will discuss seismograms and their application for classrooms. Also, we will focus on some subsequent developments built after the previous presentation. i) Evaluation of amplifier's integrated constants with parallel recordings ii) Outsourcing the amp- circuit board-making process, which was the toughest job during our hand-made process. Finally, we will identify the problems with practical operation in the school or home.

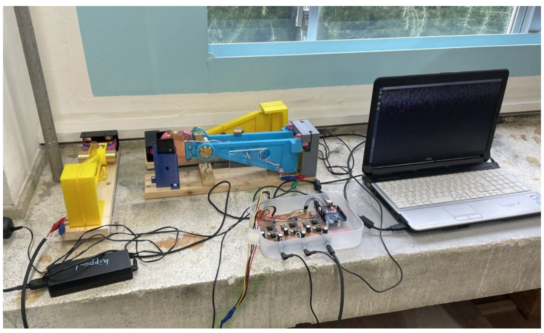

Fig.1 Operation at Shinoda junior high school

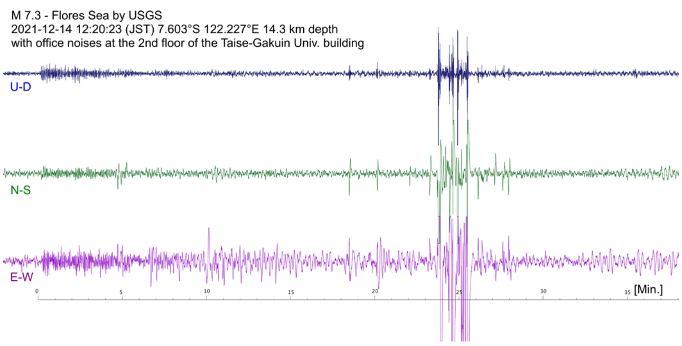

Fig.2 A teleseismic record of M7.3 Flores Sea at Taisei-Gakuin Univ.

Keywords: Seismographs, Seismograms, school use, 3D printer, Arduino.

References: [1] Yoshio Okamoto (2022) JpGU 2022.Abstract G-03 #C000449
[2] Yoshio Okamoto (2018) GeoSciEdVIII.Abstract.

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Practical study on star movement and moon shape using internet cameras i-CAN and Wel-CAM

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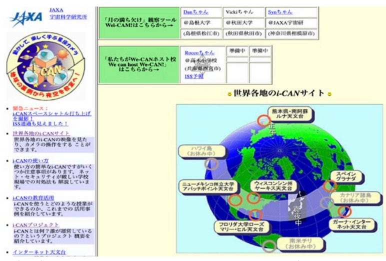
In some elementary school science units, it is difficult to experiment and observe in the classroom, and at the same time, it is physically difficult to support teachers. There are many issues mainly in the units related to earth science and biology, but it is especially difficult to study the stars and the moon in the night sky. In other words, it is not possible to observe the starry sky during the daytime when classes are held. In order to overcome such a situation, the constellation camera i-CAN was developed by Sato et al. (1999) and the moon phase camera Wel-CAM was developed by Sato et al. (2013).



The purpose of this research is to observe the actual movement of stars and the shape of the moon using an internet camera. Then, through the observation of the moving starry sky, it raises the interest of the students and leads to deep learning. Ultimately, the goal is to foster temporal and spatial perspectives and ways of thinking that are emphasized in earth science education.

There are some units of science learning in elementary school that are difficult to teach in the classroom. This is mainly the unit in the field of earth science, but especially in the unit related to the moon and stars, it is extremely difficult to teach while observing the real thing in the classroom in the daytime. It can be said that difficult education continues for the astronomical unit for the above reasons, while understanding with a real feeling is emphasized.

In this presentation, we will use this constellation camera i-CAN and the moon camera Wel-CAM to propose how to use them in the lessons, focusing on practical lessons at elementary schools in Sakaiminato City, Tottori Prefecture. In addition, we will report on how to proceed with effective lessons.

Keywords: Internet Cameras i-CAN and Wel-CAM, Elementary School, Science Class, Star Movement, Moon Shape

References:

[1] SATOH T., TSUBOTA Y., MATSUMOTO N. (1999) Making an "Internet Astronomical Observatory": I. Cheaper, Faster, and Easier. The Astronomical Herald, 92, 312-317.

[2] SATOH T., ISHII M., MATSUMOTO I., UEDA H., KIMURA K., MATSUMOTO E., MARUYAMA O. (2013) Net tool Wel-CAM that increases opportunities for continuous observation of the "moon phases". Proceedings of the National Conference of Society of Japan Science Teaching, 11L-102, 425

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Practical Research on High School Science Classes Utilizing Brackish Water in and around Matsue City.

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As a graduate student of the Professional School for Teacher Education, our research group conducts practical research every day with the aim of solving local (San-in area: Shimane and Tottori Prefectures) educational issues. In particular, Shimane and Tottori prefectures are rich in nature, and there are several geoparks and world heritage sites, but the current situation is that they are not fully utilized in natural science education.

One of the presenters, Yamaguchi, is aiming to use it as a teaching material for ecosystems, mainly biology, and Michine is aiming to use it as a teaching material for the environment of brackish lakes, mainly focusing on chemistry. One of the presenters, Matsumoto, supervised the presentation of this research as an academic advisor, and discussed the viewpoint and importance of the geological background as a teaching material.

Regarding the biological ecosystem that Yamaguchi is in charge of, the viewpoint of research is not mainly in the classroom, but in the open air as a place for observation. In other words, learning in the field tends to induce a scientific understanding with a real feeling. In addition, we are thinking of developing lessons to learn that the topography and geology that form the basis of the ecosystem create a valuable environment for the water system and the animals and plants that inhabit it. Specifically, we aim to construct a theory based on the ARCS model (Keller, 1984). The ARCS model is a theory that motivates learning through the process of four components: Attention, Relevance, Confidence, and Satisfaction. We believe that this theory is suitable for geological learning and ecological teaching materials.

Next, in the study of brackish lakes promoted by Done, the ark shells living in the Lake Nakaumi have the function of purifying the water quality, and the effect of bio meditation has been demonstrated.

As mentioned above, both Yamaguchi and Michine's research aims to form the concept that water systems and ecosystems are established against the background of topography and geology. Currently, the treatment of earth science is decreasing in high school science in Japan, but in order to solve this, we think that it is necessary to design to incorporate earth science education into the biology and chemistry classes (Matsumoto 2014).

Keywords: Practical research, High School, Geoscience Education, Brackish Water, Matsue city

References:

[1] KELLEL J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status*. Hillsdale, NJ: Erlbaum.
[2] MATSUMOTO I. (2014) Future Environmental Education in Science-Position and Importance of Awareness, Knowledge, and Behavioral Education for Creating a Sustainable Society-.

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A field guide using virtual reality technology: Introduction of outcrops around Okayama, Japan

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In Geoscience education, field excursion is essential excercise for students to explore and observe outcrops, to understand geological structures, and to consider formation process based on the knowledge obtained from classroom lectures. Unfortunately, the opportunities for field-based trainings are declining because of various reasons such as the time required to travel to the field site, the cost thereof, and the recent COVID-19 situation. In order to solve this problem and make field excursions more familiar, we are working on the creation of a field guide for beginners in Geoscience using recently developed virtual reality (VR) technology [1], taking geological outcrops around Okayama prefecture as an example.

Intra-arc sediments, accretionary complexes, high-pressure metamorphic rocks, granitic rocks, and ophiolite formed from the Paleozoic to the early Cenozoic are distributed around Okayama [2], indicating that this area is one of the best places for field excursion to observe various rocks and geological structures. At present, VR teaching materials of (A) the outcrop of the Permian accretionary complex and the Carboniferous-Permian limestone brocks (Kamba Falls) in Katsuyama area and (B) the outcrop of the Cretaceous tuff breccia in Tsuyama area both in Okayama prefecture are being prepared using 360-degree images. In the outcrop A, the ocean plate stratigraphy (OPS) characterized by sandstone and mudstone and basalt can be observed. In the outcrop B, the tuff used for the stone wall of Tsuyama-Castle and also the traces of the stone quarry at that time can be observed.

Since these outcrops are easily accessible by car, a synergistic educational effect by combining actual field excursion with VR teaching materials as the preparation and/or review can be expected. We are planning to apply this technology to other outcrops and demonstrate the VR teaching materials in classroom supposing the use in BYOD (bring your own device)-style. In this presentation, we will introduce VR teaching materials of not only the above-mentioned outcrops but also other outcrops.

Keywords: teaching material, virtual reality, field excursion, outcrop, Okayama

References:

[1] Shoji S. et al. (2021). Education of Earth. Sci, 74, 1–18 (in Japanese with English abstract).
[2] Isozaki Y. et al. (2010) Gondwana Research, 18, 82–105.

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Greenworks: A Multi-University Environmental Education Role-Playing and Community Action Experience

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Environmental crises will overwhelmingly impact Millennials and Generation Z. Most are aware of this reality and enthusiastic about finding and promoting policy and community solutions. However, many youths also lack the communication and collaboration skills necessary to implement change in their communities. The Greenworks program is a collaboration between Science Voices (a US-based nonprofit organization focused on improving science education), a political science course at Arizona State University (US), and various environmental and geoscience courses at Universidade Estadual de Campinas (Brazil), Universitas Khairun (Indonesia), and Lviv Polytechnic (Ukraine). The program provides space for students to practice deliberation and environmental policy-making in an online role-playing game and then implement their own proposal to address an ecological problem in their community.

The program consists of two stages: 1) the role-playing game curriculum and 2) community projects. During the role-playing game, students proceed through a semi-synchronous curriculum that blends science philosophy, governance theory, Earth science, and sustainability. Learning objectives are focused on scientific thinking, policy development and analysis, and effective teamwork. Students role-play as leaders of fictional nations addressing various environmental challenges through domestic policies and international negotiation. Teams who successfully complete the simulation receive funding and additional training to implement environmental stewardship projects that they have conceived and developed to address an issue important in their home communities. During this second phase, Science Voices and local partners coach student teams in project development and accountability. A few teams who completed the program in 2020 and 2021 and their faculty mentors have sustained and expanded their projects through local funding and additional grants separate from the program.

Since 2020, we have run five iterations of the program as we have worked to refine the model. We will discuss and provide examples of:

1) Program infrastructure (digital tools, curricular materials)
2) Benefits to students (engagement, international experience, real-world applications)
3) Benefits to teachers (active learning training, institutional transformation)
4) Challenges (language barriers, unfamiliarity with active learning, time zones)
5) Finance models (crowd-funding, unconventional grants)

Keywords: planetary stewardship, global university, environmental education, role-playing games, community projects

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Potential of Online Webcasts of Large Scientific Ocean Drilling Programs for University Education: A Case Study IODP Expedition 386 the R/V Kaimei

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Scientific progress is based on the understanding of many people. It is very effective to increase the number of fans of earth science to let students who study other than earth science know about it, especially at universities that are in charge of educating those who are expected to lead others in the future.
The Japan Trench is one of the Earth's most active plate convergent boundary located off the north-eastern coast of Japan. A decade following the 2011 Mw9.1 Tohoku-oki earthquake,the International Ocean Discovery Program (IODP) Expedition 386 took place during 13 April to 1 June 2021. The Expedition brought together international scientists including paleoseismologists, however, only 4 scientists were onboard_due to the effect of Covid-19 pandemic. The goals of the Expedition were: 1) to identify the proxies of earthquake-triggered deposits allowing recognition and dating of past Mw9-class earthquakes versus smaller earthquakes and other driving mechanisms, 2) to explore the spatial and temporal distribution of earthquake-triggered deposits, and 3) develop a long-term earthquake record for giant earthquakes.
During the Expedition, we hosted an outreach event for undergraduate students in the Faculty of Science and Pedagogy in Shikoku region. An online luncheon seminar was held on 7 May 2021, and this event was held at four universities in Shikoku and Tokushima University Environmental Disaster Prevention Café under joint collaboration with J-DESC. The Café was an online venue for disaster prevention specialists, architects, crisis management personnels from local governments and companies, media representatives, students and for the general public who are interested in disaster prevention to learn and discuss community safety and security from both environmental and disaster prevention perspectives. The live online webcast from the R/V Kaimei continued about an hour during lunchtime and included an overview of the Expedition and a ship tour, followed by Q&A session. After the webcast, a voluntary survey was conducted and the responses were received from 36 of the 104 mobile devices including those from the organizers. In addition, report assignments about this online webcast were conducted and 37 responses available for publication were received at Kochi University. The results showed that the majority of the audience were impressed by the actual settings onboard during the ship tour, while some commented that they wanted a more detailed tour, or not that there was not enough time for the ship tour and questions. A number of respondents indicated that the program sparked their interest in sample collection methods and marine research itself. This online luncheon seminar is expected to serve as a gateway for undergraduate students to learn about ocean science drilling and directly see how the scientists work together at sea. As many universities offer career education to students, such events would help students to have a career image of a researcher.

Keywords: Ocean science drilling, IODP, online live webcast.

Junior poster presentation abstract

Japanese junior/senior high school students will give poster presentations in English. During the conference, the posters will be displayed at the poster session area near the entrance of the main venue, and explanations of the posters will be given by students during the core time (10:00-12:00, 23rd Aug.). The posters will also be posted on the official website as an e-poster in PDF format, where online participants from overseas can ask questions and answer through the comment forms.

GeoSciEd Junior Poster Session

ID (Page No.)	School	Authors	Poster Title	paticipation
JR-001 (86)	Tottori Prefectural Tottori Nishi High School	Chikako Katakama; Hibiki Hagihara; Kaito Kimura; Kensuke Takenaka; Tomotaka Nakano; Yu Morita	A Restoration of the Paleoenvironment of Tottori Plain Based on Analyses of Sediment Samples Including Shell Fossils	in-person
JR-003 (87)	Shimane Prefectural Oki High school	Mutsuki OSADA; Ayami NAKANISHI; Local SDGs card game promotion team	Develop and practice local SDGs card game utilizing the Geopark	in-person
JR-004	Sapporo kaisei Secondary School	Muso Takimoto; Yuki Ichioka	Lava flow validation of Mt. Prometheus	in-person
JR-006	Fukuoka Institute oh Technology Jyoto High School	Yuga Miyawaki; Takumi Nakasima; Jinu Gen	Three-color metering with an old camera	online only
JR-007	Fukuoka Institute oh Technology Jyoto High School	Hana Watanabe; Kosei Terashima; Aoi Hasegawa; Miharu Taniguti; Akiko Hasegawa; Ryo Kusune	Orbit analysis of meteor	online only
JR-008	Fukuoka Institute of Technology Jyoto High School	Shin Sato; Hayato Kuroki; Shohei Oniki; Huyu Nozaki	A view of the sky above Fukuoka City	online only
JR-010 (88)	Kaisei Junior & Senior High School	Raia Sakamoto; Ena Sakamoto; Rio Sakamoto; Hina Fukui; Nana Katayama; Nonoka Kawatani; Fuga Imaoka; Yusuke Maruyama	Ruby Synthesis Experiment Geoscience Background Considered from the Laboratory Experiment of Junior and high school Earth Science Club	in-person
JR-013 (89)	Tachikawa High School	Takumi Yasuhara; Kota Toda; Haruki Inoue	Development of Automated Visibility Observation and Meteorological Observation Systems	in-person

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A Restoration of the Paleoenvironment of Tottori Plain Based on Analyses of Sediment Samples Including Shell Fossils

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The Tottori Plain faces the Sea of Japan and is thought to consist of sand and mud that accumulated in the inland sea during the Jomon marine transgression Period. However, the origins of the Tottori Plain are not yet clear due to lack of research.
This study is aimed to investigate the paleoenvironment of Tottori Plain mainly from fossils in underground sediments which were obtained as boring samples when the Tottori Prefectural Library was rebuilt. The Tottori Prefectural Library is located on the plain.
The shell fossils were extracted from sediments and cleared of dirt. This work resulted in the discovery of shell fossils, wood chips, and some sort of hair. The percentage of shell fossils found were 64% *Corbicula japonica*, Japanese freshwater clams, 7% *Clithon retropictus*, a kind of Japanese snail, 3% *Cerithidea djadjariensis*, pirenella incisa and 2% *Crassostrea gigas*, pacific oysters.
In addition, the habitats of each species of shell were investigated and compared with the strata investigated in a previous study(Yamana et al. 1975).A comparison between the previous study and this study revealed differences in the type and number of shells excavated. Based on the large number of shells which generally live in shallow sea in the sediments examined in this study and in comparison with the previous study, the environment around the library at that time was most likely shallow sea.
As our further research plan, it is necessary to discover microfossils such as foraminifera in the sediments, to investigate boring samples at other sides,and to observe the other elements - wood chips, some sort of hair and minerals-in order to analyze the estimate age and paleoenvironment of Tottori Plain in more detail from now on.

Keywords: shell fossils, paleoenvironment, Tottori Plain, brackish water region, Japanese freshwater clam

References: [1] Takashi Okutani (2017) The illustrated reference book of shells from inshore of Japan [Tokai University Press].
[2] Iwao Yamana et al.(1975) Research report of Tottori Prefectural Museum, 12

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Develop and practice local SDGs card game utilizing the Geopark

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Oki High School in the Oki Islands Geopark has been conducting Project Based Learning (PBL) utilizing the Geopark since 2015. In the first and second years, each students team decides on a theme and tries to find a way to solve the problem with local people. In the third-year option course, "Geopark Exploration," students specialize in business and work with companies to find ways to generate revenue. The students also work to extend the learning they have gained through their studies to the local community. Since 2021, We started to merge geopark education aimed at conservation through community study and SDGs movement which aims at solving local challenges through a global standpoint. As an action to spread learning to the community, an Oki islands' version of a card game was created based on a card game jointly developed by the university and a company.

In this card game, we place emphasis on two things: experiencing a series of steps from reviewing the community, thinking, and taking action and building up local knowledge. The game uses three types of cards, one linked to a specific goal ("trade-off card"), another representing a local resource ("resource card") and the other thinking about how to act ("rule card"). Players familiarize themselves with SDGs through a game format and come up with ideas to use local resources wisely for achieving the goals. We will update the game regularly, and through that create an archive of the challenges and resources that exist on the islands in specific periods of time. The game will provide a peek into the state of progress of the geopark activities.

Last year, we held trial events for educators and businesses, and made revisions to the card game. This year, we introduced the card game to first grade students studying Geoparks. We will also work to increase opportunities to utilize this game not only in the school but also in the community.



Keywords: Oki Islands, high school, geopark education, SDGs, regional cooperation

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Ruby Synthesis Experiment Geoscience Background Considered from the Laboratory Experiment of Junior and high School Earth Science Club

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Currently, although "Earth Science (Geology)" as a high school subject in Japan remains, the number of students who choose earth science is small. In addition, there are very few teachers who teach earth science, and it can be said that there is a crisis in earth science education in Japan. Especially in Shimane prefecture, there are no teachers who teach earth science, and even though there are several geoparks and world heritage sites that are rich in nature, they are not being effectively utilized for education.

We are studying at Kaisei Junior & Senior High School, which is an integrated middle and high school. Also, as a club activity, he belongs to the science club and pursues the joy of science through experiments and observations on our activity.

This time, we will introduce the artificial ruby ??synthesis experiment that has been repeated at the science club for several years since the GeoSciEd meeting was held in Matsue City. In addition, the science club is discussing geological factors in relation to naturally occurring rubies. This time, we will also introduce the contents of the discussion.

Fig.1 Artificial ruby that was successfully synthesized in an experiment

Fig.2 Heat the mixed powder using a microwave ovens

Fig.3, 4 and 5 Experimental scenes at the science clubs

Keywords: Ruby Synthesis Experiment, Science Club, Geoscience Background

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Development of Automated Visibility Observation and Meteorological Observation Systems

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In our school, weather observation has been conducted for about 75 years. Visibility is one of those observations, and it is a measure of the distance at which an object or light can be discerned. Our observation records suggested that the air pollution was terrible in the 1960s. In order to automate our observation, since 2019, we have continued to develop our own observation equipment and try to judge visibility with machine-learning-based methods. In order to automate judging visibility, we utilized a machine-learning model which is called Convolutional Neural Networks (CNNs).As a result,its accuracy was approximately 95%.

In order to centralize the observation data and publish them, we developed a system monitoring the school's weather observation data. The program synchronized the observa tion data from the meteorological observation equipment with the Raspberry Pi. Another program showed the latest data of Raspberry Pi (temperature, humidity, air-pressure) and the graphs (temperature, humidity) on the display. In addition, the other program automa tically acquired visual observation results. The observation data obtained from the equipment is utilized in the analysis. Visibility tends to worsen in the rainy season and summer. Also, it worsens in high humidity or in the morning. After raining, visibility often becomes good, it is estimated this is related to aerosols. It was thought to be largely related to forward scattering and precipitation.The researchers attempted to use deep learning to make determinations and further automate the observations.The met eorological observation data could be displayed on a display.The current visibility was related to precipitation phenomena and high humidity.The researchers will continue obser vations to further explore the relationship between visibility and air pollution and the effects of yellow sand and other factors on the visibility of Mt.Fuji. In addition, the researchers will further automate the system and aim to complete asystem that will mak e the observation data available to the public within the school

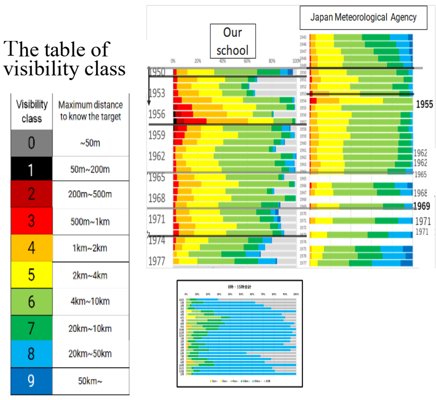

Fig1 visibility change of our school and Japan Meteorological Agency (1940~1977 annually,2020~2021Monthly)

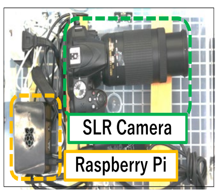

Fig2 Automatic observation device

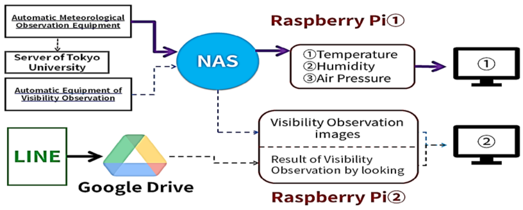

Fig3 Our Meteorological Observation Systems

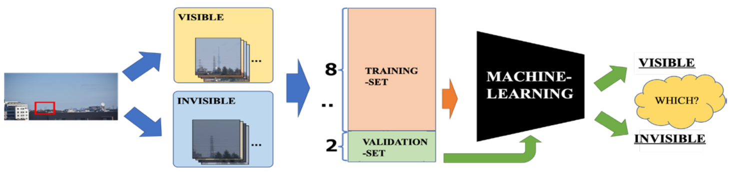

Fig4 Visibility evaluation of captured images by machine learning

Keywords: Visibility, Observation System, Air Pollution, Aerosol, Deep Learning

References: [1]T.Yasuhara,K.Toda,H.Inoue(2022)TheMeteorogikalSociety of Japan stronomy and Meteorology club (2020) [2] Y. Hamashima, T. Yasuhara et al.(2021) Meteorological Observation Equipment Contest. [3] The website of Japan Meteorological Agency

International Symposium on Natural Hazards and Education abstract

Wednesday, 24th August @ Multipurpose Hall

PROGRAM

8:50 - 9:00 Message

9:00 - 10:00 Showcase of natural disaster education

(a) S-001 Education on Disaster Prevention in Japanese Schools
Japan / Mr. Yasuhiro TAGUCHI
(Kashiwa-minami High School, Chiba Prefecture)

(b) S-002 Learning about disaster prevention in high school –Scientific understanding of natural disasters and acquisition of knowledge of disaster prevention behavior-
Japan / Mr. Katsuya KAWAKATSU and his students
(Himeji-higashi High School, Hyogo Prefecture)

(c) S-003 Incorporating disaster prevention learning into primary school science outdoor learning
Japan / Mr. Makoto OBASE (University of Hyogo)

(d) S-004 Disaster-prevention education assuming low-frequency large-scale volcanic eruptions: Teaching materials for high-school students about the widespread volcanic ash from the Kikai-Akahoya Eruption
Japan / Dr. Tatsuya KODA (Konan University)

Short break

10:10 - 11:25 Lectures (e) / Invited lectures (f to i)

(e) S-005 Research on promoting national resilience through disaster mitigation education for university students
Japan / Prof. Dr. Daiji OKADA (Hiroshima International University)

(f) S-006 Natural Disasters, Social-Natural Resources, and the Resilience of Local Communities: the Case of the Great East Japan Earthquake
Japan / Dr. Taiyo YAGASAKI (University of Hyogo)

(g) S-007 Natural Hazards and Education in East Asia: South Korea
South Korea / Prof. Dr. Young-Shin PARK (Chosun University)

(h) S-008 Disaster education in China-taking disaster education in geography curriculum as an example <ONLINE>
China / Prof. Dr. Yushan DUAN (East China Normal University)

(i) S-009 Overview of Disaster Prevention Education in Taiwan
Taiwan / Prof. Dr. Chun-Yen CHANG (National Taiwan Normal University)

11:25 - 12:00 Discussion / Q&A to the speakers from attendees / General discussion / Summary

Closing remarks

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Education on Disaster Prevention in Japanese Schools

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Japan has many disasters until now,from now because it's on tectonic and geographical location. The Japanese schools grapple to prevent their students from disasters. The Japanese schools' curricula are prescribed by the Courses of Study within their national framework (MEXT). The Courses of Study also reveal ways to prevent disasters in each subject in Japan. The Japan Courses of Study change approximately every 10 yearas. Lately the Courses of Study at Elementary schools and Junior High schools changed in 2017 and at High schools in 2018 in Japan. New text books based on the new Courses of Study are issued and used by students of Elementary schools and Junior High schools from 2021 and High schools from 2022 in Japan.

This study picks out the descriptions of education on disaster prevention in new text books which are used by Japanese students especially in Kashiwa city,Chiba Prefecture,Japan which the author lives in. And this study also examins possibilities of education on disaster prevention to refer not only the text books but also real practices historically in Japan.

Keywords: education on disaster prevention, evacuation, Ministry of Education, Culture, Sports, Science and Technology (MEXT), safety, the Courses of Study

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Learning about disaster prevention in high school - Scientific understanding of natural disasters and acquisition of knowledge of disaster prevention behavior -

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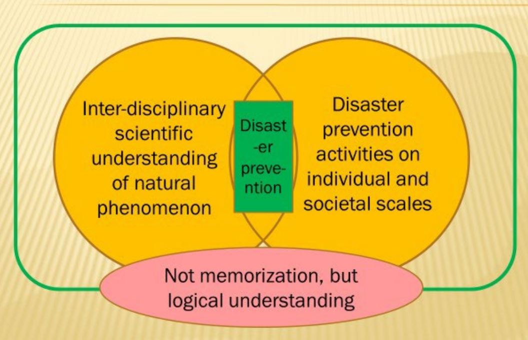
Our school is located near the epicenter of the Southern Hyogo Earthquake that occured on January 17, 1995. As the years pass by, lessons learned have started to be forgotten. The main lesson we learned from the disaster is that it is necessary to understand the natural world scientifically and to practice disaster prevention activities as an individual and societal scales to protect ourselves from disasters (Fig.1).

FIG.1 WHAT IS NEEDED FOR DISASTER PREVENTION?



Japan has many natural disasters (such as earthquakes, volcanic eruptions, tsunamis and typhoons) and students are taught how to prepare for and respond to them. Aside from those practical considerations, students learn about the underpinning scientific theories of such disasters in earth science classes. However, students don't study the four natural science (chemistry, physics, biology and earth science), but only choose to study 2 or 3 subjects from them. Therefore, students who don't choose earth science have no opportunities at school to learn the mechanisms behind disasters. In modern Japan, very few schools offer earth science courses so many students are denied the opportunity to understand the theory of natural disasters.

Our school has been designated as a Super Science High school (SSH) since April 2020. The SSH program designates high schools that focus intensively on math, science and technology education. It implements advanced math and science education programs in high schools and assigns additional funding to further develop the abilities of students. In addition, it also develops teaching methods and materials which develop students' creativity and originality.

The most important research and development theme of our school is "International Activities centered on Earth Science". Our school has set up "Basic Inquiry-Based Study of Natural Science" (worth 4 credits in 1st grade and 2 credits in 2nd grade) to encourage comprehensive across the four fields of science (chemistry, physics, biology, and earth science) with a focus on earth science. Here is also "Inquiry-Based Study of Science and Mathematics" (1 credit in 1st grade, 2 credits in 2nd grade and 1 credit in 3rd grade) research based on earth science. In this system, all students study across the four fields of natural science as well as mathematics and so they can come to understand natural phenomena and natural disasters comprehensively. In "Basic Inquiry-Based Study of Natural Science", students actually go out and get hands-on experience earth sciences. In 2021, a group of students investigated the Nojima Fault which was responsible for the Southern Hyogo Earthquake and visit the Disaster Prevention Future Center. We learned about disaster prevention and mitigation techniques there. We conducted a survey on students who participated about these activities. The results shows that our school's efforts is significant [1]. We would like to show the country the fruits of our labour nationwide.

Keywords: Southern Hyogo Earthquake; mechanisms; activities

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Incorporating disaster prevention learning into primary school science outdoor learning

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Geoscience education and disaster prevention education are important in Japan, where many natural disasters, such as earthquakes, volcanic eruptions and torrential rains, occur. Although outdoor learning in geoscience education is desirable, many schools do not conduct such learning owing to lack of suitable observation sites, time and explanatory skills of teachers[1],[2]. However, in Kyotango City, Kyoto Prefecture, a science outdoor learning programme called 'Learning of the Earth' started in 2010 for sixth-grade students, and approximately 5,400 students participated in the programme over 12 years. The Tango Earthquake (1927, M7.3) severely damaged Kyotango City, and the displacement of the Gomura Fault, which caused the earthquake, has been preserved in the city. The Gomura Fault is one of the four sites of the 'Learning of the Earth' programme.

This programme consists of three stages: pre-learning, outdoor learning and post-learning. The study covers several topics, such as topography, geology, environment, weather disasters and earthquakes. Following are the contents of the study of earthquakes: (1) Pre-learning: an overview of the Tango Earthquake; essays by children who experienced the earthquake; the relationship between the distance from the Gomura Fault and the damage. (2) Outdoor learning: earthquake observation facilities; earthquake damage in the dunes; streetscape of the reconstructed district; the displacement of the Gomura Fault. (3) Post-learning: viewing a picture depicting the earthquake disaster; analysing statistical data.

Following the outdoor learning, a child stated, 'When I saw the displacement of the fault, I found that the power of the earth is strong. I hope to become a teacher in the future and teach people about the power of the earth'. He could feel the great power of earthquakes when he saw the fault displacement after learning about the Tango Earthquake in advance. The 'Learning of the Earth' programme incorporates a visit to the Tango Earthquake traces, which is also an effective educational programme for disaster prevention.

Keywords: outdoor learning, science education, disaster prevention education, primary school, earthquake

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Disaster-prevention education assuming low-frequency large-scale volcanic eruptions: Teaching materials for high-school students about the widespread volcanic ash from the Kikai-Akahoya Eruption

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The authors used the widespread volcanic ash [1] that fell over a wide area of Honshu after the eruption of Kikai Caldera in Kagoshima Prefecture during the Jomon period as teaching material for lessons on volcanic disaster prevention for high-school students based on the assumption of low-frequency large-scale volcanic eruptions. The class comprised 95 second-year students in the 'Basic Earth Science' class at a high school in central Hyogo Prefecture, which is located in an area without active volcanoes. We observed pyroclastic materials in the first class, and we observed the Kikai-Akahoya volcanic ash [2] and predicted disasters in the second class. The Kikai-Akahoya volcanic ash is used for several reasons. First, it is the most recent eruption (7300 years ago [3]) among the large caldera eruptions, and it still has the outcrops of fresh volcanic ash layers. Second, it caused tremendous damage to the Jomon culture of southern Kyushu [4], as inferred from the artefacts excavated at archaeological sites (such as the Uenohara site). Third, the volcanic ash from the Tarumi-Hyuga site in Kobe had been collected in 1997 [5] and can be used as teaching material [6].

In the first class, approximately 75% students acknowledged the necessity of knowing the location of volcanoes and predicting triggers to prevent volcanic disasters. After the second class, more students were aware of the disaster caused by the Kikai-Akahoya volcanic ash, where the wind brought volcanic ash fall over a wide area. Among the examples of disasters caused by volcanic ash fall, students may have gained the knowledge of the impact on electronic machinery, agriculture and transportation. Furthermore, approximately 70% students mentioned some actions related to volcanic disaster prevention.

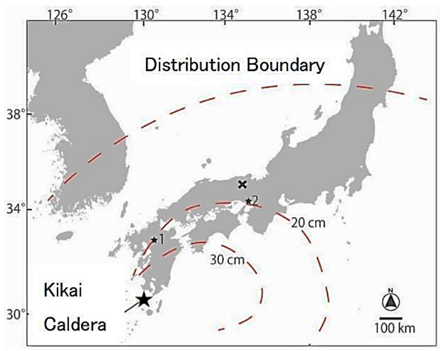

Figure: Thickness distribution map of the Kikai–Akahoya volcanic ash[1]
1, 2: sampling point, x: practice school

In conclusion, we increased the number of students aware of the dangers of volcanic disasters caused by a wind-driven volcanic ash flow from active volcanoes. However, some students do not distinguish between active and other volcanoes in the vicinity, and the authors believe that advancements in these caldera-eruption classes must focus on comprehending disasters caused by falling volcanic ash.

Keywords: disaster-prevention education, widespread volcanic ash, Kikai-Akahoya Volcanic Ash, Jomon period, high-school students

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Research on promoting national resilience through disaster mitigation education for university students

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The project aims to promote national resilience in the intangible aspects by cultivating the ability to contribute to regional disaster reduction at universities, where disaster reduction education is less prevalent, compared to elementary, junior high, and high schools. In order to nurture human resources who proactively engage in disaster mitigation throughout their lives, university students will be asked to discover issues on their own, investigate, discuss, present and summarize the results of them. It is important to expand active learning in which students actively communicate with people inside and outside the university. The followings are some of the specific curricular and pedagogical innovations and achievements we have made in recent years. 1. Hiroshima International University has made disaster mitigation education a required curriculum for all students in all faculties. We created tsunami simulations and evacuation simulations from underground malls in familiar areas and used them in class. In addition, the university has conducted hypothesizing, using Gigapan high-resolution images, field observation[1], and large-scale disaster drills in the disaster-affected areas for those who wish to participate. 2. In the first-year course "Regional development and crisis management" (compulsory; Fig.1), we aimed for a synergistic effect between the improvement of crisis management skills through learning the basics of disaster phenomena, psychology, and primary life-saving measures, and regional development skills from the perspective of the SDGs during normal times. 3. In the "Interprofessional Education: IPE" (compulsory; Fig.1) from the 1st to 4th year, students from health, medical, and welfare departments were mixed together in various scenarios, including disasters. They improved communication skills in IPE I, presentation skills in IPE II, and various medical skills in IPE III. They discussed and worked together to solve various complex problems in a comprehensive manner in IPE IV[2]. 4. Students who wished to do projects were given the opportunity to initiate (Fig.1) on their own. They discussed issues both at the time of disaster and in ordinary time with the residents, therefore students were motivated and acted as facilitators for cultivating elementary, junior high, and senior high school students and residents as disaster mitigation leaders. 5. In addition to training medical professionals such as nurses, licenced psychologists, paramedics, physical therapists, and nutritionists, the program has promoted the acquisition of qualifications such as Red Cross Society First Aid Provider, disaster prevention specialists, and active participation in DMAT, DPAT, DHEAT, and JRAT. As a result, both university students and residents have increased their awareness and practical skills for disaster mitigation. The university also utilized SNS with a high level of disaster mitigation awareness at the time of the large-scale debris flow disaster, miraculously resulting in zero casualties. University students provided various kinds of assistance to the elderly in the affected areas and actively provided practical disaster mitigation education to residents and children. This work was supported by JSPS KAKENHI Grant Numbers JP20H01749, JP20K20850.

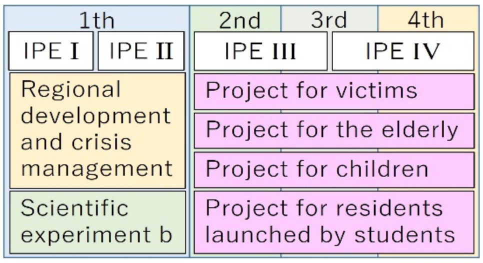

Fig.1 Disaster mitigation curriculum

Keywords: University student, Disaster mitigation education, Finding issues, Facilitator

References:

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Natural Disasters, Social-Natural Resources, and the Resilience of Local Communities: the Case of the Great East Japan Earthquake

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The concept of "resilience" has come to stand in the limelight in many branches of disaster studies, reflecting increasing concerns about global climate change and serious natural disasters. Resilience is discussed in ecology, psychology, anthropology, sociology, and geography, which study natural disasters. In disaster studies, resilience is regarded as the character or ability of the social system formed in the process of interaction between natural environments and local communities. Aldrich defines resilience as "the process of repopulation by survivors and new residents along with the gradual resumption of normal daily routines for those occupants"[1]. The concept of resilience assumes that natural disasters inevitably occur and social systems change consequently. This differs from the way of thinking about disaster prevention and risk reduction, whose purpose is to eliminate natural disasters. Resilience provides a framework for analyzing disaster history as the relationship between local communities and natural disasters, and for scrutinizing the process of reconstruction of local communities after devastating natural disasters.

Local communities are reconstructed after natural disasters by restoring or relocating buildings and infrastructure in which local history, culture, society, economy, social capital, and disaster prevention awareness are combined to facilitate the resilience of local communities. Accordingly, disaster studies need to consider not only natural hazards, but also the social and cultural characteristics of local communities. Rural communities, rather than urban communities, are formed by taking advantage of local natural resources. Therefore, it is important to examine the relationship between the natural environment and society at the scale of the local community.

This presentation aims to examine the resilience of local communities by examining the case of Moune, Kesennuma City, Miyagi Prefecture, after the Great East Japan Earthquake, to promote natural disaster education. The resilience of local communities is effectively understood by examining the process of four stages: the pre-disaster period, evacuation, recovery, and reconstruction [2].

Moune, a typical rural village located on the rias shoreline, had various industries owing to the advantage of local natural resources, such as forestry for firewood, mining for gold, salt making, coastal fisheries, and aquaculture, up to the mid-1940s. After World War II, Moune's industrial structure changed as aquaculture and deep-sea fisheries gained importance, while many villagers came to be employed in service industries in the urban center of Kesennuma City. Furthermore, as motorization proceeded, houses and other buildings often moved to the lowlands, increasing the tsunami hazard risk before the Great East Japan Earthquake occurred in March, 2011.

The tsunami caused by the Great East Japan Earthquake devastated almost all the houses and buildings in Moune. Within a month of the tsunami disaster, the residents agreed and decided to begin a group relocation project, in which the social capital formed in the pre-disaster period and communal living at the evacuation shelter played an important role. The residents selected the hill overlooking Moune Gulf with low tsunami risk for their group relocation project. The Moune Gulf is the heart of daily life activities and the local economy, and is a symbol of the community. In promoting natural disaster education, it is important to focus on the social, cultural, and historical aspects of local communities and social resources, in addition to physical features and natural hazards.

Keywords: resilience, tsunami, Kesennuma City, the Great East Japan Earthquake, regional resources

Reference

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Natural Hazards and Education in East Asia: South Korea

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We face more and more natural hazards due to climate change now. This is worse in Asia regions which locate on the boundary of plate technics, ring of fire. When we talk about natural hazards, most cases of earthquakes, Tsunami, landslide, and more are from Asia regions. When we assume that those natural hazards can be severer than before, we need to stop ruin the Earth where we live and we need to hand over the better environment for future generations. Therefore, it is our responsibilities to make students and citizens to be informed of what those natural hazards are, why those happen, how we can restore them, and how we prevent them in advance to reduce the loss of people and economics. We are not free zone any more from earthquakes (we had over 5 magnitude in Gyeongju and Pohang in 2016) and we are starting to be very concerned about Tsunami since Korean peninsula is surrounded by the ocean. Students learn about natural hazards from K to 12 and the content of natural hazards cover the followings; climatological disaster like typhoon, flood, heavy rain, drought, and heavy snow, and geophysical disaster like earthquake and volcanic activity. Students learn why, when, where those disasters happen, and what kinds of advantages we can get from those natural hazards. However, those contents are covered in social studies or science subjects and those contents deal with common knowledge which doesn't make students feel belongings to the community nor responsibilities to solve those disasters to reduce the loss of people and economics.

At the level of secondary schools, for equipping students with competencies of facing the natural disaster issues, recognizing the problem, and solving the problem, I need to develop the integrated science programs through which students learn scientific concepts related to natural disasters. More than anything else, students learn how to prevent those natural disasters with the use of engineering and technology (which has been called STEAM program). For example, in the case of landslide disasters, students learn retaining wall can reduce the loss from landslides. In the case of Tsunami, students learn what water breaks works to reduce the loss. In the case of earthquake, students learn seismic design to reduce the loss. To use the wave, students become to know that wave energy power plant can be built to generate the electricity as renewable energy to weakening the climate change (Figure 1). More than beyond learning natural disasters by concepts, we need to provide chances for students to apply those concepts in finding out the solution through engineering-based experiments on the basis of scientific concepts. During this process students feel belongings to the community and responsibilities to preserve the earth from natural and human-made disasters. I could say that we need to provide students with chances where students build concepts through science experiments to understand natural hazards and build device through engineering-based experiments to solve the problem.

At the level of higher education at universities, it is very essential for students to be exposed to learn natural hazards. I can suggest different learning strategies where students at groups interact each other to solve the problem. I teach natural disaster course to the sophomore students at my university, and I asked them to use PBL (problem-based learning) approach to investigate frequent and remarkable natural disasters in Korea. Students learn basic concepts of each natural disaster by lecture with the examples from well-known cases in Asia mostly with the following orders; (1) science helps to predict the coming natural disasters, (2) Systematic evaluation of natural disaster risks can help to make appropriate decisions. (3) All-natural disasters are inter-related. (4) Human being activities can turn light disasters into severe ones. (5) Disaster damage can be reduced. Students learn concepts of 10 different natural disasters and they were assigned the project to work in a group to apply the concepts from the lectures to the national ones, Korea case. I picked the most 5 paid attention natural disasters and students need to complete their tasks with the following orders; (1) frequency and damage of the selected natural disasters in the last 5 years in Korea, (2) scientific reason why that disaster happens in Korea, (3) additional disasters accompanied by the selected disaster, (4) the damage of the disaster had been restored? How fast? How? (5) the way of how to prevent the disaster with the use of science and technology. (6) my personal opinion after this task.

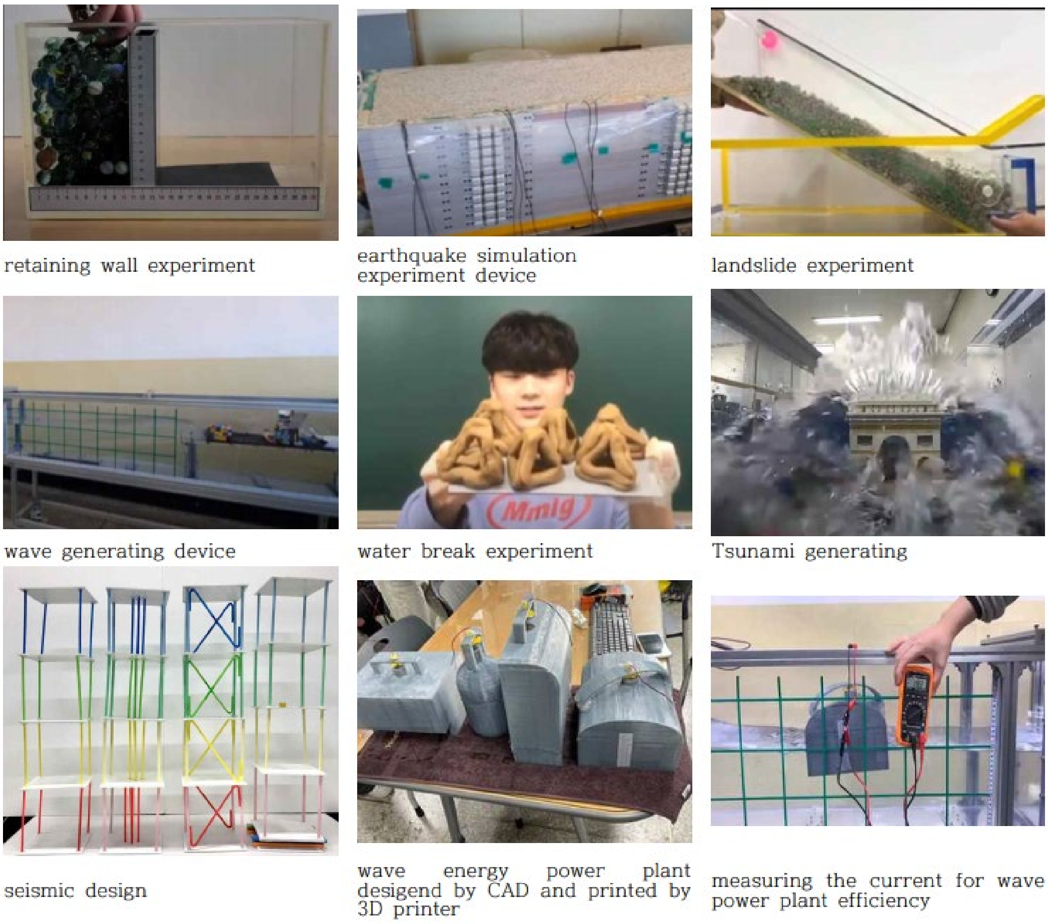

Figure 1. Engineering-based experiment for the natural hazards learning

University students used PBL approach to complete the task for each disaster assigned during the semester. The point for higher education is aiming for students to investigate the information to be shared to recognize the issue, collect the information, analyze the information, carry out the experiment if needed, interpret their results, and conclude to imply in natural disaster education. Students showed their opinions that they really learned natural disasters through investigating Korean cases on the basis of their learned knowledge through the lectures. Students were motivated to solve the problem when they shared the sympathy arisen from their own community cases.

From the examples of natural hazards education in secondary education and higher education being carried out by my research team, I can conclude the following for natural hazard education. Engineering-based experiment is pivotal for students to be equipped with competencies of applying the concepts to find the solution. Students experience scientific thinking during scientific experiment to understand its principles and they also experience computational thinking during engineering-based experiment to find out the solution. Also, students must be trained to communicate and collaborate each other to solve the problem to make decisions in selecting most efficient solutions logically. Who can reduce the damage and loss of people and economics from natural disasters? They must be 'we'. Students from the early stage to higher education need to be trained to be equipped with competencies for saving the earth from the disasters.

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Disaster Education in China

- Taking Disaster Education in Geography Curriculum as an Example

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Introduction

China has traditionally attached importance to disaster education, which is implemented at the primary, middle and high school levels. The national curriculum organizes disaster education content according to the occurrence of natural disasters in China and students' cognitive developmental characteristics. Textbooks convey systematic and universal disaster knowledge, and provide realistic regional environment for students to observe, investigate, and predict disaster problems by providing actual disaster cases and inquiry activities and presenting disaster situations with information technology. Primary and secondary schools widely carry out various practical activities of disaster prevention and mitigation education, and focus on improving students' disaster prevention, mitigation and relief capability.

Disaster education in the Chinese national curriculum

China has traditionally attached importance to disaster education, and disaster education has been set up in primary, middle and high school levels.It is organized according to the occurrence of natural disasters in China and students' cognitive development characteristics (see Table 1), focusing on improving students' disaster prevention, mitigation and relief capability and establishing a scientific view of disaster.

The Chinese elementary school science curriculum includes four areas: Material Science, Life Science, Earth and Cosmic Science, Technology and Engineering. In the area of Earth and Cosmic Science, students learn that "human survival requires defense against various disasters and human activities affect the natural environment".

There are five themes in the Chinese junior high school geography curriculum:Earth's Cosmic Environment,Earth's Movement, Earth's Surface, Recognizing the World, and Recognizing China. The disaster education in the national curriculum at this stage is set in "Recognizing China" of the geography curriculum.

The Chinese senior high school geography curriculum is divided into three types of courses: compulsory curriculum, optional compulsory curriculum and optional curriculum. The compulsory curriculum consists of two modules, namely Geography 1 and Geography 2. The optional compulsory curriculum consists of three modules, namely Fundamental of Physical Geography, Regional Development, Resources-Environment and National Security.The optional curriculum consists of nine modules, namely Fundamental of Astronomy, Marine Geography, Natural Disaster and Prevention, Environmental Protection, Tourism Geography, Urban and Rural Planning, Political Geography, Geographical Information Technology Application, and Geography Field Practice. Disaster education in the national curriculum at this stage is set in the compulsory curriculum Geography 1 and the optional curriculum Natural Disaster and Prevention.

Table 1 Content setting of disaster education in Chinese national curriculum

Stage	Course Location	Content requirement
Elementary School Science Curriculum	Earth and Cosmic Science	Grade 3~4: Understand the impact of typhoon, flood, drought and other meteorological disasters on human beings. Grade 5~6: Understand the impact of natural disasters such as earthquake and volcanic eruption on human beings, and know the basic knowledge of earthquake and disaster prevention.
Junior High School Geography Curriculum	Topic Five Recognizing China	Describe the major natural disaster and environmental problem in China using maps and relevant information. Make reasonable recommendation for the prevention of a natural disaster or environmental problem. Acquire certain safety and protection skills for meteorological and geological disaster.
Senior High School Geography Curriculum	Compulsory Curriculum Geography 1	1.11 Use information to explain the causes of common natural disaster and understand measures to avoid and prevent disaster.
		1.12 Explore issues related to physical geography and understand the application of geographical information technology .
	Optional Curriculum Natural Disaster and Prevention	3.1 Describe the types of natural disasters and their impact on human beings.
		3.2 Explain the causes and hazards of geological disasters such as earthquake, mudslide and landslide.
		3.3 Analyze the causes and hazards of typhoon, cold wave, drought, flood, storm surge, and other meteorological disasters.
		3.4 Give examples of the hazards of biological disaster such as insect and rodent infestation.
		3.5 Give examples of the effects of human activities on natural disaster.
		3.6 Describe the spatial distribution of the world's major natural disasters and compare the geographical differences in the degree of damage caused by the same natural disaster using geographical information.
		3.7 Describe the environmental characteristics of natural disaster-prone areas in China with examples.
		3.8 Describe the precursors and methods of forecasting the outbreak of certain natural disaster with examples.
		3.9 List appropriate responses or emergency measures, using a natural disaster such as earthquake.
		3.10 Describe the use of geographical information technology in natural disaster prediction, monitoring and assessment.

Disaster education in Chinese geography textbook

The content of disaster education in Chinese senior high school geography textbooks covers meteorological disaster, marine disaster, geological disaster, and biological disaster. The topics and educational objectives of disaster education are shown in Table 2.The textbook conveys systematic and universal disaster knowledge and deepens students' disaster awareness by explaining the causes, characteristics, hazards, and spatial distribution of meteorological, marine, and geological disasters. By providing actual disaster cases and inquiry activities (see Figure 1), students develop the ability to acquire disaster information and argue disaster problems, stimulate individual disaster awareness, and enhance their consciousness and action of disaster prevention.By presenting disaster situation with information technology (see Figure 2), such as Virtual Reality Technology, Remote Sensing maps, schematic diagrams, and comparison maps, textbook can visually represent natural disaster situation and human initiatives to cope with natural disaster, providing a real environment for students to learn to observe, investigate, and predict disaster problems, and form a disaster concept of harmonious coexistence between human beings and nature.

Table 2 Content topics and objectives of disaster education in textbook

<table>
<tr><th>Topics</th><th>Types</th><th>Educational Objectives</th></tr>
<tr><td rowspan="2">Meteorological Disaster</td><td>Typhoon</td><td rowspan="7">(1) Holistic thinking: analyze the causes of a natural disaster; propose measures for disaster prevention and mitigation.
(2) Regional cognition: use geographical information technology to analyze and summarize the characteristics of the spatial and temporal distribution of common natural disasters in China.
(3) Human-environment relationship: understand the hazards of natural disaster to human survival and development; understand the man-made causes of disaster objectively; view the relationship between the natural environment and human activities dialectically, and establish a scientific view of disaster.
(4) Geography praxis: Use geographical tools to obtain and process information on natural disaster; investigate and probe the impact of natural disaster on human production and life; use geographical information technology to observe geographical phenomena and predict natural disaster.</td></tr>
<tr><td>Flood</td></tr>
<tr><td rowspan="2">Marine Disaster</td><td>Storm Surge</td></tr>
<tr><td>Algal bloom</td></tr>
<tr><td rowspan="3">Geological Disaster</td><td>Earthquake</td></tr>
<tr><td>Landslide</td></tr>
<tr><td>Mudslide</td></tr>
</table>

Figure 1 Inquiry activities in the textbook

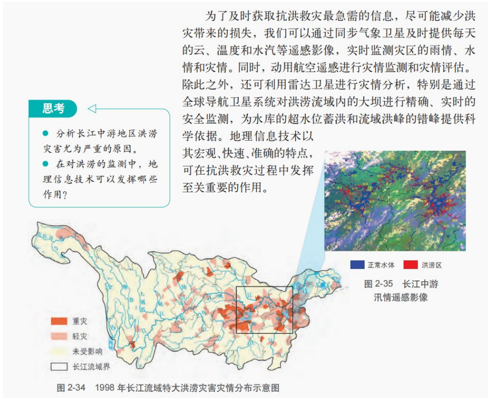

Figure 2 Remote Sensing map in the textbook

Practical activities in disaster education

In order to deeply implement the disaster education purpose, focus on improving the students' ability to prevent natural disaster, minimize casualties and property damage caused by disasters, and ensure the safety of teachers and students and campus stability, Chinese primary and secondary schools widely carry out various forms of disaster prevention and mitigation activities. For example, Beihai Second Middle School organized all teachers and students to carry out earthquake emergency evacuation drills, by simulating the arrival of the earthquake scenario and field exercises. Schools guide students to understand the knowledge of survival in the event of a flood,combing with flood safety work, flood prevention, flood emergency drills and drowning safety first aid drills, etc.

Keywords: disaster education; Chinese national curriculum; geography textbook; practical activities in disaster education

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Overview of Disaster Prevention Education in Taiwan

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The World Bank's "Natural Disaster Hotspots: Global Risk Analysis" shows Taiwan has the highest natural disaster mortality risk in the world, with more than 90% of its land and population exposed to three or more natural disasters [1]. Among the natural disasters, earthquakes, typhoons, floods, landslides, and fires, are the most serious. In order to improve the disaster prevention literacy of students and the public, the Ministry of Education of Taiwan has included disaster prevention topics in the curriculum outline [2] to cultivate a positive attitude towards disaster prevention and further strengthen the public's ability to respond to disasters to improve society's overall resilience and reduce the losses caused by disasters.

Since 2003, various official institutions in Taiwan have continued to promote a number of disaster prevention education programs and established a complete disaster prevention education promotion and supporting mechanisms [3-7]. For example, educators have developed a variety of localized disaster prevention teaching and teaching materials, established a seed teacher training mechanism for disaster prevention, cultivated the foundation of disaster prevention campus construction, and expanded publicity results. Educators also formulated an effectiveness evaluation mechanism and confirmed changes in improving students' disaster prevention literacy. Disaster prevention education has also initiated diverse and innovative teaching methods, materials, and assessments from the bottom up. In the course, teachers use the inquiry learning method to allow students to explore disaster problems, find the causes of disasters from the surroundings, and further explain feasible solutions. Teachers use technology to assist learning, such as augmented reality, virtual reality, and digital games showing disaster situations, so that students can learn and implement contingency measures and examine the results. In addition, through board games, students are immersed in playing an important disaster prevention organization and roles and cooperating in disaster prevention to protect life and property. Other outdoor activities include teachers taking students to disaster reserves that have been hit hard by disasters so that they can feel and understand the destructiveness of disasters and then have a sense of facing disasters. The Ministry of Education regularly promotes nationwide teacher training to develop the knowledge and ability of disaster prevention educators [8,9].

In order to test the effectiveness of disaster prevention education, the Ministry of Education issued the Disaster Prevention Literacy Test Manual for schools to assess students' disaster prevention literacy [10]. The evaluation results show that both students and teachers have positive disaster prevention values and concepts, but the attitude scores of undergraduate students are lower than middle school students; the possible reason for the results is that the opportunity for everyone to notice disaster prevention courses is low and has been ignored [11-13]. Since 2019, in conjunction with schools and communities, the Ministry of Education has promoted "2.0 Disaster Prevention Education,". With independent disaster prevention as the core, this new disaster prevention education model aims to strengthen cross-ministerial cooperation based on catastrophe scenarios. Through the realistic technology experience and advanced disaster prevention technology, the public will be able to effectively improve disaster prevention awareness and disaster prevention knowledge, strengthen the school's ability to adapt and recover after a single natural disaster or a complex disaster, implement the construction of localized disaster prevention campuses, and expand the formation of disaster prevention campus networks.

Keywords: Taiwan education, Disaster prevention education, Situation-based teaching, ICT-integrated teaching, Disaster prevention literacy

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