Session 5: Innovation in Education

https://doi.org/10.1017/S1743921321000922 Published online by Cambridge University Press

Education and Heritage in the era of Big Data in Astronomy
Proceedings IAU Symposium No. 367, 2020
R. M. Ros, B. Garcia, S. R. Gullberg, J. Moldon & P. Rojo, eds.
doi:

Introduction

Boonrucksar Soonthornthum was invited to discuss "Strategies on Astronomy Education in the Era of Digital Transformation" and opens this section. He stresses the uses of astronomy literacy and data intensive astronomy in the support of astronomy education. He continues about how big data astronomy plays an important role in school and higher education. A focus to increase astronomy literacy is to promote astronomy on an even wider scale with regional and inter-regional collaboration.

After the presentation Paulo Bretones asked:

Let me know about not only careers in astronomy research, but also about education studies. Do you have contact with people of the education field with whom you are promoting studies about curriculum, evaluation, learning, and the teaching process? Do you have any contact with colleagues in this area?

Boon answered:

Yes, as I show here is a slide on "A strategy to disseminate 'Astronomy Education' through 'School network' in Thailand". We have delivered 10-inch Dobsonian telescopes, which were built in Thailand, with intensive training, to 460 schools in 76 provinces in Thailand. So, now, we have a very strong school network, actually, in Thailand. We also organized teacher's training programs in 3 levels: basic, intermediate, and advanced. We provided teachers with astronomy education materials for schools all over Thailand. Since we are an "IAU Southeast Asia Regional Office for Development (IAU SEA ROAD), we extend teachers' training activities for teachers in the Southeast Asia. As Thailand also been appointed as an "International Training Centre on Astronomy (ITCA) under Auspices of UNESCO", we can extend these activities to more regions in the world, especially Africa and South America.

Paulo continued:

Yes, yes very interesting. I knew that you have offered Master's or Ph.D. degrees in astronomy and about the specific contents regarding astronomy research. I asked you that if you also have a postgraduate program in education or sociology or psychology. Do you have any connection or contact with these people in the universities where you combine astronomy with education, sociology, psychology etc. in order to be able to go in depth about teaching and learning and how teachers reflect about astronomy education.

and Boon replied:

Yes, we do, and we also know the importance of astronomy education for research and realize how important it is to use "STEAM education" to promote astronomy education. We now have several collaborations with faculties and universities in Thailand, especially Chiang Mai University, to promote astronomy education and astronomy education research. We hope to extend more collaborations on astronomy education and research to other universities internationally.

Rosa M. Ros, Beatriz García, Ricardo Moreno, Mahdi Rokni, and Noorali Jiwaji described "NASE workshop: Eclipses and Gravitational Lenses." Their article describes how astronomy can be used to inspire interest in science in general. They describe the nature of the IAU's Network of Astronomy School Education (NASE) program and its contributions, using as an example eclipses that have fascinated the public as well as that of gravitational lensing.

Following the presentation Devendra Bisht asked:

It's an extraordinary way to teach Astronomy. How to download the materials and where?

Rosa answered:

The materials presented here are in NASE website http:nasepreogram.com. At present NASE web page has 16 subpages with the information of the courses in the different languages in which the course is given. All materials are in English, Spanish, Portuguese, French, Romanian, Mandarin Chinese and Persian. We are working on the translation of the basic book and / or the ppt for presentation such as Russian, Indonesian, Japanese, Armenian, Mongolian, Kiswahili, Greek and Catalan. In addition, in this moment, we are beginning to translate to, Hungarian, Cantonese Chinese, Thai, South Korean and Arabic.

Anahí Caldú asked:

Georg, thank you very much for the nice talk and to all the Stellarium team for such a great work! I imagine everything is done in a voluntary way? Is it possible to raise funds somehow to hire more developers?

Rosa then invited Noorali to explain the interest to translate NASE materials:

Noorali continued:

Yes, we are translating to Kiswahili then we can open up to many more teachers in the country than just handling English. There are some difficulties of a lack of scientific vocabulary but it is an interesting help for teachers.

Paula Chis commented:

The great interest that NASE has in giving the courses in the languages of the country, that in Romania most teachers do not handle English easily and that by having the ppt translated and the books with all the NASE contents are very useful and teacher use in many secondary schools.

Beatriz Garcia replied :

There were lot of congratulations and greetings from different countries and people. She continued that it should be mentioned that the videos used within the training course are silent so that the instructors can explain them in the language of the country and adapt them to the corresponding latitude and cultural context. Thus in the experiments simple materials are used to get in that place, or with typical toys of the place …

The article that follows is one called "A HOLOtta Fun: Explaining Astronomy with 3D Holograms" by Anne Buckner. Anne stresses the value of using 3D holograms instead of 2D images for outreach and describe how this can be done with anyone's virtual presentations. Such can be useful for explaining complex topics in an easy-to-understand manner in less formal public talks. Explanation and direction is given.

After Anne's presentation Mary Kay Hemenway asked:

Please share hologram link from end of talk in chat.

and Anne provided:

https://youtu.be/Xv7YH-y7UzQ

Raphaël Peralta asked:

Do you have instructions for building bigger holograms ?

Anne answered:

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Yes for larger holograms you use the same videos but (1) choose a large screen and (2) scale up the perspex pyramid. For the 60inh screen the scaled up pyramid needed structural support as it was heavy but for unto 40 inch screens the pyramid doesn't need supports. Here is a template for smaller ones (just scale measurements with screen size): https://www.bealsscience.com/post/2016/02/15/3d-hologram-projector-for-you-phone-or-tablet

This link is better as it gives measurements! https://www.johnnosscience.com/make-a-holo-projector.html

For very large screens using acrylic sheets rather than think plastic sheets would be better for structural integrity

For the 60@ my acrylic sheet was 6mm thick, for 32 inch it was 2mm thick. I think uptown about 20 inches thin acetate sheets should be fine to make it

Priya Hasan and Najam Hasan contributed "Astronomy Data, Virtual Observatory and Education." The authors begin by discussing that virtual learning is valuable in astronomy, both synchronously and asynchronously. They discuss their work and give as example several projects. They then present lessons learned from their project for others to use in the future.

"Real data for Astronomy class in the college and University" was written by Ilhuiyolitzin Villicana Pedraza, Francisco Carreto Parra, and Julio Saucedo Morales. Through this the authors talk about how astronomy education can be used to inspire people to study other sciences as well. They also relate that students with this exposure that do not enter STEM fields will often continue to support astronomy and space sciences no matter where they are. They provide examples in support.

"IBSE-Type Astronomy Projects Using Real Data" by Fraser Lewis talks about Inquiry-Based Science Education (IBSE) activities employing resources from the National School's Observatory and the Faulkes Telescope Project. Both provide free access to 2-meter robotic telescopes and the described activities are designed to be projects for students that are teacher-free.

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Strategies on Astronomy Education in the Era of Digital Transformation

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Abstract. Two important strategies on astronomy education in the era of digital transformation proposed on this presentation are the uses of "Astronomy Literacy" and a "Deep Learning" through "Data Intensive Astronomy" to support astronomy education.

Astronomy literacy can create several thinking skills to young generation and public for promoting human capacity buildings on science and technology.

Nowadays, the astronomical data archives are impressively large and the "digital age" has made it easy to make the data available to astronomers, researchers, under graduate and graduate students and even to publics. Big data in astronomy has then played an important role in astronomy education both in higher education and school education. Astronomers and researchers can access "big data" for the deep learning through data intensive astronomy on their research works and school students and publics.

We hope to extend these strategies through regional and inter-regional collaboration to promote astronomy education in wider scale.

Keywords. astronomy education, digital age, astronomy literacy, deep learning.

1. Introduction

To promote "Astronomy Education" thoroughly to all regions across the globe, the IAU has emphasized astronomy education as one of the major key roles in the IAU Strategic Plan 2020–2030. In 2019, IAU has established the "Office of Astronomy Education (OAE)" (Fig. 1) and the "IAU Commission C1: Education and Development" will serve as a driving force and a crucial mechanism of the IAU to support the plan and action of the OAE on astronomy Education.

At present, we have already been in the era of the "Digital Transformation". Most people learn how to utilize digital technologies on their livings to adapt themselves to a drastically change in their careers on the quick flow of the digital technologies (Fig. 2).

Astronomy activities have also to be modified and adapted from the traditional ways to the new normal ways through the applications of the digital technologies especially in the unprecedented difficult period of the "COVID-19" pandemic or even in the "Post-COVID" time. Digital technology will become a powerful tool to serve our regular activities eg: conferences, symposia, schools and workshops etc. and digital network solutions will enable new types of creativities and innovations.

Astronomy is one of the oldest sciences which has strongly driven curiosities, passions and inspirations of young generations and publics. Therefore, a strategy through astronomy education for promoting "Human Capacity Building (HCB)" and "Human Resource Development (HRD)" in science and technology can be driven through "**Astronomy**

Figure 1. IAU strategic plan and the Office of Astronomy for Education.

Figure 2. Digital transformation and global digital network (Zaki 2020).

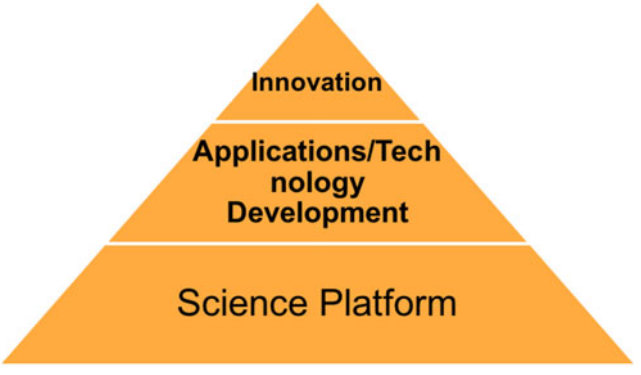

Figure 3. A strong science platform to support applied sciences and technology development to build innovation.

Literacy" eg: teacher trainings, school student trainings etc. eg: teacher trainings, school student trainings etc.

Astronomy requires students to learn several disciplines espeacially Physics, Mathematics, Statistics, other branches of science and engineering to understand deeply on the mysteries of the universe. Therefore, astronomy has led to novel and innovative questions of the universe which requires a "**Deep Learning**" especially the use of "**Data Intensive Astronomy**" as a second strategy on promoting astronomy education. And finally, a strong "**Science Platform**" can be established to support another "**applied sciences**" and "**technology development**" which lead to the final goal of building "**Innovation**" (Fig. 3).

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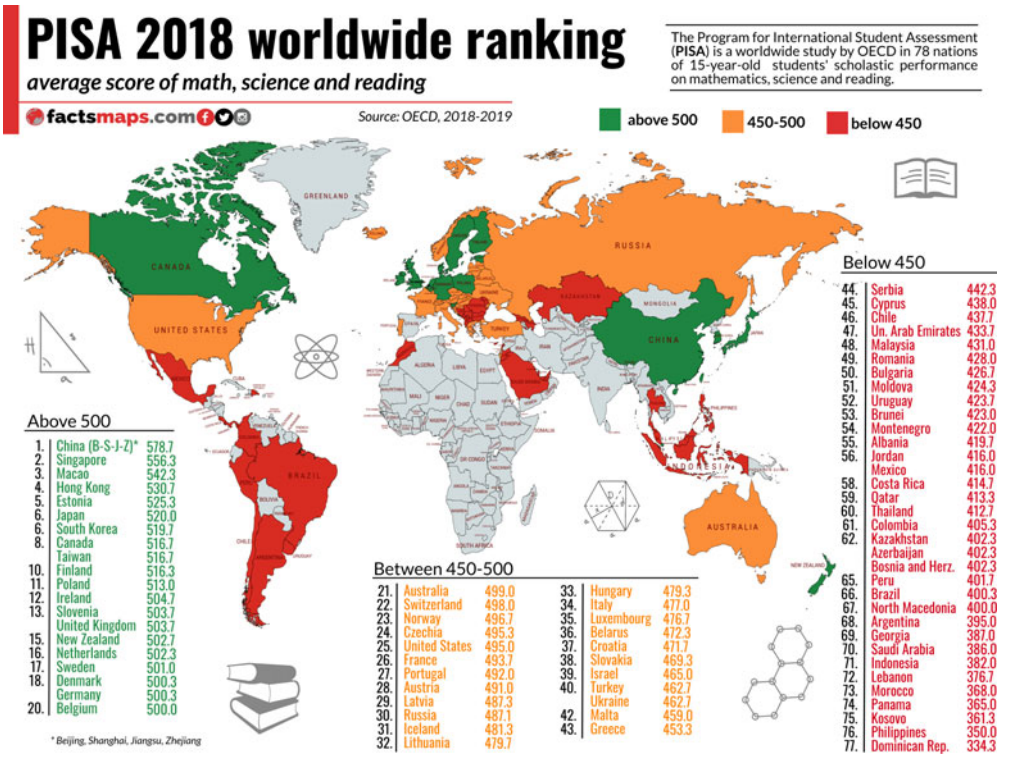

Figure 4. PISA 2018 worldwide ranking (OECD).

2. Astronomy Literacy as a driver of human capacity buildings

Astronomy education through the mechanism of astronomy literacy can be used as a powerful driver for human capacity buildings in science and technology.

Astronomy literacy is one of the powerful tool to promote several thinking skills eg: critical thinking, logical thinking, systematic thinking, analytical thinking etc. of the young students and publics.

The "Programme for International Student Assessment (PISA) worldwide ranking is one of a tool for international student assessment which is used widely in Thailand and several countries to help in evaluating and improving thinking skills on science, mathematics and reading for school's students. Although many people believe that this assessment would help to promote the development on science literacy skills in the country, but there are still some queries on how this pre-designed test would fit well with education culture in every country. Therefore, PISA worldwide ranking may still be insufficient for overviewing knowledges and thinking skills of young students in the country. Astronomy literacy can be one of a vital tool to support the development on knowledges and thinking skills for students.

Figures 4 shows a PISA 2018 worldwide ranking in 79 countries (en.wikipedia.org) in the world.

Teacher trainings and student trainings in astronomy are the activities used for human resource development and human capacity buildings through astronomy education. The "on-site communications" on trainings, workshops, schools can be effectively replaced by "on-line communications" during the COVID-19 pandemic (Fig. 5).

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Figure 5. Transformation from teacher "on-site" training to "on-line" training.

3. An example in using a strategy to create a school network and disseminate "Astronomy Education" in Thailand

The National Astronomical Research Institute of Thailand (NARIT) is a national institute under the Ministry of Higher Education, Science, Research and Innovation with a main mission to promote research, education and outreach in science and technology using astronomy.

For driving a country-wide astronomy education, NARIT has initiated the "school network" since 2015 by delivering the home-made 10-inch Dobsonian telescopes and learning materials to selected schools throughout Thailand with the intensive trainings (Fig. 6). At present, NARIT has distributed 460 telescopes to 460 schools in 76 provinces in Thailand. The schools become a strong network to co-organize astronomy activities, either on-site or on-line, with NARIT.

NARIT has been endorsed by the IAU since 2012 for hosting a "Southeast Asia Regional Office of Astronomy for Development (SEA ROAD)" and also endorsed by the UNESCO to be an "International Training Centre in Astronomy(ITCA)". So, we can extend both regional and inter-regional collaborations to cooperate and support astronomy education in an international level (Fig. 7).

Commission C1 initiates several working groups which expected impact on astronomy education in a global scale. Thailand, through NARIT, has some opportunities to cooperate with Commission C1 organized astronomy education activities which gave a broad impact in enhancing astronomy literacy and human capacity buildings in Thailand. NARIT hosted a Network for Astronomy School Education (NASE) workshop during 21–24 May 2019 and there were 38 teachers from NARIT's schools network joined NASE courses and brought some projects and materials for teaching in schools.

NARIT had also opportunity to join a first "Astronomy Day in Schools" during 10–17 November 2019. There were132 schools with 45,970 participants involved in "Astronomy Days in Schools" program in Thailand. The Astronomy Day in Schools initiative is an

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Figure 6. A home-made 10-inch Dobsonian telescope and the distribution to the school network with intensive training by NARIT.

IAU100 Global Project with the vision of mobilizing and disseminating astronomy activities in schools. The most popular astronomy education activities involved: 1) Lectures related to Astronomy Topics 2) Astronomy Exhibitions 3) Day and Night Observations. This will bring a good opportunity for students to directly interact and engage with astronomers in their communities, and learn about the important role of astronomy in our daily lives which is a very important strategy in promoting astronomy literacy for young students in schools.

During the COVID-19 pandemic, NARIT had joint with the IAU Commission C1 organized the "2nd NASE Workshop", on-line, in Thailand during October 17-18, 2020 with 130 teachers participated (Fig. 8).

NARIT also co-organized the "Astronomy Day in Schools", on-line, during the event of the "Great Total Solar Eclipse" in Argentina on December 14, 2020 and there were 180 schools participated on this activity. Moreover, a webinar on "A Dialogue on the Role of Astronomy in the COVID-19 Era" was organized with the IAU OAD on August 25, 2020 which the digital communication has played an important role in replacing the regular on-site activities.

4. Deep Learning: Data Intensive Astronomy for Education

The "Deep Learning" through "Data Intensive Astronomy" is one of the proposed strategic goals in astronomy education for human capacity buildings on Science and Technology. NARIT creates a "University Network" with many universities in Thailand and abroad to collaborate on astronomy research and education. NARIT's researchers has now worked closely with university academic staff to supervise both undergraduate and graduate students using observational data collected from the 2.4-m Thai National Telescope, the Thai Robotic Network Telescope and the 40-m Thai National Radio Telescope including the observational data from NARIT's international collaborative network projects such as Gravitational Wave Optical Transient Observers (GOTO) project, Jiangmen Underground Neutrino Observatory (JUNO) project and Cherenkov Telescope Array (CTA) project (Fig. 9).

The use of those massive observational data collected at the Data Archive Center at Princess Sirindhorn AstroPark (NARIT's Headquarter) under co-supervisions between NARIT's researchers and the university academic staff, the graduate and undergraduate students from many universities in Thailand and abroad have the opportunities to

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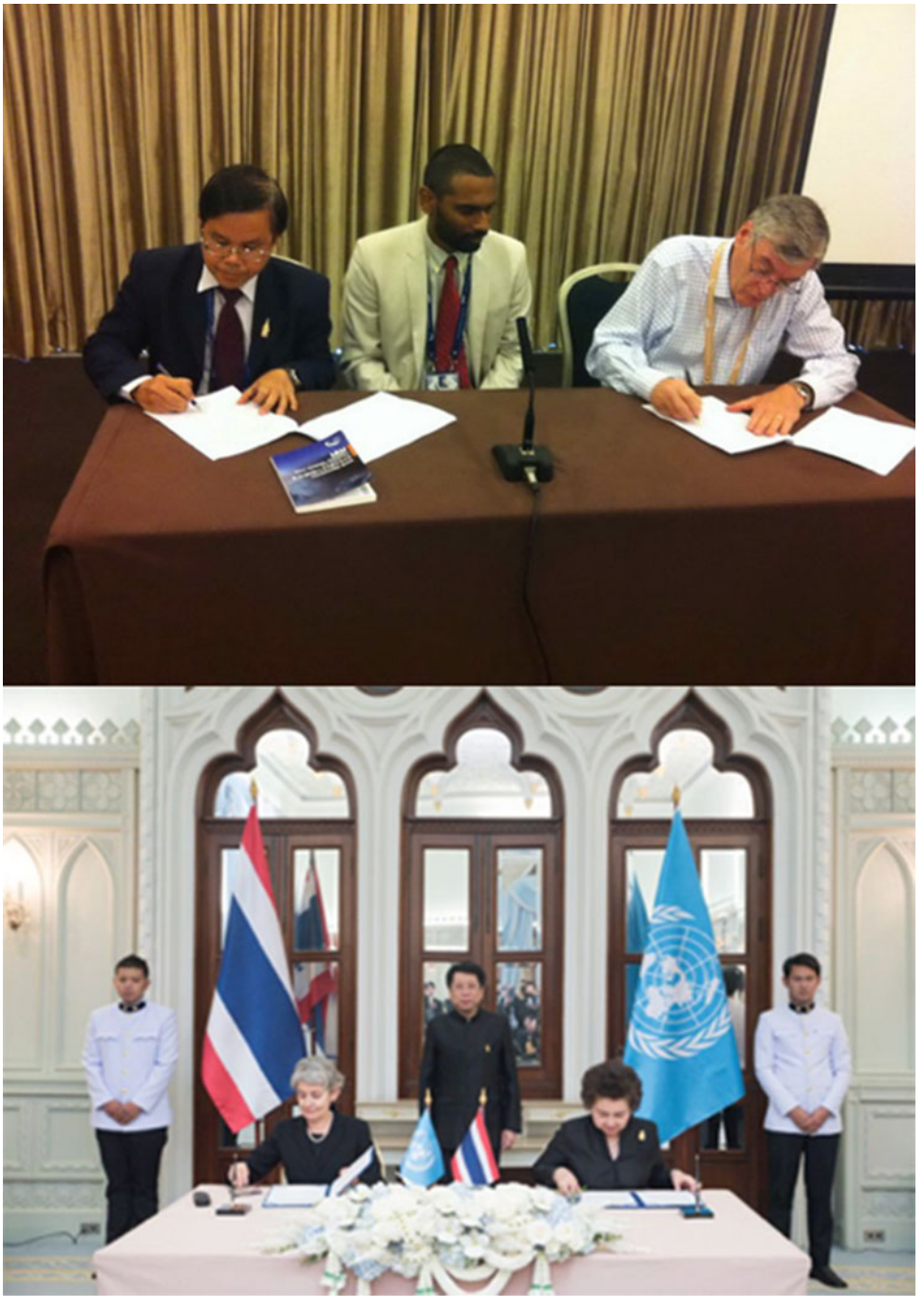

Figure 7. MoU signings for SEA ROAD and ITCA of NARIT.

access through the varieties of massive observational data. Therefore, the data intensive learning through a High -Performance Computing (HPC) cluster at NARIT's headquarter (Fig. 10) can support vitally for the graduate and undergraduate student's projects. We also use data intensive astronomy as a tool for preparing the 21 Century skills for

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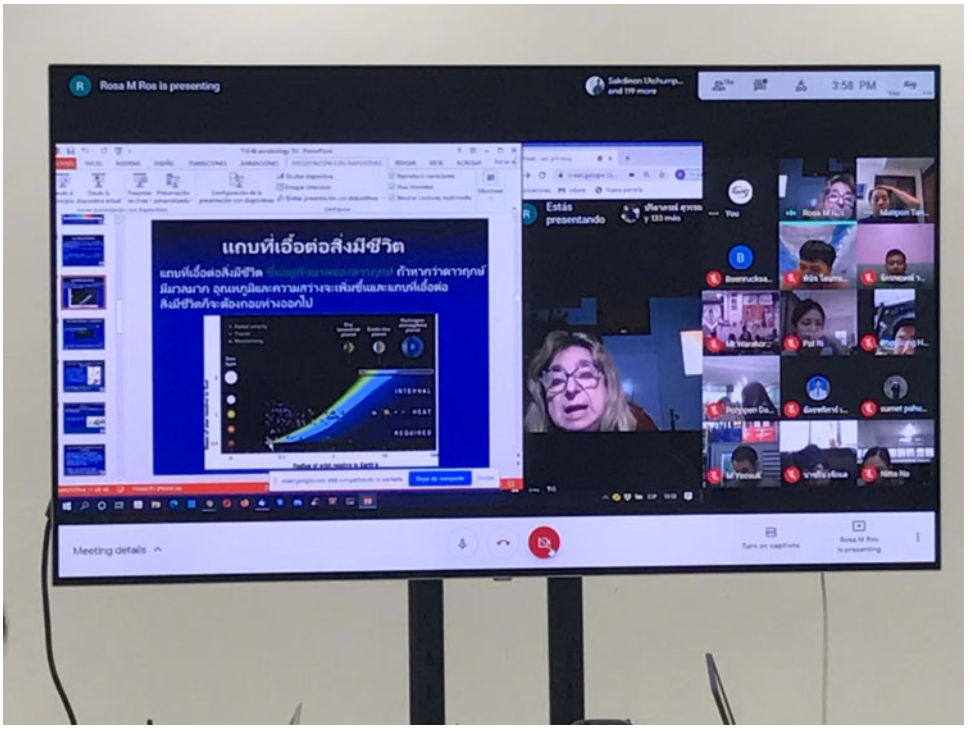

Figure 8. NARIT co-hosted with the IAU on the on-line NASE Workshop.

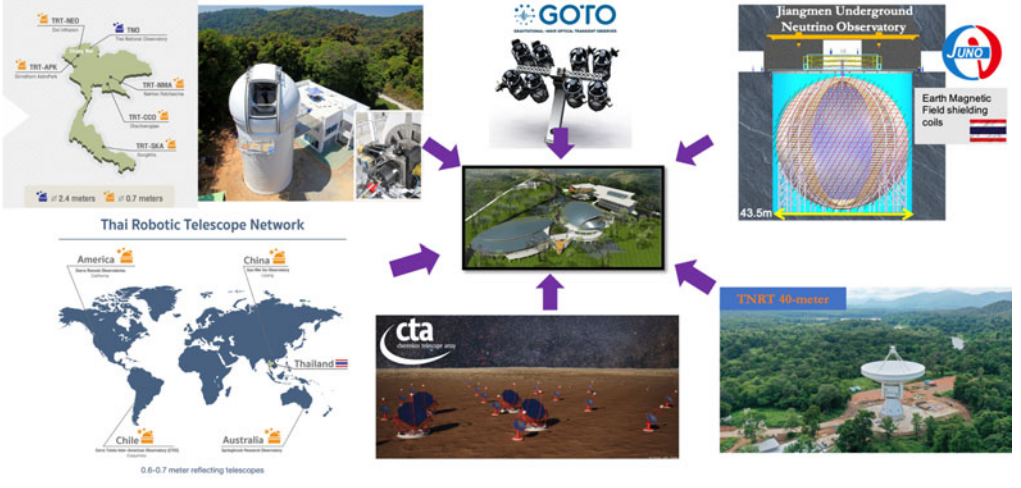

Figure 9. Data Intensive Astronomy for Education.

students, early career researchers through trainings, workshops and conferences on big data, data pipelines reduction and analysis, machine learning, artificial intelligence etc.

5. Conclusion

IAU Commission C1 is an important mechanism of the IAU under Division C to support the OAE, OAD and the OAO in nurturing and driving activities through astronomy education.

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Figure 10. A High-Performance Computing (HPC) cluster at NARIT.

Several activities performed under Commission C1 working group such as activities under AstroEdu and NASE working groups etc. have been performed successfully and deserved to be continued. The OAE has been established since 2019 and subsequently has created National Astronomy Education Coordinators (NAECs) in many countries and continents. Therefore, an important mission of Commission C1 in the next few years (2021–2024) is also to support and promote several educational activities through the network of NEACs such as a promotion on Astronomy Education Research (AER), a project on preservation, digitization and access of publications of astronomy education, outreach and historic documents through the regional and inter-regional collaboration. Through the "International Training Centre in Astronomy (ITCA)" under auspices of UNESCO and the "IAU Southeast Asia Regional office of Astronomy for Development (IAU SEAROAD), the initiative of astronomy education activities through an international, young astronomy ambassador scheme on astronomy education and the

https://doi.org/10.1017/S1743921321000922 Published online by Cambridge University Press

collaborative activities on astronomy education for diversity, equity and inclusion are also planned.

The strategies of disseminating "astronomy literacy" for publics and building up career paths of human resources by providing a 21st century skills using "data intensive astronomy" can be a powerful driver for the future "astronomy education" in digital era. The astronomy activities regarding these 2 strategies should be concretely implemented and evaluated through the astronomy education research to show the impact of the strategic plans and their implementations. We plan to extend the activities on astronomy literacy and data intensive astronomy for education to promote human capacity buildings and human capitals in science and technology also through regional and inter-regional collaboration to support the fulfillment of the IAU Strategic Plan 2020-2030.

References

Zaki, T.2020 How your business can succeed in a digital transformation project, Information/age, Editor's Choice, https://www.information-age.com/how-your-business-can-succeed-digital-transformation-project-123488683/

OECD, 2018–2019 PISA 2018 Worldwide Ranking-average score of mathematics, science and reading, FactsMaps, Editor's Choice, https://factsmaps.com/pisa-2018-worldwide-ranking-average-score-of-mathematics-science-reading/

https://en.wikipedia.org/wiki/Programme_for_International_Student_Assessment

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