

COMMISSION C1

WG FOR ASTRONOMY EDUCATION RESEARCH AND METHODS (AERM)

CHAIR

Urban Eriksson

CO-CHAIR

Akihiko Tomita

CO-CHAIR

Robert Hollow

ORGANIZING COMMITTEE

Urban Eriksson, Akihiko Tomita,

Robert Hollow

TRIENNIAL REPORT 2018-2021

1. Introduction

On 22nd August 2019, the IAU Commission C1 approved the WG for AERM based on the proposal submitted by the chair and co-chairs above. Building on the successful work of the previous WG for Theory and Methods in Astronomy Education, the WG for AERM will have three main foci, in accordance with the proposal and decision made by the IAU Commission C1:

- (a) Astronomy Education Research (AER, Urban Eriksson chair)
- (b) Teachers and Educators Training (TET, Akihiko Tomita chair) and,
- (c) Astronomy Literacy and Curriculum Development (ALCD, Robert Hollow chair).

This report is structured as such that it starts with the common activities done by the WG and then the three sub-groups report individually on their work.

Due to many factors, the WG has had a slow start, mainly because of the delay of the formal decision of creating the WG and then the Covid-19 pandemic preventing us from performing and prioritizing the WG activities and tasks.

However, from the below it is clear what the WG has done. There have been several major activities that the work by the WG has led to, for example, the first Astronomy Education Conference, the new international Astronomy Education Journal, and the Astronomy day in School. Each one is described below.

2. Common activities

2.1. *the First Astronomy Education Conference: Bridging Research & Practice*

After some years of preparation, we organized the first conference/meeting under IAU Commission C1 on Astronomy Education. It was held 16th-18th September 2019 at ESO/Supernova planetarium in Garching, Germany (<https://iau-dc-c1.org/astroedu-conference/>).

Three invited keynote speakers, many oral presentations and poster presentations, covering all areas of astronomy education, made the conference a success! The visit and talk by the IAU President Ewine van Dishoeck was much appreciated. There were 114 Participants from 25 Countries, with an almost perfect gender balance: 44 Talks, 10 Workshops and 50 Posters. More information are available in:

Vieser W. et al. – Report on the IAU Conference “Astronomy Education — Bridging Research & Practice”, The Messenger, No. 178 – Quarter 4, 2019, p. 63-66, at: <https://www.eso.org/sci/publications/messenger/archive/no.178-dec19/messenger-no178.pdf>

2.1.1. *About the event*

The field of astronomy education has grown significantly over the last few decades, with an increasing number of research articles having been published by a growing number of academic and practitioner groups. Despite this, there has been no regular international conference place for astronomy education researchers and practitioners around the world to convene and discuss their work in the field. Hence this meeting was the first of a regular, biennial, IAU Commission C1 Astronomy Education Conference with an aim to increase the quality, quantity, community and impact of astronomy education research and practice.

This conference aimed to bring together astronomers, astronomy education researchers and education practitioners to communicate, discuss and tackle common issues. The three key topics span traditional and practical research exploring the purely theoretical to issues encountered attempting to embed research results into practical situations, usually mediated by standards, curriculum and instruction. The conference also provided an opportunity for the community to discuss the results in astronomy education stemming from the IAU Strategic Plan 2010-2020 and discuss the requirements for meeting the next IAU Strategic Plan goals regarding astronomy education.

2.1.2. *Conference Proceedings*

The proceeding from the conference is now published and you can find it here: https://iau-dc-c1.org/iauastruedu2019/wp-content/uploads/AstroEDU_Proceedings_2019.pdf

This conference is intended to be biannual but due to the pandemic, we have had to postpone it and the next AstroEDU conference will be in-person in May 2023 at the Dunlap Institute, Toronto, Canada.

2.1.3. *Conference organisation*

Scientific Organising Committee Co-Chairs:

Paulo S. Bretones (Universidade Federal de São Carlos, Brazil)

Urban Eriksson (Lund University, Sweden)

Pedro Russo (Leiden University, Netherlands)

Scientific Organising Committee (SOC):

Janelle Bailey (Temple University, USA)

Ian Bearden (University of Copenhagen, Denmark)

Lars Lindberg Christensen (ESO, Germany)

Rosa Doran (NUCLIO – Núcleo Interactivo de Astronomia, Portugal)

Michael Fitzgerald (Edith Cowan University, Australia)

Tania Johnston (ESO, Germany)

Katrien Kolenberg (Antwerpen University, Belgium)

Nicoletta Lanciano (Università di Roma “La Sapienza”, Italy)

Anthony Lelliott (University of the Witwatersrand, South Africa)

Christine Lindstrøm (University of New South Wales, Australia)

Amelia Ortiz-Gil (University of Valencia, Spain)

Mark Subbarao (IPS/ Adler Planetarium, USA)

Akihiko Tomita (Wakayama University, Japan)

Local Organising Committee (LOC):

Wolfgang Vieser (ESO, Germany) – LOC Chair

Nelma Alas Silva (ESO, Germany)

Tania Johnston (ESO, Germany)
 Álvaro Caseiro de Almeida (ESO, Germany)
 Lars Lindberg Christensen (ESO, Germany)
 Saeed Salimpour (Deakin University, Australia)

We thank the Co-chairs, SOC and in particular the LOC for an excellent job in making the conference a big success! Thank you all!

2.2. *The Astronomy Education Journal (AEJ)*

As a consequence of the preparation of the conference, and discussions during the conference, Urban Eriksson and Paulo Bretones, at the conference, announced the inauguration of a new journal: the Astronomy Education Journal (AEJ). This journal is to publish both astronomy education research articles and astronomy education papers, to fill a whole in the international body of scholarly research and knowledge and practice in the field of astronomy education. Since the conference, preparations have been ongoing and on December 2, 2020, the journal and first call for papers were announced, and we now have some +15 manuscripts under review and more is *en route*. The first issue will be published during summer 2021.

Urban Eriksson and Paulo Bretones are co-editors of the AEJ. More information on the journal, editorial board, etc., can be found here: www.astroedjournal.org

3. Astronomy Education Research sub-WG

Chair: Urban Eriksson

Unfortunately, due to the Covid-19 virus pandemic the work by the sub-WG has been very limited and slow, as for many other WGs and indeed all academic work world wide.

Below follows a summary of what the sub-WG was set out to accomplish and what actually was done.

Members mainly in charge of the theme (Additional members are in the table at the end):

Urban Eriksson (Lund University, Chair)

Bretones, Paulo (UFSCar, Br)

3.1. *Description of the the WG's intentions*

3.1.1. *Objectives*

The growing amount of emerging astronomy projects, stimulated by the existence of the e.g. IAUs OAD and OAE, and its annual calls for projects, but also many new initiatives outside this channel, require adequate research into learning processes, educational tools, models, quality and impact evaluation. As such the AER theme aims to fulfil the following needs.

- Develop a promotional strategy for enhancing AER by promoting summary reviews of scholarly production that already exists and report this to the iSTAR database.
- To promote discussions about a theoretical transdisciplinary approximation on how to effectively teach and learn contemporary astronomy at different levels.
- To actively encourage and nurture diversity in astronomy education research and researchers, to join the IAU through their national members or to join as Associate and Junior Members.

3.1.2. *Goals*

As first steps, the AER theme commits to three goals:

- (a) Promoting AER by adopting the international collaboration model used by astronomy researchers,
- (b) Fostering international astronomy education and AER capacity through the development of networks, training and shared resources, and
- (c) Improving astronomy education by describing research-based approaches to teaching and learning of astronomy.

3.1.3. *Tasks*

In service of these goals, the AER theme commits to two immediate tasks:

- Promote, in different regions and continents, surveys, literature reviews and summary reviews of scholarly production that already exists on PhD and MSc Thesis, published papers in journals and proceedings of meetings on Astronomy, Physics and Science Education, and
- The organization of a series of symposia and conferences in AER, to include structured networking, collaborative research sessions, methodological and publishing workshops, and the presentation of works of interest.

3.1.4. *Products*

Products from these beginning steps will be a result of collaborations in the diverse body of astronomy education researchers. In the near term these products will include:

- (a) The production of works that describe the nature of the existing literature in the field, and
- (b) The production of works describing the range of methods and findings found in international research databases, across a variety of constructs, including subject matter, instructional settings, audiences, cognitive processes, etc.

3.1.5. *Documents*

From these products the AER theme will be able to create documents that describe: 1. State-of-the-art research-based practices in astronomy education, addressing the diversity of educational needs internationally, and 2. A research agenda for the international astronomy education community.

Most importantly, since the ultimate implementation of the WG's efforts is to improve astronomy education internationally, the results of the WG's effort will continuously be communicated, and discussed, with professional astronomers and astronomy educators or else the work will have no use. This could best be done at meetings, conferences and via the new Astronomy Education Journal, similar to the successful CAP journal. Finally, the IAU offices (OAO, OAE, OAD and, OYA) may all benefit from the results of the AER theme. However, AER theme will exclusively focus on research aspects of astronomy education and as such no direct conflicting overlap with the offices can be foreseen; we rather see cross collaboration that will nurture our collective struggles to better educate people in astronomy.

3.2. *Accomplishments during the triennium:*

From its approval by the IAU the WG had only approximately two years to work and during most of this period the pandemic unfortunately stopped us from trying to achieve the goals of the WG. However, some very important work was indeed accomplished and is summarised below and presented in detail in the previous and present annual reports. We refer the reader to these reports for details.

In summary, and with the goals of the WG in mind, the following have been done: *First*, we set out to promote AER by adopting the international collaboration model

used by astronomy researchers and this goal has been met by the organisation of the first Astronomy Education Conference. See above for details, the webpage <https://iau-dc-c1.org/astroedu-conference/> and the annual report.

Second and third, in fostering international astronomy education and AER capacity, and improving astronomy education, we have beside the conference organised one workshop on AER in the middle east before the pandemic prevented any further such activities (more information are available in the website at: <http://saasst.myscass.com/AstroEduWorkshop> and at: <https://scass.sharjah.ac.ae/en/news/Pages/scassnd.aspx?mcid=289>).

Further, by creating the AEJ, we meet this goal by now being able to publish AER and best practice on astronomy education.

Hence, and despite the pandemic, we have met the goals of the WG and look into the future for being able to further this work after the pandemic.

From the previous annual report and the present, we have also performed AER surveys which have resulted in several reports and the result from these surveys are now to be found in the iStar database (istardb.org). This is a work in progress, coordinated by Urban Eriksson, and all newly found work will be added to the iStar database. We are especially grateful to Michael Fitzgerald and Saeed Salimpour for their efforts in creating and maintaining the iStar database.

4. The Teachers and Educators Training (TET) sub-WG

Chair: Akihiko Tomita

Members mainly in charge of the theme: (Additional members are in the table at the end):

Rosa Doran (NUCLIO)

Paulo Sergio Bretones (UFSCar)

Michael T. Fitzgerald (Edith Cowan Institute for Educational Research)

Rosa Ros (NASE)

Edward Gomez (Las Cumbres Observatory)

Lars Lindberg Christensen (ESO)

Boonrucksar Soonthornthum (NARIT)

Wichan Insiri (NARIT)*

Tessa Vossen (Leiden/UNAWE)*

Additional members:

Julie Bolduc-Duval (Discover the Universe, Canada)

Hasan Baghbani (President of Iranian Teachers Astronomy Union, Iran) *

Rica Sirbaugh French (Center for Astronomy Education, MiraCosta College, USA)

* Not jet IAU members but worked with other members.

4.1. Background of the TET Theme:

Background of the TET Theme: There are various teacher training programs including NASE, GTTP, GHOU, UNAWE / Space Awareness, many organized by space agencies such as NASA, ESA, JAXA, and many organized by observatories and societies such as ESO, Las Cumbres, PASP. There are not only the programs above which are publicized worldwide but also various programs in each country and community. Many teachers and educators have been developing their own skills through the training programs, and many children all around the world are enjoying learning astronomy by trained teachers

and educators. Each of them has great importance and value and has a particular way of approach and material. The IAU will establish Office of Astronomy Education (OAE) in near future. It is time to survey and review as many as possible of the astronomy teacher and educator training programs in the world.

4.2. *Description of the the WG's intentions*

4.2.1. *Objectives and goals:*

The focus of this section is to provide the groundwork (see expected products below)

(a) for the mandated Office of Astronomy Education "National Astronomy Education Coordinators" (NAECs), and

(b) to encourage teacher training activities in all communities.

4.2.2. *Expected products:*

The survey and review (see description of the work below) will be summarized as a document which contributes to

(a) framework and standards for teacher and educator training in astronomy education in all communities, and

(b) the future OAE's "International School for Astronomy Education" in collaboration with the ALCD section.

4.2.3. *Description of the work - Tasks:*

(a) Report the achievements of projects, such as NASE, GTTP, GHOU and all the projects which are publicized worldwide.

(b) Survey various projects in each country and community which are not so publicized worldwide but show good practice.

(c) Review all the programs the theme for TET group can reach and summarize best practices, best approaches, and scientifically and educationally innovative things.

In any stage of the work, we will respect all the projects and communicate with persons related to the projects, making a good network of the teacher and educator training.

4.2.4. *A timescale for the work:*

All the tasks 1 to 3 described above will be made simultaneously in each year, but we will focus on 1 in 2019, 2 in 2020, and 3 in 2021.

4.2.5. *Ways of involving a good mix of people as appropriate:*

For work 2, we need people with various geographical distribution who are familiar with local activities, and for work 1 and work 3, we need experienced people with various career stage, gender, and cultural background. We will continue to call as various people as possible considering gender balance as member of this theme.

4.3. *Report in 2019*

(a) Network of TET work: discussion at astroEDUconf 2019 and new member:

Julie Bolduc-Duval, Discover the Universe, Canada

Hasan Baghbani, President of Iranian Teachers Astronomy Union, Iran

(b) NASE practice:

NASE course in Japan for the first time, in November 2019

Japanese is the 12th language of NASE materials after Spanish, English, Romanian, Chinese, Indonesian, French, Portuguese, Persian, Catalan, Mongolian, Russian.

5. Accomplishments in 2020:

Due to the COVID-19 pandemic circumstances, the survey has not been made as planned. Nevertheless, taking the opportunity of the total solar eclipse in South America on 14 December 2020, the Astronomy Day in Schools 2020 program could be incorporated into the sub-WG activity.

The Astronomy Day in Schools program was originally carried out as one of the IAU100 programs, taking the opportunity of the Mercury transit in front of the Sun in November 2019. Chaired by Paulo Bretones and Akihiko Tomita, the program continued with the steering committee of the program. The program prepared a website that introduced various teacher and educator training programs and highlights teaching materials related to the solar eclipse.

The website called teachers and educators around the world to report education activity related to the solar eclipse. The program was advertised through emails to the Commission C1 members, personal connection from the sub-WG members and the steering committee members, and the OAE basecamp bulletin board. This activity collected actual education activities. This was one of the examples of collaboration between Commission C1 and the OAE.

Web site "Total Solar Eclipse" <https://iau-dc-c1.org/eclipse-2020/> The website was designed by Saeed Salimpour.

About:

To celebrate the Total Solar Eclipse of December 14, 2020, we have prepared this website to provide you with resources to engage your community. This event presents a special opportunity for students to learn more about the science of eclipses. When possible, we will advertise the link(s) of the live streaming(s) even in these times with remote teaching in many schools in the world. For the countries where the eclipse will be visible as total (Chile, Argentina) or partial (Ecuador, Peru, Bolivia, Uruguay, Paraguay and Brazil) it is important to take care about Eye Safety and Solar Filters. Any amateur or professional astronomer, scientist or teacher is invited to participate. We would like to enthusiastically continue the Astronomy Day in Schools and hope you enjoy! This initiative is run by the IAU Working Group: Astronomy Education Research and Methods (AERM, Commission C1: Astronomy Education and Development

Steering Committee: Paulo Bretones, IAU Commission C1 President, Brazil (Chair)
 Akihiko Tomita, Wakayama University, Japan (Co-Chair)
 Rosa Doran, NUCLIO – Núcleo Interactivo de Astronomia, Portugal
 Urban Eriksson, Lund University, Sweden
 Edward Gomez, Las Cumbres Observatory, United Kingdom
 Carmen Pantoja, University of Puerto Rico, United States of America
 Rosa Maria Ros, IAU Commission C1 WG Network for Astronomy School Education (NASE) Chair, Spain
 Boonrucksar Soonthornthum, Southeast Asia Astronomy Network, Thailand

Programs and Materials for Teacher Training in Astronomy:

Live broadcasts
 International Astronomical Union Inter-Division C-E WG Solar
 Eclipses
 Eclipse Maps & Info
 Totality App
 Network for Astronomy School Education(NASE)
 Global Hands-On Universe(GHOU)

Galileo Teacher Training Program(GTTP)
 NUCLIO
 Open Astronomy Schools
 Einstein Schools
 Universe Awareness(UNAWE)
 Space Scoop
 astroEDU
 L'eclisse di Sole in miniatura: Esperienze didattiche (in Italian)
 ITAU, Iranian Teacher's Astronomy Union
 IAU Symposium 367

For the registration, we asked items below as well as the face sheet items: Event Location (City, State, Country)
 Age group: example 11- 14 years
 Event Type (selective): Talk/Lecture, Observing Session, Exhibition, Other

Statistics of the registration according to countries/areas, total: 79:
 Romania 63, Brazil 3, Bulgaria 2, Chile 2, France 1, Serbia 1, Japan 1, Italy 1, Croatia 1, Peru 1, Armenia 1, Thailand 1, Iraq 1 Especially, Ana Naghi of NAEC Romania actively encouraged Romania teachers to register their activities.

Statistics of the registration according to age group:
 The categories are set every 5-year-old bin as below. Input of 11-17 is allocated into one in 11-15 and one in 16-20, for example. 10 or younger: 11, 11-15: 63, 16-20: 28, 21-25: 8, 26-30: 7, 30 or older: 8
 Since this registration was for the Astronomy Day in Schools program, most of the age groups were primary and secondary school ages.

Statistics of the registration according to event type:
 Talk/Lecture: 50, Observing Session: 29, Exhibition 22, Others: 18
 The observing session included observing the live stream through the internet. "Others" included experiments or show case activity using models or on-line tools.

All the registered received the certificate of participation. The certificate was designed by Saeed Salimpour.

Statistics of the web site visitors, counting only new visitors:
 From 1 November 2020 to 25 March 2021, a total of 1930 visitors from as many as 86 countries/areas.
 Number of visitors with more than and equal to 5: Romania 912, United States 157, Brazil 135, Armenia 103, Serbia 74, France 70, Mexico 43, Japan 40, Italy 34, China Nanjing 27, Germany 22, Portugal 22, India 20, Russia 19, Columbia 18, Lithuania 16, Poland 14, Spain 13, United Kingdom 13, Iran 12, Austria 11, Chile 10, Peru 8, Thailand 7, Belgium 6, Bulgaria 6, Croatia 6, Algeria 5, Turkey 5
 Most of the visitors, 1823 out of 1930 visited the website from 10 November to 20 December 2020.

The statistics were obtained through Google Analytics.

6. The Astronomy Literacy and Curriculum Development (ALCD) theme

Chair:Robert Hollow (CSIRO, Australia)
 Members mainly in charge of the theme

(Additional members are in the table at the end):

Hidehiko Agata (NAOJ, Japan)

Saeed Salimpour (Deakin University, Australia)

Pedro Russo (Leiden University, the Netherlands)

Lina Canas (IAU OAO/ NAOJ, Japan)

Tim Spuck (AUI, USA)

6.1. *Introduction and background*

This proposed theme for Astronomy Literacy and Curriculum Development addresses the need for a group to collect and analyse astronomy curricula from formal education systems around the world, both F-12 and at the Tertiary (college and university) level. The “Big Ideas in Astronomy, A Roadmap to Astronomy Literacy Goals” project, due for release by the IAU provides a current framework with which to measure and map how these formal curricula match the identified key concepts that comprise astronomy literacy. Data and trends identified will help inform the priorities for ongoing and future AER and provide tools and guidelines for IAU members seeking to contribute to or review relevant future STEM curricula in their countries or education systems.

The establishment of an IAU Office of Astronomy Education (OAE) is a timely and welcome initiative. One focus of the OAE will be in training teachers to effectively teach astronomical concepts and deliver authentic, engaging astronomy activities and programs. To maximise the effectiveness of teacher workshops and professional learning it should be matched to the needs of teachers in their specific systems whilst also informed by global trends. As such, this ALCD theme seeks to enhance professional training by developing focussed training programs and resources, with the intention that this work will result in a modern conception of the ways in which teaching, and learning can effectively happen in the context of astronomy.

6.1.1. *Alignment with mandates of OAE:*

The proposed IAU Office of Astronomy for Education (OAE) focuses on providing the training and resources necessary to use astronomy to stimulate teaching and education from elementary to high school level (astronomy and science education), with a network of National Astronomy Education Coordinators and a database of IAU volunteers.

6.2. *Description of the the WG's intentions*

The proposed ALCD theme provides a platform for the OAE to draw on focused research in order to enhance and fulfil its goals. Given that, the theme will be comprised of individuals from a range of backgrounds and experiences in AER.

6.2.1. *Aims:*

As such the proposed ALCD theme aims to fulfil the following needs:

(a) Develop and maintain records of astronomy curriculum in F-12 and Tertiary education from around the world.

(b) Develop, promote and regularly review the roadmap to Astronomy Literacy Goals, through discussion with astronomy and STEM education groups.

(c) Through analysis of curricula and mapping to literacy goals provide advice to the IAU via the theme for AER and educators involved in Astronomy Education Research, professional learning for educators and curriculum developers, suggesting changes where appropriate,

(d) To actively encourage astronomy educators to join the IAU through their national members or to join as Associate and Junior Members.

6.2.2. *Goals:*

As first steps, the ALCD theme commits to the following goals:

(a) Expand the review of astronomy curricula in F-12 formal education beyond OECD curricula and further develop tools for analysing them.

(b) Extend the review of astronomy curricula to tertiary level degree courses globally and identify the key elements of astronomy degrees and astronomy within other degree paths.

(c) Promote the Roadmap to Astronomy Literacy Goals within the professional astronomy community and more broadly to STEM educators globally.

(d) Improving astronomy education, teacher professional learning and curriculum development by providing data and advice to relevant groups.

(e) Establish mechanisms facilitating discussion and sharing of best practices and ideas in the astronomy and education communities.

Within the first three years, the ALCD theme initially commits to:

(a) Solicit contributions to a broader range of astronomy curricula at both F-12 and tertiary levels to expand the data sets available for analysis.

(b) Establish a database of curriculum contacts for each country and or system globally.

(c) Provide input to planned and future symposia and conferences in AER, where the Roadmap to Astronomy Literacy Goals can be promoted and discussed.

(d) Liaise with the other themes in AERM and the OAE to map out a plan for ongoing collaboration and identify the priorities for each group.

Through these initial activities and collaborations, the ALCD theme will:

(a) Report and analyse astronomy curricula globally

(b) Commence mapping these to the Roadmap of Astronomy Literacy Goals (ALGs), identifying areas of omission and error.

(c) Provide advice on priorities for future astronomy curriculum development and priorities for AER and teacher professional development.

From these products the ALCD theme will produce within the triennium reports and databases that describe:

(a) Astronomy curriculum with mapping to ALGs

(b) A research agenda for the international astronomy education community

(c) Review of Astronomy Literacy Goals.

6.3. *Activities during 2019-2020:*

Key points in the area have been:

- Saeed Salimpour's paper on OECD curricula has now been published (Salimpour, S., Bartlett, S., Fitzgerald, M.T. et al., The Gateway Science: a Review of Astronomy in the OECD School Curricula, Including China and South Africa. Res Sci Educ (2020). <https://doi.org/10.1007/s11165-020-09922-0>)

- the IAU "**Big Ideas in Astronomy**" booklet.

What does it mean for a citizen to be "literate" in astronomy? Those members of the International Astronomical Union (IAU) who are active in public outreach have practical experience of the kinds of astronomical knowledge commonly held by the general

public. Until recently, however, there had not been a systematic evaluation and a clear definition of what astronomical literacy means. In May 2019, a “Big Ideas in Astronomy: A Proposed Definition of Astronomy Literacy” booklet has been released with the aim of clarifying these ideas. It is intended for use by the astronomy education and outreach community, and within a process of community consultation. The booklet is the culmination of years of debate and discussion over the essential things that an astronomically literate person should know. For more detailed information, please go to the official IAU announcement page here: <https://iau.org/news/announcements/detail/ann19029/>

These will inform ongoing expansion of curricula coverage and help us map out work for rest of the year. Due to the Covid-19 pandemic, the activities during 2020 have been very low but we hope to continue our work in the post-pandemic future.

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