Proceedings for the
3rd Shaw-IAU Workshop
on Astronomy for Education

What Everybody Should Know about Astronomy Education

12 – 15 October, 2021

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The following is a summary of the 3rd Shaw-IAU workshop on Astronomy for Education held 12 – 15 October, 2021 as a virtual event. The workshop was organised by the IAU Office of Astronomy for Education. More details can be found on: `https://astro4edu.org/shaw-iau/3rd-shaw-iau-workshop/`.

The Office of Astronomy for Education (OAE) is hosted by the Haus der Astronomie on the campus of the Max Planck Institute for Astronomy in Heidelberg. The OAE's mission is to support and coordinate astronomy education by astronomy researchers and educators, aimed at primary or secondary schools worldwide. The OAE is an office of the International Astronomical Union, with substantial funding from the Klaus Tschira Foundation and the Carl Zeiss Foundation. The Shaw-IAU Workshops on Astronomy for Education are funded by the Shaw Prize Foundation.

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Foreword

3rd Shaw-IAU Workshop on Astronomy for Education

Teaching astronomy takes both solid knowledge of the subject itself as well as educational skills, such as knowing appropriate methods and techniques for teaching. To this, specific sub-fields of astronomy education add their own specialized skill sets: knowing how to operate remote telescopes, for instance, or the ins and outs of daytime observations. Last but not least, there are the skills needed in order to make our teaching fair, equitable, and inclusive.

In practice, most of us who are active in astronomy education have only been taught a subset of those skills in our academic training. Those who come from professional astronomy and have branched out into education and outreach typically have advanced training in astronomy, but not in the relevant areas of pedagogy. Most teachers, on the other hand, have pedagogical training as well as training in the subjects their teach, but often that does not include formal training in astronomy and astronomy education.

If this description includes you, and if in consequence you have ever felt motivated to expand your astronomy education skill set, then this workshop was, and is, meant for you. It is the third in a series organised as a collaborative venture between the Shaw Prize Foundation and the International Astronomical Union, and with 89 talks and 50 posters in a total of 18 sessions, it provides a fairly comprehensive "Astronomy Education 101".

For those who were unable to attend, or did not manage to attend all of the sessions they were interested in, we present these proceedings, and the associated talk videos from the workshop. While they lack the interactivity that the 580 workshop participants enjoyed as they posed their questions to the speakers, or interacted in the chat, we do believe that they are valuable in their own right — and we asked speakers to include in their write-ups helpful pointers to additional resources, so you have the opportunity to delve deeper. If you find these resources useful, and I hope they will be useful to many, please share them widely.

The workshop was made possible by funding from the Shaw Prize Foundation, for which we are very grateful. You can find the names of the individuals and institutions who organised the workshop on p. 6 — a big "Thank you!" to all of you!

For us at the International Astronomical Union's Office of Astronomy for Education (IAU OAE), this is just the start. Helping those who are active in astronomy education to grow their skills, and to become more professional in their activities, is one of our main objectives. Stay in touch if you want to make sure not to miss what is next — from additional events to more resources. On the web, you can find us at http://astro4edu.org, and on that page, you can also find your country's National Astronomy Education Coordinator Team. We are also on Twitter and on Facebook as @astro4edu.

Markus Pössel
Director, IAU Office of Astronomy for Education
Heidelberg, November 16, 2021

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In addition to the efforts from the OAE office in Heidelberg, Germany, the following OAE Centers and Node made key contributions to organizing this event:

OAE Center Italy

OAE Center Cyprus

OAE Node Nepal

The OAE Center India was not formally established at the time of this workshop but also made significant contributions.

Astronomy Education Research 101

Session organiser: Saeed Salimpour, Office of Astronomy for Education/Max Planck Institute for Astronomy, Germany and Deakin University, Australia

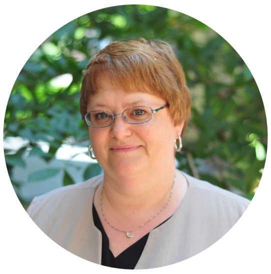
Session overview

Astronomy Education Research (AER) as a discipline-based researched field is rich, layered and multi-dimensional, drawing on a range of fields and subfields, which includes but is not limited to education, cognitive science, psychometrics, astronomy (and its cognate disciplines) for content knowledge, and various others.

The AER 101 session was aimed at providing an overview of some key aspects of AER, each of these can be unpacked and explored in much more depth than is possible in a single or multiple sessions. Given this aim, the session brought together a panel of experts with vast experience in conducting AER: Janelle Bailey (Temple University), unpacked Quantitative Methods in Astronomy Education Research; Julia Plummer (Penn State University), provided an overview of Qualitative Methods in Astronomy Education Research using projects to highlight the characteristics of qualitative research; Kathy Cabe Trundle (Utah State University), highlighted the complexities involved when conducting research with schools and teachers, and the three types of teachers based on their engagement (learners, vacationers, and prisoners); Erik Brogt (University of Canterbury), emphasised the importance of ethics when conducting research, and how as researchers we need to make this our top priority (cardinal principle); and finally Urban Eriksson (Lund University), editor of the Astronomy Education Journal, highlighted the avenues for publishing when it comes to AER.

Quantitative Research Methods in Astronomy Education Research

Speaker: Janelle M. Bailey, Temple University, Philadelphia, PA, USA



The use of quantitative research methods within astronomy education research is appropriate for answering questions about changes in or relationships between variables. Quantitative data comes in multiple types (categorical/nominal, ordinal, interval/scale, or ratio) and different analysis strategies are appropriate for each. Although assessing p-value for statistical significance is common, it should be used in conjunction with other indicators of statistical quality. Effect size is one of the most important indicators but should be put in context of prior work and theory that drives the research question. It is critical to ensure that there is strong alignment between your study's literature and theoretical framework, research questions, data collection, data analysis, and discussion.

Talk link: https://youtu.be/yBMDcWKBHO0

Quantitative research methods are very common within astronomy education research (AER). As such, it is useful to keep in mind a few basics before deciding to embark upon this approach. Many people with astronomy backgrounds will feel quite comfortable with quantitative methods because they may have used similar statistical analyses within astronomy research, and they are generally at ease with mathematics. Of course, being proficient in quantitative methods would likely require a great deal of learning and a large time investment – for example, multiple semester-long courses or their equivalent. We cannot come close to covering everything here, so instead I take the focus of hitting some highlights, important or common terms, and foundational considerations for anyone who might not already have experience with quantitative methods. Quantitative methods are typically used for three purposes: to measure differences between groups, to understand relationships between variables, or to test hypotheses.

In AER, the group differences question is very common – for example, you might want to compare grades for students in a course section using a new intervention with students in a section using a traditional instructional approach (or not using the intervention in question). Physics education research (PER) has been using quantitative methods to better understand the relationship between race/ethnicity and Graduate Record Examination (GRE) scores to determine whether or not the GRE is a good criterion for use in graduate admissions (spoiler alert: it is not!) Finally, you might want to test a hypothesis such as, 'higher spatial reasoning scores will yield higher final course grades'.

Once you have determined your purpose, you also need to think about the type of data you can collect. Quantitative data are those that are — or can be converted into — numeric format. There are four types of quantitative data. *Categorial* (sometimes called *nominal*) are data that are distinct types but that have no inherent order to them. A classic example of this is gender – although we could assign female to be 1, non-binary to be 2, and male to be 3, there is nothing about these classifications that indicate whether one is higher or more intense or better than the others as might be interpreted from the assigned numbers. *Ordinal* data are those that do have an inherent order but that there is not necessarily equal separation. Education level (e.g., K-8, high school, college, graduate school) does have an order to it (those examples are listed from lowest to highest level) but the number of years in each is not necessarily the same. Another common example of ordinal data is the Likert scale (e.g., 1 = strongly disagree to 5 = strongly agree), as there is no guarantee that one person's difference between 3 and 4 is the same as their difference between 4 and 5 or as another's differences. *Interval* or *scale* data are ordered numbers with equal separate; age, barring leap years, is a great example of this. Finally, *ratio* are interval data where 0 means there is no measure of that data. Time on task might be an example from education; temperature measured in Kelvin is a physical science example (note that temperature measured in Celsius or Fahrenheit is interval data). The types of statistical analyses you can perform vary depending upon what type of data you have — for example, a mean or median of categorial data is meaningless, but frequency or percentage of each category is appropriate.

A decision tree, such as that found in Figure 2.2 of Mertler and Vannatta (2002), can help you decide what type of analysis is appropriate based upon the number and types of variables (both dependent and independent) you have. Some of the common analyses you will see within AER include t-tests, different analyses of variance (ANOVA, ANCOVA, MANOVA, or MANCOVA), linear regression, factor analysis (exploratory or confirmatory), or structural equation modeling. T-tests, a special case of the ANOVA, are among the most commonly used. Most of these tests will provide some measure of *statistical significance*, often designated by *p*-value; .05 is most common in education research, though sometimes .1 is used, and smaller values are typically preferred. The *p*-value is a measure of how likely it is that the observed effect is real compared to a statistical model. That said, there are a number of reasons to not rely solely on *p*-value (see, e.g., Wasserstein & Lazar, 2016, and associated pieces). One way of better parameterizing your results is to include *effect size*, an estimate of the magnitude of difference (or of relationship) between variables (Ferguson, 2016). There are different effect size measures depending upon your research question, data, and analysis. Kraft (2020) provides a great discussion on interpreting effect sizes in a way that puts them into context for the type of research at hand. Effect size is particularly useful for comparing multiple studies because it allows for formally analyzing data that comes from studies with different number of participants, analysis types, etc., such as in a metaanalysis where a single omnibus effect size is the goal (a PER example is by Madsen et al., 2015) or a systematic review where the effect sizes are used to support clarity without the omnibus calculation (e.g., Lombardi et al., 2021, which includes AER and PER as well as other disciplines).

As you embark upon a quantitative research study (ok, really any kind of study), you want to make sure there is strong alignment between its different pieces. The background literature and theoretical framework should explore what has been done and lead into well-informed research questions. Those research questions should define the types of data and methods of collection. Quantitative analyses should be determined by the research questions and data types. And the results and discussion should connect the analyses back to the theory and prior literature to show how the study contributes to our understanding of the field. Ensuring such alignment is critical for robust research design and implementation. The American Psychological Association (APA), whose guidance is typically followed by education researchers, have provided 'journal article reporting standards' that will help you consider what to include and how to present common types of data (see https://doi.org/10.1037/amp0000389 for the quantitative JARS; there are qualitative and mixed methods JARS available as well). Finally, if you are not comfortable with quantitative research methods, collaborating with others is a great way to get going.

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Qualitative Research Methods in Astronomy Education Research

Speaker: Julia D. Plummer, The Pennsylvania State University, USA

Qualitative researchers are concerned with how the social world is interpreted, experienced, or understood. Qualitive research methods are useful when exploring or identifying unanticipated phenomena, generating new hypotheses, and gaining a better understanding of an educational context or problem. This presentation will introduce you to qualitative research methods and when they are appropriate to astronomy education research questions; why this methodological tradition can contribute to a deeper understanding of teaching and learning; and provide examples of how to use qualitative methods during studies of astronomy education.

Talk link: https://youtu.be/73-Jb4RQVk4

This talk provides a broad overview of qualitative research, focusing on when it is appropriate to use qualitative research and some elements of the design of a qualitative research study. Below I describe a few resources that will give additional depth if you are interested in pursuing qualitative research.

Books on qualitative research methods

Glesne & Peshkin (1992). Becoming Qualitative Researchers: An Introduction. Longman.

I cited this text in my talk as it provided a helpful table contrasting qualitative and quantitative research. The book helpfully clarifies how to think about the role of the researcher as an observer or participant or both, in your research.

Maxwell (1996). Qualitative Research Design: An Interactive Approach. Sage Publications.

I found this book to be especially helpful as I designed my talk. If you are interested in learning more about the design of qualitative research studies, this is a useful text as it clarifies the nature of each aspect of the qualitative research design with helpful examples.

Merriam (1998). Qualitative Research and Case Study Applications in Education. Jossey-Bass.

One useful type of qualitative research is case study, an "intensive, holistic description and analysis of a single unit or bounded system" (Merriam, 1998, p. 12). This approach is useful when you want to develop an in-depth understanding of a situation and the people involved.

Saldana (2016). The Coding Manual for Qualitative Researchers. Sage.

Once you have taken the plunge and started doing qualitative research, you will soon discover that you need to think about the systematic process of moving from raw data to findings. Often this is through a process of generating codes and categories. This is a detailed guide to the process of coding and all the nuances you might need to think about when working with qualitative data.

Strauss & Corbin (1998). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Sage.

Another useful type of qualitative research is grounded theory. Grounded theory is "theory that was derived from data, systematically gathered and analyzed through the research process… A researcher does not begin a project with a preconceived theory in mind" (Strauss & Corbin, 1998, p. 12). This is one of the strengths of qualitative research – the ability to develop theory from data.

Learners, Vacationers, and Prisoners: Conducting Astronomy Education Research in PreK-12 Settings

Speaker: Kathy Cabe Trundle, Utah State University, USA

To improve science teaching and learning for all children, we must first understand effective strategies teachers use and the challenges they face in PreK-12 classrooms. Just as many biologist and geologist conduct field studies out in nature, educational researchers' field work often takes place in PreK-12 settings. This session focuses on astronomy education research with teachers and students and provides insights into successfully conducting research in schools.

Talk link: https://youtu.be/Uh_-BXNGFLM

Why?: Conducting research in school settings allows researchers to understand effective strategies teachers use and the challenges they face in PreK-12 classrooms. Just as many biologist and geologist conduct field studies out in nature, educational researchers' fieldwork often takes place in PreK-12 schools and classrooms. Partnerships and collaborations with schools and teachers allow us to work together to improve astronomy teaching and learning for all children. Schools, universities, and researchers share common missions. First, we work to expand the knowledge base of our fields, including what we know about effective strategies for teaching astronomy. Second, we strive to educate future generations while we instill and facilitate our students' interests in and fascination with the wonders and mysteries of the universe.

In order to maximize our influence on astronomy education in PreK-12 classrooms, we must communicate our research to broad audiences, including teachers. One such option is to publish our work in practitioner journals like *Science and Children*, *Science Scope*, and *The Science Teacher*. Our research team often works with teachers as co-authors on these articles. The inclusion of the teachers' perspectives provides authenticity to the manuscripts, and conducting research in schools facilitates these co-authoring opportunities to contribute the knowledge base.

How?: The key to conducting research in school settings resides in relationships – with school districts, science leaders, principals, and most importantly teachers. All relationships with school personnel should be founded on mutual trust and respect. As academicians, others may perceive us as disconnected and insulated from "real-world" realities and concerns. School personal may see us as aloof "ivory tower" dwellers. Working with teachers and students in PreK-12 classrooms can help bridge the ivory tower gap between universities and schools while increasing the relevancy of our work. Establishing close work relationships with teachers is critical for successful collaborations. A place to initiate a relationship built on trust comes from inclusion of a teacher partner as a member of the research team. Over the years my research teams have always included an educational researcher (me), a scientist (astronomer, geologist, physicist), and a teacher or teachers. When possible, and especially when working with groups of teachers, we also include a teacher peer mentor who has experience with the content and/or prior work experience with our team. The inclusion of teachers as research team members grounds our work in the realities of the classroom. The teacher serves as a integral team member in every step of the research from the design to implementation (instructional intervention) to data gathering and analysis to writing and publication. In fact, we have published numerous practitioner and research articles with classroom teachers as co-authors.

Where?: Our team experienced the most success in recruiting teachers as research partners by connecting through existing relationships. For example, we identify teachers who are interested in educational research via teacher professional development workshops and institutes that we provide. We also reach out to former students from our classes who are currently classroom teachers. Since these contexts allow for longer-term interactions and the establishment of trusting relationships, the teachers know us personally. And we have information to help us identify teachers who might be interested in the projects and who will likely be good contributing team members. While we have had the greatest success recruiting through existing relationships, in some cases we have contacted district science leaders and principals who recommend teachers who might be interested in the project.

Who?: In working with inservice and preservice teachers over the years, we have enjoyed collaborating with many science enthusiasts who are avid learners and great research collaborators. These teachers usually self-select to participate in the workshop, institute, learning opportunity, collaboration, and/or research team. The **learners** engage with the tasks and content, interact in positive ways with team members, contribute to discussions, and ask questions. In addition to learners, we also have worked with two other types of teachers that we characterize as vacationers and prisoners. We have the utmost respect and admiration for teachers and their commitments to and sacrifices for their students. By describing these characterizations, we do not intend to denigrate teachers, and the characterization is in no way a reflection of their effectiveness as a classroom teacher. Rather, these next two types of teachers usually emerge when an administrator selects and/or directs a teacher to participate in a project. In other words, the teacher's participation is not voluntary.

The **vacationer** teacher may self-select or be selected or directed by an administrator to participate. These teachers disengage for all or a portion of the experiences. The motivation for these teachers to show up for the experience can stem from an administrator directive, a desired break or vacation from the classroom, and/or the free materials offered with the experience – the souvenirs.

The final type of teacher is the **prisoner**. An administrator directs, shames (tries to fix a teacher who does not see herself as broken), or coerces the prisoners to attend the experience. These teachers disengage throughout the experiences, and they can be resentful about being forced or coerced to attend. Prisoners may openly complain about or even disrupt the experience. Thankfully, most of the teachers with whom we have worked over the years are definitely learners, with very few vacationers or prisoners in the mix. We have found our work with teachers whose motivations originate from sources other than learning or the research itself to be unproductive. Of course, we work to engage the vacationers and prisoners and provide opportunities and support so that they may shift toward being learners in the experiences.

I offer these characterizations so that you may be aware of the issue of why teachers show up for workshops, institutes, or research opportunities. Their varying sources of motivation may influence the nature of your relationship with them and affect the success of your research project. The key to successful research projects in PreK-12 schools resides in your relationships with teachers. Look for the learners and cultivate positive relationships built on mutual trust.

Human Ethics in Astronomy Education Research

Speaker: Erik Brogt, University of Canterbury, Christchurch, New Zealand

In most jurisdictions, research that involves human participants or data obtained from human participants is bound by ethical and legal requirements, and most scholarly journals require a statement confirming that projects have obtained the necessary approvals. In this session, we will explore some of the common ethical and legal requirements on astronomy education research, such as voluntary informed consent, power dynamics, data confidentiality, and the ethical use of secondary data sources. We will pay particular attention to potential ethical pitfalls when researching your own students, whether they are legal minors or not, and ways to avoid those pitfalls through good and ethical research design.

Talk link: https://youtu.be/_vMGTUItZvU

Astronomy education research means doing research with humans, on how they teach and learn astronomy. This means that as researchers, we are bound by the legislation, regulations, and human ethics protocols to do our research. These were set up in the wake of a number of biomedical and socio-behavioural experiments that resulted in physical and/or psychological harm to participants. For many beginning astronomy education researchers, especially those coming from astronomy or physics, human ethics processes are a new concept. But in a sense, the ethics committee serves a similar function to a Time Allocation Committee for a telescope. Just like you cannot just go to a professional telescope and expect to be able to take data without having gone through an approval process, you cannot go out and collect data from human participants without some form of external scrutiny. In addition, most education journals require a statement of having obtained the appropriate ethics approval as part of the submission process. At its best, the ethics process is an opportunity to engage in constructive dialogue with knowledgeable colleagues on how to best design and do your research in a way that helps you answer your research questions while minimising impact on your participants (who might very well be your students to whom you also have a duty of care). An ethics application typically covers a number of distinct elements: Recruitment; Methods; Informed Consent; Privacy and Confidentiality; Data Storage, Access, Security, and Future use. These cover the typical questions that would come up in your mind if someone were to ask you to participate in a study. In astronomy education research, as in most discipline-based education research fields, a lot of research is done by researchers with students who they also teach. This provides unique ethical challenges related to these five points that need to be carefully thought through to ensure that the research is done in an ethically appropriate way. It is the author's firm conviction that when we do research with students who we teach, our duties as a teacher take precedence over our research study, and research design and methods should not diminish the student experience.

Recruitment and informed consent Potential participants should be able to decline to participate without fear of retribution or penalty. As teachers, we hold a position of power over our students. As such, when we ask students to join our research project, they may feel coerced to participate, even if they do not really want to. In some cases, in an attempt to increase participation rates, researchers link participation to a percentage of the course grade or extra credit. At that point, students will be penalised for not participating, which definitely would be considered coercive.
A particular point is the use of data that was gathered for another purpose, for your research. It is worth keeping in mind that while you may have access to data in your capacity as a teaching (e.g. student grades, demographic data, GPA), you cannot use that for research purposes without ethics approval (which will most likely insist on consent from the students).

Methods As astronomers and physicists, we are comfortable with experimental designs (randomised trial, randomised control) and quantitative methods such as surveys and statistics. However, these designs and methods are not necessarily the right tools to answer the research question at hand. Qualitative methods provide additional unique insights that should not be overlooked or dismissed because we are not as familiar with them. One is not necessarily better than the other, they just are able to provide different data sets to paint a fuller picture. It is in a way comparable to photometry and spectroscopy. Both are valid tools for particular sets of research questions, one is not better than the other, and they each have their place.

An ethics committee typically has jurisdiction over methods, and they can require you to make changes or justify your methods if it is not clear how your chosen methods will help you answer the research questions. Gathering data that does not (seem to) serve a purpose goes against the concept of minimising impact, as you are in essence wasting participants' time.

Privacy and confidentiality, and data security The right to privacy is absolute and participants have a right to know how the data will be used, published and what the long-term plans of the data are (e.g. longitudinal studies, merging with other data from other institutions etc.). An additional ethical concern is when you know who of your students has participated in the study, and the students know this as well. This might lead to pressure to participate, or data bias in the sense that students say what you want to hear, rather than what they think. It is critical that data is anonymised as soon as possible, preferably by someone else than the teacher / researcher, that the teacher / researcher does not look at the data until teaching is over and final grades have been submitted, and that the students are made aware of this.

Where to go for help and support?

- Your human ethics committee or board if your institution has one
- Colleagues in Education and the Social Sciences
- Educational developers in a Teaching Centre or similar if your institution has one

Further reading

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Publishing in Astronomy Education Research

Speaker: Urban Eriksson, Swedish National Resource Centre for Physics Education, Lund University, Sweden

Last year the new international Astronomy Education Journal (AEJ) was launched and the first issue will be published soon. In this talk I will present the journal, its different sections. I will further present how to write manuscripts for the journal's different sections and how the manuscripts are being reviewed and/or curated. The journal is found online here: www.astroedjournal.org.

Talk link: https://youtu.be/TgEQDZ0_4Yk

Publishing astronomy education research (AER) and astronomy education (AE) material can be challenging when it comes to considering what journal to submit the manuscripts to. There are several international journals that do publish such articles but only very few that focus on AER and AE. Here we find, for example, RELEA and JAESE, but none that publish both AER articles and other AE material.

Further, when writing a manuscript for publishing one needs to follow many rigorous traditions when it comes to structure. Usually, journals provide templates, and these must be followed to be able to get a manuscript considered by the editors. Start by reading the guidelines for the journal you may consider for you manuscript and follow them when writing! When publishing AER manuscripts these rules are rather strict but when publishing other AE material, you are freer to do as you (and the editor) want. However, always strive to write short and concise and, if possible, cite relevant work by others. These manuscripts do not usually get reviewed by referees, but are curated by editor(s), sometimes after discussion amongst the editorial board members.

AER as a discipline-based research field draws on traditions from education and astronomy, and so manuscripts need to consider the theoretical and methodological frameworks that underpin each of the disciplines. This can often be challenging given that education research methods include both qualitative and quantitative approaches and philosophical underpinnings that are foreign to astronomy research. Therefore, it is important when publishing in AER to collaborate with those who are familiar with the approaches in either or both fields. At times it may be necessary to seek the experience of collaborators beyond those fields, for example, psychology, policy and governance.

At the inaugural IAU Astronomy Education Conference (AstroEdu [1]), we thus announced the new *Astronomy Education Journal* (AEJ). The journal is officially open and is accepting submissions of manuscripts – www.astroedjournal.org – and the first issue will be published shortly. This online journal aims to be a key global publication platform for both researchers and practitioners, in the field of Astronomy Education, Research, and Methods.

AEJ aims to meet the needs of the astronomy education community by providing a location for all manner of practical, newsworthy and scholarly publications involving developments in the field. In a sense, the journal tries to capture the original spirit whilst taking on board the important lessons from the, now out-of-print, Astronomy Education Review. By focusing on building community collaboration, disseminating important news and opinions, while also maintaining a section on more formal, technical, Astronomy Education Research (AER). This research section intends to compliment the current scholarly discipline-based work undertaken by Latin-American Journal of Astronomy Education (RELEA), the Journal of Astronomy & Earth Sciences Education (JAESE) and, recently, the acceptance of AER articles into Physical Review Physics Education Research (PRPER).

Inspired by our sibling, IAU Commission C2: Communicating Astronomy with the Public journal, the *CAP journal*, we will accept various types of articles. AEJ will draw on journals such as the *CAP Journal*, *Nature*, *and Science*, to incorporate both peer-reviewed and non-peer reviewed articles. There will be a peer-reviewed section of research articles that will be incorporated into AEJ's scholarly indices. These research articles will be formally peer-reviewed as traditional scientific journal manuscripts and, as such, need to be of a sufficient scholarly standard as recommended by, for example, Scopus. In addition, there is also scope for published invited reviews written by specialists of the area of AER.

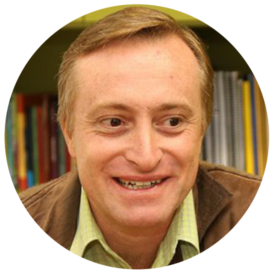
There will also be a less formal, non-peer-reviewed, but edited and curated section that contains other relevant material, such as, news, announcements, interviews, opinions, resources, correspondences, best-practices, classroom and astronomical activities, to help circulate information among the community.

We welcome everyone to submit manuscripts to AEJ by visiting: www.astroedjournal.org

[1]Held in Garching, Germany, 16-18 September 2019, https://iau-dc-c1.org/astroedu-conference/

Importance and Particularities of Astronomy Education: What the Research Says

Presenter: Rodolfo Langhi, São Paulo State University (Unesp), School of Sciences, Astronomy Observatory, Brazil



This presentation shows that research results in the field of Astronomy Education point to justify the importance of its teaching and some of its particularities that differentiate it from other sciences. What are the aspects that differentiate Astronomy from other sciences regarding its popularization and teaching? Why is it important to teach Astronomy? What Astronomy is present in the Brazilian government curriculum? The answers are presented using the results of research in the field of Astronomy Education through a bibliographical survey.

Poster link: `https://astro4edu.org/siw/p32`

This paper shows that research results in the field of Astronomy Education point to justify the importance of its teaching and some of its particularities that differentiate it from other sciences. What are the aspects that differentiate Astronomy from other sciences regarding its popularization and teaching? Why is it important to teach Astronomy? The answers are presented using the results of research in the field of Astronomy Education through a bibliographical survey. This study is a qualitative research in Education and the method of analysis of data is the Content Analysys (Bardin) with bibliographical survey. The phases of this study are: Pre-analysis, Material exploration, Treatment of obtained results and interpretation. The corpus of analysis are the academic bibliographical production in Brazil ("voice" of researchers): journals of "Banco da CAPES", "Teaching" Area (from 2004 to 2017); thesis and dissertations about Astronomy Education (from 1973 to 2018); proceedings of Brazilian scientific congresses (from 2004 to 2017).

The results of this research answer the question: It is important to teach Astronomy because: It Awakens curiosity and motivation in students and people in general, because the Astronomy is "popularizable", favoring scientific culture; Teaching Astronomy can demystify some common-sense ideas or misconceptions; Frees the student from certain fears and ignorance; Illustrates and contributes to a vision of scientific knowledge as a process of historical and philosophical construction; It represents a clear example that science and technology are not far from our society; It is highly interdisciplinary, because Astronomy connect with other disciplines; Its physical objects of study are beyond the eyes of students, we cannot "touch" most astronomical materials to be properly analyzed; It is basically a visual science - the teacher needs to make use of pictures, photos, videos, models and other specific teaching resources; It enhances teaching work focused on the practice of experiments and models 3D, because three-dimensional astronomical phenomena is not always understandable in teaching with a two-dimensional figure; It involves systematic observation of the sky with the naked eye and with telescopes; Your laboratory is natural and free, with sky available to everyone; Many of the phenomena observed in the universe have never been, and are not usually found or reproduced on Earth; Its study challenges the ability of imagination and understanding; Allows the existence of an amateur area - amateur astronomers collaborate with observational data and studies; It enhances citizenship and interpersonal and social relationships (amateur or scholar clubs and associations); It favors the construction of specific non-formal teaching spaces (observatory, planetarium); Learning Astronomy we can note the errors in the sensationalist media news and conceptual errors in textbooks; Learning Astronomy, the teacher not needs to feel fear of this content, neither run away from teaching it; It leads the human to mental restructurings that surpass intellectualism and simple knowledge; Studying the universe provides the development of unique aspects of the human mind: fascination, admiration, curiosity, contemplation and motivation; Only understanding the dimension of universe, we can develop awareness of the urgent need to take care of our planet (the only possible home to live for now).

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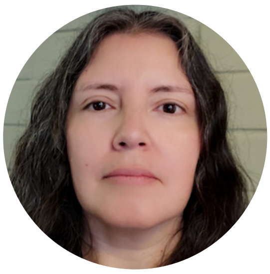
Astronomy Alternative Conceptions in Pre-service Science Teachers

Presenter: Leonor Huerta-Cancino, Universidad de Santiago de Chile, Chile



Student's alternative conceptions are persistent, and teachers should be aware, to address them.But teacher´s alternative conceptions can influence their students to elaborate alternative conceptions too. To prevent this from happening, it is necessary for teachers to be able to differentiate between scientific concepts and the most common alternative conceptions on the topics they teach in school.In this sense, an important step is to identify pre-service teacher´s alternative conceptions, to then develop didactic designs that facilitate the learning of scientific concepts, with the aim of pre-service teachers do not use alternative conceptions at the time they teach astronomy or science in schools.

Poster link: `https://youtu.be/OsEbcI1erQI`

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In this sense, an important step is to identify pre-service teacher´s alternative conceptions, to then develop didactic designs that facilitate the learning of scientific concepts, with the aim of pre-service teachers do not use alternative conceptions at the time they teach astronomy or science in schools.

My research was designed to identify and to analyze most common alternative conceptions (CAM), of future Physics teachers, for three cohorts (2014, 2015 and 2016). Categories of analysis were defined allowing to select a set of CAM for which it was determined the need to develop specific teaching sequences to facilitate future Physics teachers learning the current scientific knowledge on those contents. To identify CAM, it was used a modified version of the standardized test Astronomy Diagnostic Test v2.0. Results show a limited set of CAM, similar to the three groups, on the following topics: movements in the celestial sphere, sizes and distances at scale, moon phases, eclipses and seasons, and star's properties.

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Statement of Astronomy Education in Chile

Presenter: Angie Barr Domínguez, Universidad Autónoma de Chile,
NAEC Chile team, Chile

Collaborators: Carla Hernández (Universidad de Santiago de Chile), Daphnea Iturra (Universidad de la Santísima Concepción), Maritza Arias (Colegio Leonardo da Vinci Vicuña), and Hugo Caerols (Universidad Adolfo Ibáñez).

The exceptional conditions of the Chilean sky for astronomy have allowed it to be an undisputed leader concentrating 70% of world capacities. However, Astronomical Education in Chile is not a developed area. Currently, there is no teacher training in astronomy. In the primary education, the astronomy occupies only 6.25% of the topics in the Natural Sciences. After that, astronomy is lost until high school, when students are 15 years and older. For this reason, NAEC Chile team carried out the I National Conference of Astronomical Education, which arises from the latent need to strengthen the teaching and learning of astronomy in our country. As a result, it was possible to identify new topics of interest to teachers, needs for their training and to strengthen the study program at school.

Poster link: https://astro4edu.org/siw/p34

The exceptional conditions of the Chilean sky for astronomy have allowed it to be an undisputed leader concentrating 70% of world capacities(1). However, Astronomical Education in Chile is not a developed area. In primary education, astronomy occupies only 6.25% of the topics in the Natural Sciences area. The aim is to develop a state of art of astronomical education in Chile, for this reason meetings(2) and focus groups were held with science teachers of primary, secondary education and all people interested in astronomical education in Chile.

This research is explorative, using data collection with qualitative analysis techniques. The data collection was carried out through surveys and virtual meetings with teachers from different regions throughout Chile. In total, 256 people interested in astronomical education in Chile participated, of which 28% correspond to primary education, 41% correspond to secondary education, 11% correspond to preservice teacher, among others. The participants came from different areas of the country.

We identify some weaknesses in the teacher training about astronomy education. The activities and resources most used in class are videos and models, and the least frequent are observations of the sky with their students in class. In the scholar programs, there is a discontinuity of astronomy from the third to the ninth year of schooling (9 years old to 15 years old). From this there is consensus in the interest to expand the astronomy contents incorporated in the curriculum, and connect astronomy with other areas of knowledge, such as mathematics, history, arts, etc., as a multidisciplinary science. With this review it was possible to characterize the experience of teachers on Astronomy Education in Chile and identify the challenges faced by teachers to teach astronomy at different educational levels. Lines of action for future investigations are proposed according to the findings like:

1. Establish a link between program experts and work with the local educational community to modify the curricula.

2. Organize teacher training events and developing educational material adapted to the needs of our country.

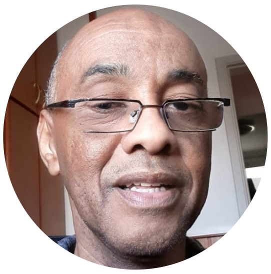
3. How to promote astronomy in an integral way in the school program.

References: Reaching for the Stars, Alcanzando las Estrellas: Hallazgos de las Cumbres Chileno-Estadounidenses de Educación y Difusión de la Astronomía Santiago de Chile, noviembre de 2016, https://sites.google.com/view/naec-chile

Justifications for Teaching Astronomy in Basic Education: A Look at Research Carried out in Brazil

Presenter: Antônio Carlos da Silva, University of São Paulo, Brazil

Collaborators: Rubens Parker Mamani Huaman (Cristina Leite), Raquel Gomes dos Santos (Inter-unit Post-Graduation in Science Teaching, University of São Paulo)



It presents a survey of the last ten years, of the importance and justifications attributed to the Teaching of Astronomy by Brazilian researchers in the area, in their investigations. Of 220 works found in journals related to this field of knowledge, arguments were identified in 67 of them. To verify the nature of these justifications, categories established by Soler (2012) were used: the awakening of feelings that astronomical themes can arouse in different audiences; the socio-historical-cultural importance attributed by humanity to Astronomy; the possibility that this Science can broaden the worldview and raise awareness on issues such as environmental preservation and citizenship; and the ability that Astronomy has to interrelate with other areas of knowledge (interdisciplinarity).

Poster link: https://astro4edu.org/siw/p35

Many researchers in Astronomy Teaching affirm in their investigations the need to promote the dissemination of teaching in this discipline through the stages of Basic Education (LANGHI; NARDI, 2014). Thus, we seek to answer "how do Brazilian researchers in the field of astronomy education justify the importance of this teaching in Basic Education?". This work, of bibliographical review, inserted in the perspective of qualitative research, analyzes the main periodicals in the area in Brazil published between 2010 and 2020 in order to map the main justifications for the teaching of astronomy.

Starting from the context of qualitative research, Moreira (2011) says that the interest of this type of investigation is anchored in the elucidation and exposition of meanings by the researcher to the meanings people attribute to events and objects in a social context. The research methodology is guided by Content Analysis (Bardin, 2016) and went through the organization phases: pre-analysis, material exploration and treatment of results and interpretation.

We analyzed articles published in the main periodicals in the area in Brazil: Revista Latino-Americana de Educação em Astronomia; Brazilian Notebook of Physics Teaching; Brazilian Journal of Physics Education; Science & Education - UNESP; Science & Teaching - UNICAMP; Essay: Research in Science Education - UFMG; Research in Science Teaching - UFRGS; Brazilian Journal of Research in Science Education – ABRAPEC. In all, 220 works on Astronomy Teaching were analyzed.

In the pre-analysis stage, we performed a manual search on the websites of the journals themselves and collected all articles available until the end of 2020 and that presented a study within the astronomy theme indicated in the titles, abstracts or keywords. With this set of 220 articles, we organized the material using a reference manager and then skimmed all the works, selecting those developed in the context of basic education, excluding articles on hard astronomy. In the next phase, designated as material exploration stage, 67 articles were read in full, in search of arguments aimed at Basic Education and discarded those aimed at non-formal and informal education; later, we carried out an exhaustive reading of the excerpts that had the justifications present in the articles. Finally, in the stage of processing the results and interpretation, we analyzed the justifications found and categorized them. We use four major categories built from a rereading of a previous work (LEITE; SOLER, 2012): the awakening of feelings that astronomical themes can provoke in different audiences; the socio-historical-cultural importance attributed by humanity to Astronomy; the possibility that this Science can broaden the worldview and raise awareness on issues such as environmental preservation and citizenship; and the ability of Astronomy to interrelate with other areas of knowledge (interdisciplinarity).

Among the considerations, it can be indicated that, although there is an increase in the number of researches that seek to justify the presence and importance of Astronomy Teaching in Basic Education, the arguments pointed out remain similar to those found by Soler (2012). In addition, the justifications continue to be presented without theoretical foundation, that is, in a superficial way, which reveals the need for research dedicated to investigating these arguments in greater depth.

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Discussion summary

The talks from our experts[2] instigated some key discussion points that were unpacked during the live panel. The overarching themes can be summarised into: Fostering collaborations between astronomers, astronomy educators and astronomy education researchers; tips for those new to AER; ways to inspire teachers who may not be interested in participating in research projects, and to foster collaborations with teachers; navigating the Ethics landscape especially across countries; and the nuts and bolts of the Astronomy Education Journal.

Janelle Bailey's wise statement "there is no point re-inventing a flat tire" provided a fundamental insight. Although there are resources, when starting out (or even if you are already) in AER, it is prudent to collaborate with individuals who have expertise in various aspects. For example, have a teacher on your team who can engage with not only the excited teachers ("learners"), but also those not interested ("tourists and prisoners"). One way to foster collaborations with teachers is to approach pre-service teachers via the relevant universities and/or colleges, because early engagement can potentially sow the seeds for long-term collaborations.

Although some countries/institutions may not have an ethics board, it is vital to understand that we are dealing with "autonomous human beings", and that we are not doing research on people but with people. Therefore, collaborating with researchers who have access to an ethics board can provide an objective assessment and guide the ethical considerations of your project, rather than trying to build your own ethics board.

[2] Sanlyn Buxner joined us as a guest expert for the second live panel session.

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