WEST AFRICAN INTERNATIONAL SUMMER SCHOOL FOR YOUNG ASTRONOMERS (WAISSYA), NSUKKA 2015

GENERAL REPORT

1. PROJECT SUMMARY

The West African International Summer School for Young Astronomers (WAISSYA) 2015 is the second organized school after the one held in October 2013. The school was organized and taught by a collaboration of astronomers from the Canadian Institute for Theoretical Astrophysics / University of British Columbia, the Dunlap Institute for Astronomy and Astrophysics at the University of Toronto, the NASRDA Centre for Basic Space Science (CBSS) at the University of Nigeria, Nsukka, the European Southern Observatory, and the University of Cape Town. The school was held between July 13-17, 2015 at the University of Nigeria, Nsukka.

West Africa has huge potential to develop a strong astronomy community; thanks especially to its large number of talented students interested in science. Nigeria is especially interested in building up a critical mass of West African astronomers and establishing collaborations with universities/astronomy institutes outside the region. This brought about the idea for WAISSYA through conversations at the International Astronomical Union (IAU) General Assembly held in Beijing in 2012. Major goals for the school include the following: encouraging West African science students to further their interest in astronomy, exchanging ideas on education between West Africa and North America, and developing critical thinking skills in students.

The school consists of a compact lecture series and activities covering the basics of astronomy and space science as well as some advanced astronomy. Findings from science education research were used in designing teaching plans to be as effective as possible. In particular, lessons included teaching scientific thinking along with scientific content, and incorporating rigorous assessment to evaluate the effectiveness of the program. The teaching activities we designed included the following: (1) community-building group discussions on topics like why one might study astronomy; (2) lectures and problem sets using "peer instruction" techniques (e.g., questions where students vote alone, discuss in groups, then vote again) on the topics of stars, extrasolar planets, galaxies, and cosmology; (3) solar observing with Sun spotter telescopes; (4) an advanced session on Python and data analysis; and (5) the educational focal point, a two-day inquiry-based lab on the Cosmic Distance Ladder designed by the Canadian team in collaboration with the Institute for Scientist & Engineer Educators at the University of California, Santa Cruz.

2. PLANNING & GOALS

In order to maximize the success of WAISSYA, a local organizing committee (LOC) was formed by CBSS Management in addition to the International technical committee. Several

SkyPe meetings were held between the LOC and the Technical committee for proper synergy.

To ensure that enough funds were raised for the successful organization of the school, the organizers were given a grant of 7,000 euros by the Office of Astronomy for Development (Task Force 1) through a joint proposal by Bonaventure Okere, Linda Strubbe, and colleagues.

To ensure effective teaching and learning, the organizers designed both learning and teaching goals for the school, which are outlined below. The school was divided into two streams: most of the students were part of the general undergraduate / teacher stream, and a small group of students were enrolled in the advanced stream. Students in the advanced stream took part in most of the undergraduate / teacher stream, but they also attended an advanced workshop during the middle of the school.

2.1. Overall Goals for Astronomy / Science Education in West Africa

- Build a critical mass of astronomers who will support the upcoming astronomy projects in Africa.
- Strengthen capacity building for astronomy development in West Africa.
- Continue laying groundwork for sustainable Canada-West Africa astronomy partnership.
- Exchange ideas about teaching and learning science between West Africa and North America, including inquiry-based teaching.
- Help students to become more confident and empowered to pursue science, and to think analytically about the world.

2.2. Undergraduate / Teacher Stream

Overall Goals

- To make students feel inspired to continue learning astronomy.
- To increase the general knowledge in astronomy of students to the level that they are able to read basic astronomy texts on their own.
- To give students the know how to apply the principles of critical thinking and the scientific method to pose their own questions and investigate those questions.
- To make students feel excited to share what they learned at the school with others

- To incite students to feel interested in trying new (e.g., inquiry-based) teaching and learning methods.
- To allow alumni to stay connected and engaged after the school finishes, especially as the community of astronomy-interested people in West Africa continues to grow.
- To support alumni who are interested in attending graduate school, and provide information to navigate that path.
- To offer students and instructors a cross-cultural exchange which would allow each group to learn more about the other, i.e., participants would learn what people from North America and West Africa are like, and feel more perspective about the similarity of people here on our small planet.

Content Areas

- Measuring distances in the Universe (Inquiry Activity)
- Stars
- Exoplanets
- Galaxies
- Cosmology

Inquiry Activity Goals

Main Content Goals

- Students will learn how the method of parallax works for measuring distances in astronomy.
- Students will learn that the apparent brightness of an object decreases as the inverse square of the distance from the object, and that objects of known intrinsic brightness can be used to measure distances in astronomy.
- Students will learn the limitation of the parallax method, and therefore, why standard candles technique is required.
- Students will learn important distance scales in the Universe (size of solar system, distance to nearest star, size of galaxy, distance to nearest galaxy, size of observable universe).

Main Scientific Practice Goals

- Students will improve their ability to devise a question that is investigable and to plan a path or procedure for investigating that question in a team, e.g., big problems need to be broken down into smaller problems.

- Students will understand that they can use the same techniques to measure vast distances across space that they use in their backyard.

Advanced / Postgraduate Stream

Content Areas

- UNIX Fundamentals
- UNIX Based research tools and their usage
- Astronomy data reduction packages (IRAF, DS9, AIPS, KARMA, CASA, etc)
- Sources of freely accessible astronomical research data and how to use them (archives of Spitzer, WISE, 2MASS, VERA, VLBA, GBT, SMA, ALMA, ACTA, etc)
- Astronomy data reduction procedures

Goals

- Train postgraduate students on how to access online data sources.
- Teach students how to use astronomy software for data reduction.
- Provide a 'launchpad' for those considering a career in Astronomy
- Exposing them to available Astronomy research resources (archive, astronomy data reduction/analysis software packages).
- Stimulating their minds in the research-oriented direction.
- Hands-on/Group training on research proposal and paper writing.
- Exposure to Astronomy Data Reduction Packages.
- Exposure to UNIX based research tools.
- Learn to write observation proposal.

3. LOCAL ORGANIZING COMMITTEE

For a successful hosting of the Summer School/Workshop, the Director of CBSS set up a local organizing committee (LOC), on 13th May, 2015. The committee was mandated to;

i. Plan for the successful hosting of the Summer School

ii. Source for funds

iii. Review the cost estimate to a realistic and affordable level

iv. Search for collaborators for the hosting of the Summer School

v. Report to the Senior Management team within two (2) weeks.

4. WAISSYA 2015 - INSTRUCTORS

The school started with the arrival of the instructors on July 7, 2015. The instructors include:

1. Linda Strubbe (University of British Columbia / Canadian Institute for Theoretical Astrophysics), - Canada Team leader
2. Jielai Zhang (Dunlap Institute for Astronomy and Astrophysics, Canada),
3. Wolfgang Kerzendorf (European Southern Observatory),
4. Thai Duy Cuong Nguyen (Dunlap Institute for Astronomy and Astrophysics, Canada),
5. Patrice Okouma (University of the Western Cape, South Africa / NOMMO ASTRONOMIA, Gabon),
6. Bonaventure Okere (NASRDA Centre for Basic Space Science, Nsukka), - West Africa Team leader
7. Romanus Eze (University of Nigeria, Nsukka),
8. Finbar Odoh (University of Nigeria, Nsukka), and
9. Eseanwi Sudum (NASRDA Centre for Basic Space Science, Nsukka).

Team Members working on planning and post-school analysis:

i. Valerie Murray (Canada),

ii. Meiling Deng (University of British Columbia), and

iii. Anabele Pardi (Max Planck Institut für Astrophysik, Germany).

We also acknowledge the contributions of Kelly Lepo (McGill University) and Heidi White (University of Toronto) who were designers and instructors for the first WAISSYA in 2013.

5. PRE-SCHOOL WORKSHOP & PAIRED TEACHING

Prior to the commencement of the school, the instructors held a 3-day pre-school workshop to enable the West African team to understand the application of the inquiry based method of teaching, and for each teaching pair to harmonize their teaching plan. The first day involved introductory group discussions on the reasons we teach astronomy, the teaching backgrounds of everyone, evidence-based teaching principles from the book "How Learning Works," then practical experience and discussion on an interactive learning activity on cosmology. The second day introduced the idea of inquiry-based teaching. This gave instructors the opportunity to experience parts of the Cosmic Distance Ladder inquiry activity as students, and included discussion of how to facilitate inquiry activities.

The third day comprised pairs of instructors working together on developing interactive lectures. Physics education research suggests that pairs of instructors teaching together can provide professional development to both members, and enable one member to introduce the other to evidence-based teaching strategies (such as peer instruction and inquiry). There were four teaching pairs, three of which comprised one West African instructor and one Team Canada instructor, and the fourth of which comprised two West African instructors. Each pair planned and taught an interactive lecture together on one of the content areas. An informal survey following the school found that instructors enjoyed and felt that they benefited from this paired-teaching arrangement (although the ability to begin planning together sooner would be helpful). For example, one instructor wrote, "Collaborating with other teaching partner works perfectly well because… we discussed and decided our roles and responsibilities in advance… I enjoyed equal status with my partner… [and] I learned a lot from my partner."

6. THE SCHOOL

The School started proper on July 13, 2015 with an opening ceremony witnessed by Emeritus Prof. Pius N. Okeke, Prof. F.E. Opara (Director NASRDA CBSS), Prof. F.N. Okeke (Member Space Advisory Council of Nigeria), Deputy Vice Chancellor of University of Nigeria, Nsukka, The Director, National Centre for Energy Research and Development, University of Nigeria Nsukka, among others.

The school was designed so that passive learning could be minimized. Instead, more active learning methods such as inquiry based learning (a method adapted from the Institute for Scientist & Engineer Educators, USA) are used.

Major learning environments of the school are:

1. 2.5 day Inquiry-method based activities
2. Five lectures with interactive activities or questions addressed to students
3. Group teaching activity
4. Facilitated discussions throughout the school (groups of 10 or less)
5. Self reflection

Below we describe components of the stream for undergraduate students and teachers of the school. The advanced stream of the school is described in Section 8.

6.1. The Inquiry Activity

The inquiry activity was designed so that scientific practices and scientific content is learned at the same time, mirroring authentic scientific research. Students are given a set of stimulus images which provoke their own questions. Based on common interest in questions, students get into groups of four and undergo problem solving together.

The content goals of the Inquiry Activity were:

- Students will learn how the method of parallax works for measuring distances in astronomy.
- Students will learn that the apparent brightness of an object decreases as the square of the distance from the object, and that objects of known intrinsic brightness can be used to measure distances in astronomy.
- Students will learn the limitation of the parallax method, and therefore why the standard candles technique is required.
- Students will learn important distance scales in the Universe such as the size of solar system, the distance to nearest star, the size of galaxy, the distance to nearest galaxy, and the size of observable universe.

The scientific practice goals of the Inquiry Activity were:

- Students will improve their ability to devise a question that is investigable and to plan a path or procedure for investigating that question in a team. e.g., big problems need to be broken down into smaller problems.
- Students will understand that they can use the same techniques to measure vast distances across space that they use in their backyard.

6.2. Lectures

Lecture topics covered were:

- Exoplanets
- Stars
- Galaxies
- Cosmology
- Instrumentation

The lectures were given by a pair of lecturers, usually one from Nigeria and one from outside of Nigeria. This enabled collaboration and mutual learning.

6.3. Group Teaching Project

Students designed a module that can be used as a teacher to teach a group of students about something they have learned at the school.

Goal + Rationale for Group Teaching Project:

- In the process of designing this teaching module, students would better understand the content they are trying to teach, and students would get practice in new teaching techniques.
- During the poster sessions, students would have another avenue to discuss astronomy concepts that stood out to them.
- We hope students would teach their module after returning from WAISSYA, and share on their ideas on Facebook, as well as help to contribute to an active and lively community of alumni and instructors.
- Students would get practice communicating and overcoming stage fright.
- By working in pairs and having students give feedback, a community would be built around the school.

6.4. Facilitated discussions throughout the school (groups of 10 or less)

As part of the Inquiry Activity Group Teaching project and lectures, various forms of facilitated discussions occurred. Beyond this, the following special discussions occurred:

- How to build an astronomy community together
- Careers in astronomy and beyond

6.5. Self-Reflection

From the second day onwards, students spent 5-10 minutes each morning reflecting on their learning with the following question prompts:

- Write down a few interesting things you learned yesterday
- Write down a few questions you have on what you learned yesterday
- Write down a few things you would like to learn today or would like to eventually learn related to astronomy and astrophysics
- Comment what you liked or disliked about yesterday's lecture and activities. (Please include a comment on the pace of lectures.)
- How were the learning experiences you had yesterday different to what you've experienced before?

7. EVALUATION & STUDENTS' RESPONSES (Undergraduate stream)

7.1. Students' attitudes

We conducted the well-known and extensively used CLASS survey (Colorado Learning Attitudes about Science Survey[1]) with our WAISSYA students, pre- and post-summer school. The survey consists of 42 statements that students must rate using a Likert scale, from "strongly disagree" to "strongly agree" (from 0 to 5). The CLASS has been validated using interviews, reliability studies and extensive statistical analyses of responses from over 5000 students around the world[2]. For more details see http://www.colorado.edu/sei/class/.

The statements of the survey are grouped into categories. For example, *conceptual understanding* (e.g., "A significant problem in learning physics is being able to memorize all the information I need to know."), *applied conceptual understanding* (e.g., "If I get stuck on a physics problem, there is no chance I'll figure it out on my own."), and *learning styles* (e.g., "I cannot learn physics if the teacher does not explain things well in class.").

Nineteen of our students completed the survey pre- and post-summer school. We analyzed the percentage of responses for which the students agree with the experts' view determining their shift in attitude after the summer school.

Generally, students stated a strong personal interest in connection to physics. They reported that they were not satisfied until they understood why something works the way it does, and they strongly agreed that they study physics to acquire knowledge that would be useful in their lives outside of school, and also that learning physics changed their ideas about how the world works. However, a quarter of the students felt that the subject of physics has little relation to what they experience in the real world (24% pre- / 21% post-school).

Most of the students (72% pre- / 74% post-school) were confident they could deduce equations and figure out a way to solve a problem they were stuck at, and they agreed that spending time on understanding where formulas come from is important. Still, a significant percentage (44% pre- / 42% post-school) feel that learning physics means being able to memorize new information, and about one-third of students (38% pre- / 32% post-school) had difficulties solving problems even after having studied a certain physics topic. Also, half of the students stated that they are not flexible with the methods they need to apply for solving problems. Interestingly, while more than 70% of the students prior to the school felt that problem solving and attention to details were the most important methods for learning physics, this percentage dropped to 50% after the school.

The WAISSYA summer school helped improve students' confidence in problem solving and being creative in applying a method to a variety of situations. After the school, we saw an increase in intuitive approaches (35% shift from before the school

[1] Adams et al., Phys. Rev. ST Phys. Educ. Res., 2, 010101 (2006)

[2] However, note that we did not have the opportunity to validate the survey with our specific population of students for WAISSYA 2015. We plan to do this for future summer schools.

to after) for problem solving and a more critical attitude about the validity of their results. We are pleased that 74% (increased by 2 percent after the school) of the students believe that nearly anyone is capable of understanding physics. We saw a significant expert-like shift for the statement "I cannot learn physics if the teacher does not explain things well in class." Prior to the school, 47% of the students agreed with this statement (and disagreeing with an expert opinion), and this percentage dropped dramatically to 37% after the summer school. These findings suggest that students felt more empowered to learn on their own after the school, which was one of the overall goals of WAISSYA.

Figures 1 and 2 summarize the CLASS results. The plots show the percentages of students who agree and disagree with expert-like responses, before and after the summer school. There is a noticeable increase in student agreement with expert-like responses, and decrease in disagreement with expert-like responses. These CLASS survey results help support the idea that WAISSYA fulfilled some of its most important goals: helping students feel more confident and empowered to pursue science, to think analytically about the world, and to apply critical thinking to investigate their own questions.

A more detailed analysis (including comparison with groups of students from other countries) is in progress and will be available in the near future for whomever is interested.

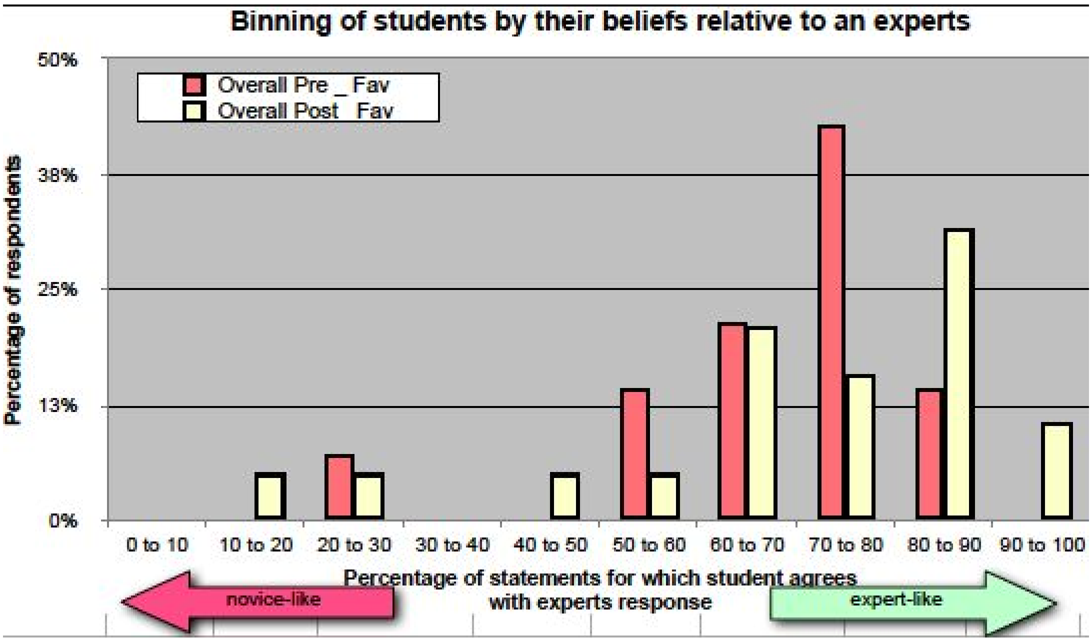

Figure 1: Binning of students by their beliefs relative to the expert's beliefs. Overall pre-summer school favorable answers (red columns) and post-summer school favorable (yellow columns). Above 80% of student statements are noticeably shifted towards the expert-like response.

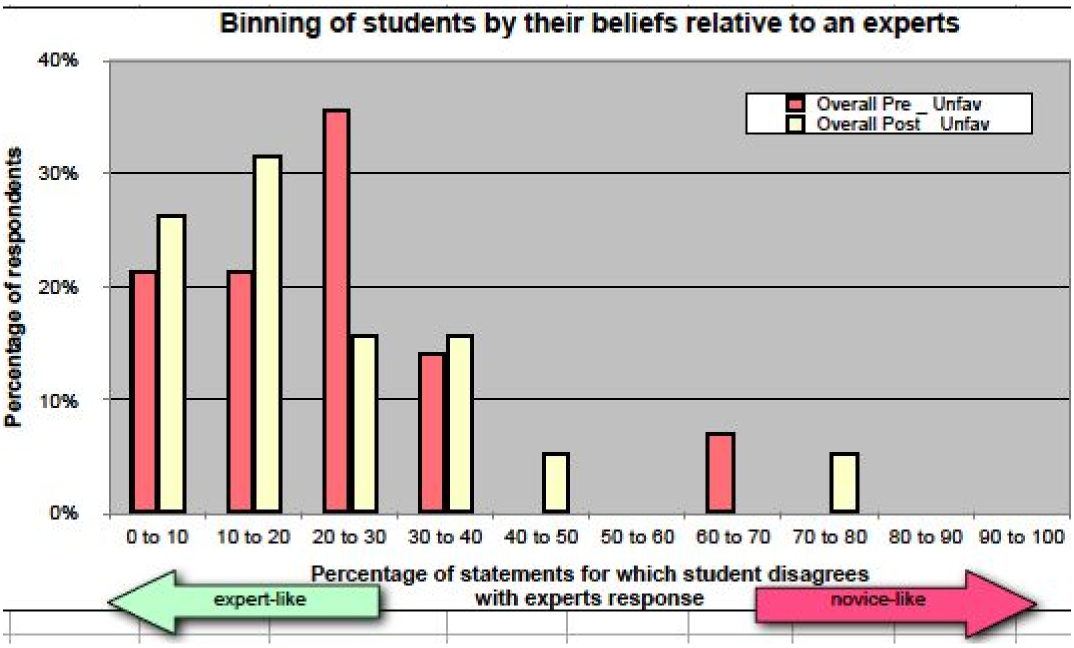

Figure 2: Same as Figure 1, but for the unfavorable statements. Here we can see the same noticeable shift towards the expert's view for up to 20% of statements.

7.2. Concept inventory survey results

We gave students a 15-question concept survey about astronomy, at the beginning and at the end of the school, to measure their learning of astronomy content. Our survey was largely adapted from the *Astronomy Diagnostic Test*[3] *Version 2.0*, used in many first-year astronomy courses in the United States. We gave the same survey to students at the school in 2013. We found that the average score at the beginning of the 2015 school was 30%, and the average at the end of the school was 51%.

Figure 3 shows the scores for each individual question, before and after the school. The boxed questions are those most relevant to the content taught at the 2015 school.

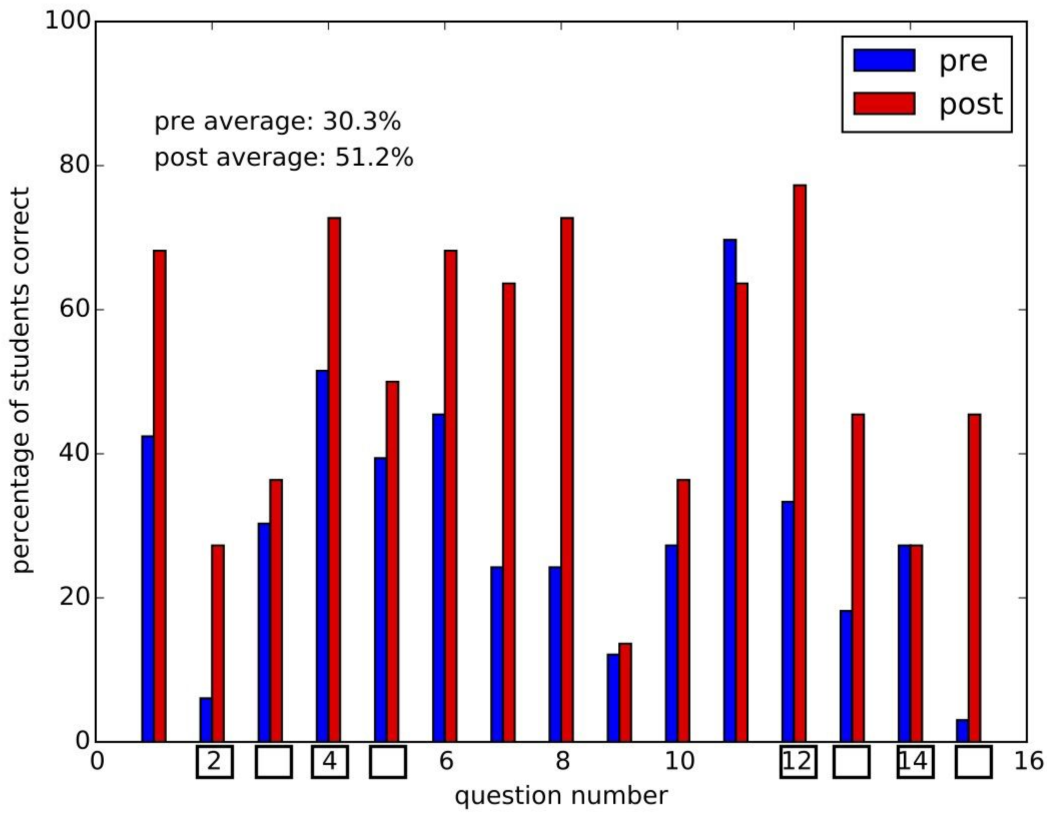

Figure 3: The scores for each question of the concept inventory survey. Boxed question numbers are those most relevant to the content taught in WAISSYA 2015.

[3]The ADT was written by the Collaboration for Astronomy Education Research in 1999, and is available at http://solar.physics.montana.edu/aae/adt/.

Example questions:

12. *According to modern ideas and observations, what can be said about the location of the center of the Universe?*
A. The Earth is at the center.
B. The Sun is at the center.
C. The Milky Way Galaxy is at the center.
D. The Universe does not have a center.
E. An unknown, distant galaxy is at the center.

14. *As viewed from our location, the stars of the Big Dipper can be connected with imaginary lines to form the shape of a pot with a curved handle. To about where would you have to travel to first observe a considerable change in the shape formed by these stars?*
A. Across the country
B. A distant star
C. Europe
D. Moon
E. Pluto

Students were also asked about their confidence in their answers. At the beginning of the school, most students chose "not sure" or "confident", and after the school, more students chose "confident."

We are currently preparing to give a follow-up survey to WAISSYA alumni (8 months post-school). For the next summer school in 2017, we are considering using a concept inventory more targeted to the content focus of the school (e.g., a concept inventory specifically on distances in the universe).

7.3. Students' reflections

At the beginning of each day, we gave students the following questionnaire:

1. Write down a few interesting things that you learned yesterday and that you'd like to learn today.

2. How were the learning experiences you had yesterday different from what you have experienced before?

3. Comment on what you liked and what you disliked about yesterday's lecture and activities.

Here is a brief summary of the results.

Generally, students expressed high satisfaction with the activities of the summer school, especially the interactive parts. Most commonly mentioned highlights were the group discussions, presentations, and assembling the Galileoscope (a small plastic telescope). Fully 100% of students wrote positive comments about the school in their reflections. For example, one student wrote: “Yesterday’s lectures are highly informative and educative. I enjoyed every aspect of it.” Many students wrote that they like our instructors, in particular for their patience and passion. In terms of areas students would like to learn more about, the most common response was cosmology (11% of students). There were few negative comments, but the most common suggestions were to slow the pace (10%), spend more time on mathematical derivations (10%), and give more clear/direct answers (5%).

7.4. Students’ evaluation survey

On the last day, students were given an overall evaluation survey where they were asked open-ended questions. We were able to get a sense of students overall impression of the school, as well as what they wanted changed in future schools.

Students really felt that instructors were interested in making sure they learned well in the course and found the course intellectually stimulating. Students had more varied opinion on whether pace of the school was comfortable and whether there were reasonable learning expectations. There was a real sense that students got a taste of what doing science is like, and that new connections were made as a result of the school. Here are a few quotations from students:

“I've learnt a great principle in life and that is to break mighty problems into smaller tasks using through-provoking questions and finding solutions to those tasks. Consequently, I'll solve the mighty problem with time.”

“It is wonderful, learning astronomy from the little things we see and do everyday.”

“The program has indeed made me to acquaint myself with other students and as such this bring about exchange/ sharing of ideas. If the program could be a regular routine, it will be quite commendable.”

Changes students wanted to see in future schools were as follows:

- Advertise the School more widely, get more participating Universities and countries
- Some students noted the lack of observing equipment
- Some students needed more time for calculations and discussions
- Some students noted the need for accommodation and lunch to be provided
- Some students suggested having two streams/ classes or having students that have more similar knowledge/ experience of astronomy
- A few students noted the lack of teaching on instrumentation, and noted it would be good to have especially for engineering students

7.5. Overall comments

Overall, responses of students at the end of the school were recorded and some of them are included below.

i. I have learned that when you are a scientist, you are always asking why, why, why, why, why -- Sister Matilda Okoyeowell

ii. I have learned that scientists are very curious...They are not so exceptional, just that they ask lots of questions, and they're really passionate about finding solutions to things. -- Emmanuel Ezenwere

8. ADVANCED SUMMER SCHOOL STREAM

Concurrent to the main stream for undergraduate students and teachers, instructor Patrice Okouma ran a small-scale hands-on session for a small group of advanced students. This session was aimed at introducing these students to a practical understanding of Bayesian Techniques in inference from datasets of any type. Twelve postgraduate students attended this advanced stream. Most of them were at a masters level or above in their academic training. The initial step consisted in making the group familiar with basics of writing and executing a few lines of Python code. The session relied on the Anaconda[4] platform since most of the participants were using the Windows operating system. Settings for Anaconda are straightforward under Windows. Given the time constraints, the Python introduction was done in a crash-course mode such as to allow the participants to explore further on their own. The next stage consisted of gradually presenting first the Least Square approach (weighted and unweighted) followed by the Bayesian approach in inference. To serve as a general introduction to both the Frequentist (Least Squares) and the Bayesian methodology, the problem given to the students to approach was laid down as follows.

The aim was to fit a model with N adjustable parameters $\Theta = (\Theta_1, \Theta_2, ..., \Theta_N)$ to a set of M data points (our observations) (x_i, y_i, σ_i), $i = 1, ..., M$ where σ_i are the error per datapoint. In the hands-on session, we wanted to fit a straight line (our model) $y = mx + b$ to a set of data plotted in the figure below. Our model was therefore described by two parameters (Θ_1, Θ_2), i.e., $N = 2$ where $\Theta_1 = m$ is the slope and $\Theta_2 = b$ is the y-intercept of the straight line. The problem was that we wanted the best fitting straight line for our dataset. Hence, the subsequent question: "Best" in what sense. In other words, students were faced with an optimization problem that could be transcribed either into Frequentist terms or Bayesian terms. Highlighting this methodological distinction was a requirement for clarity at an early stage. The students were then helped to understand that a basic methodological goal in any Frequentist optimization lies in the Maximization of the Likelihood. This is what is done when performing a (weighted or unweighted) least-square fitting of a straight line to a given dataset. To maximize time-efficiency, the students were provided with clearly laid down

[4] Anaconda is a completely free Python distribution. It includes more than 400 of the most popular Python packages for science, math, engineering, and data analysis. It comes as a self-contained stand-alone package easy to install on Windows platforms: https://docs.continuum.io/anaconda/index.

Python routines to perform both the weighted and unweighted least-square fitting of a straight line to a given dataset, relying on the introductory Python crash introduction. All the resources were stored on a single repository webpage accessible at http://cosmowassya.weebly.com/. From this "copy and paste" exercise in exploring the Frequentist approach and simultaneously discovering a basic structure for a typical beginner's Python code, the students had to gradually move towards understanding and then coding a simple Bayesian inference scheme based on the Metroplis-Gastings algorithm. This was to lead them into progressively understanding the Bayesian optimization framework where a key goal is the Maximization of the posterior distribution. In handling this exercise, preliminary lines of Python code were handed over to the participants, as well as a set of notes written by the lead instructor.

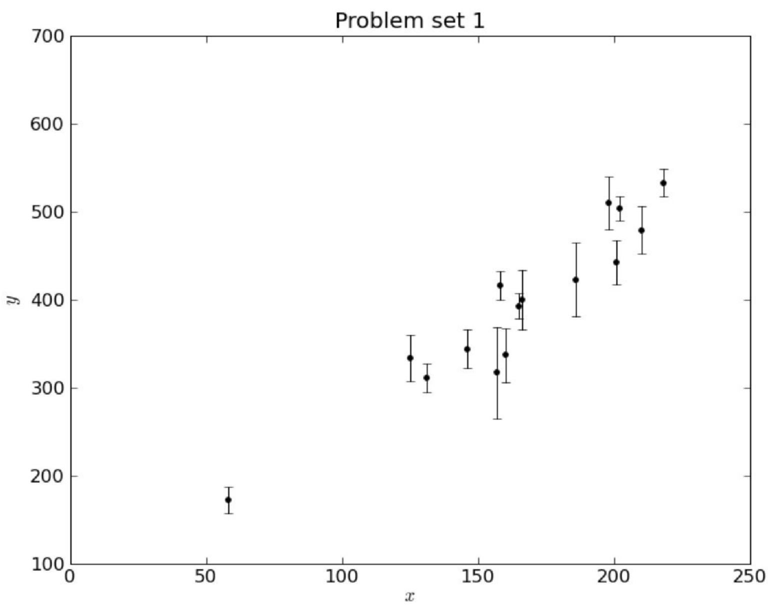

Figure 4. A plot of the data for the Advanced Stream problem set. The initial aim was to fit the "best" straight line to this data set, using a simple MCMC sampler (Metropolis-Hastings algorithm).

Due to lack of time, we were not able to finish up this last stage of the hands-on session while at the summer school. Arrangements were then made to have the interaction continued over the internet. The long-term intention was to use their understanding of the Bayesian approach towards having them working as a team on a research project whose aim would be to minimally perform a spectral characterization of a few Type Ia supernovae (SNe Ia) from a well known database using as templates:

1. Standard templates available on the Web;
2. Computer-generated templates generated by one of the School instructors based at the European Southern Observatory (ESO) in Germany.

Due to lack of time in 2015, the full implementation of this gradual immersion into a paper-oriented research project will be optimally rolled out at the next West African Summer School. Notice that as initially stipulated for this round, no students were attending both the

School and the Advanced Stream workshop at the same time. A formal feedback on the form and content of the workshop was not explicitly requested for. However, it was felt from informal interactions both on site and remotely with the students that there was a strong need for this hands-on data driven practical sessions. The option to expand the work into a clear research project with a potential for publication found a positive echo among the participants. The students asked for more of that, and this stream should be a highlight for subsequent schools.

9. PARTICIPANTS

The school comprised 60 participants distributed as follows: 50 undergraduate students and teachers and 10 postgraduate students. Among them were three participants from Ghana (though six were invited), 1 participant from Senegal, and the rest were participants from various institutions in Nigeria.

10. PUBLICITY

The Summer School was publicized through posters and email. Hardcopies of posters were sent to various institutions by express mail while soft copies of posters were sent by email to various available addresses.

11. ACCOMMODATION AND MEALS

The Instructors and foreign participants were lodged at the University of Nigeria, Nsukka Guest House, located in the University campus. They had their breakfast and dinner at the hotel while lunch was served at the Conference Centre. The local participants arranged for their individual accommodations.

12. TRANSPORTATION

Vehicles were made available to transport the foreign instructors and participants between Enugu Airport and Nsukka in both directions. Daily, the instructors were transported from the guest house to the venue of the school.

13. ATTENDANCE

All of the 50 invited students participated in the summer school/workshop. The spread of the students were as follows:

i. Nigeria 46

ii. Ghana 3

iii. Senegal 1

The breakdown of participants is as follows:

1. Undergraduate students 32

2. Postgraduate students 8
3. Teachers 10

All the invited lecturers were in attendance.

13. BUDGET IMPLEMENTATION

The budget for WAISSYA was implemented as planned. The grant received from OAD was used for the transport, accommodation and feeding of participants from other West African countries as well as the accommodation and feeding of instructors. The receipts are as attached.

14. STAKEHOLDERS MEETING

There was a meeting of all instructors, country representatives and Director of CBSS at which the following issues were considered:

i. There is need to source for funds for future WAISSYA

ii. The next WAISSYA will hold in Ghana in 2017

iii. All Instructors pledged their commitment to future WAISSYA

iv. WAISSYA shall be held biannually

15. ACKNOWLEDGEMENTS

The entire WAISSYA team would like to offer deepest thanks to the following institutions for their support:

1. International Astronomical Union Office of Astronomy for Development, for giving us a grant of 7,000 euro and for logistic support
2. Dunlap Institute for Astronomy & Astrophysics
3. Canadian Institute for Theoretical Astrophysics
4. Centre for Basic Space Science, Nsukka
5. University of Nigeria, Nsukka
6. Nigerian National Space Research and Development Agency (NASRDA)
7. University of British Columbia
8. European Southern Observatory

16. AUTHORS OF THIS WAISSYA REPORT

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Below are pictures of scenes from the School:

Instructors getting ready for WAISSYA

Students doing parallax and inverse square law inquiry activities

Participants discussing parallax inquiry activity

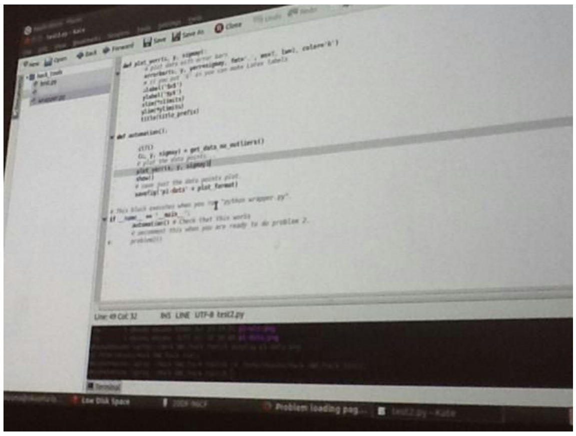

Participants in group discussion



Lecture Scene

Students viewing the sun with a solarscope

Lesson Plan preparation and presentation



Postgraduate students with Patrice Okouma in the Advanced Stream