2017-18 Report: Modeling Workshops for High School Physics and Physical Science Teachers

UM/UWC Faculty Exchange Program; Meera Chandrasekhar, Physics Department, MU

Host: Prof. Mark Herbert, Physics Department, UWC

Visitors: Prof. Meera Chandrasekhar and Mr. Douglas Steinhoff, Physics Department, University of Missouri, June 24-July 5, 2018

Purpose: To conduct a physics teacher workshop for 9th and 10th grade teachers as part of the Modeling Workshop series coordinated by Prof. Mark Herbert.

Physics Teacher Workshop

The weeklong workshop was part of a series entitled Modeling Instruction for High School Natural Sciences Teachers, A Pilot Project for Natural Sciences Teachers. In 2017-18 the project consists of eight afternoon-long meetings in January, February, March, April, May, September, October, November and December; and two summer workshops, one for lead teachers (3 days, June 26-28) and one for science teachers (July 3-5); and a daylong conference on July 2. About 90 high school science teachers attended all three activities, In addition, several education faculty and school district subject advisors attended the activities in various roles. Herbert is the coordinator of the project.

The goals of this pilot project, which runs from 2017-2020, are the following:

- Strengthen grades 8 and 9 Natural Sciences teachers' and their learners' understanding of physics and the application of physics to the world around them.
- Create a solid base of knowledge for learners choosing Physical Sciences in FET.
- Build a strong professional learning community (PLC) between the Science faculty of UWC and MSED high school teachers to enable continuous (professional) practice-based learning.
- Create leaders who will become activists for excellence in Mathematics and Physical Sciences.
- Increase interest of learners to take Mathematics and Physical Sciences in FET, as key subjects toward their future career choice.
- Provide Practice-Based Learning through three years of monthly academic training sessions and continuous academic support.

UWC-MU collaborative activities conducted Sep 2017- May 2018: (collaborators: Herbert, Steinhoff, Englebrecht and Chandrasekhar)

- Monthly Skype planning meetings (monthly; all meetings attended by Herbert and Chandrasekhar; Englebrecht and Steinhoff attended 30-40% of the meetings).
- Exploring Physics App access set up for teachers, faculty, and school district administrators in summer 2017 and 2018 workshops (about 130 persons total).
- Draft curriculum alignment between chosen units of the Exploring Physics App and South Africa CAPS, Grades, 10 and 11, Term 3, Physical Science Strand Energy and Change. This included alignment to Exploring Physics Units 3. Uniform Motion, Unit 4. Accelerated Motion, Unit 5. Introduction to Forces and Unit 8.

- Two July 2018 workshop schedules were designed, one for the smaller lead teacher workshop, and another for the larger science teacher workshop. It was agreed by the team that Unit 5 should be addressed for grade 9 and Unit 8 for grade 10 teachers, in two separate workshops, understanding that time restrictions would allow only part of the content to being addressed.
- A shared Google drive folder was set up with resources and other planning documents (shared by all faculty).

Activities during summer visit by Steinhoff and Chandrasekhar, June 25 - July 5, 2018

June 25: Planning meeting with Herbert, Englebrecht, and other members of teaching team.

June 26-28, 9-3:30 pm daily: Lead teacher workshop for 10 teachers and staff. This workshop addressed part of the content to be covered in the following week's workshops, but focused primarily on methodology and implementation. The primary goal of this workshop was to get lead teachers ready to be "table mentors" at the following week's science teacher workshops, get them familiar with the content, methodology and the Exploring Physics Curriculum app, and to make them actively think about a discussion-based classroom rather than a teacher-directed traditional classroom.

July 2: First Annual Teachers Professional Development Symposium. About 90 teachers and school administrators attended this symposium. Local District administrators, "star" teachers from Cape Metro districts, Chandrasekhar and Steinhoff made presentations.

July 3-5: Two parallel science teacher workshops were conducted. In Workshop 1, Steinhoff and a team of three lead teachers from the previous week's workshop taught 9th grade teachers content from Unit 5. Forces and Newton's Laws. In Workshop 2 Chandrasekhar and a team of four lead teachers taught grade 10 teachers content from Unit 8. Energy. In both workshops, the time period before lunch was used to address content and pedagogy in an integrated fashion. After lunch, teachers worked a short independent lesson-planning project. They were organized into small groups of 4 or 5 teachers, each led by a lead teacher, and were asked to prepare a lesson on content that had not been taught in the workshop. They then presented the present the lesson to the rest of the class on the last two afternoons. Through this independent lesson-planning project, teachers expanded their use the EP app beyond the content learned in the workshop, allowing them to use the resource more broadly in their upcoming classrooms.

About 60 teachers attended all three days of these workshops. Another 20 teachers attended one or two days. Subject advisors from Metro South and North, Englebrecht and Julio Voges, respectively, attended both workshops. Furthermore, they generated enough interest that upper level administrators from WCED, Suanne Rampou, Trevor Daniels, and Lyndon Manas spent varying amounts at time at the workshops and interacted with teachers and workshop leaders.

During the workshop science teachers conducted hands-on activities in small groups of 3-4 teachers, with lead teachers at working with their small groups. Teachers were asked to "think like 9th or 10th graders" so that the atmosphere would mimic their classrooms, particularly as regards student misconceptions. Furthermore, they could learn to use

questioning strategies to probe student ideas. This allowed teachers to open up and voice ideas that they might encounter in their own classrooms. Teachers used the Exploring Physics App, which includes extensive opportunities for exploration of concepts and discussion among teachers as they conduct the hands-on labs. They used whiteboards to gather their group's ideas and report back to the class. Whiteboarding was also used to present designs for experiments that they could conduct, or to collect their pre-lab ideas.

Due to the rather short 3-day time-frame, the instructors choose to address a few key concepts and labs in detail rather than gloss over large swaths of content. This choice was made deliberately, since we wanted to make the simultaneous learning of content and pedagogy a top priority. For the rest of the content the Exploring Physics App provides extensive teacher help, and is written with built-in questioning strategies for direct use in teachers' classrooms.

During the UWC summer workshop teachers conducted hands-on activities in small groups of 3-4 teachers. Lead teachers worked with their assigned science teachers. Teachers were asked to "think like 8th or 9th graders" so that the atmosphere would mimic what they might encounter in their classes, particularly as regards student misconceptions. Furthermore, they could learn to use questioning strategies to probe student ideas. This allowed teachers to open up and voice ideas that they might encounter in their own classrooms. Teachers used the Exploring Physics App, which includes extensive opportunities for exploration of concepts and discussion among teachers as they conduct the hands-on labs. They used whiteboards to gather their group's ideas and report back to the class. Whiteboarding was also used to present designs for experiments that they could conduct, or to collect their pre-lab ideas. Segments of the workshop were videotaped for future reference.

Figure 1. Lead Teachers discussing an activity

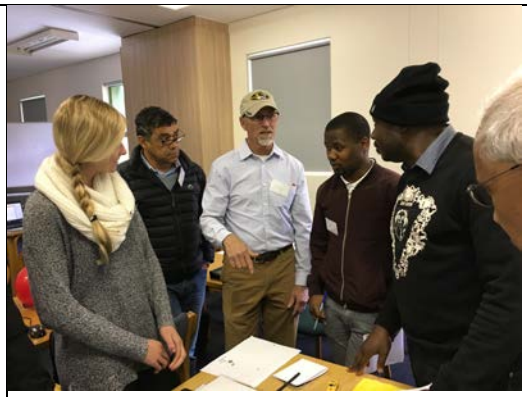

Figure 2. Lead teachers discuss setting up a lab with Doug Steinhoff

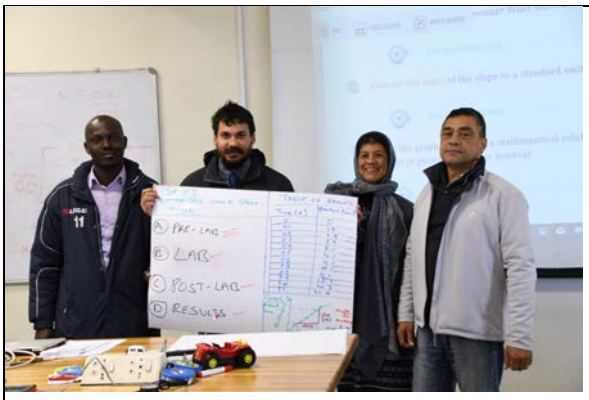

Figure 3. Science Teachers presenting their independent study lesson with a whiteboard.

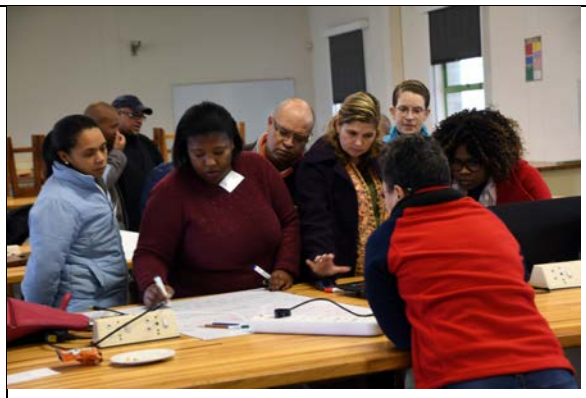

Figure 4. Science Teachers writing their consesus ideas on a whiteboard.

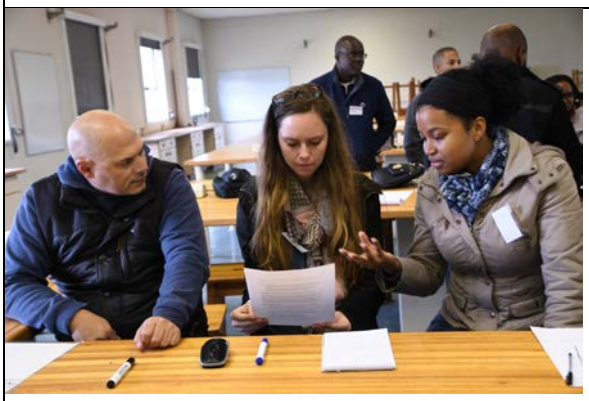

Figure 5. Discussing a sticky point.

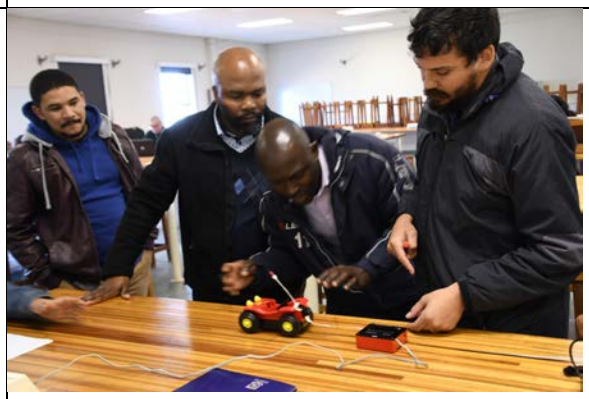

Figure 6. Taking data with a constant velocity car and a spark timer.

The atmosphere in the workshop was never quiet – there was animated discussion about teachers' ideas about physics content, how the method might play out in their classes, or ideas for conducting different labs. Mentors and instructors moved among the groups and answered questions or asked questions. There was a considerable excitement about using hands-on materials. Some of the materials were cheap and easily found (such as cut-up holiday light bulbs), while others were somewhat more "lab-like" (such as multimeters). Teachers immediately began discussing substitutions that were easily obtainable.

Evaluation Survey Results

Baku Audu, a graduate student in Physics and Education, gave evaluation surveys at the end of the workshop. 45 out of 60 teachers in the Science Teacher workshops responded to the survey. This group included the Lead teachers that had taken the Lead Teacher workshop the previous week.

1. Please rate your overall experiences of the symposium and teacher workshops on Modeling Instruction: Likert scale, 5= very useful, 4= quite useful, 3= somewhat useful, 2= not useful, 1= poor, 0 = very poor

Responses: 5, very useful (55%); 4, quite useful (40%); 3, somewhat useful (5%)

2. How did this workshop on Modeling Instruction challenge classroom practice, and in what way(s) has it cause you to review how you would teach in future?

   Responses: More than 80% said the workshops has caused them to reflect on their classroom practice, which is overwhelmingly the traditional form of teaching. They say they would try Modeling Instruction but would need more support. Also they expressed concern about their class sizes if they want to try Modeling Instruction in their classes.
3. What new insights, if any, have you gained and how do you plan to implement these new ideas in view of your current classroom teaching practice?

   Responses: More than 90% said they had a lot of misconceptions about force and energy. The workshops helped them better understand the concepts of force and energy. It gave them ideas on how to teach these concepts through hands-on labs.
4. In your opinion, what would present as the greatest obstacle(s) in your implementing Modeling Instruction?

   Responses: More than 90% said time, class size and resources, i.e. equipment.
5. What specific suggestion do you have that would help us support you in implementing, Modeling Instruction?

   Responses: More than 90% said to provide them with the necessary resources and give more workshops covering different topics with Modeling Instructions
6. Additional comments:

   Responses: Most teachers' comments indicated that they enjoyed the workshops and found them very useful and informative.

   Quote form one of the teachers:

   Gave me the confidence to allow learners to work more hands on, and do experiments.

   Allow learners to make mistakes and learn from them.

Other Successes of the 2017-18 workshops:

- In 2017 one school district (Metro East Education District) participated in the Modeling Workshops, with 30 teachers attending. In 2018, two other districts (Metro North and Metro East) had joined this collaboration, so that we had about 90 teachers who attended the science teacher workshops (60 for all three days, and the other 30 for one or two of the three days).
- In 2017, Ronald Englebrecht, Subject Advisor for the Metro South Education District was involved throughout the year. Another subject advisor (Manas) attended all summer workshop sessions, while two others (Rampou and Agulhas) attended 1-2 days of summer workshops.
- In 2018, school administrator involvement registered a noticeable increase. Several of them attended several or all sessions of the Science Teacher Workshops. Administrators seemed pleasantly surprised by the involvement and energy of the attending teachers, as well as their numbers. Teachers thus got direct access to discuss their needs in order to implement the modeling curriculum. Among them were (in increasing order of rank)

    - Julio Voges and Ronald Englebrecht, Subject Advisors, Metro North and South Educational Districts, respectively.
    - Charmaine Pietersen and Trevor Daniels, Chief Curriculum Advisors, Metro South and Metro East Educational Districts, respectively
    - Marius Diergaardt, Deputy Chief Education Specialist: Physical and Technical Sciences Western Cape Education Department.

- In 2018, prominent teachers in the district, including Wendy Horn of the Protea Heights Academy, Top 50 finalist for the 2018 Global Teacher Prize[1] (https://www.globalteacherprize.org/person?id=3947) , were present at the workshop. Teachers like Wendy are a catalyst for change and motivators for other teachers. Her enthusiasm infected not only teachers from her school, but others as well.
- The First Annual Teacher Professional Development Symposium brought together over 100 teachers, administrators, graduate students and UWC faculty for a day of talks about teaching. Three district administrators gave presentations, as did teachers, UWC faculty, Steinhoff and Chandrasekhar.
- Teachers' talks at the 2018 conference and participation in the 2018 summer workshops have energized their administrators, particularly Suanne Rampou, Deputy Chief Education Specialist, Natural Sciences, Head Office, WCED. After spending three full days at the science teacher workshop, and speaking with teachers who have implemented the modeling methodology despite limitations of equipment in their classrooms, Ms. Rampou has now pledged equipment support so that at least one teacher in each of several high schools can pilot the curriculum in 2018-19, and gather data on the efficacy of the method. This is a major "shot in the arm" for this workshop, since implementing change in large school systems is usually a slow process, and administrator support in doing so is vital. She also talked about trying to find funding to bring a team of teachers to visit schools in Missouri that were implementing modeling curricula.

Conclusion

As a team, Steinhoff and Chandrasekhar are pleased with the progress made during the two years of academic year and summer workshops. Change is slow, but the UWC project has the momentum and broad-based contacts in the Cape Town region to make a qualitative difference. By bringing together science teachers, district administrators and university faculty, they have produced the right mix to implement the changes that the Western Cape Education Districts wish to put in motion.

[1] The Global teacher prize is a $1 million award presented annually to an exceptional teacher who has made an outstanding contribution to their profession.