Learning Physics with Refugee Children in Germany

Dan MacIsaac, Florian Genz, and Michael Resvoll, State University of New York, Buffalo State College; Zukunftsstrategie Lehrer*innenbildung (ZuS) & Institut für Physikdidaktik, Universität zu Köln; Städtisches Gymnasium Thusneldastraße, Köln-Deutz

"We can manage this."
Wir schaffen das - refusing to set quotas upon migrant refugees to Germany[1]

"Nobody in Europe will be abandoned. Nobody in Europe will be excluded. Europe only succeeds if we work together." *Bundestag Speech*[2]

Former physicist Bundeskanzlerin Dr. Angela D. Merkel
PhD Quantum Chemistry, 1986
Chancellor, Federal Republic of Germany 2005-2021

Background

Since 2015, Germany has officially registered over 1.3 million refugees, many fleeing the Syrian civil war during the most recent European migrant crisis.[3] The majority reaction of 82 million German citizens and their government to the crisis led to the welcoming culture (*Willkommenskultur*)—the development of multiple government, non-government organization (NGO), and private programs of accommodation, resettlement, German language training, and more general education, acculturation, and inclusion into German society for many of these refugees.[4] With government and private funding for supplies, training, and administration, the German Physical Society (*Deutsche Physikalische Gesellschaft* or *DPG*) under the guidance of Professor Dr. Arnulf Quadt of Georg-August-Universität Göttingen established a program in which volunteers provide physics educational experiences to these refugee children and possible future German citizens called Physics for Refugees (*Physik für Flüchtlinge* or *PfF*).[5]

In spring 2018, Physics for Refugees activities were provided by about 470 registered and vetted volunteers at 82 sites around the country,[6] about split evenly between refugee centers temporarily hosting families in communal housing (in Cologne at a repurposed retirement home/center run by the German Red Cross called the *Boltensternstraße Zentrum*) and at grade schools serving refugee children (e.g., *Städtisches Gymnasium Thusneldastraße, Köln-Deutz*—a high school).[7,8] All volunteers were background vetted by a police check, many volunteers received expense-reimbursed training from the DPG, and most were physicists—physics students, teachers, and faculty, and physics enthusiasts. All worked under guidance of and with reporting back to DPG, usually providing one to two hours/week of volunteer work at their registered PfF site.

Goal: The aim is to teach physics to children and adolescents in refugee camps and primary reception facilities throughout Germany in a playful manner with simple experimentation tasks. Physical and playful experimentation should provide children and young people in the facilities with a distraction from everyday life and signal that they are welcome in Germany.
<dpg-physik.de/pff/ueber_pff>

Students, settings, and expectations

The two settings in Cologne presented two different student populations with differing expectations. The refugee transitional housing center (Figs. 1-2) resident children were mainly of Syrian and/or Kurdish extraction, and those of age were attending various local schools while living with their families in the buildings. All residents were limited to a 90-day maximum transitional center residency while awaiting long-term government sponsored relocation. The classroom we used was ordinarily used as a German adult language classroom in the main residential building, which also housed the main cafeteria and administrative offices, as well as some small apartment-style housing, with communal laundry and

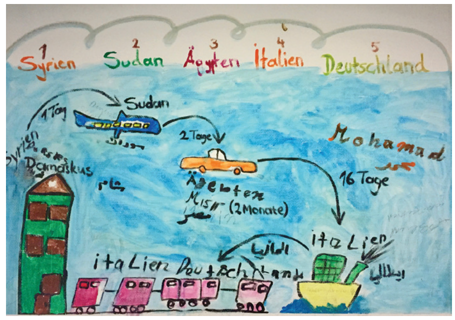

Fig. 1. Mohamad's journey from Damascus, Syria, to Cologne, Germany. Note mixed languages and scripts. Wall mural, German Red Cross transitional resettlement Center, Boltensternstraße, Cologne.

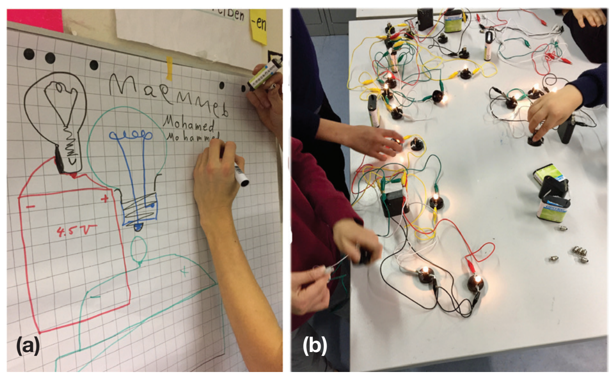

Fig. 2. (a) Mohammed's circuit sketch representations. Note attempts to direct helper focus on connection details within bulb, and student practicing writing his name in Latin script. (b)Also batteries and bulbs activity apparatus. The three-cell 4.5-V rectangular-ish format battery seen is widely available in Europe (supplied in PfF circuits kit used at center).

bathrooms. Children attending our weekly Tuesday evening (4:30-6:00 p.m.) physics activities experienced an afterschool physical science club-like atmosphere. Attendance was voluntary and highly variable from zero to 40 participants aged 2 to 15 years old. Typically there were a dozen students aged 5 to 13, with students joining late and some leaving early; in fine weather we often went outdoors, where parents and folk of all ages would wander into and out of the activities. Most students had limited practical proficiency in spoken German (Arabic and Kurdish were ubiquitous, with some French and English), but few could write in German, and most struggled to even form Roman letters at the start of the semester. We did not expect students to collect or maintain notes from week to week.

Our informal guiding goals with these students included: 1) have **fun**; 2) motivate students to **appreciate science**; 3) practice speaking and writing **German**; 4) practice basic **science skills** like observing, verbally describing, drawing, labeling, and exploring interesting physical phenomena, 5) practice social skills transferable to German classroom culture such as listening to one another, 6) **following craft directions** to make simple scientific objects like sundials and pinwheels (aka *mach mit*); and 7) to extend German *mach mit* (**maker culture**) to simple **engineering design** via paper airplane experiments, etc. There was no expectation of mathematics other than sometimes simple measurements of length and angle to cut and fold paper. No formal notes were taken by or expected of students, although sketching and labeling phenomena, coloring, and writing were encouraged. Our activities were led by volunteer undergraduate and graduate students from Cologne University physics and physics didactics, including some pre-service teachers and one volunteer visiting faculty member.

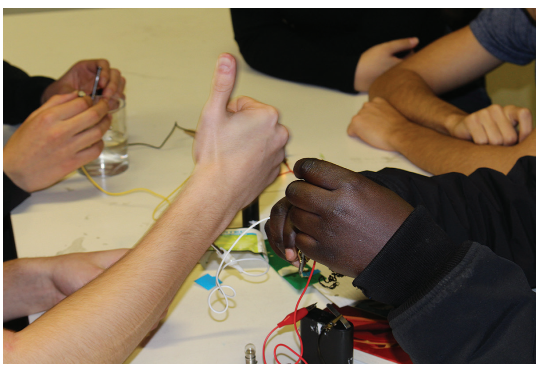

Fig. 3. Multiple ethnicity refugee children performing a conductivity/electrolysis of water activity from the electric circuits PfF curriculum at the Städtisches Gymnasium Thusneldastraße.

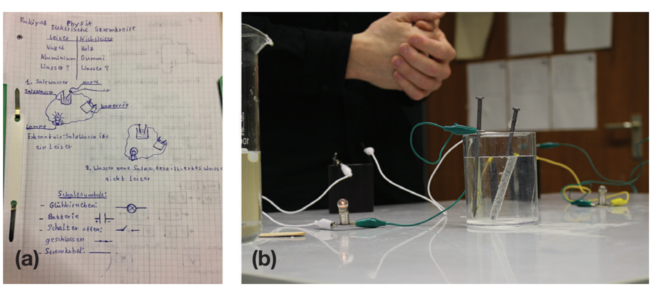

Fig. 4. (a) Student notes on the conductivity/electrolysis electric circuit activity at the Gymnasium. (b) Apparatus detail.

The Thusnelda street city *Gymnasium* (Fig. 3-4) high school setting was in a high school physics classroom led by two experienced high school teachers and a volunteer physics class translator (with a degree in astrophysics) as part of a regularly meeting elective class aimed at immigrant students (not only refugees). This very ethnically and linguistically diverse class enrolled 19 students (7 girls and 12 boys) aged 12 to 16 from Albania, Armenia, Gambia, India, Iraq, Iran, Italy, South Korea, Spain, Syria, and Tajikistan. These students were enrolled in special gymnasium courses in German language with some sports, English, and mathematics intended to address their interrupted formal and nonstandard (to Germany) schooling. Students are expected to remediate for no more than two years before moving into the regular gymnasium curriculum, which is quite demanding—finishing gymnasium students are expected to attempt the challenging ***Abitur*** exam sequence, equivalent to the well-known ***International Baccalaureate***.

Goals for the once weekly (Tuesday morning) hour-long gymnasium class also included **having fun—motivating science** and practicing basic **science** skills just like the center students. However, activity was much more directed towards developing German **classroom skills**, including: practice reading and writing German physics vocabulary, short questions and phrases, making drawings and simple reports, copying work from the board and producing short classroom notes (which were kept in custody of the teacher), participating in guided classroom discussion, and learning German **classroom behavior norms**. At least one of the gymnasium students had a strong math and physics background, but struggled reading and writing German. While activities were led by teachers, a significant number of volunteer senior gymnasium student helpers (*helferinnen*) participated (usually two to five each class, and some of these students were considering a teaching career) who usually also learned physics during these very rich open-ended activities. Helpers sometimes learned supplementary details and at different levels (e.g., including geometry, trigonometry, and algebra). The participation of these helper students was highly valued by the school and teachers, and by helpers themselves.

Three curricula: Adventure, Optics, and Electric Circuits kits

The **Adventure Box** (***Abenteuerkiste***) is a physical science curriculum and kit *explicitly designed for elementary refugee children*. The storyline follows the adventure travels of two young storks named Kalle and Yara, who participate in the northward annual stork migration starting from South Africa —up East Africa and along the Nile via Tanzania, Kenya, Somalia, and Egypt, around the Eastern Mediterranean through the Middle East via Israel, Jordan, Lebanon, Syria, through Turkey, and along the Black Sea via Bulgaria, Romania, Hungary, the Czech Republic, Slovakia, and Ukraine, then through Poland finally to summer nesting grounds in Germany. Along the way the stork children encounter hands-on physical science phenomena-centered adventures exploring floating and sinking, volcanic cratering, sand/particulate deposition, sound conduction, paper chromatography, images from a concave mirror, water tornadoes, rocket balloons, oobleck, and leaf wetting/wettability. The storks also construct and experiment with sundials, spectroscopes, pinwheels, Newton's cradles, kaleidoscopes, pinhole cameras, Cartesian divers, and parachutes. The 18 countries are each represented with an open-ended 30-minute to two-hour long investigation, and children were provided with a printed passport-like explorer card where they record and receive a stamp for completing each activity.

Necessary materials (paper, markers, string, rulers, tape, foil, compasses, mirrors, protractors, pencils, cornstarch, etc.) were provided in a large plastic bin—the box, which was in turn provided cost-free to qualified registered individuals upon request by the DPG. The Adventure Box curriculum was written by Esra Mendaci and Sara Schulz and published in 2018 by DPG, and includes posters of the migration route, illustrated read-and-experiment booklets for students, and a facilitator's guide.[9]

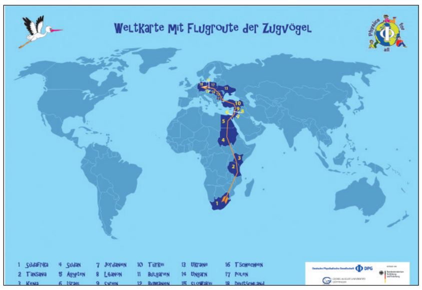

Fig. 5. World map showing stork migration path from South Africa to Germany. "The Adventure Journey of Kalle and Yara" follows two stork children having hands-on science adventures in 18 countries along the route. (Copyright DPG)

Our students did identify with the story of the (girl and boy) stork characters and their travels (most students had visited several of these countries), with the map (Fig. 5) and with the "passport"-like activity record card (refugee children and parents prize official documents and records). The German everyday vocabulary, introductory technical vocabulary (particularly concrete nouns), and the German making things together culture (*mach mit*) were well explored in these activities. We primarily used these activities (supplemented with others) with younger (ages 3 to 13) children at the refugee center in the afterschool science club-like setting.

The **Optics Box and Electric Circuits Box** are two independent kits (boxes of apparatus and curricular materials) originally developed as part of a separate **"Patio 13: School for Street Children"** project during 15 years of experience with Colombian middle and high school-aged homeless street children. Their **Physics for Street Children** (***Physik für Straßenkinder* or *PfS***) curriculum project has been carried out since 2001 under the supervision of Dr. Manuela Welzel-Breuer and Dr. Elmar Breuer of University of Education Heidelberg. PfS engages Colombian street children who socialize and learn either in the street or in a safer environment called a "patio" by experiencing and informally exploring physics phenomena while eschewing mathematics. PfS activities are delivered by pre-service Colombian elementary and secondary STEM teachers in the Medellin region. In 2015

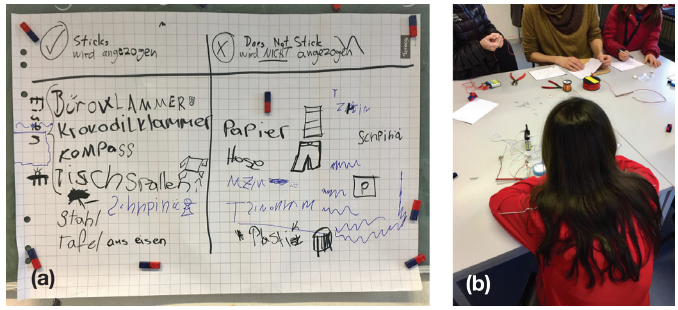

Fig. 6. (a) "What sticks to a magnet?" (b) Constructing electromagnets.

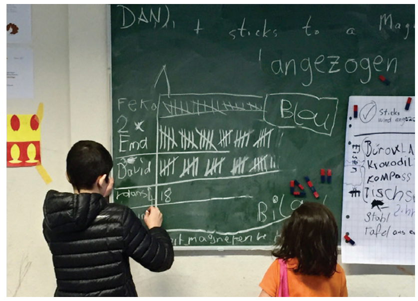

Fig. 7. Left, "How many paperclips will my electromagnet lift?" activities from PfF electric circuits curriculum at the center.

Fig. 8. Helpers, children, and pinhole cameras outdoors at the center.

Welzel-Breuer and Breuer received the DPG Georg-Kerschensteiner Prize for PfS-related activity.[10-14]

In 2015-2016, the PfS activities were adapted (e.g., providing vocabulary sheets) for use with refugees in Germany, and the two kits also contain student worksheets, instructor's manuals, and copious materials for up to 24 students to do hands-on and inquiry experiments. The Optics Box apparatus examines 12 themes (Fig. 8) including: white light body and face shadows from Cree flashlights; single and multiple overlapped white and colored light shadows from miniature clear, red, green, and blue bulbs and LEDs; color perception and addition with red filters; reflection with mirrors and transparent glass including multiple reflections (infinity mirror); building a kaleidoscope; water and plastic cylindrical and thin glass lens image phenomena, puzzles, and characterization; spectral examinations by CDs and interference gratings and so forth. The separate Electric Circuits Box activities (Figs. 6-7) include light the bulb, simple batteries and bulbs, series and parallel activities with miniature bulbs, diodes and polarity, switches, using compasses to see magnetic fields near wires and permanent magnets, making and characterizing electromagnets, electrolyzing water, and simple digital multimeter (DMM) use.

Some activities have optional worksheets, but all have thoroughly tested guiding questions for teacher use, though the phenomena are rich and attractive enough that simply examining them and reflecting leads to lots of physics discourse by the students—and of course challenges helpers, teachers, and even experienced experimental physicists. Many optics and

Fig. 9. Outdoor tracing afternoon Sun shadows with sidewalk chalk to examine apparent motion of the Sun with younger children at the center. Activity from ASP's "The Universe at Your Fingertips" curriculum, which includes making "sun clock" sundials. Making a sundial also commences the DPG "Adventure Journey of Kalle and Yara" curriculum.

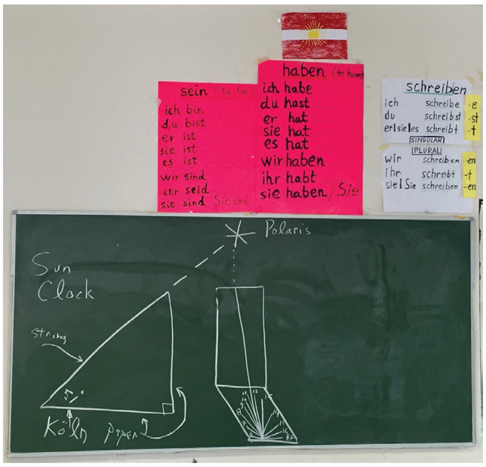

Fig. 10. Helpers figuring out how a paper and string portable "sun clock" sundial works in classroom, note German verb conjugations and Kurdish flag rendered in red crayon above chalkboard.

circuits activities were challenging enough that some younger students struggled to focus and even observe regular patterns, though group work and focusing questions helped a great deal.

The German Ministry for Education and Research (BMBF) supported the DPG in purchasing materials for all three kits, copying the didactic materials and offering all cost-free to the PfF sites.

Physics in Advent (*Physik im Advent*) and other supplementary activities

Another curricular source used with refugee students mainly in the beginning of the PfF project in 2015 was the Physics in Advent series of hands-on physics and mathematics activities and puzzles presented by video also by Professor Quadt. These are built around a Christmas theme (24 activities presented during December every year), presented in five seasons of English language videos.[15] We also used activities from "The Universe at Your Fingertips" curriculum (Figs. 9-10) series.[16]

Outcomes and observations

The most noteworthy observation from our experiences was simply that refugees or not, ***kids are kids are kids***—boisterous, joyful, and exuberant; struggling with their daily lives and identities, sometimes acting out while dealing with their past, happy to be affirmed, acknowledged, and praised; and happy to see and do fun, cool physical things. Some were very eager to please, and some had excellent powers of observation, attentiveness, and persistence; all could be engaged, and most were readily distracted.

At the center the atmosphere was such that we had to work to keep the noise level down in the classroom and tried to head outdoors when we could. Many children arrived late and/or departed early, and attendance was not taken, though the students who remained until the end and received notes on their Adventure Box activity cards valued that recognition. Initially at the center we had a mother chaperoning the class for several weeks, but that ceased within the first month. We instructors behaved as guests and kept our expectations low key, though we were used as a babysitting service in early weeks (lots of coloring for those kids), and more problematically had an adolescent student with behavioral issues who was placed with us. As expected[17] in early weeks the students automatically self-selected into two large groups by gender, but after a few months this ceased to happen, we suspect due to enculturation by regular daytime schooling. Finally, students and instructors both enjoyed and appreciated outdoor activities requiring cooperation and persistence, e.g., the "protect a falling egg" and "sun clocks and shadow tracing" activities. Children particularly loved repeatedly tracing their shadows, and watching their shadows grow 10 cm in length over a five-minute interval during late afternoon.

Organizationally, the students volunteering at the center were quite challenged as they were mainly not experienced grade school teachers—they were physics students. Activities were prepared at the university and brought to the center, for both practice and due to a lack of onsite materials storage at the center. Space at the university was problematic as well—loss of our original shared preparation/storage space at the student Café Chaos was eventually solved by space loaned by the Institut für Geographiedidaktik. Regular calls for volunteers produced three to five consistently available students, and another three to five itinerantly available university student volunteers. German teacher preparation does not stress team teaching, so PfF provided a unique opportunity for several of the university volunteers.

At the gymnasium professional teachers tolerated behavior outside high school classroom norms for these students but still wrested with behavior (imagine a typical U.S. middle school classroom). Some of the more boisterous students got a little extra attention and bonding-counseling-like guidance they would not have received in their standard classes – one refugee student was encountered by the physics teacher by happenstance truant off campus, counseled, and returned to campus and the physics classroom. While most German students were expected to maintain their own notes throughout the semester, the refugee class kept notes on bound sheets handed out when notes were deemed appropriate, but collected into teacher custody at the end of class, so notes could

Fig. 11. Introductory optics activity: Shadow tracing of heads and faces (PfF optics curriculum at Gymnasium). Student will later add name, list of past countries visited to the shadow drawing and take it home as an artifact.

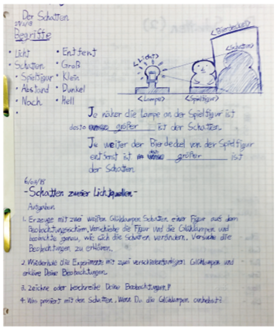

Fig. 12. Gymnasium student notes with ray tracing and text analysis of the shadow of their toy "play figure" on a small screen illuminated by a flashlight bulb.

be resumed next class without being lost or misplaced. Most students enjoyed writing things down and making notes, diagrams, and in some cases completing vocabulary worksheets, some with great exactitude and pride.

For example, one lesson series on shadows largely followed the PfF optics curriculum. First students were shown some shadows with flashlights, including the shadow of a teacher's facial profile on a chalkboard, which was then traced and labeled with the teacher's name and countries he had visited. Students were then asked questions like: "Where did you see shadows?" "Where did you see them when you grew up?" "What is necessary to see a shadow?" etc. These questions were intended to get the kids personally involved in the activities and set some basic examples of how to think in a scientific matter (cause-effect relationship). After that, the helpers—some motivated, scientifically skilled upper grade kids—got short task sheets requiring them to trace the shadow of another student (Fig. 11) on a piece of butcher paper. While tracing shadows, students were encouraged to explore how big or small they could make their shadow to fit it to the paper. The relative placement of flashlight, object, and image of the shadow were briefly cued during this process (for extensive discussion and analysis later). The product of this first lesson was a shadow tracing of the student's head and face with name and countries visited to be taken home as an artifact.

The next lesson started with a small analogy from the previous week: lighting a flashlight lamp bulb in a socket that projected the shadow of a small model wooden figure onto a white paper card (Fig. 12). Students could view this apparatus from many angles and explore distances and shadow sizes again, and asked to complete a pair of "if this, then that"-type statements: **When the object is (far from, close to) the lamp, the shadow is (small, big)**. This set up a traditional ray diagram (standard representation) for a shadow that was put on the board. This week was spent getting these representations, statements, and standard vocabulary into notebooks. While the refugee students did their notes, interested gymnasium student helpers were challenged to try to use the ray diagram figures to identify triangles, and use simple geometry (similar triangles and ratios) to produce the standard magnification formula $M = h_i/h_0 = d_i/d_0$. The goals were for the students to have fun, create and alter shadows exploring interesting optics, make and discuss observations, draw apparatus, and also learn and practice new German vocabulary, standard representations, and generate classroom notes. The third lesson moved on with multiple shadows and bulbs, introducing colored bulbs and colored shadows.

Physik macht Spaß… und ist überall.

Physics is fun — and is everywhere.

DPG outreach poster series theme popularizing physics[15]

The final word: Why physics for refugee children?

The DPG, PfF, and PfS literature repeatedly stressed that physics is universal, compelling, human, and enjoyable (Fig. 13). Exploring physical phenomena and discovering patterns in the natural world *simply does not require an initially shared spoken or written language, or culture, or religious background, etc.* Most refugee children are proven flexible, adaptable survivors, and some are spectacularly observant.[18] While classic Western science is not culture-free, sense-making is a universal human activity—we can still collaboratively investigate, observe, marvel at, and try to interpret the natural wonders in our shared human experience. Given physics' deep ties to attractive natural phenomena together with shared human curiosity, appreciation for beauty, and the need to find patterns, physics seems a very appropriate discipline for developing and sharing the joy of understanding with children who will become members of their new society. In a very practical way, all human beings are naturally physicists, particularly including refugee children.

Fig. 13. Sophie Makes Waves," poster #3 from the "Physics is fun … and everywhere" DPG outreach campaign. (Copyright DPG)

Certainly while experiencing these cool physics activities together with these refugee children, we bonded and had fun, and felt welcome with one another although speaking many different and usually exclusive languages. And we even learned some physics together.

Acknowledgments

We acknowledge the assistance and support of Städtisches Gymnasium Thusneldastraße, Köln-Deutz; Universität zu Köln (Institut für Physikdidaktik, Institut für Geogra-

phiedidaktik & Café Chaos); and Deutsche Physikalische Gesellschaft (DPG), German Red Cross (Deutsches Rotes Kreuz), Pädagogische Hochschule Heidelberg (Physik und ihre Didaktik), the State University of New York- Buffalo State College, Prof. Dr. M. Welzel-Breuer, Dr. E. Breuer, Prof. Dr. A. Bresges, Prof. Dr. A. Quadt, S. Schulz, S. Lotfipour, A. Schmitz, C. Kaschny, K. Falconer, and many refugees, volunteers, and students.

Supplemental comments

by MacIsaac, Genz and Resvoll

We developed this paper for a number of reasons: to inform *The Physics Teacher* readers of an interesting and unusual non-U.S. physics program for a nontraditional student population, to celebrate and reclaim a physicist who became Chancellor of Germany and supported initiatives like this as one of our own, and to possibly inspire others to take action to help refugees.

First of all, the Physics for Refugees curriculum project is quite unique—we know of no other large scale attempt to use physics and physical science to welcome refugees into their new society. And this effort was led by the world's largest professional physics society. We'd like to promote this and similar efforts. It was particularly compelling to find physics activities with an avowed goal to make people feel welcome, in a playful manner using simple experimentation tasks. We would like to encourage more of these kinds of interventional goals into standard instruction, and feel such an approach could address equity issues anywhere in the world, including the U.S.

There have been a number of physicists who became politically active and even political leaders, and we would like to reclaim Dr. Merkel as she has taken her career path through politics and may even return to academia. We believe that her highly principled and politically costly decisions regarding the admission of refugees into Germany were brave and humane, and we believe these particular decisions are amongst the finest examples set by recent politicians. We are proud to recognize her as an inspirational person and female physicist.

We would like to call upon readers to themselves take action to support refugees in their own communities. The current political climate—political rhetoric vilifying refugees some of who lost their lives in the Mediterranean Sea and the Rio Grande—is unfortunately not at all unusual in human history, even in the last 150 years. Fear and hatred of the stranger has always been part of human nature (and of animal nature), and we encourage readers to take action to address this by example. Speak up and vote. A quick google of the name of your town and the word "refugee" will uncover groups who are actively volunteering to help refugees near where you live. Most *TPT* readers are professional educators, and many refugees are looking for simple support such as basic language training. You can volunteer to help and demonstrate your support for refugees with actions (while still periodically yelling at the radio). One of our proudest outcomes from this manuscript has been that it inspired a newly retired physics teacher to become a refugee coordinator—can you spare 1-2 hours per week or month?

Finally, we would like to thank our reviewers for their passion and insight in commenting upon our manuscript. That passion resulted in this supplemental comment.

References

1. "Bund und Länder: Kontakte auf ein Minimum beschränken," bundeskanzlerin.de/Webs/BKin/EN/AngelaMerkel/Biography/biography_node.html .
2. "The Outsiders: How the Lives of Margaret Thatcher and Angela Merkel Created Modern Europe," yris.yira.org/essays/1458.
3. "European Migrant Crisis," Wikipedia, en.wikipedia.org/wiki/European_migrant_crisis, (600+ references).
4. Federal Office for Migration and Refugees, BAMF (2018), https://tinyurl.com/RefugeesBAMF.
5. Physik Für Flüchtlinge, https://tinyurl.com/refugeesPFF.
6. Private communication with S. Schultz, DPG.
7. German Red Cross, drk.de/en; Köln Refugee Center, drk-koeln.de/aktuelles/meldung/238-fluechtlinge-in-koeln.html.
8. Städtische Gymnasium Thusneldastraße, thusnelda-gymnasium.de.
9. See dpg-physik.de/pff/material, which provides links to curriculum guide, poster, explorer pass, reading and experimenting book, etc.
10. E. Breuer, M. Welzel, A. Crossley, and H. Weber, "Colombian teacher students develop teaching sequences in Physics for Street Children - An International Project," paper presented at the annual meeting of the National Association for Research in Science Teaching, Vancouver, Canada (April 1-4, 2004).
11. M. Welzel-Breuer and E. Breuer, "Science for Street Children. Results of a Longterm Developmental Project in Science Education," in E-Book Proceedings of the ESERA 2013 Conference, Nicosia, Cyprus. Strand 12 - Cultural, Social and Gender Issues in Science and Technology Education (2014), http://www.esera.org/publications/esera-conference-proceedings/esera-2013#strand-12.
12. M. Welzel-Breuer and E. Breuer, "Physik für Straßenkinder," Physik J. 14 (8/9), 71–74 (2015).
13. M. Welzel-Breuer and E. Breuer, Physik (nicht nur) für Straßenkinder, Ein Praxis-Handbuch mit Experimentiervorschlägen [Physics (not only) for Street Children. A Best Practice Handbook with Suggestions for Inquiry Based Experimentation Settings] (Springer Spektrum, Heidelberg, 2018). DOI: 10.1007/978-3-662-57663-2.
14. Physics for Street Children, https://tinyurl.com/refugeesPfS.
15. Physik im Advent, physik-im-advent.de/about.
16. "Education and Outreach Programs," Astronomical Society of the Pacific, astrosociety.org/education/the-universe-at-your-fingertips-2-0/ (especially apparent sun motion, sun clock, shadow tracing).
17. An extensive and active scholarly literature base exists on culturally responsive teaching (CRT) and teaching Students with Limited and Interrupted Formal Education (SLIFE); we have found practical classroom advice from teachingrefugees.com and therefugeecenter.org/.
18. https://www.dpg-physik.de/veroeffentlichungen/publikationen/schulposter/physik-macht-spass.