My Experience with Physics Education in East Timor

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For two years I worked in East Timor helping to develop the new nation's physics curriculum. Together with local teachers, I created a manual of hands-on lessons, solidified the pre-secondary and secondary (middle and high) school curriculum, conducted nation-wide training for physics teachers of pre-secondary and secondary schools and began a new physics department at the national university complete with basic lab courses.

physics, science, curriculum development, teacher training, third world

HISTORICAL CONTEXT FOR EDUCATION IN EAST TIMOR

For about 400 years Portugal ruled East Timor and ran colonial schools for a very small number of children from upper-class families. The quality of education was quite good in some of the schools, if stiff and formal. From 1975 to 1999, Indonesia occupied East Timor and the education system was run the same as in other parts of the sprawling nation. Most teachers and nearly all principals in East Timor’s middle and high schools were imported from other parts of Indonesia. Many were not top quality, and few were highly motivated to educate East-Timorese children. As of 1999, there was only one East Timorese physics professor at the University of East Timor.

In 1999, Indonesia’s government finally allowed the East Timorese to vote on whether they wanted independence, or to be an “autonomous” region within Indonesia. On August 30, 1999, the East Timorese came out in vast numbers, in the face of massive danger and intimidation from the Indonesian military and their militias, to vote 78.5 per cent in favour of independence. After the results were announced, the Indonesian military and their militias destroyed much of East Timor’s infrastructure, killed thousands of East Timorese and forcibly deported close to 300,000 people, one-third of the population. After the destruction had run its course, the United Nations set up and led a transitional government that ended in May 2002. East Timor is now an independent nation.

Around 80 per cent of the schools in East Timor were destroyed or damaged in 1999. Nearly all former Indonesian teachers left their positions before the vote. Most current education leaders have little experience in administration. Today, not a single physics teacher in the middle and high schools in East Timor holds a four-year degree in physics, and some have never studied physics. There is a dire shortage of teachers for most technical subjects. The previous university physics professor died in the violence of 1999, and the university with its connected technical school was destroyed by fire.

Today, most of my students at university have huge gaps in their comprehension arising from the chaos and mediocrity of their middle- and high-school experience. Many of the concepts I teach at university are taught in upper level middle-school classes in the United States.
MY STORY

Starting Out

I came to East Timor in October 2000 with no firm plans for my occupation. My partner Pamela had work lined up, and we were convinced that I could find something useful to do. In the United States, I teach physics and had worked at the Exploratorium Teacher Institute in San Francisco in some capacity for several years leading up to my move to East Timor.

Upon arriving in East Timor, I set out ambitiously to learn the local lingua franca, Tetum. I found it to be an archaic language, with most modern words taken from Portuguese, the language of East Timor’s first colonisers. Mixed with Tetum was Bahasa Indonesia, the language of East Timor’s most recent occupiers. By learning parts of these three languages, I could soon make myself understood talking about science and mathematics.

In December 2000, I was granted a two-year fellowship from the Institute of Current World Affairs. This fellowship essentially allowed me to pursue my own interests, all (reasonable) expenses paid, while writing an informative newsletter to members of the Institute once a month. This opened up great opportunities for me: I could work where I wanted without needing a salary.

While continuing work on language skills (work that has continued until today), I found two places to put my efforts. The first was a well-organised Catholic high school in Baucau. I had previously met the headmaster priest, and in January 2001 I offered to work with the school’s science and math teachers on various hands-on activities that could be carried out in their classrooms. I held training sessions with them once a week for several months during which time we conducted simple experiments in math, chemistry, biology, and physics. These hands-on lessons (called pratika in Tetum) were entirely new to these teachers. I found physics teachers who had never handled a magnet and biology teachers that had never made the connection between the curriculum they taught and the animal parts available for consumption (or experimentation) at the local market. My language skills began improving more rapidly in the course of preparing and delivering these lessons.

In April 2001, I also approached the East Timor National University (UNTIL) to see if I could be of use in its Faculty of Education. I found physics to be the subject most desperately in need of teachers, and signed up to teach hands-on physics lessons to first-year students in the math and biology departments, four classes every week until July. There was as yet no physics department.

It was a light workload, and I filled my days developing activities for future use. Good activities must have a close connection to local culture and life and use only the most readily available materials. My large repertoire of science and math activities from the United States was severely limited by availability of supplies in East Timor, and I began to search the streets, forests and garbage dumps to determine what was out there waiting to be used in an experiment. I found banana leaves, palm fronds, bamboo, rocks, and various seeds and leaves from the forest; candles, rubber bands, gum balls, balloons, marbles, food colouring, and tiny straws all for under ten cents at local shops; and limitless 1.5 litre water bottles and aluminium beer cans in garbage piles courtesy of the United Nations.

Here are some examples of the activities I came up with. Banana leaf spines have a smooth track down the centre, custom made for marbles to roll down. If you prop one up on a chair, you can release marbles from different heights and measure their velocity as they race across the floor, then compare kinetic and potential energy to see how much was lost to friction. You can make a one-wheeled, rubber band-powered car with cardboard, palm-fond spines, and an aluminium can. If you make it well, it will cross the whole room. If you measure the force given by the wound-up
rubber band before release, and the distance the car rolls, you can use a simple bit of calculus to determine the amount of energy it used. Trashed fluorescent light units have ballast inductors in them that consist of fine magnet wire that you can use to make electromagnets, motors, speakers and current meters. You can use your homemade current metre to measure the strength of a battery you make by filling an aluminium wok with salty water and vinegar and plunging in a chunk of charcoal from a fire. With three kebob sticks, you can make a model of the human arm and hand in order to demonstrate muscles, tendons, ligaments and the different types of joints at each bend. The standard lung model can be made with a bottle, balloon and plastic bag, and you can complement the experiment with a sheep’s lung from the market: if you jam a straw into one of the main holes and blow, the whole thing inflates like a puffer fish.

I took these prototype activities directly to trial at both UNTIL and the Baucau Catholic high school. All in all, my students were overjoyed at the opportunity to learn directly from experience, rather than from texts or a lecture.

Making a Manual for Hands-on Lessons

Near the end of the semester Miguel Maia, the dean of UNTIL Education Faculty, asked me if I was writing down my activities for future reference. I wasn’t, and he asked me if I could. I thought it was possible, and we discussed the idea of a manual for other teachers. I began writing drafts of activities following the format of the Exploratorium Snackbook: simple, clear directions, followed by a short explanation and a bit about the activity’s connection to real life.

After a few months it became clear that I could write up several dozen activities and make a good-sized manual. I could include lessons about most major topics in the middle- and high-school physics curriculum. I knew I would need physics teachers for editors, and we found four that were interested. I began to meet with them once every two weeks to edit one or two lessons. First I’d do the activity with them, then we’d slog through the bad Tetum of my draft, together making decisions on how to explain things and which words to use for various concepts. These teachers were paid through UNTIL for their work.

I began recruiting any and all students interested in being models for a physics manual. I found plenty in various venues, and the manual became filled with local personalities demonstrating how to carry out the activities. I took digital photos and was soon learning more than I ever wanted to know about word processing and layout.

From my years at the Exploratorium Teacher Institute, I knew that if this book was to be successful, each activity needed to be tested by East Timorese teachers on East Timorese students. About that time I met Rui Belo, the head of curriculum in the East Timor Ministry of Education. He was quite excited about the idea of the manual, and offered to put together a group of teachers to do the trials. He would invite several from each of the 13 districts of East Timor. In order to do this, we needed a bit of money for transportation and food for these teachers, as well as printing and photocopying of the lessons themselves. Maia and I wrote a proposal to AusAID, Australia’s international aid agency, through a small-grants program they have. We got the funding, and ended up asking AusAID two more times for money to finish the project and print 800 manuals. In October 2001, I began giving two-day training sessions, in which the group of 30 or so teachers would do about eight activities and choose one to take back to their school. At their schools, they would try the lesson with their students and report back to me on their success or lack thereof. I taught these sessions every month or so for the next eight months. This group of teachers tried

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1 The Ministry’s full name is “East Timor Ministry of Education, Culture, Youth and Sport,” and is the largest and best funded ministry in the government. By some accounts, it is also the most chaotic.
over 60 lessons, and together with other informal trials I arranged, each lesson in the manual was put to test. With information from these trials, many lessons were improved and two were scrapped completely.

When the trials, photos, and content editing was finished in May 2002, the *Manuál LISAUN Pratika Fizika* was sent to the National Linguistic Institute where several local linguists made corrections to standardise spelling and usage in Tetum. The Manual contains a glossary of technical terms listed in Tetum, Portuguese, Bahasa Indonesia, and English. Seventy-two experiments and over 500 photos appear in its 350 pages. It is the first technical book published in Tetum, and a step toward developing the language of Tetum for use in technical subjects. Appendix A presents a sample lesson.

**A Physics Department at East Timor’s National University**

Jumping back a bit, during East Timor’s 2001 school break – August and September – I was asked to participate in creating a physics department within the education faculty of UNTIL. I worked with the one teacher in the country with a bachelor’s degree in physics, Teresinha Soares. She completed her degree in the year 2000, and was frankly not so interested in becoming the director and sole faculty member of the UNTIL physics department. But with sufficient prodding by higher-ups and colleagues, she rose to the occasion. We looked at various other universities’ curricula, and designed a three-year curriculum specifically to produce future middle- and high-school physics teachers.

In October 2001, 60 students were accepted into the physics department. To date, they have no textbooks to use. Truth be told, most classes at UNTIL use no textbooks, because books are not readily available in East Timor, are expensive when one can find them and no public money has been budgeted for them. Teresinha teaches from her own books and the students spend a lot of time copying from what she writes on the board. Occasionally they put up money to photocopy her notes or textbook pages. Nor does there exist any formal laboratory facility. I have taught lab classes for a year and a half using normal classrooms and cheap, ordinary articles.

Our physics students are slated to become teachers, but due to poor conditions in schools and moderate salaries, the best students will undoubtedly look for better jobs in organisations or other branches of government. I think a realistic prospect is probably 25 to 35 new, well-qualified physics teachers entering the nation’s middle and high schools by October 2004. To make things worse, many of those resigned to teaching will attempt to get a position in Dili as opposed to returning to their home districts, leaving the remote schools to languish without qualified teachers.

**Teacher Training as Problem Assessment**

Mid-year 2001, I also got to know the Catholic Teacher Training College of Baucau. Marist Brothers, mostly from Australia, run the College and put on teacher-training courses in a number of subjects. The director, Brother Mark Paul, was very keen to begin offering courses in physics. He offered to procure a small set of materials that the teachers could haul back to their schools and use for carrying out hands-on physics lessons. He also offered to buy full sets of quality physics textbooks from Indonesia so that East-Timorese teachers would have a source of reference. I assisted him in this preparation and began giving full-week courses through the Catholic College in late 2001. I taught mostly prototype activities from the Manual-to-be. Teresinha worked with me during these sessions teaching theory and exercises related to the hands-on activities. At each session we would give out our so-called ‘science kits’ – a locally

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2 Photocopies in East Timor run from five to ten cents a page, quite a high price compared to local salaries.
hand-made basket filled with class sets of simple science gear (prisms, magnets, lenses, tape measures, stopwatches, spring scales, scissors, tape, straws, etc.) – as well as the set of reference books, one to each school.

These courses proved to be invaluable for me to understand the situation in East Timor’s schools. I solidified my initial feeling that what we were offering was valuable: inspiration for overworked teachers bored with teaching directly from the textbooks, a new pedagogy, additional knowledge and help understanding basic concepts, as well as the new gear and reference texts. More importantly though, I learned that what we were offering was insufficient. I became aware that four main problems prevented most teachers from carrying out the hands-on activities in their schools.

First, many of the schools had no security whatsoever. Schools were fortunate if they had received a new roof and classroom furniture after the destruction of 1999. Solid doors and windows were few and far between. Thus some of the kits we handed out, which contained many items tantalising to the average curious student, were soon ravaged. Second, most teachers were unable to make the connection between the concepts in the hands-on activities and the national syllabus for physics. Naturally, this connection existed, but it was beyond the capacity or confidence of most teachers to decide where to insert a given activity. Third, the national physics syllabus, carried over from Indonesia’s education system, was bloated: too many topics for the time teachers were allotted to teach. Teachers could find no time to offer interesting activities in the midst of spewing forth all the theory. Finally, and possibly most significant, the teachers were not required to do the activities. Ultimately, hands-on education requires more preparation, and any sort of new method requires courage and confidence. If not highly motivated and also not required, many teachers will opt for the familiar (and mostly ineffective) lecture.

Visions for Improvement

From this insight, I began to develop a vision of how physics education in East Timor could be improved. First of all, the national syllabus would need weeding: topics of lesser import would need to be cut out to leave more time for a few important ones as well as for hands-on activities. This trim syllabus, as well as the hands-on activities in the Manual-in-progress, would need to be linked directly to the textbooks currently in use. The new, doable national syllabus, including the hands-on activities, would then need to be required for all teachers. East Timor has decided to continue national examinations, an artefact of questionable value left over from Indonesia’s education system, so these exams would need to include questions on topics in the syllabus, as well as each hands-on activity. Finally, each school would need to receive a science kit complete with all special materials necessary for each of the required hands-on activities. For security, a sturdy, lockable cabinet would need to be placed in each school.

All my experience in the United States and China has led me to be highly sceptical of standardised syllabi, required lessons, and the like. It was therefore a very difficult process for me to come to

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3 I recognized this so called 'more is less' problem from my years in China. The primary function of China’s national examination system is to select a tiny percentage of students – around three per cent in the mid nineties – to go on to university. Since standardized tests primarily check for information retention, the national syllabus has been loaded with an unbelievable amount of information. Chinese universities are filled with students with photographic memories while millions of critically thinking, practical-minded students fail to make it into college. Middle- and high-school teachers are stuck with the job of cramming enormous quantities of esoteric information down students’ throats day after day, year after year. Students’ interests, opinions and ideas have no value in the system, and are actually detrimental to 'success' as defined by the system.
the above conclusions. Won’t such a rigid system stifle teachers’ abilities to inspire their students? No, I realised, the current teachers of East Timor have such poor preparation for their current jobs that they need a solid structural base to work from, a clear path to tread. In addition, they need the motivation of a required syllabus. The syllabus must contain plenty of hands-on lessons with ample leeway for creative adjustment and fine-tuning to follow the interests of both student and teacher. Through the process of learning these required activities, teachers will become familiar with the methods of learning from observation, discovering physical principles directly from experimentation and using scientific method to deduce and prove concepts in the classroom. They will also begin to fill the gaps of their own understanding. In the future, the state will be able to give teachers freedom to develop and teach with their own activities, ideally linked to their own communities as well as to the standard body of physics knowledge. The syllabus I envisioned was a necessary first step.

Setting up the System

In January 2002, I asked Rui in the Ministry of Education who was working on the national physics curriculum. He groaned, said no one was and that it was increasingly difficult to get any teachers to come to the Ministry to work on curriculum because there was no money to pay stipends, or even transport. I proposed that I get a few good, interested teachers, pay their transport to and from our work sessions, and revamp the entire middle- and high-school syllabus. Rui agreed on the spot, and I went off to find five of the teachers I had noticed to be the sharpest among the group of teachers doing trials on the hands-on activities. Each lived near Dili, and each was more than willing. I arranged a few dollars each for transport each time we met. Together with Teresinha from UNTIL, we met six afternoons over the course of a couple months and pulled off a very thorough weeding job on the national syllabus as well as planting hands-on activities from the Manual, now nearly completed, among the various topics in the syllabus.

One thing I had noticed early on was that the physics textbook used at high-school level was of very poor quality. The curriculum group heartily agreed and I inquired of the director of primary and secondary education if it was possible to purchase new ones. He asked us to make a recommendation and he’d see what he could do. Since there is nothing resembling a book store in East Timor, we then went on a wild chase for textbooks: each teacher brought their own ragged volumes, ransacked their own school in search of odd, old ones and confiscated any that students brought to class. We were able to get examples from five different publishers in Indonesia.4 Using phone numbers in these books, we called up each publisher (on my phone) and asked for a free, complete set. Remarkably, each publisher came through and shipped us a set within a month, and we were able to make a detailed comparison of each text’s treatment of various topics. We chose the one that was best suited for East Timorese students, and wrote our recommendation back to the Director.

To make a long story longer, the Director sat on the recommendation for a month, approved it, sent it on to the Minister of Education himself who sat on it for several weeks, then wrote a preface for it (a requirement for any textbook coming from Indonesia) and sent it to the folks in the Ministry of Education Finance office, who wrote up a requisition order and sent it off to National Treasury. Treasury soon sent it back to Finance saying the funds were not available. Only then did the folks in Finance look at the Ministry of Education’s budget, and sure enough, in the category of high-school supplies there was not nearly the US$90,000 required. This was all a bit

4 Though the official languages of East Timor are Tetum and Portugues, virtually no one under 40 speaks Portugues, and no science books exist in Tetum. Thus, middle and high schools use textbooks from Indonesia, and learn in Bahasa and Tetum, as well as their own local language.
disheartening, but fortunately a friend of a friend in AusAID offered to look at a proposal. I helped the Minister write a quick proposal for the funds and AusAID approved it within two weeks. The new texts are on their way.

And well they should be, since our curriculum group had written the national high-school syllabus around these hoped-for books. Now it looks like it will all work out.

Meanwhile, on the kit front, things were feverishly coming together. Grants from four different donors covered the creation of kits for all 150 middle and high schools in the nation. I found money to be the least of my problems. How does one procure 1,500 nylon graduated cylinders from East Timor? How does one find even a single source, let alone a reasonable price? How many shops in Dili does one have to visit before finding 1,500 mirrors? What if a foreign company requires payment before shipment and the donor requires shipment before payment? What happens when 1,000 multimetres show up different from the ones ordered? This logistical nightmare occupied me for the better part of five months in early 2002. The Science Kit is presented in Appendix B.

Various vendors from Indonesia and Australia eventually supplied the items not available off-the-shelf in Dili. The gear seeped slowly in through customs and was stacked in the Ministry’s storeroom. I then paid various neighbour kids to help me divide the mountain of equipment into class sets and pack them into rice bags (donated by World Food Program) in preparation for delivery to the schools.

Teacher Training as Launching of New Curriculum

At this point, the only element missing was training the teachers. For teachers so new to the pedagogy, good training was going to be crucial. Of course, how to teach with hands-on lessons is best learned by means of doing hands-on lessons. I found that Manuela Gusmao in the National Teacher Training Centre had no funds or staff to carry out the training. I told Brother Mark of the Catholic College about the situation and he stepped up to fund and administer the training courses. It was more complicated than that, however. The kit was necessary to teach the national curriculum, so training would be required for all teachers. Thus, we couldn’t just invite interested teachers; we had to make it mandatory. For this to happen, we had to work closely with the Ministry of Education.

Working closely with the Ministry of Education is like working closely with a nice, but utterly senile grandparent. Every step requires assistance, prodding, kind reminders, fond threats, long repetitive discussions. Every activity must be rechecked to be sure it went in the desired direction. Himalayan patience is a daily requirement and outside psychological support is helpful. To make it even harder, in the middle of our operation the United Nations transitional government shut down and East Timor became an independent nation. This was a good thing, don’t get me wrong, but the United Nations also pulled out a lot of the logistical support they had been giving to the half-island, especially communication and transportation. So it is that at the time of our trainings, we still didn’t know exactly how many physics teachers there are in each district, how many never

5 Many times during this process I thanked my lucky stars that this nation is so small. The problems here of communication, transportation, bureaucracy and lack of experience are all so overwhelming that it is a breath of fresh air to find the numbers involved in any given operation so small. With a population of around 800,000, East Timor is about the size of San Francisco.

6 Before I came to East Timor, I knew nothing about donors and fund-raising. I still know nothing – the funds I was able to raise came to me by way of chance acquaintances and instances of bizarre happenstance. All my attempts at methodical searching led to naught. In the end we used US$157,000, including the new high-school textbooks, and not counting several thousand contributed by the Catholic College of Baucau through its programs.
received information about our courses nor how many received the information but were unable to find transport to attend.

By the time we were developing the national training courses, I could see the end of my stay in East Timor. I wanted to prepare people to take my place when I was gone, so I asked Brother Mark if he would fund the training of trainers. He agreed, as did the five teachers I had been working with to develop the syllabus. We met several times and I attempted to pass to them what I know about the art of teacher training. We also planned the courses together, choosing and reviewing lessons from the Manual to present and deciding which concepts were most important. Our goals were three: a) teachers carry out the activities and learn from them; b) teachers learn how to teach with hands-on activities; and c) teachers increase their understanding of various physics concepts.

At the first national training course in June, my trainer mentees were on the front line. I sat in the back and watched while they carried out the training of their peers. From time to time I would step in and make corrections or add things they had missed. All in all it worked well, and by the end of two courses, we had reduced the number of trainers necessary to two, plus Teresinha to work some exercises with the teachers and me as on-call mentor, now reading (and writing newsletters!) in the back of the room.

These courses were intense: Monday through Saturday, 8am to 9pm, with short breaks for food and bathing. We had divided the nation into four sections and conducted these courses in four central locations throughout the country. Twice they were held in a high school with teachers sleeping on grass mats at night in a bare classroom, eating in another classroom and bathing in the squalid school toilets. We offered no entertainment beyond the experiments themselves (which were often quite entertaining, mind you).

Nevertheless, the teachers’ response was spectacular. They showed up on time, stayed awake and never complained about the conditions. Only six schools in the nation failed to send teachers. A few teachers travelled to other regions to participate more than once. Nearly all wanted more! (And the reality is, they need more. In our weeklong course, we carried out only 23 lessons touching on most major topic areas, and quickly demonstrated about ten more. There are 41 required hands-on lessons for middle schools and 44 for high schools.)

Personally, I must say it was a non-stop thrill to watch group after group of teachers perform the simple activities, then become engrossed in genuine discussions about what they observed and its meaning. One by one they discovered that their subject is not just a set of isolated factoids, and is in fact tightly woven into the everyday lives of themselves and their students. Seeing them make these realisations was like witnessing the spring thaw.

We gave a total of six courses in four months. At the end of each course, we had the pleasant job of handing out a set of reference texts, the new *Manual* for teaching hands-on lessons and a complete kit of gear for the teachers to take back and put in their newly delivered cabinet.

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7 The Catholic College of Baucau has a policy of charging for its courses. The theory is that teachers paying for the courses will be more serious. Teachers were charged US$10 a piece for this 55 hour course. This money did not even cover their food for the week, but was still a steep price considering their US$150 monthly salaries. Some teachers complained about the price, and we discussed this issue at length, in part because this course was a national requirement. In the end a compromise was reached: teachers could attend the course for free, but if they wanted the certificate to prove they had completed the course, they needed to pay. The Catholic College paid for teachers’ transport to and from the courses. I’m personally not satisfied that the compromise was adequate, but the trainings to date have been successful beyond my expectations.
Watching the happy teachers walk away with their loot at the end of an exhausting week reminded me of the summer camps of my youth.

The Situation I Left in East Timor

I departed East Timor in November, leaving vacant my place teaching the UNTIL lab courses. UNTIL needs a lot of support to develop proper laboratories for biology, chemistry and physics. Until this happens, our plan is to use lessons from the *Manual* as the lab curriculum. My mentee teachers, as the most qualified lab teachers in the country, have each chosen a lab course to teach in the coming school year. Before leaving, I helped them develop the activities to a higher level, and take advantage of some of the equipment we found in dusty boxes left over from Indonesian times. For the next two years this should be adequate. After that, high-school students entering UNTIL will have already seen many of the activities and will need more rigorous lab courses.

As it stands today, the problems with physics education in East Timor are broad and various: General chaos at the Ministry level, and no science and math coordinator. Many teachers at elementary level completely avoiding science education. No proper lab facilities in middle- or high-schools. Most teachers with poor preparation, not enough teachers and few rising up to fill in the gaps. At university level, no laboratory, no books, only one moderately qualified teacher and no international help forthcoming.

At the same time, physics teachers in East Timor go to school and teach classrooms full of students everyday. Now many have some ideas about how to carry out hands-on education. They have a manual to give them step-by-step directions for some activities, a bit of gear locked in a cabinet to use for these activities, textbooks of tolerable quality, a set of reference texts and a national syllabus that is reasonable and gives them space to be creative. In short, middle- and high-school physics teachers in East Timor are equipped, required and generally inspired to begin working out how to teach with a method new to them, a method that puts great value on students’ observations and on their culture and daily lives.

These teachers, however, are not satisfied. They have created the *Forum Komunikasaun Mestre/a Fizika Timor Lorosa’e*, an organisation devoted to further development of East Timor’s physics curriculum. (Incidentally, the *Forum* is looking for funding, primarily for teachers’ transport and photocopying. If you have ideas, please contact me via email at cake@exploratorium.edu.) I have every reason to believe that the state of physics education in East Timor will continue to improve after I’m long forgotten.

PHYSICS PHOTOS

If you skewer a guava on a nail, you can paint the equator on its waste and insert a pin, the head of which will represent the island of Timor. A gumball skewered on another nail will represent the moon. Both nails can be stuck into a banana leaf spine, and when you hold this fully rotating and orbiting apparatus under the sun, you can demonstrate day and night, seasons, moon phases and eclipses. Here, our neighbour Zeze models a solar eclipse on Timor.
Playing guitar could be East Timor’s national pastime. If you bite a guitar as it is strummed, you can learn something about where the sound comes from.

Making and playing a bamboo slide whistle gives great insight into the concepts of frequency, wavelength and resonance.

A prerequisite for the model-arm activity is to eat three kebabs.

Why is this boat floating? East Timorese students can do Archimedes’ experiment to find out more about this integral element of Timorese culture.

Believe it or not, this old woman knows all about angular momentum and inertia. The fat, heavy bottom on her spinning rod is not just for looks.

Our 12-year-old neighbour Ana understands why pressure increases as you go deeper in the ocean or the atmosphere.
With aluminium foil from a box of clove cigarettes and a couple of batteries pilfered from the family flashlight you can illustrate the principle of a fuse.

What happens if you turn on your radio then stick it in a pot and put on the lid? Try it!

A couple of crackers and some rice porridge make a model of plate tectonics that you can use to explain earthquakes and nearby volcanoes. The model can be eaten when you’re done.

Some of the 150 kits we distributed.

Nuno, one of the trainers-in-training, giving directions for an activity on Archimedes’ principle.

Marcal from Aileu district displaying his kit.
A group of teachers thinking hard about atmospheric pressure.

**APPENDIX A: SAMPLE LESSON**
**FROM THE MANUÁL LISAUN PRÁTIKA FÍZIKA**

This lesson’s name means “Winnowing Rice.” The concept is that dense, compact things will move more easily through a fluid, such as air, than things with large surface areas. This principle is used to winnow grain, and is key to life in East Timor in that most people winnow rice daily to remove hulls and other foreign objects before preparing it to eat. It is also the principle behind a simple toy that can be made from string, a stick and plastic sack cut into a long strip.

The sections are standard to each activity in the Manual: *Supplies The Student Will Bring, Supplies The Teacher Will Bring, Group Size, To Do It, What Happened, Connection To Life, Connection to Textbook.*

**TAHEK FOOS**

Hadulas tali, ai no plástiku ikun atu komprende oinsá halo ketak foos nia isin no kulit.

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*Tamañu grupu nian:* konforme – estudante ida-idak bele halo mesak
Atu halo:

1. Tesi plástiku lotuk no naruk hanesan metru ida ka rua. Mós, bele uza tali rafia.

2. Kesi plástiku ba ai, no mós kesi tali ba ai.


4. Fila ba sala no halo diskusaun kona-ba sá mak mosu.
Sá mak mosu?

Tanbasá tali loos de’it maibé plástiku halo forma hanesan kabuar? Tanbasá ai sempre ba primeiru no plástiku tuir?


Entre tali, ai, no plástiku, ai todan liu. Tanba ne’e, nia iha enerjia barak liu atu hasoru ho anin, no dudu anin. Plástiku no tali kamaan, no la iha enerjia barak atu dudu anin.

Mestre bele halo demonstrasaun balu atu hatudu ba estudante sira sá mak mosu bainhira troko tali, ai, no plástiku.

- Hakotu plástiku no hadulas ai iha tali de’it. Haree sá mak mosu.
- Hasai ai husi tali no hadulas tali de’it. Haree sá mak mosu.
- Kesi plástiku diretamente ba tali no hadulas tali. Haree sá mak mosu.

Se anin la iha, esperimentu ne’e sei sai la hanesan. Tur teoria, tali, ai, no plástiku bele dulas loos de’it. Mós, bele halo esperimentu ne’e iha bee nia laran – iha tasi nia laran. Sá mak sei mosu? (Forsa friksaun bee nian boot liu forsa friksaun anin nian.)

Ligasaun ba moris:


Lisaun ne’e liga ba:

Eskola Pre-sekundária Livru Testu Fízika 1B, Konsep 5, p. 20.
Eskola Sekundária Livru Testu Fízika 1A, Bab II, p. 43, no mós 3A, Bab II, p. 1
APPENDIX B: THE SCIENCE KIT

Each middle and high school in East Timor will receive the following list of supplies. Together with the cabinet, the cost per kit came out to US$380. Two-thirds of the activities in the Manual use only items that students can find, bring from home or buy for less than ten cents. Just one-third use special materials.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compass, magnetic</td>
<td>10</td>
</tr>
<tr>
<td>Diffraction cloth</td>
<td>10 pieces</td>
</tr>
<tr>
<td>Electrical components</td>
<td>10, 6 kinds</td>
</tr>
<tr>
<td>Food coloring, powder</td>
<td>1 pack</td>
</tr>
<tr>
<td>Glue</td>
<td>3 bottles</td>
</tr>
<tr>
<td>Graduated cylinder, 500 ml</td>
<td>10</td>
</tr>
<tr>
<td>Hand lens</td>
<td>10</td>
</tr>
<tr>
<td>Knife</td>
<td>1</td>
</tr>
<tr>
<td>Light bulbs, 3V</td>
<td>100</td>
</tr>
<tr>
<td>Magnet, large</td>
<td>1</td>
</tr>
<tr>
<td>Magnet, small</td>
<td>60</td>
</tr>
<tr>
<td>Mirror</td>
<td>10</td>
</tr>
<tr>
<td>Multimeter</td>
<td>10</td>
</tr>
<tr>
<td>Nails</td>
<td>1/2 kg</td>
</tr>
<tr>
<td>Prism</td>
<td>10</td>
</tr>
<tr>
<td>Protractor</td>
<td>10</td>
</tr>
<tr>
<td>Ruler</td>
<td>40</td>
</tr>
<tr>
<td>Scissors</td>
<td>10</td>
</tr>
<tr>
<td>Screwdriver, Philips</td>
<td>1</td>
</tr>
<tr>
<td>Slinky</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaker</td>
<td>1</td>
</tr>
<tr>
<td>Speaker plugs</td>
<td>5</td>
</tr>
<tr>
<td>Spring scale, 5 newtons</td>
<td>10</td>
</tr>
<tr>
<td>Stopwatch</td>
<td>10</td>
</tr>
<tr>
<td>Straws</td>
<td>6 packs</td>
</tr>
<tr>
<td>String, cotton</td>
<td>3 rolls</td>
</tr>
<tr>
<td>String, plastic packing</td>
<td>1 roll</td>
</tr>
<tr>
<td>Syringe, 10 ml</td>
<td>10</td>
</tr>
<tr>
<td>Tape measure, 1.5 meters</td>
<td>10</td>
</tr>
<tr>
<td>Tape, masking</td>
<td>6 rolls</td>
</tr>
<tr>
<td>Tape, packing</td>
<td>2 rolls</td>
</tr>
<tr>
<td>Thermometer</td>
<td>10</td>
</tr>
<tr>
<td>Thread</td>
<td>3 rolls</td>
</tr>
<tr>
<td>Transformer</td>
<td>1</td>
</tr>
<tr>
<td>Translucent plastic bags (for optics)</td>
<td>7 packs</td>
</tr>
<tr>
<td>Tubing</td>
<td>3 meters</td>
</tr>
<tr>
<td>Used disposable camera</td>
<td>1</td>
</tr>
<tr>
<td>Wire, connection</td>
<td>6 meters</td>
</tr>
<tr>
<td>Wire, magnet</td>
<td>200 meters</td>
</tr>
</tbody>
</table>

I managed to have the cabinets made by a group of local carpenters and coax the Ministry’s lumbering logistics unit into hauling them off to each individual school in the farthest corners of this nation of treacherous mountain roads. This also took several months of patience and persistence, with gifts and sweet-talking to all sides.