The Learning Physics as One Nation Initiative: Bypassing the National STEM Teacher Shortage

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Learning Physics as One Nation (LPON) is an initiative of the Fund for Assistance to Private Education, funded by the Department of Education of the Philippines, and designed to bypass the nation's severe STEM teacher shortage. Project components include a specially designed Physics Essentials Portfolio of 239 learning activities to be independently accomplished by students during one school year, and associated 18 DVD volumes of video lectures by national educators. The materials are designed such that a command team can monitor student progress, and address questions from the field through e-mail, mobile phone text messages, Skype, and fast courier services. Initial assessment of student performance shows a positive trend. Thus, after field studies in over 200 schools, plans are to produce Learning as One Nation materials for all other STEM subjects following the LPON model.

Keywords: STEM, Teacher shortage, Physics learning activities, LPON

Introduction

In an increasingly knowledge and technology-based global community, discoveries in science and innovative technology drive the economy with excellent scientists and engineers can dominate those without the required scientific manpower. Thus, most governments are seriously working on the development of their human resources for the science, technology, engineering and mathematics (STEM) disciplines (AAU, 2006; Hardy, Howes, Spendlove, & Wake, 2009). The challenges faced by such development programs can be formidable, including the declining interest of the young in pursuing careers in the STEM disciplines, as well as the increasing shortage of STEM teachers in many countries.

The Learning Physics as One Nation (LPON) Project (Carpio-Bernido & Bernido, 2005) is an initiative of the Fund for Assistance to Private Education under a grant of the Department of Education of the Philippines. The project is designed initially to address the severe lack of qualified Physics teachers, especially in the Philippines which has only 8% deemed qualified at present by the country's Department of Science and Technology – Science Education Institute. The LPON project therefore answers the question: *Can high school students learn essential physics topics effectively even if their classroom teacher has little or no physics training?*

Strategy and Project Components

The LPON theoretical framework and implementation strategy is derived from the Central Visayan Institute Foundation Dynamic Learning Program (CVIF-DLP) applied since 2002 at the CVIF High School in Jagna, Bohol, Philippines (Carpio-Bernido & Bernido, 2004, 2005). The CVIF-DLP is essentially an independent learning program where lectures and teacher-directed classroom activities occupy only 20% to 30 % of the required class period. The rest of the time (70% - 80%), the students independently accomplish learning activities where the hands-on minds-on maxim is applied. By design, the program is applicable for a normal distribution of fast, average and slow learners with varying levels of math-science preparedness.

The 30%-lecture – 70%-activity ratio is implemented with the LPON on a large-scale, *i.e.* nationwide, by having students view video lessons (on DVD) by Filipino physicist-educators as specially arranged by licensed high school teachers to suit high school students. The lectures are designed to specifically complement and tie up with the learning activities for the whole school year that are to be accomplished in class by the students. These written activities comprise the students' Physics Essentials Portfolio (PEP). We note that in the LPON Project, the assigned teacher (who need not be familiar with physics) is in class essentially for classroom management. However, the teacher assigned to a physics class who will watch the video lessons can simultaneously have a year-long, curriculum-based, in-classroom training in physics.

The LPON project was initially implemented in 34 private schools in the Philippine school year (SY) 2008-2009, with 28 of the Physics teachers being non-Physics majors in college or graduate school. The project has been expanded to include 26 public high schools in SY 2009-2010 (with only two Physics teachers having majored in Physics), and over 200 private and public schools for SY 2010-2011.

Initial Assessment of LPON Student Performance

For comparative descriptive statistics and analysis during the pilot phase, a repeated measures design was followed (Carpio-Bernido, Bernido, & Porio, 2010). A pre-test and a post-test were conducted by the Center for Educational Measurement (CEM), a nationally recognized independent testing center, in July 2008 and March 2009, respectively. The tests consist of multiple choice type items covering a whole school year of basic topics in high school physics including the *nature of physics, force and motion, energy and power, electromagnetics and current circuits, waves and energy, communications, topics in thermodynamics and modern physics*. Twenty-nine (29) schools were given tests following the traditional physics curriculum. The paired t-test was done for students with both pre-test and post-test, a total of 4,362 students. Of the 29 schools, 25 had all-LPON classes with a total of 3830 students, while four had both LPON (532 students) and non-LPON classes (379 students).

The group of 25 schools with all-LPON classes had a statistically significant gain in means for percent correct (PC) score, at 95% ($p = 0.05$) confidence level for three schools, and 99% ($p = 0.0$) confidence level for the 20 schools. One LPON school had a statistically non-significant increase in PC mean, while one school, the post-test PC mean had a statistically insignificant PC mean decrease. The LPON classes in the four swith and non-LPON classes also posted statistically significant gain in mean scores.

Results also show a significant percentage gain in the number of students in the LPON classes in the upper six performance levels of the CEM tests: Excellent (from 0% to 1%), Superior (from 1% to 2%), Above Average (from 1% to 4%), High Average (from 4% to 9%), Average (from 7% to 11%), Low Average (from 14% to 17%), and a significant decrease in the number of students in the lowest three performance levels: Below Average (from 17% to 15%), Poor (from 32% to 25%), Very Poor (from 24% to 16%). This indicates the acquisition of competencies within the whole spectrum of learners from slow to fast learners. This also coincides with the observation expressed by principals and teachers in the evaluation workshop conducted in May 2009, that all types of learners had improved performance. Naturally, efforts are now directed at further improvement of performance and percentage of students in the different categories. For benchmarking, the rates were also compared to the CEM Non-LPON cohort performance of 2%, 3%, 5%, 11%, 12%, 17%, 14%, 22%, and 14% for the categories from Excellent down to Very Poor, respectively. (It should be noted here that the CEM tests are availed of by more affluent schools which can afford the fees. On the other hand, most LPON schools have limited budgets and have not availed of the services of the CEM.)

All teachers who responded to the questions in a separate survey form accomplished during the LPON Evaluation Workshop in May 2009, indicated a gain in confidence and competence (25 teachers). Twelve out of twelve principals/ academic coordinators who attended the workshop also indicated a gain in teacher confidence and competence. Nine out of nine principals/academic coordinators who answered the relevant questions (with available data) indicated an improvement in students' mean performance in external and/ or national scholastic assessments. Two principals explicitly remarked on parents being happy about the improvement in performance and behavior of their children who may be slow to average learners.

LPON Advantage over Other Approaches Addressing STEM Teacher Shortage

As to the question why the LPON initiative is needed when there are ot her approaches to upgrade STEM education, we briefly comment on various features of other approaches.

Existing Textbooks

— Many students (and even teachers) find these voluminous and difficult to read. Note that any misinterpretation of textbook material can be a weak link in the teaching chain from expert to student.

— The LPON Physics Essentials Portfolio is designed with only one learning activity for each page to facilitate understanding and recall of strategically selected topics. Students can then refer to other books for details and additional material.

Video tapes and teaching support materials prepared by the Philippine Foundation for Upgrading the Standard of Education - Studies via (-CONSTEC)

— The materials are addressed to physics teachers, not students.

— Most sessions are demonstrations with lab equipment not available in many high schools in the country. In contrast, the LPON lectures are very detailed and step-by-step to appeal to a broader spectrum of learner abilities and preparedness, and demonstrations use simple locally available materials.

— The materials for teachers, together with the Physics Essentials Project materials for the students, can facilitate learning. Teachers can focus on the topics deemed essential by the LPON national team of physicists and educators.

Foreign libraries of VCD's and materials from different Internet websites

— The LPON materials are prepared by local experts with international research and teaching experience and based on actual local classroom learning conditions in the Philippines. This perspective makes it significantly different.

— The medium of instruction in the LPON is English, but used in a way that facilitates learning in a foreign language.

Seminars, training workshops and scholarships for teachers

— Considering the present lack of physicists and highly qualified trainers for teachers in the Philippines, there is the present risk of diffusing misconceptions and/or ineffective techniques.

— Expertise of resource persons may be in pedagogy but not in content; on the other hand, most physicists have no hands-on experience in the day-to-day run of lessons in basic education for an *entire school year*. Close coordination between educators and physicists is necessary for significant results; this is done for the LPON project.

— The large scale effect of short-term 'out-of-context' science teacher-training seminars and workshops is debatable.

— Returns are slow due to migration of science and math teachers to advanced countries. (Over 3,000 Filipino teachers have migrated to the US and other countries since 1992, according to a survey done by a national daily.)

— It is more cost-effective to produce the LPON project materials. The printed Physics Essentials Portfolio and 18 DVD volumes for over 1,500 minutes of video lessons, used in the pilot phase were prepared on a budget of PhP 2 million or less than US $45,000, much less than the multimillion dollar budget for instructional materials and massive training programs for science teachers all over the country.

Conclusion

The Learning Physics as One Nation (LPON) project is a prototypical STEM large-scale learning program on a limited budget, with expectations of significant improvements in scholastic performance on a time scale of half a decade or less. With advanced technologies, it is now possible to have such a program that could be enjoyed by a larger number, on a larger geographical scale, on demand. Thus, the scope of both direct and indirect training covers school students, classroom teachers, and national/regional master trainers for all regions of the country.

Assessment and comparative evaluation has been done for the LPON project cohort and institutional performance. Still ongoing is a study which will look at correlation between the different variables involved in the evaluation of different groups of students in different schools. Work is also being done on a test item-by-item analysis, and pattern-seeking in the performance of individual students for the different content areas. This should be important for the choice of the optimally effective physics curriculum for future implementation.

The LPON model also naturally allows for adaptation and expansion. Because of generally positive results of assessment and feedback, the LPON project is being expanded to over 200 high schools all over the Philippines. There are also plans to produce Learning as One Nation materials for all other STEM subjects following the LPON model.

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