

AN INTERNATIONAL QUANTITATIVE EDUCATION INITIATIVE AND ITS IMPACT ON STATISTICS EDUCATION

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Several years ago the author established the annual INFORMS/IFORS International Teaching Colloquium series. In these workshops he collaborates with instructors from developing regions to co-organize teaching effectiveness colloquia. These colloquia, hosted by organizers of a conference in the region that is home to the instructors with whom the author collaborates, have been held in Montevideo (2006), Cape Town (2007), Cartagena (2008), and Jaipur (2009). Similar workshops are now being organized for Dakar, Nairobi, Melbourne, and Buenos Aires. The author will share what he has experienced in organizing these colloquia, focusing on what he now perceives to be the similarities and differences in how students from various cultures develop quantitative skills. He will also discuss how these colloquia help improve statistics education and encourage the enhancement of student's statistical skills.

THE INCEPTION OF THE INFORMS/IFORS INTERNATIONAL QUANTITATIVE EDUCATION INITIATIVE

In 1995 the author proposed that the Institute for Operations Research and the Management Sciences (INFORMS, <http://www.informs.org/>) provide sponsorship for a series of international colloquia on teaching operations research and management science (or ORMS). These proposed colloquia would be similar to the annual series of domestic Teaching Effectiveness Colloquia (or TEC) the author had established in 1999. The two-day long domestic INFORMS TEC are made up of several sixty-minute workshops during which recognized leaders in ORMS education and pedagogy demonstrate effective and innovative methods of conveying various ORMS concepts to students. The domestic TEC are held immediately prior to the annual INFORMS Conferences and are entirely subsidized by INFORMS; the organization pays for all costs associated with conducting the TEC (attendees are responsible for paying for their room and travel, but since attendees generally plan to attend the INFORMS conference that immediately follows the TEC, the only additional expense incurred by participants is typically the cost of 1-2 nights of lodging). These TEC, which are targeted at college instructors of quantitative methods, have been very popular; they generally draw 30-40 participants each year and consistently receive very positive reviews from these participants.

INFORMS agreed to fund the international teaching effectiveness colloquium initiative for one year (with funding for ensuing years contingent on a review of the outcomes of the first international colloquium); the organization would pay for up to three INFORMS members to travel to an ORMS conference in a developing region to give workshops as part of this colloquium. The host organization would be for local travel, conference registration, lodging, and meals for these INFORMS members. In addition, the host organization would recruit 2-4 of its members to give workshops as part of the TEC.

The author then contacted the executives of the Asociación Latino-Iberoamericana de Investigación Operativa (ALIO, <http://www.dc.uba.ar/alio/index-en.htm>) to initiate a discussion on a potential joint ALIO/INFORMS teaching effectiveness colloquium. ALIO executives enthusiastically embraced the initiative and agreed to host the 1st ALIO/INFORMS Colloquium on OR Education as part of the 2006 Congreso Latino-Iberoamericano de Investigación Operativa (XIII CLAIO, <http://www.fing.edu.uy/inco/eventos/claio06/eng/>) on November 27–28, 2006 in Montevideo, Uruguay. The Conference co-chairs (Héctor Cancela, Carlos Testuri, and María E. Urquhart of the Universidad de la República, Uruguay) worked with the author to organize this colloquium. The author also gave an education-oriented plenary, “Confessions of an Optimistic Cynic - Using Active Learning to Increase Comprehension and Retention in the Quantitative Classroom,” early in the conference to increase awareness of the colloquium among XIII CLAIO attendees. Topics of the individual workshops that comprised this colloquium included:

- Innovative Approaches for OR Education
- Using Games as a Pedagogical Method for Teaching O.R.
- Establishing and Running a University Teaching Center
- Teaching Modeling Skills.

The 1st ALIO/INFORMS Colloquium on OR Education was very successful; it attracted over forty very enthusiastic participants (approximately 10% of the XIII CLAIO participants). Participant comments were very positive, and the presenters also felt they learned a great deal from their colleagues. The success of this TEC resulted in a commitment between the organizers to continue to offer these colloquia at future biannual CLAIO.

THE INFORMS/IFORS INTERNATIONAL QUANTITATIVE EDUCATION INITIATIVE GROWS

After reviewing the outcomes of this colloquium, INFORMS extended its support for this initiative for five years. At this point the International Federation of Operational Research Societies (IFORS, <http://www.ifors.org/>) also committed to sending one or two representatives to each of these annual international TEC for five years. The author then turned his attention to Africa and began working with officers of the Operations Research Society of South Africa (ORSSA, <http://www.orssa.org.za/wiki/pmwiki.php?n=Main.HomePage>) to organize the 1st ORSSA/INFORMS/IFORS Workshop on OR Education. This international TEC was held on September 10 - 11, 2007 in conjunction with the 2007 Operations Research Practice in Africa (ORPA, <http://www.orpagroup.net/>)/ORSSA Conference in Cape Town, South Africa (<http://www.orssaorpa2007.org.za/>). The author worked with Neil Manson of Monash University, Ozias Ncube of the University of South Africa, and Johan W. Joubert of the University of Pretoria to organize this TEC. Workshop topics included:

- Modeling for Insights
- Spreading Knowledge using Spreadsheets
- Uncertainty Modelling and Applications to Optimization
- Free/Open Source Software Tools for O.R. Education
- Multiple Objective Optimisation through Computational Intelligence Means: Theory and Practice
- Teaching the OR Method
- Using Action Research Projects as a Medium to Teach OR in Development
- Public Policy Evaluation.

The author again gave an education-oriented plenary; he spoke on “Ennoblement through Mobilization: Establishing a Pre-eminent Societal Position for the Quantitative Sciences,” to increase awareness of the colloquium among 2007 ORPA/ORSSA attendees.

The 1st ORSSA/INFORMS/IFORS Colloquium on OR Education was very successful; it attracted over 50 very enthusiastic participants (close to 50% of all 2007 ORPA/ORSSA participants). Participant comments were again very positive, and the presenters again felt they learned a great deal from their colleagues. One important outcome of this TEC was the creation of the Network of Operations Research Educators for Africa (NOREA, <http://tech.groups.yahoo.com/group/norea/>), a Yahoo group established to promote and support the teaching of Operations Research in Africa.

In 2008 this initiative returned to Latin America and cooperated with the executives of the ALIO to organize the 2nd ALIO/INFORMS/IFORS Colloquium on OR Education as part of the 2008 Congreso Latino-Iberoamericano de Investigación Operativa (XIV CLAIO, <http://www.socio.org.co/CLAIO2008/>) on September 9 - 10 in Cartagena, Colombia. Alberto Canen of Universidade Federal do Rio de Janeiro worked with the author to organize this colloquium, which consistently attracted over fifty participants to its various workshops. Workshop topics included:

- Contribuições Multiculturais Para o Ensino da Pesquisa Operacional
- Experiencias en el rediseño e implementación de los cursos de Investigación de Operaciones en la la carrera de Ingeniería Industrial
- Projects and Cases for Community Service-Based Education - Getting Students out of their Seats and into the Bona Fide Real World
- Bringing the Exciting Real World of OR Into the Classroom
- Project-Based Teaching in Operations Research/Management Science Courses.

In 2009 the initiative moved to Asia and collaborated with the Association of Asian Pacific Operational Research Societies (APORS, <http://www.apors.ms.unimelb.edu.au/>) on the *1st APORS/INFORMS/IFORS Colloquium on OR Education* as part of the 2009 APORS Conference (<http://apors2009.com/>) on December 7–8, 2009 in Jaipur, India. Conference co-chair Ashok Mittal of the Indian Institute of Technology worked with the author to organize this colloquium, this colloquium, which consistently attracted over fifty participants to its various workshops. Workshop topics included:

- Teaching Across Divides
- Use of Cases for Teaching OR/OM/Modeling
- Exploring Best Practices in OR/MS Education
- Bringing the excitement of OR into the classrooms
- Success in Teaching Operations Research to MBAs: Philosophy, Goals, Content and Approach
- Using Active Learning to Improve Student Comprehension and Retention in Quant Courses.

Plans are now being made for future international TEC to be held in Dakar, Buenos Aires, Nairobi, and Melbourne.

WHAT DOES THIS INITIATIVE HAVE TO DO WITH STATISTICS?

Note that although these colloquia and the sponsors are all primarily oriented toward operations research and management science, these disciplines make heavy use of statistics and probability. Several of the workshops given during these colloquia have actually been statistically oriented, while other workshops (such as those generally given by the author) have intentionally been defined very broadly so as to allow for coverage of approaches that are relevant to all quantitative methods courses (including statistics as well as ORMS). Furthermore, the disciplines of operations research and statistics are frequently grouped together in a single academic unit by universities outside of the United States. Finally, the skill sets that instructors generally agree to be necessary for students to understand and appreciate the concepts covered in ORMS and statistics courses: abstract thinking, analytic thinking, critical thinking are comparable. Thus, the lessons learned in these ORMS colloquia are very relevant to instructors of statistics.

WHAT LESSONS HAVE BEEN LEARNED BY THE WORKSHOP INSTRUCTORS AND ORGANIZERS?

Before the author began organizing these international workshops, his efforts in organizing the INFORMS domestic ORMS teaching effectiveness colloquia and his classroom experiences (teaching both statistics and ORMS) had led him to five epiphanies about teaching quantitative methods at the college level. These five epiphanies are:

- Students learning styles generally differ from the learning styles of the quantitative methods instructors. Instructors of quantitative methods courses were usually atypical undergraduate students with atypical interests, aptitudes, and learning styles.
- Although they have a strong tendency to do so, instructors of quantitative methods do not have to teach the way they were taught. Instructors who have not been trained in pedagogical theory and methods tend to approach a topic in the same manner as the individual(s) who provided their instruction on the topic.
- Instructors do not have to work at making the study of the quantitative sciences interesting and fun for students; these topics are inherently interesting and fun to study, and the instructor need

only to help her/his students understand why and how one could enjoy studying the quantitative sciences.

- Every student will remember something from every course s/he takes, so the instructor should endeavor to make what s/he wants to stress memorable.
- Students are very forgiving if an instructor makes an earnest mistake while attempting to do something different in the interest of improving student understanding and retention. The key to engender a forgiving attitude among students is to explicitly discuss (as much as is practical) the new approach and how the instructor expects the approach to benefit the students *before the instructor attempts the new approach*, i.e., the instructor should make the students her/his partners in such endeavors.

These realizations are extremely liberating; if an instructor is convinced they are true, s/he will be much less averse to experimenting her/his approach to teaching quantitative methods courses (including statistics). As he and his colleagues have interacted with each other across cultures and attended workshops given at the international TEC, the author and his colleagues have arrived at several additional general realizations about teaching quantitative methods (statistics and ORMS). These general realizations include:

- The author and his colleagues have been amazed at the similarities in students across cultures. After he gave a quantitative methods oriented plenary at a recent conference in Latin America, one of the attendees approached the author, hugged him, and exclaimed, "I am so glad to learn that dogs eat homework on every continent!" The author has also found a great deal of agreement among quantitative methods across cultures with the results of Hartley and Davies (1978); instructor experiences support the notion that the typical student's level of attention increases during the first ten minutes of a typical lecture and then rapidly diminishes.
- The author has also found the similarities in quantitative methods instructors across cultures to be very reassuring. Instructors of quantitative methods are generally passionate about their subject and care deeply about their students, want their students to understand and appreciate what knowledge of basic quantitative methods can mean to them, and are frustrated by the lack of understanding and appreciated exhibited by students who have completed introductory quantitative methods courses.
- On the other hand, the author has been very humbled by the differences in conditions faced by quantitative methods instructors from different countries. During a break between workshops at the 2007 ORSSA/INFORMS/IFORS Colloquium on OR Education in Cape Town, the instructor and several other participants were discussing what they found to be most frustrating about their teaching quantitative methods at the college level. Initially the discussion focused on the usual complaints voiced by instructors; students frequently arrive to class late, fail to turn in their assignments, or miss exams without prior notification or valid excuses. After a few minutes of this discussion, several of the participants turned to one participant from a central African nation who had been noticeably silent. In a friendly attempt to engage the central African instructor, someone asked him what frustrated him most about his efforts to teach introductory quantitative methods to undergraduate students. After pausing momentarily to consider his response, the central African instructor responded, "I only have electricity in my office for two hours each day, and I often do not know which two hours the electricity will be available until I arrive to campus that morning."
- Many instructors do not initially understand the notion of an education oriented conference presentation—when invited to give such a presentation or workshop, many initially focus initially on presenting research results that have been achieved through joint instructor/student efforts.

These realizations are critical considerations when organizing international teaching effectiveness colloquia. The similarities in students suggest that student-oriented instructors of quantitative methods will share many common interests and needs. The similarities in instructors suggest that many instructors will generally be receptive to the same new and novel approaches. The differences in conditions faced by instructors (and of course, by students) must be given heavy

weight when organizing such colloquia; indeed, a primary purpose of these colloquia must be to help instructors who are dealing with such difficult circumstances find creative, innovative, and easily transferable ways to overcome (or at least mitigate) these circumstances. Finally, organizers of such colloquia must be diligent in working with workshop presenters who are new to the concept of an education-oriented conference presentation. Colloquia organizers must be patient and understand that their diligence may not be sufficient, and that occasionally a workshop will have a heavier research orientation than is appropriate. The organizers must also understand that one purpose of these colloquia is to acquaint instructors of quantitative methods with the concept of education-oriented conference presentation; once an instructor has attended a few such presentations, s/he will understand the purpose and potential content of such presentations.

In addition to these general realizations, the author and his colleagues have reached some specific (but perhaps still somewhat preliminary) conclusions about various alternative approaches to quantitative education. These conclusions, based primarily on anecdotal evidence, include:

- Cases appear to be more effective in cultures with folklore traditions. Students from such cultures appear to be more receptive to the case approach; they are better prepared to sort through the information provided in a case narrative, identify what information is relevant and what information is irrelevant, use the relevant information to address the case issue(s), and apply lessons learned from past cases to analogous problems they face in the future.
- Students from various cultures may have different notions about how alternative pedagogical approaches will actually be implemented. During a visit to a Chilean university, the instructor attempted to integrate a case into an introductory statistics class in which he was guest lecturing. He had provided the case narrative, the relevant data in an Excel file, and generic instructions on how to analyze cases and summarize results in a brief or report. The author also indicated that he expected each student to submit a two page report/brief on the case at the end of the class meeting during which the case was to be discussed. Much to his surprise, the students arrived to the class meeting without completed reports; their collective expectation was that the author would guide them as a group through the analysis during the class meeting, while the author expected the class meeting to be used for discussion of and debate on the students' various approaches, results, and recommendations.
- Area of application matters. A country's positions in the economic and political development cycles largely dictate what applications will interest and inspire that country's students. Throughout most of Asia, in South Africa, and in large portions of Latin America, economic development and expansion are realities (even with the recent economic turndown), and students from those countries and cultures are very interested in business oriented problems. In some of these cultures interest focuses on problems faced by large corporations, while other cultures in these regions are more interested in small businesses or sole proprietorships. On the other hand, in most of Africa as well as in the regions of Latin America and Asia where the economies are not growing, students have a much stronger interest in applications to societal problems.
- The types of active learning exercises that are effective depend largely on the culture. For example, some cultures seem to be very open to playing games while others appear to be much less receptive to these activities. After participating in the 1st ALIO/INFORMS Colloquium on OR Education, an Argentinean instructor of quantitative methods was inspired to create and integrate various games into her courses (Funes, 2008). She reports great success; her students are more enthusiastic about the courses and the topics covered, and their understanding and retention appear to have improved dramatically. Her conviction in the potential success of this approach for her culture is extremely strong. She has expressed this conviction by giving workshops and presentations at Argentinean conferences and imploring her colleagues/countrymen to adopt a game-oriented approach. On the other hand, such games may not be embraced as enthusiastically by students from other cultures.

These preliminary conclusions about various alternative approaches to quantitative education represent important research opportunities in statistics education.

CONCLUSION

The author has been extremely gratified by the reception this initiative has received and by the overwhelmingly positive and enthusiastic feedback it has generated. The author believes this is evidence (again anecdotal) of the following:

- *Boots on the ground* are far more important than *checks in the mail*. While many well-intentioned initiatives exist for sending books, supplies, and money to developing regions in support of education efforts, there is no substitute for *highly interpersonal collaborative efforts*. Furthermore, while technology enables easy electronic communication between individuals almost anywhere on the globe, such communication is not sufficient for the development of the type of relationship one must establish to create a high likelihood of success for such international initiatives.
- Building support networks matter. While it is important to spend time in the region in which an education initiative is to be established, it is also imperative that all individuals involved work together to develop a network of like-minded and concerned instructors who will work with each other to resolve specific classroom problems and address broad pedagogical issues. The Internet and other electronic means of communication are very useful for this purpose.
- Ownership belongs to the host. While an individual (such as the author) who creates an international education initiative must make a long term commitment to nurturing, maintaining, and growing the initiative, s/he must also recognize her/his limitations. The director of an international initiative cannot expect to fully understand, appreciate, or anticipate the legal, cultural, political, social, and economic environments that her/his initiative may face. The success of these initiatives depends on the establishment of strong partnership relationships in which the host is primarily responsible for planning, organizing, and promoting the activity that has been proposed by the organizer of the initiative. The organizer of the initiative must trust her/his partners to guide her/him through the challenges that the legal, cultural, political, social, and economic environments of the host region may present. Once again, this is an important reason why it is critical for the initiative's organizer(s) to spend time in the host country.
- Most importantly, there is a strong need and appreciation for these efforts when they are properly executed. The opportunities for similar collaborative efforts are abundant, as are the personal and professional rewards that come with successfully establishing such an initiative. Quantitative methods (especially statistics and operations research) are key tools for resolving problems in industry, government, and society (Horner, 2008; Cochran, 2009a, 2009b, and 2009b).

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