CYBER RESEARCH MENTORING IN SCIENCE IN PHILIPPINE PRIVATE UNIVERSITIES: LEVERAGING ONLINE COLLABORATION TECHNOLOGIES AND OFFSHORE-BASED ALUMNI

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Abstract

The paper discusses an innovative, low-cost, and result-oriented approach to science research mentoring for graduate students and/or junior researchers in Philippine private universities. This so-called Cyber Research Mentoring in Science (CRMS) program has three unique features. First, it leverages offshore-based alumni who are active in science and technology research to be mentors. Second, it utilizes free or inexpensive online collaboration technologies as platforms to bridge the physical gap and to provide virtual presence of the mentors. Third, it requires that all activities lead to journal publications. We evaluate the required collaborative technologies from the perspective of students and mentors, offer best practices as well as critical evaluation, and identify other structural/institutional mechanisms and supports to enhance the success of the program across a range of activities. The last section suggests new avenues for future research.

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Introduction: Scientific Research

Graduate student research is an integral part of science and engineering education at any higher learning institutions. It is an essential training ground for students pursuing research careers in academia as well as in industries. One important by-product of these research activities are journal publications. The students' research undertakings are oftentimes constrained by (1) insufficient funding support for the faculty researchers, (2) limited financial resources of the university, and (3) restricted economic state of the country. Due to these limitations, the quality and quantity of science research experienced by graduate students from developing countries are oftentimes at a disadvantage compared with their foreign counterparts in developed countries.

In developing countries like Philippines, three of the most persistent and often-cited major challenges in advancing science research especially in private universities are: (1) limited well-trained technical personnel (teachers, scientists, engineers, researchers, and technologists which we will refer to, for simplicity, as scientists) available to conduct

research, (2) restricted time for local scientists to conduct research since majority of them are tied to lectures, classes and administrative tasks, and (3) lack of affordable facilities and operational laboratories that can be used by these dedicated scientists to advance their research works.

Historically speaking, the first and second problems are a by-product of the complex brain drain problem where large numbers of educated individuals or groups with high technical skills and knowledge emigrate to developed countries for various reasons [1-3]. The third problem is an equally challenging issue, and is rooted to the economic condition of the country, in general, and to the limited financial resources of the private university, in particular. Consequently, these problems (among other issues) narrow the research activities that university scientists can undertake, lower the number of graduate students that they can mentor, and eventually limit their overall productivity to produce Institute for Scientific Information (**ISI**)-indexed/cited international publications.

Table 1 shows a comparison of two universities in terms of scientific publications in a sub-field like physics from year 2008 to 2012. The two universities are in Philippines - one private (Ateneo De Manila University, ADMU) and one state university (University of Philippines, UP Diliman)

Year	ADMU	NIP
2012	2	20
2011	1	11
2010	3	12
2009	1	21
2008	3	23

Table 1. Comparison of scientific publications in physics for two local universities.

This table depicts two important points. First, it illustrates the fact that universities with healthy scientific publication outputs tend to have a strong access to human and financial resources. State universities like UP receive governmental research supports which lead to higher scientific publication outputs compared with a private university like ADMU. Second, the amount of financial supports that UP receives has a direct impact on the overall quantity of research publications. This fact becomes more apparent when we compare the number of ISI publications for the entire university of ADMU against Nanyang Technological University (NTU, Singapore) as shown in Table 2. During a 5 year span, it is apparent that on sheer volume alone, NTU leaps and bounds ahead of ADMU. Here most of the research done by NTU are funded by grants from the government which, according to the statistics provided by NTU, started in fiscal year 2008 at $180M and is steadily increasing per year [4-5]. It supports the strong correlation between healthy scientific publication outputs and country's economic and political standing primarily because the state funds research projects that are in line with the goals of the state. Thus, the call for private universities like ADMU to increase its scientific publication output is more challenging compared with UP or NTU.

Year	NTU	ADMU
2008	736	85
2009	634	73
2010	147	161
2011	298	116
2012	771	163

Table 2. Amount of Journal Publications per year for ADMU and NTU over 5-year span

Against this background, there is a need for private universities like ADMU to explore other creative strategies that can increase its scientific publication outputs. Any strategies must complement on-going efforts of ADMU scientists. Furthermore, it is imperative that any strategies must be result-oriented and low-cost since financial resources are limited to start with. Lastly and most importantly, these strategies must focus on graduate students and junior researchers since they are the engine of sustainable research activities.

In this paper, we propose a new and interesting approach to science research mentoring for graduate students/junior researchers which we refer to as **Cyber-Research Mentoring in Science**. Briefly speaking, it is an offshore-assisted, long-distanced, journal-publication-driven, low-cost, science research mentoring program with the goal of publishing papers at ISI international journal within 6- to 9-months timeframe. In section II, we discuss CRMS and its 4 critical components. In section III, we provide our preliminary results while in section IV we evaluate the internet-based technologies that support this approach. A number of technical issues related to quality of online/distance conferencing including research topics selection are discussed. We also report the best practices we learned in our pilot trial as well as the limitation or practical issues or challenges. In section V, we discuss some recommendations for improvements.

Role of Cyber Research Mentoring in Science (CRMS)

University research is critical to ADMU's continuing efforts to grow and expand from a "Learning University" to a "Learning and Research University" where productive research could lead to goods and products that are explored, designed and branded in Philippines and that will eventually contribute to sustainable national economic developments [6].

Research is one of the main components of science and engineering education that needs special attention. It brings hand-on experience where learned knowledge can be practiced and tested with the eventual goal of creating new goods, products or applications. Although graduate students and junior researchers are the engine of any university research activities, it is scientific research mentoring that is the critical vehicle to bring out the best formation for these future scientists.

Good research mentoring leads to ISI-journal publications which are significant in four levels. First for the graduate students, a list of ISI-publications in their resumes is very helpful especially if they are planning to pursue higher degrees in overseas universities. It is becoming the mode on how students are evaluated in today's highly connected, web-centric world. Second, for the local faculty member, it is significant because a list of ISI-publications is very healthy for rank promotion and career advancement. Third for the university, it is one of the major criteria on how the performance of a particular university is ranked both domestically and internationally. Lastly, for the country, there is a strong correlation between strong ISI publication outputs and economic development. This is clearly visible in the case of Japan in the '80, South Korea in the '90 and China, India and especially Singapore in the recent years.

II-A. Cyber Research Mentoring in Science (CRMS)

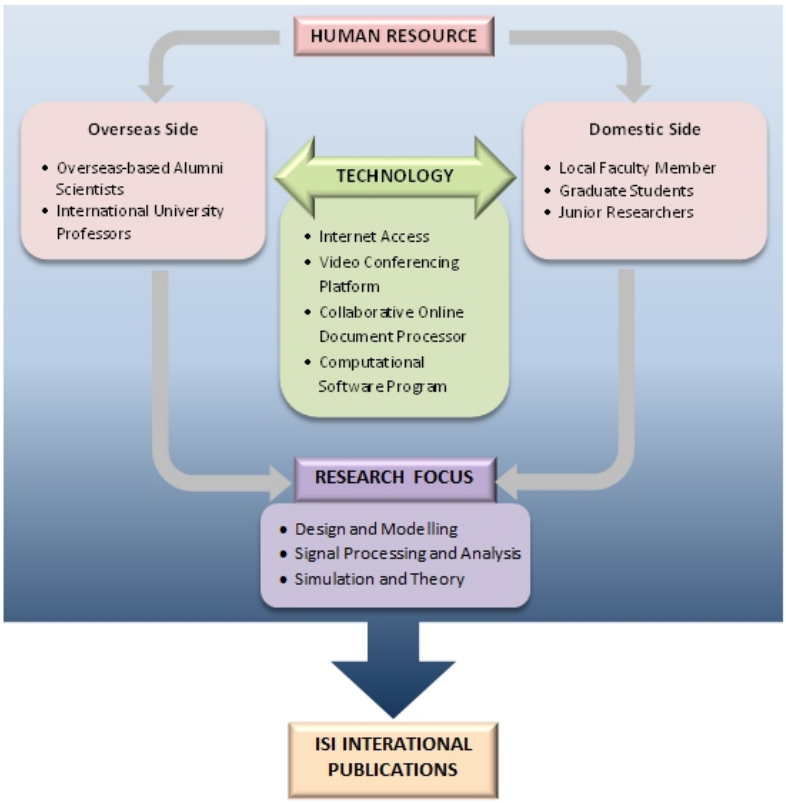

Figure 1. Diagram showing the concept of "Cyber Research mentoring" (CRMS)

CRMS is a long-distanced, research mentoring pilot program arranged by ADMU faculty member(s) in partnership with overseas-based Filipino, ADMU alumni/scientists to co-mentor or co-advise graduate students or junior researchers. It is a low-cost, journal publication-driven initiative whose success or failure is judged solely on whether the program translates into ISI journal publications within a period of six to nine months. This short timeframe is based on the principle of "quick failure and learning". **CRMS** started this June 2013 and is currently in its preliminary stage. Figure 1 graphically conveys the general framework. Operationally speaking, **CRMS** consists of four core features which are described below.

First, CRMS is a partnership between three players namely; (1) ADMU faculty member(s), (2) overseas-based Filipino, ADMU alumni who are also active researchers/scientists, and (3) graduate students or junior researchers. It taps the technical expertise of overseas-based ADMU alumni. CRMS is a vehicle for overseas-based Filipino scientists to contribute their technical talents and time. This approach is premised on the commitment of these Filipino scientists to partially share their expertise on pro-bono basis. This is a sort of "brain-sharing" phenomena instead of the "brain drain" that is happening across different countries [7-8]. We are moving away from "brain-drain era" where technical knowledge are "carried away" by local scientists when they migrate to developed countries to a new "brain-sharing era" where actual residence of scientists becomes secondary as long as the commitment to serve its country of origin is there. This "new era" is made possible by the rapid development in internet's collaboration technologies that cut across national boundaries.

Second, **CRMS** leverages these low-cost internet's collaboration technologies which include the (1) fast internet access, (2) free video conferencing products (ex. Skype, ooVoo, Google Hangouts), (3) free online social networking and collaboration products (ex. Google

doc), (4) open-access publication journals, and (5) other inexpensive internet-based communication tools. The need for physical presence of the mentor is now disappearing with rapidly advancing video conferencing technology. Taken as a whole, all these technologies offer a new platform where "regular but virtual meetings" can be realized between offshore-based scientists and the local graduate students for research mentoring.

Third, CRMS limits its research topics to modeling, designs, processing, analysis, theory, and simulations because of two reasons. One, the long-distance aspect of **CRMS** does not make it ideal for physical experimental work. Second, the required software tools to conduct research are easily available in the university setting or are locally accessible at lower cost. These tools include the ever-increasing computing power of today's modest desktop/laptop computers, and easy access to sophisticated yet low-cost mathematical programs like Mathematica, and MATLAB. This simulation-focus research allows the whole program to maintain its low-cost structure. Together with student's increasingly sophisticated coding/programming abilities, these research topics are very doable.

Lastly, it requires that the research activity lead to publishable papers at ISI-journals after 6-or 9-months. The whole strategy is judged by this sole criterion. If it can produce publications, then the benefits are clear and obvious to the university, faculty members, graduate students and overseas-based scientists. If it fails, then other alternative strategies should be explored. This is based on the principle of "quick failure and learning".

II-B. Formation of the CRMS Program

CRMS is a pilot program participated by three entities namely; (1) a New York State (US)-based start-up technology company called Nasfine Photonics Inc. represented by ADMU alumni (Dr. B. Dingel), (2) ADMU Physics Department under the Vacuum research group (Prof. I. Culala), and (3) Mr. M. Jallorina (MJ), and Ms. E. Aranas (EA). Mr. M. Jallorina is currently pursuing his MS degree at ADMU while concurrently teaching in the same department as faculty instructor while Ms. E. Aranas just recently finished her MS at ADMU and is currently teaching at Miriam College, Philippines. Mr. M. Jallorina and Ms. E. Aranas are our graduate student and junior researcher, respectively.

Initial discussion of the CRMS concept took placed in April 2013 between Dr. B. Dingel and Prof. I. Culala via email, followed by preliminary tour visit to ADMU Physics Department in May 2013 by Dr. B. Dingel. The program was approved and supported by other faculty members of the Physics Department namely; Dr. Minella Alarcon, and the department head Dr. James Simpas. The actual program started the following month June 2013 with the formation of weekly online meetings using Skype.

II-C. Research Topics and Research Process

As mentioned previously, CRMS limits its research activities to simulation-centric-research topics involving modeling, design, processing, analysis, theory, and simulation because the required software tools are available in the university setting. This simulation-focus research allows CRMS operation to maintain its low-cost structure.

With the goal of publishing papers, Dr. B. Dingel selected the "Microring resonator (MRR)-based, Slow/Fast light-Assisted Optical Devices and Applications" as research area because of his technical familiarity and work in this area. MRR is considered a building block in many highly dense photonics integrated circuits and has wide applications in many fields. This general topic covers full spectrum of state-of-the-art, high performance optical device design challenges from the basic elementary device like optical filters for telecommunication applications to more complex applications such as optical interconnect systems and data center where future petascale and exascale MRR-based architectural platforms are needed. It is the core element in many MRR-based optical bio/chemical sensing applications, and many

physical phenomena such as EIT, etc. Thus, this topic provides a solid foundation where other research topics could emerge.

As an entry point to this research area, we focus on simulation of MRR-based Slow/Fast light-Assisted Gyroscope. Our plan is to initially follow the work of earlier researchers with the goal of extending their work, and then moving toward designing new and better configurations. In the initial online meetings, Dr. B. Dingel gave a series of lectures on on State-of-the-art and current trend in microring-resonator (MRR) technology. He also provided necessary background journal papers and thesis/dissertations as technical background information and references. In the succeeding weeks, Mr. M. Jallorina and Ms. E. Aranas devoted themselves in reproducing simulation results from these earlier journal publications. In between these weekly meetings, there were numerous one-on-one skype meetings between Dr. B. Dingel and M. Jallorina / Ms. E. Aranas to get technical clarifications and answers as well as to provide latest update on the simulation results. Originally, this research topic on MRR-based gyroscope is intended for international journal submission in mid-November 2013.

III. Preliminary Results

Table 3 summarizes our preliminary, 5-month results related to publishing scientific papers. Although we originally planned to publish only international journal paper, the opportunities to submit papers at domestic conference and UNESCO e-conference just presented itself to us.

Research Paper Title	Research Duration	Conference Type	Conference Submission	Conference Website	Results and Comments
Microring Resonator Gyroscope: Comparison of the Sensitivity Profile for Various Coupling Conditions	3 Months (June to August 2013)	Domestic	SPP 31st Congress (Philippine Physics Society)	http://www. spp-online.org	• Missed due date by 1 week and the paper was not reviewed by the panel • There are plans to submit this paper to another local conference
Design and Modeling of a New Microring Resonator (MRR) based Gyroscope	5 Months (July to November 2013)	International	Optical Communications Journal	http://www. journals.elsevier .com/optics-communications	In preparation for submission mid November 2013
Cyber Research Mentoring in Science in Philippine Private Universities: Leveraging Online Collaboration Technologies and Offshore-Based Alumni	2 Months (August to October 2013)	eConference	UNESCO World Science Day Celebration Conference: Global Multidisciplinary eConference on "Science Does Not Know Borders"	http://www. econferencunday .net	This Conference

Table 3. Summary of the research paper submissions in the last 6 months.

The first publishing challenge came to us after the initial 3-month of research work where we had 80% new simulation results to justify submitting a paper at domestic conference (31st Annual Philippine Physics Society Congress). The research paper is entitled "Microring Resonator Gyroscope: Comparison of the Sensitivity Profile for Various Coupling Conditions". However, the tasks required to complete the remaining 20% and to write the collaborative research paper lead us to miss the submission date by 7 days. Although we submitted with request for consideration, the conference organizers unfortunately decided not to accept all other 50 late-submission papers including our paper. At present, we plan to submit this paper to other regional conferences.

This experience brought out both the strengths as well as the weakness of CRMS operation. On the positive side, the fast and speeding learning curves experienced by M. Jallorina / Ms. E. Aranas confirmed that our research topic is appropriate for students in Philippines and the our research mentoring structure under CRMS is working. On the weakness side, it required us to improve our operation and help us identified keys issues such as time allocation and others. These weaknesses will be discussed in details in section IV.

The second publishing challenge came to us after reading this UNESCO e-conference on Global Multi-disciplinary Science's Call of Paper whose conference theme is "Science does not know borders". This came to us as an opportunity to disseminate our proposed science mentoring strategy which blends well with our goal of this e-conference.

Our third publishing challenge is still on-going with the original goal of submitting journal the paper entitled "Design and Modelling of New Microring Resonator (MRR)-based, Slow/Fast Light-Assisted Gyroscope" at ISI journal this coming early December 2013.

All these aggressive submission goals under limited but aggressive 5-month time frame have helped us identify and evaluate key issues both in terms of the necessary collaboration technologies as well as the manpower concerns. In the following section, we discuss these issues in greater details.

IV. Evaluation of the Required Technologies:

In this section, we highlight the evaluations of the technologies, best practices, open issues, and articulate this new perspectives toward remote research mentoring,

IV-A. Low-Cost Technology Platform

Because local universities are hyper-sensitive to overall cost, a major consideration to CRMS operation is low-cost. Thus, CRMS utilizes (1) free high-speed data internet access at the university setting, (2) inexpensive video conferencing technologies (examples, Skype, Oovoo, Hangout, etc), (3) free social media collaboration (Google Doc, etc) software, (4) locally available computers with increasingly higher computing power, (5) pervasively available generic mathematical software tools (Mathematica, MATLAB, etc), and (6) open-access journals. Taken as a whole, these technologies act as enabling platform that solve many of the financial constraints on the institution side, and yet provide a vital infrastructure for CRMS.

Technologies	Products	Useful Features	Needed Features
Internet Speed	Local ISP provider	University has decent internet bandwidth	Locations outside the University need to have a decent internet connection
Video Conferencing Tools	Skype	Decent network which provides a stable internet connection	Other features such as group video and screen share are only available after a fee
	ooVoo	Group Video and Screen Share	Network is slow and connectivity is an issue, even with a high-speed internet connection
Online Cloud Storage	Google Docs	Users can simultaneously edit a document	Cannot handle equations and certain limitations to word processing functionality
Mathematical Tools	Mathematica	Interactive Parameter Manipulation and Dynamic Data Visualization	Software version mismatch
	MATLAB		Software version mismatch

Table 4. Evaluation of technologies/products, its useful features, and recommended features to enhance the productivity of CRMS experience.

Despite these huge low cost advantages of these above mentioned technologies and tools, they have limitations compared with traditional face-to-face meeting between mentor and graduate student. Here, we provide our evaluation from the perspective of both the overseas-based mentor and the graduate students. Table 4 summarizes these limitations or difficulties.

First, the fluidity of discussion during the long-distance, online meeting is often times compromised. In the typical setting, the mentor and the student working in the same university can discuss any time as long as their schedules allow. In off-shore research, however, the participants must consider global time zones. This imposes an additional constraint on both parties, and may sometimes dampen research momentum. Especially in the context of resolving conflicting results or interpretations where a vigorous exchange of reasoning and explanation is needed, the time difference delays the response of both parties, something that does not happen in regular research set-ups.

Second, technological limitations also compromise fluidity. Slow internet connection delivers poor video and audio quality, thereby impairing understanding. The need to terminate the call a few times in the middle of a dynamic discussion just to improve the connection impedes learning.

Third, the video conferencing platform used to facilitate the research meeting can still be improved. While Skype manages group calls neatly, it does not cater much to scientific discussions where a lot of equations and derivations have to be shown and written in real time.

Fourth, the collaborative technical writing programs like Google Drive also needs to be improved. Google (Doc) Drive allows the simultaneous editing of manuscripts where changes can be tracked easily and automatically saved online. This avoids the clutter that would have been brought by repeatedly downloading and uploading the manuscript again every time something is changed. However, the problem with Google Drive is that it does not handle equations, tables and figures well. It destroys the manuscript's format, thereby forcing us to revert to the old, cumbersome way.

Fifth, the mathematical software tools (Mathematica, MATLAB) used to facilitate the numerical simulations are exceptional but software version mismatch used between two parties can lead to difficulties. We had occasions where simulation results have numerical differences from the same Mathematica program run by the two parties using different software versions at two different computers. The worst case is when the Mathematica program created from the latest version can not run on an older one. This forces one party to purchase the latest version of Mathematica to avoid this problem. The emerging applications and services like "cloud computing" where software can be accessed by either parties in the "cloud" would offer the best future solution and create a higher-class of research mentoring experience for the graduate students.

Lastly, projection screens, electronic whiteboards and two-camera setups would be useful technologies. An ideal improvement, however, is to develop an integrated CRMS software application consolidating all the video conferencing, manuscript writing, and electronic discussion tools in one platform.

On a different note, we believe that working on simulations and theory made CRMS more manageable. Had the research study been more experimental in nature, the monitoring of laboratory set-ups and troubleshooting of equipment over the internet would have been more challenging.

IV-B. Participants and University Structure

Beside technologies, we also evaluate the participants' concern on the following issues as them impact to their performances as they relate to CRMS. These concerns are: (1)

different global time zones, (2) time allocation per day, (3) research topic mismatch, and (4) university structures as shown in Table 5. These issues are rated with rating #1 being minor concern to rating #5 being major concern.

Although CRMS can be very helpful to university, faculty members and graduate students, CRMS would probably fail if it is not integrated into the educational curriculum and/or supported by the university structure. In our experience, one of the most important problems is time allocation of faculty members and graduate students for CRMS. At present, faculty members are participating in CRMS on top of their current administrative duties, teaching loads and current research group activities, while graduate students are performing research activities on top of their current class loads. Eventually, time allocation touches the educational curriculum and the university structure since research activities, in general, and research mentoring, in particular, are time consuming activities. Time is the critical resource. We therefore suggest that the faculty member engaged in CRMS should receive a "deloading credit" from their teaching units while graduate students should received a class "credit".

Other concern is the mismatch of research topic being conducted with student graduate or junior researcher or faculty member's specialization or expertise. At present, this can not be avoided since research topic is selected based on overseas-based scientist's expertise. The rationale for this arrangement is dictated by the goal to publish at the earlier time where overseas-based scientist can provide guidance and direction to the research work. However, future work has to integrate the current research works in the university so that it will truly be sustainable.

Participants	Issues			
	Time Zone	Time Allocation per Day	Research Topic Mismatch	University Structure
ADMU Faculty Members	2	4	3	Faculty De-loading
Graduate Students or Junior Researchers	2	4	2	Class Credit
Overseas-based Scientist or Alumni	2	4	1	N/A
Rating of 1 to 5: 1 being a minor concern and 5 being a major concern				

Table 5. Evaluation of participant's main concern experience.

Conclusion

For a decade now, these collaborative technologies have been changing the way student learn-read-and-absorb "old" traditional materials, and tinker-and-experiment with "new" materials. They have revolutionized our educational institutions. Now, these tools in conjunction with offshore-based expatriate talents will constitute a paradigm shift in the way we conduct science research mentoring in the future. When video conferencing, mathematical tools, and Google Doc-like application software are integrated with "cloud computing", this scenario will create an ideal platform for any CRMS activities that can lead to higher-class of research experience for graduate students.

Given the above future outlook, the essential component in making CRMS successful would still be Filipino scientists abroad committed to sharing their talents, time and expertise. ADMU would still need to continue to enshrine the "man-and-women-for-others"upbringing. This is aside from being able to give both its students and faculty the necessary processes and incentives to do and sustain scientific research.

As a summary, we proposed and presented an innovative, low-cost, and journal-publication driven approach to science research mentoring for graduate students and/or junior researchers in Philippine private universities, which we refer to as Cyber Research Mentoring in Science (CRMS). It leverages the two above mentioned elements namely; (1) offshore-based alumni who are active in science and technology research to be mentors, and (2) free or

inexpensive online collaboration technologies as platforms to bridge the physical gap and to provide virtual presence of the mentors. Our preliminary results showed promising potential. We also evaluated the required collaborative technologies from the perspective of students and mentors, offered best practices as well as critical evaluation, and identified other structural/institutional mechanisms and supports to enhance the success of the program.

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