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ENGAGING STEM STUDENTS IN RESEARCH AND PRESENTATION ACTIVITIES

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Abstract

College faculty often attempt to find innovative methods to facilitate student learning and retention. One way of accommodating this is to involve students in research projects that offer students the opportunity to present at local conferences or educational forums, as attending regional conferences is rather expensive. This can be done in many ways. Student presentations, for example, can be part of the evaluation of course grades. But they can also be a part of a large educational project that contributes to student learning, success, and retention. This paper outlines a project undertaking conducted at Texas A&M International University (TAMIU) with an emphasis on the extent of such educational endeavors. Student self-evaluation results are used as an indication of how successful the project was in achieving desired outcomes.

Keywords: Students, presentations, STEM disciplines, self-evaluation, Hispanic

1. Introduction

Oral presentations provide a learning opportunity for students to develop their communication skills. Most importantly, they serve to strengthen students' knowledge about a topic of interest or subject that they wish to pursue. A key feature of a high quality learning experience for students in an academic institution is establishing a scholarly culture that includes integration of research into the learning process in which students are encouraged to construct their own meanings and deep understandings of

the subject materials. This process makes students engage in critically constructing knowledge and does not merely depend on instructions being provided to them with access to the contents. The learning experience therefore is facilitated by sustained interaction between the faculty and students in the classroom and beyond.

On the other hand, learning keeps students and their teachers in touch with understanding and achievement of subjects on a continuous basis, thus allowing students to know what specific actions they must take to improve the learning everyday of their lives. Depending upon the nature of the task, these skills may be sometime very generic in nature, such as public speaking or more specific to STEM (Science, Technology, Engineering, and Mathematics) students involved in research projects. For example, a presenter is able to communicate the findings of primary research directly to the audience using graphs and charts to present information and discuss at length the research project, including responses to comments and questions from the audience. While this interaction helps the presenter in developing listening and reasoning skills, it also helps students in the audience learn from observing and asking questions, one aspect of presentations that is generally neglected. Questions and responses are normally instantaneous, spontaneous, and well thought out. This undertaking is mainly carried out under the auspicious of STEM Research Experiences to Enhance Retention (STEM-REER), which is part of STEM Recruitment, Retention, and Graduation (STEM-RRG). STEM-RRG is an innovative recruitment and retention program, funded by the US Department of Education, to increase the number of Hispanic and other minority students pursuing degrees in STEM fields at TAMIU. Studies have suggested that involving undergraduate students in research has several benefits, including attaining a higher level of competence, understanding the methods and process of research, making informed judgments about technical matters, working in teams to solve complex problems, improving their oral and written communication skills, and pursuing graduate degrees.

2. Objectives of STEM-REER

This project offers real-world learning experiences to outstanding students in STEM majors at TAMIU. The project is aimed primarily at students who have the desire and talent but are constrained by various environmental factors. The program awards 10 internships and 20 research

assistantships to highly qualified students. Interns are placed in private industry or government positions and mentored by the client organization. Research assistants are placed with STEM faculty members doing research in computer science, mathematics, biology, physics, or engineering. The goals of this project are: 1) To offer real-world learning experiences to help students complete undergraduate degrees in engineering, mathematics, biology, chemistry, and physical science; 2) To increase the retention of talented minority students in the STEM disciplines and accelerate their pace toward obtaining their undergraduate degrees; 3) To improve students' employability through career planning and internships in industry; and 4) To improve graduate school opportunities through participation in undergraduate research with a faculty mentor. Interns and research assistants are required to: a) Meet regularly with a faculty member, who will serve as the students' mentor for the entire period of the program; b) Participate in a monthly colloquium and share experiences with students and faculty; c) Attend on-campus seminars offered by faculty, representatives and experts from industry; d) Prepare and submit a progress report at the end of each semester; and e) Become active members of the Society of Engineering at TAMIU (SET), the Mathematics Society of TAMIU (MST), or the TAMIU Biology Club.

The project also provides students with a basic groundwork on management, operations, and research techniques, focusing on problem formulation and model construction. Finding a quantitative solution, interpretation and performing sensitivity analysis for deterministic problems using spreadsheet capabilities is generally common. At the end of their presentations, they must be able to show evidence of their ability to plan, execute, manage, control, and report on the project independently or in group setting. Finally, if someone is unable to carry out the tasks expected of the project, the presenter needs to seek mentoring and further faculty intervention.

The reasons for a presenter to miss making a planned presentation can vary from logistic nature to a simple avoidable circumstance. This project has two similar cancellations altogether. In one, the presenter could not make it on time and other was the presenter did not receive the e-mail communication informing the time and day of the presentation. The latter

has been subsequently made a classroom presentation. There was a case where the presenter had to change the topic of the presentation.

3. Methodology and Analysis

For the analysis, a group of 20 presentations (24 presenters) at The 2009 Lamar Bruni Vergara University Conference at TAMIU, held from April 20-23, 2009, was examined [LBV University Conference]. Of 17 oral presentations and 3 poster presentations, 10 were graduate student presentations, 9 were STEM-RRG presentations, 3 were honors student presentations, and 2 were undergraduate class project presentations done by course re-takers. All STEM fields were represented ranging from mathematics (50.00%), biology (20.83%), statistics (8.35%), engineering (12.50%), computer science (4.16%), to management information systems (4.16%) as appears in Tables 1 and 2, for those who participated in the self-evaluation (see the appendix). In addition, there were seven other STEM-RRG presenters in Table 3 who did not participate in the self-evaluation. All STEM-RRG presentations were from the projects the student research assistants undertook under this program and supervised by STEM faculty [STEM RRG Project]. This faculty member essentially mentors these students how to conduct research, documenting and presenting them. Most of the cases, research topics are selected by the students in consultation with the faculty member. The honors students on the other hand need to undertake projects related to the course and then present at a local venue before the final project report is submitted for honors credits. These project assignments will also further facilitate students' improved understanding of conceptual knowledge as they were assigned written research papers, oral presentations or poster presentations. The process of explaining to themselves and to others during the practice sessions and in the actual presentation develops and constructs conceptual and extended knowledge of the topic [Kitto (2008)].

4. Tables and Figures

Tables 1 and 2 provide the breakdown of student presentations by major, classification, and title of presentation or poster for those who participated in the self-evaluation.

Table 1: Programs, classifications, and titles for each STEM-RRG presentations

Student Major, Classification	**Title of Presentation/Poster**

MIS, Graduate	Software as a Service
MIS, Graduate	HY WIRE: A Revolution in Mobility
MIS, Graduate	Logic Gates (Poster)
MIS, Graduate	Trigonometry: Pythagorean Theorem (Poster)
Engineering, Junior	Rates of Change: Position of a Falling Object (Poster)
Engineering, Junior	Topography of an Object: Detection and Display of Software and Hardware
Biology, Freshman	The Impact of Natural Selection on the Evolutionary Process of Species
Biology, Freshman	The Study of Heat Shock Proteins and Adaptive Thermo Tolerance
Biology, Junior	Smallpox

Table 2: Programs, classifications, and titles for each course-related presentation

Student Major, Classification	**Title of Presentation/Poster**
Mathematics, Graduate	Nonlinear Systems of Differential Equations: Dynamical Systems
Mathematics, Graduate	Equilibria in Nonlinear Systems of Differential Equations
Mathematics, Graduate	Global Nonlinear Techniques: Nullclines
Mathematics, Graduate	Nonlinear Systems of Differential Equations: Closed Orbits and Limit Sets
Mathematics, Graduate	Nonlinear Linear Systems of Differential Equations: Applications in Circuit Theory
Mathematics, Graduate	Nonlinear Linear Systems of Differential Equations: Applications in Mechanics
Mathematics, Senior	Divorce and Marriage Rates: Local vs. National Data

Biology, Sophomore	A Statistical Overview of the Service-related Activities by the Doctors Hospital of Laredo
Psychology/Statistics, Freshman	A Statistical Overview of Over the Counter Drug Abuse
Mathematics, Senior	Sudoku
Mathematics, Senior	Blackjack (a class presentation)

Table 3 is the list of programs, classifications, and titles for the other seven presentations that consist of topics from computer science and biology for those presenters who did not participate in the self-evaluation process.

Table 3: Programs, classifications, and titles for each other STEM-RRG presentation

Student Major, Classification	**Title of Presentation**
Computer Science, Senior	Peer to Peer Networks
Biology, Senior	Assessment of Water Distribution Changes in Human Cortical Bone by NMR
Biology, Junior	The Characteristics of Simulated and Functional Disuse on Mouse Bone by Nuclear Magnetic Resonance
Biology, Junior	The Geodynamo Theory and How It Affects the Earth
Biology, Senior	Survey of the Presence of Lectin Activity in South Texas Plants
Biology, Senior	The Use of the Tandem Inverted Repeat System to Screen Carbonic Anhydrases: RNAi Transformants in Chlamydomonas Reinhardtii
Biology, Senior	Patterns and Distribution of Mealy Galls in South Texas

All presenters in Tables 1 and 2 were requested to participate in the self-evaluation. The results derived from 24 self-evaluation instruments are summarized in Figures 1-6.

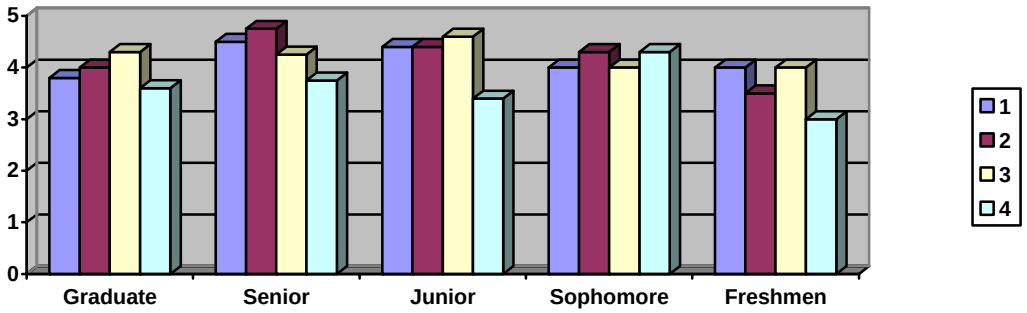

Figure 1: The student self evaluation of presentations: 1-overall presentation, 2-extent of learning outside the classroom, 3-extent of thoroughness, and 4-difficulty of presentation on a scale of 1-5 for graduate, senior, junior, sophomore, and freshman students

Freshmen encountered least amount of difficulties in their presentation; seniors exhibited extensive learning activities outside the classroom, and juniors expressed thoroughness and satisfaction with their overall presentations as were evident from Figure 1.

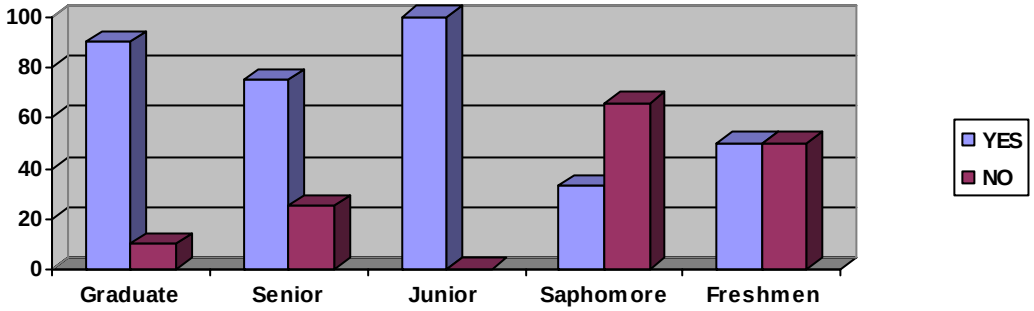

Figure 2: The extent of preparation through rehearsals before actually presentation

Most graduate and junior students indicated that they have rehearsed the presentation as per Figure 2. About fifty percent of freshmen had rehearsed their presentations.

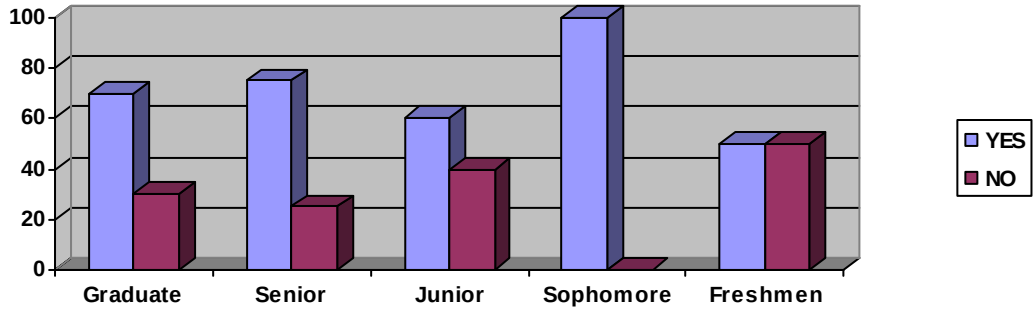

Figure 3: The extent of participants seeking outside help

According to Figure 3, sophomore students sought the most outside help in getting ready for the presentations. About fifty percent of freshmen sought outside help for their presentations.

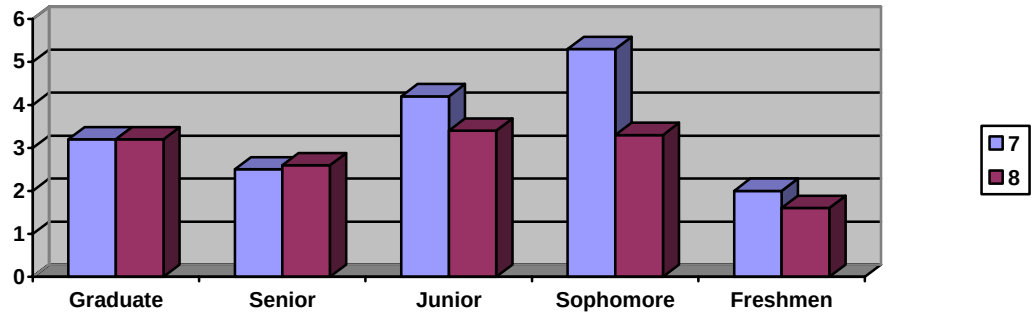

Figure 4: The extent of time spent preparing (7) and gathering information (8)

The graduate students have spent equal amount of time preparing and gathering information for their respective projects as depicted in Figure 4.

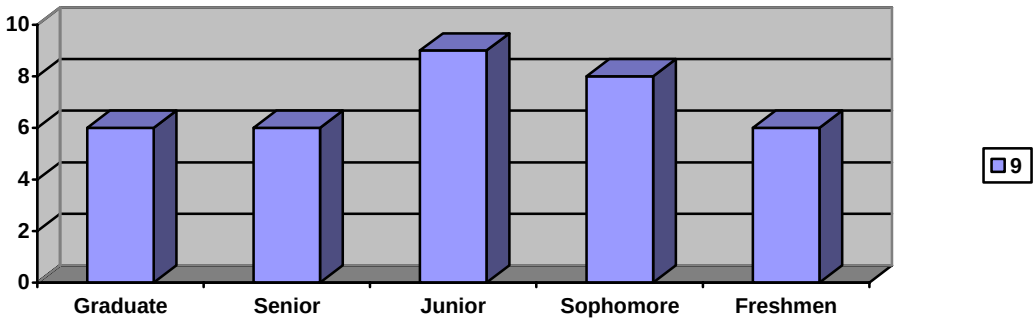

Figure 5: The average number of sources consulted for the delivery of the presentation

Among all presenters, the juniors and sophomores have consulted more sources in preparation for their presentations according to Figure 5.

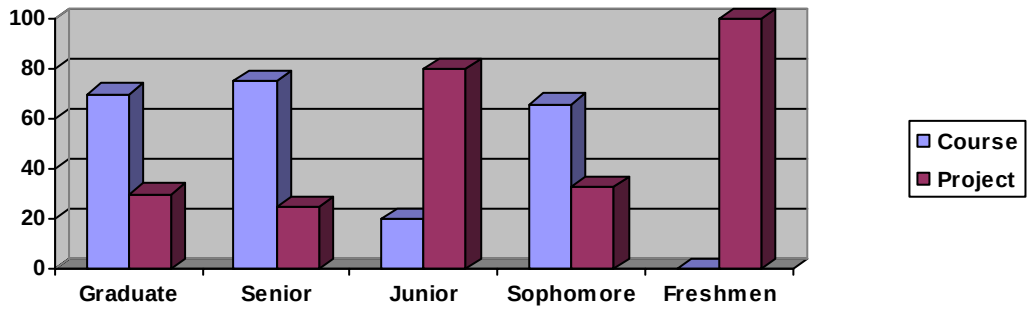

Figure 6: The percentage of presentations that are course-related or project-related topics

Figure 6 shows that most of the presentations by juniors and freshmen were project-related while the presentations by seniors and graduates were course-related.

5. Discussion

Adequate cognitive flexibility in these forums by taking on multiple cognitive perspectives helps the learner to absorb new information and particularly the faculty should be flexible as such both of them are trying to understand the new topic for furtherance of the research topic in hand or assigned. More importantly, this means to transparently communicate to

students some of one's personal understanding in response to their actions, whenever this is considered supportive in the argument. For example, the faculty mentor might genuinely comment on a student's presentation before it is actually presented. There were occasions in the past where some students felt that they were bored by another presentation as it was almost a repetition of the materials they have previously learned or have seen [Boud (1995)].

Analysis and utilization of literature provided the presenter an opportunity to learn beyond the scope of the course materials for his or her advancement. In preparation for this project, a presenter may have reviewed as much as possible, published articles and reports that address the outlines of the project. They have definitely cited some information from them. The faculty involvement is highly critical as the benefits of undergraduate research defined as the engagement of undergraduate students in authentic research conducted in long and intensive summer programs under the direct supervision of faculty researchers. Project organizers were concerned to establish what is known with any certainty the qualities and effects of research, thus defined. The previously published work has been developed on the basis of research and evaluation, and the completeness and quality of the evidence offered to them in support of hypothesized arguments to participating students in a variety of different formats [Seymour, Hunter, Laursen, and Deantoni (2003)].

A mechanism for rapid assessment must be established to allow the presenter to benefit from the results of the self-evaluation. Self and peer-assessment will have dual roles. One is that the presenter will be able to evaluate in writing their presentation themselves closely. The other is to sort out their strengths and weaknesses for future presentations. The use of posters to accomplish this task is impressive. It not only conveys the main theme of the project undertaking, but also clear and reflective of the findings for audience to easily grasp. The assessment of these projects must meet these aspects. The criteria of a similar assessment can be less dependable for complex and open-end responses. It can be either self or peer-assessment, it must also agree within a specified range, whether expressed as a qualitative grade or as ranking, award points or the higher grade if it is done for a class project [Motschnig-Pitrik and Holzinger (2002)].

6. Conclusions and Future Work

Participants in this project believe that presenting in the conference was a quite learning experience for them. Several participants were the recipients of awards. One oral presentation received master's level second place and two presentations received first place and second place undergraduate awards. As we concluded initial results unique to this study, these results are subject to further investigations before validation.

Acknowledgements

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Appendix

STUDENT SELF EVALUATION OF PRESENTATION

POSTER/ ORAL Presentation: _____

Graduate/ Undergraduate: _____

Major/ Minor: _____

STEM discipline: Math/Bio/Stat/CS: _____

Senior/Junior/Sophomore/Freshman: _____

Evaluate your presentation on _____@_____ on a scale of 1—5, 5 being the superior for each of the following. (For Example: 1 = inadequate, 2 = mediocre, 3 = satisfactory, 4 = good, 5 = very good).

1) How do you rate your overall presentation?
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

2) What is the extent of learning outside the classroom activities?
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

3) What was the extent of your thoroughness of the topic in your presentation?
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

4) What was the extent of difficulty of getting this presentation done in time?
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

5) Did you rehearse your presentation before actually presenting?
   ☐ Yes ☐ No

6) Did you seek outside help?
☐ Yes ☐ No

7) What is the amount of time spent preparing for the project?
☐ 1 day ☐ 1 week ☐ 1 month ☐ 2 months

8) When did you start gathering information on the topic?
☐ 1 week ago ☐ 2 weeks ago ☐ 3 weeks ago ☐ 4 weeks ago

9) How many sources did you consult?
☐ 0 ☐ 0-4 ☐ 4-8 ☐ 8-12 ☐ 12 or more

10) Is the topic course-related/ project-related?
☐ Course ☐ Project