

# Virtual Community Building for Effective Engagement of Students of Color in Earth System Science: Minorities Striving and Pursuing Higher Degrees of Success in Earth Science Case Study

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## ABSTRACT

The NASA and NSF-funded Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science® Professional Development Program (MS PHD'S PDP) initiative provides professional development and mentoring experiences that facilitate the advancement of persons of color committed to achieving outstanding Earth system science (ESS) careers. The three MS PHD'S PDP phases are connected by virtual community-building activities that occur through asynchronous/synchronous web-based dialogues. The purpose of this case study is to investigate virtual team building methods as tools for engaging and developing sustainable communities of students of color in ESS.

researchers and educators committed to facilitate the full participation of minorities in ESS.

MS PHD'S Professional Development Program activities were carefully crafted utilizing community input, evaluation findings, and insight gained from the 2003 MS PHD'S Ocean Sciences Program and other efforts designed to engage minority students in the ESS (Windham et al., 2004; Bingham et al., 2003; Cuker 2003; Cuker, 2001; Gilligan, 1996). This approach has allowed for the incorporation of assessment findings, increased organizational partnerships, valuable community input and participant feedback in the development of the MS PHD'S Professional Development Program, by leveraging existing funding, infrastructure, and organizational partner's resources.

Phase I of the MS PHD'S PDP was prepared to solidify a three-phase project structure. Phase I includes participant and mentor orientations, initial mentor-mentee partner interactions, networking, professional development, broad ESS and engineering exposure, a tour of NASA Ames Research Center facilities tour and MS PHD'S PDP community building activities. Phase II provides ESS and engineering exposure, mentor-mentee interaction and networking at one of seven MS PHD'S PDP organizational partner meetings that align with each participant's specific academic interests. During Phase III, participants engage in brownbag discussions, government agency visits, and dialogues with professional society and foundation representatives. These three MS PHD'S PDP phases are connected by engagement in virtual community building activities that occur through the website, listserv and asynchronous/ synchronous web-based dialogues.

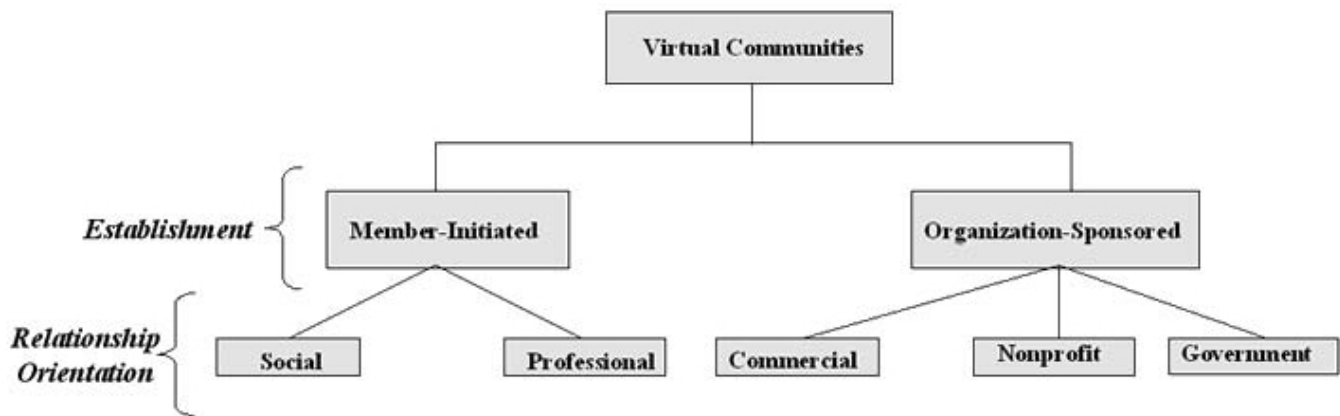
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## INTRODUCTION

Minority Students Pursuing Higher Degrees of Success (MS PHD'S) in Earth System Science® is a vehicle through which Earth system science (ESS) (e.g. oceanography, meteorology, environmental science, geology/geophysics, and astronomy) interests are encouraged and sustained to ensure full participation by members of underrepresented populations (e.g. African Americans, U. S. Hispanics, Puerto Ricans, Pacific Islanders, Native Americans and Alaska Natives, hereafter referred to as persons of color). This initiative was established by and for persons of color with the overall goal of facilitating activities that enable participants to achieve outstanding careers across ESS and engineering disciplines. MS PHD'S in Earth System Science-sponsored programs such as the MS PHD'S Professional Development Program (MS PHD'S PDP) engage undergraduate and graduate students of color in activities designed to:

- increase exposure to professional scientific communities, via participation in professional society conferences, mentoring relationships, virtual activities and guided tours of research facilities;
- enhance professional skills (e.g. grantsmanship, teaching, research, oral and written communication, etc.);
- inform and provide resources regarding future funding, education and career opportunities;
- facilitate networking opportunities with established researchers and educators; and
- provide on-going interaction, communication and support via membership within a virtual community comprised of peers, junior- and senior-level

**Conceptual Framework** - The MS PHD'S PDP virtual community building is informed by instructional technology research. In her article "A Typology of Virtual Communities: A Multi-Disciplinary Foundation for Future Research", Constance Elise Porter (2004) notes that despite the increase in virtual communities, researchers do not have consensus on the definition. Porter (2004) advocates defining a virtual community as "an aggregation of individuals or business partners who interact around a shared interest, where the interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms" (Porter, 2004). Unlike other definitions, Porter's includes aggregated business partners, extends to completely or partially virtual, can be mediated by any technology and not merely computer mediated technology and includes



**Figure 1. A typology of virtual communities.**

Attributes of Virtual Communities	MS PHD'S PDP Virtual Community
Purpose	to engage students in the program and ESS
Place	face-to-face meetings happen during the 3 phases of the program; virtual space through the Community Forum
Platform	asynchronous using the Community Forum or synchronous using web-cams
Population Interaction Structure	virtual community as a computer supported social network (CSSN)
Profit Model	no profit model that fits the tangible economic value Porter (2004) notes as part of the criteria; virtual community increases social capital of participants

**Table 1. Attributes of the MS PHD'S PDP virtual community.**

the notion of roles, protocols, policies and/or norms (Figure 1).

The first level of Porter's (2004) typology includes Member-initiated and Organization-sponsored categories. The second level of the typology, virtual communities are categorized based on the relationship orientation of the community. Within this paradigm, the MS PHD'S PDP virtual community is an organization-sponsored educational community.

Porter (2004) extends her definition by providing attributes of virtual communities to provide researchers with a consistent and practical way to describe virtual communities. According to Porter (2004), the literature suggests that five attributes could be used to characterize virtual communities: (1) Purpose, (2) Place, (3) Platform, (4) Population Interaction Structure, and (5) Profit Model. The following table (Table 1) illustrated the attributes of the MS PHD'S PDP Virtual Community based on this model.

Research generated by the Online Social Networks 2005 Conference Manifesto provides new constructs for understanding virtual communities. Ethnographic data is used to illustrate how people perceive virtual communities, which in this case are called online social networks. Some participants define a social network as "a group of people with common interests who are linked together through regular contact: face-to-face, telephone, Email, snail mail, and online tools." Other participants note that "A social network is a group of people, who may or may not be part of one or more organizational or self-defined communities, who recognize a shared interest or some degree of interdependence and who choose to interact with one another to deepen, broaden or otherwise extend their knowledge, skills, attitudes,

power, influence, passion, fun or other dimensions of their shared interest or interdependence by leveraging their relationships with one another. There is an "us", an "it", one or more clear potential connections, energy, focus and intention."

In the same study, participants respond to the following prompt, "What do you think is the biggest payoff for leveraging social networks with online tools and media?" Respondent answers include the following:

- "More equal distribution of information."
- "Access to knowledge and wisdom for better decision support."
- "Speed, efficiency, cost."
- "Faster development of thoughts and planning by group. Maintaining group identity between face-to-face meetings."
- "More effective organizations. More informed participants."
- "Flexibility in (time and space) and transparency of organization."
- "Creates broader and more diverse networks and allows for asynchronous participation."

Research indicates that there are benefits of analysis of social networks and virtual community. The research also suggests that community members that use these tools can describe their experience, define terms like online social networks and virtual community and identify the benefits of computer mediated communication (CMC). An important example of this research emerges from the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) community.

Researchers of the DO-IT community use qualitative data used to analyze virtual communities. The students of DO-IT express similar concerns as those expressed by MS PHD'S PDP participants. In their article, "Supporting Peer-Peer and Mentor-Protégé Relationships on the Internet", authors Sheryl Burgstahler and Deb Cronheim (2001) note that several factors contribute to the low success rates of people with disabilities in post secondary programs and careers in engineering, science and technology. These factors (2001) include isolation, low expectations and lack of encouragement. They (2001) present a study in which participants are members of DO-IT community. The authors explicitly assert that the two primary research questions investigated in this study are as follows:

1. Can computer-mediated communication (CMC) be used to initiate and sustain peer-peer and mentor-protégé relationships and alleviate barriers to traditional communication support behavior (CSB) related to time and schedule limitations, physical distances, and disabilities of participants?
2. How do the functions of peer-peer and mentor-protégé electronic communications on the Internet compare in psychosocial, academic, and career areas?

In addition to personological variables, the ratio measurements investigated are the number of e-mail messages exchanged over a period of two years and the e-mail message direction (i.e. mentors to protégés, protégés to mentors, and peers to peers). E-mail data was collected from written surveys and focus groups. Authors (2001) note that coding systems were designed to reflect the content of the messages. The authors (2001) of this study affirm that results support the electronic community as a favorable environment in which to provide peer and mentor support for high school students with disabilities. It is concluded that "results suggest that peer-peer and mentor-protégé relationships perform similar functions; however, peer-peer relationships are more personal." Based on this study, it is proposed that mentor-protégé interactions will result in a higher degree of academic and career discourse. Finally, the authors of this study assert that these conclusions serve as a guide for youth centered programs designed to help individuals achieve their personal, academic, and career goals.

The findings in this study affirm the possibility of building successful peer-peer relationships using a variety of technological interactions. Researchers (2001) note that CMC makes communication across great distances and different time zones convenient by eliminating the time and geographic constraints of in-person communication.

**Rationale for Virtual Communities within MS PHD'S PDP** - Due to historically low numbers of persons of color in ESS schools, societies, institutions, organizations), students of color pursuing higher degrees in ESS often feel a sense of isolation, alienation, lack of community support and limited dispersion of academic and professional information. Low numbers of students of color, limited time and existing distance are limitations to creating community. Informal and formal student interviews and focus groups revealed that technology may be an important medium for connecting

mentorship and building community to combat the alienation students of color feel in predominately white academic environments. The MS PHD'S PDP case illustrates how virtual community building strategies help overcome these obstacles and promote peer to peer and peer to protégé mentoring possibilities. Furthermore, the work seeks to understand how these tools can be leveraged to create sustainable community, and a more democratic and inclusive ESS.

The intellectual merit of this study includes expanding definitions of virtual community and increased understanding of virtual community building as a tool/function for organizational use. The findings of this ongoing investigation will provide insight on how national organizations, higher education practitioners, community-based support systems and underrepresented minorities in the sciences promote diversity by developing successful cyberspace programs and networks. The groups that may determine findings helpful include institutions, organizations, clubs, classrooms, scientists, grassroots organizations, non-government organizations and other groups seeking to create sustainable community beyond time and space.

**Designing the Virtual Community** - The MS PHD'S PDP leadership team envisioned a sustainable virtual community where the MS PHD'S PDP community could meet in between and beyond face-to-face activities. With this goal in mind, the MS PHD'S PDP leadership team created an infrastructure of tools and applications for a virtual community.

### Tools and Applications

Web site [www.msphds.usf.edu](http://www.msphds.usf.edu)

- Recruitment
- Program Application
- Scientist Profiles
- Virtual Orientation
- ESS Information and Opportunities
- Networking, Professional Development and Exposure to ESS Information and Opportunity

MSPHD'S PDP Community Forum

- Asynchronous Dialogue
- Mentoring relationships among peers, researchers & educators

Web video conferencing

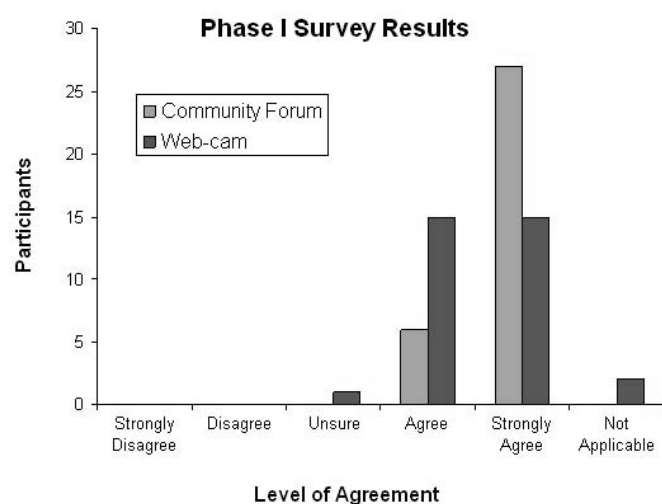
- Synchronous or Real-time virtual discussions and/ or video
- Capture videos and photos
- Uses high-quality images (VGA 640 x 480 resolution)

Hosted by the PI's home institution, the website is the first stage of participant engagement in the virtual community. It serves as a reference, recruitment medium and a means of completing the program application. The profiles of accepted participants, mentors and invited scientists are featured on the website.

Upon acceptance into the program, participants are required to send an email confirming their ability to become a member of the MS PHD'S PDP Cohort. For the second assignment, participants are required to register

Type of Virtual Interaction	Phase I	Phase II	Phase III	Phase IV	Phase V
Time Period	Jan. - April	April-June	August	Sep. - Nov.	Dec.
Events	Phase II	Debrief Phase II & Summer Schedule	Plan for Year	Prepare for Phase III	Reflect & Next Steps
Forum Postings	1 Per Month	1 Per Month	1 Per Month	1 Per Month	1 Per Month
Near-Peer Web Cam Interaction	1 Per Month	1 Per Month	Optional	1 Per Month	1 Per Month
Mentor-Mentee Web-Cam Interaction	1	1	Optional	1	1
Mentor-Group Web-Cam Interaction	Optional	1	Optional	1	1
Mentors-Evaluator Web-Cam Interaction	1	Optional	Optional	Optional	1

**Table 2. Virtual world curriculum: a guide for interactions.**



**Figure 2. Phase I survey results on projected usage of community forum and web-cam.**

on the Community Forum and post acceptance into the program. The Community Forum (<http://www.msphds.usf.edu/forum/index.php>) is a free online bulletin board run using phpbb software.

MS PHD'S PDP participants extend face-to-face Phase I, II & III experiences with virtual interactions. The MS PHD'S PDP use a web-site, e-mail, Community Forums, and web-cam discourse to maintain a sense of community even though participants and mentors are scattered throughout the United States. Members of the MS PHD'S PDP stay connected virtually through "The Community Forum", <http://www.msphds.usf.edu/forum/index.php>. Users can review the "Ask a scientist?" question; help compile a cookbook and research REUs/ internships/ opportunities. All members of the scientific community are encouraged to post messages. The computer-mediated engagement of the MS PHD'S PDP group is a virtual community. As their introduction to this medium, participants respond to the following prompt.

Log on to [www.msphds.usf.edu](http://www.msphds.usf.edu) - Go to Community - Page 2 and click on MS PHD'S PDP Online Discussion. You should see a screen entitled "MS PHD'S PDP Community Forum". On the top yellow bar, you will see the word "Register". After you have registered, go back to the Community Forum Index and go to MS PHD'S PDP Cohort. Write the sentence "As a member of the MS PHD'S Cohort, the gift I give to MS PHD'S PDP is . . ." Give whatever you like, truth, justice, jokes, joy . . . the possibilities are endless.

In addition to ensuring that students are capable of registering, this prompt also gives members of the cohort an opportunity to introduce themselves. It is critical that there is available technical support during the time period allotted for initial postings because participants have a range of technical experience and exposure.

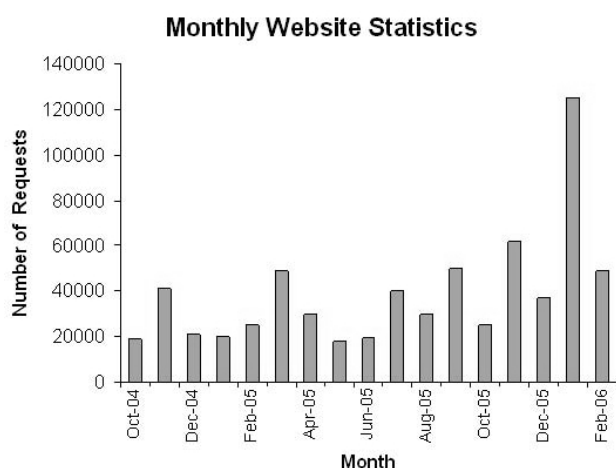
During this post-acceptance period, participants also receive web-cams. In the program structure, objectives, responsibilities and goals are addressed during a virtual orientation. This pre-meeting dialog serves as the start of the virtual community. During the orientation, individuals are provided with background information regarding their assigned mentors/students. Prior to attending the organizational partner meetings, mentors and students are encouraged to review mentor-student partnership guidelines (posted on the website) and to engage in dialog regarding their scientific interests and individual expectations.

The next step is the co-constructed curriculum. The content of informal focus groups with participants during Phase I led to the collective development of a virtual curriculum. The following is an excerpt from an e-mail to participants.

February 11, 2006

Virtual World Curriculum

The following (Table 2) is a schedule of the types and amount of virtual interactions you should have with the MS PHD'S PDP family. If you have exceeded this expectation, great! If not, please use it as a guide for future interactions.



**Figure 3. Monthly website statistics.**

After Phase I, participants are required to complete an evaluation. One of the questions posed relates to participant projected usage of the virtual community tools.

The following graph (Figure 2) reflects the projected usage of the Community Forum and Web-cam of all members of the MS PHD'S PDP cohort.

As is evidenced by the graph, the majority of students strongly agree that they will use the Community Forum, whereas significantly less state that they will use web-cams. When asked a clarifying question about how they will engage in the virtual world, student's responses were similar to the findings above. Responses include:

- "I will use all venues made available to maintain and stimulate contact with peers, colleagues, mentors, and others associated with scientific research"
- "Emails and the community forum will be best because I can do it when the time permits."
- "On a plane trip my web-cam was lost in baggage claim so I can participate all but web-cam discussions."

After conceptualizing virtual community, identifying appropriate tools, giving directions for how to use these tools, co-constructing a virtual community curriculum with feedback from interviews, focus group and surveys; a moderator was assigned to guide the implementation of the virtual community.

**Implementation** - The website statistics are a helpful means of telling the story of the MS PHD'S PDP virtual community. The figures in the parenthesis in Figure 3 reflect the unsuccessful attempts.

#### Website Statistics

Successful requests: 657,143 (19,590)  
 Average successful requests per day: 1,339 (2,798)  
 Successful requests for pages: 37,551 (855)  
 Average successful requests for pages per day: 76 (122)  
 Busiest month: Jan 2006 (5,007 requests for pages).

These statistics illustrate that there is a substantial community using the MS PHD'S PDP website. The Community Forum statistics (Table 3) provide a more specific illustration of the to the MS PHD'S PDP virtual

Statistic	Value	Statistic	Value
Number of posts	741	Posts per day	1.42
Number of topics	220	Topics per day	0.42
Number of users	71	Users per day	0.14

**Table 3. Community forum statistics.**

engagement. The topics within the Community Forum are illustrated below (Figure 4). These topics provide a guide for participants. Within all of these topics though, the three primary themes that emerge relate to the academic, professional and psychosocial interests of participants.

#### Community Forum: Example of Academic Theme

##### Participant A:

As time progresses I get more and more anxious about defending. . . I get angry, sad/stressed, and frustrated. I am trying to keep it together. MSPHD'S, anybody, could you provide me with some insights into defending.

##### Participant B:

One suggestion would be to invite a couple of friends over and have a mock thesis defense. Have them give honest critiques about your presentation style, and information to making sure graphs, tables, results and conclusions are clear. . . I am proud of you. This frustration won't last long. I used to run the 400 meter dash and at the last 200 meters the "monkey would jump on my back." Meaning I could clearly see the finish line, my legs started to tighten, I was tired and all I could think about was crossing the finish line. But my coach always said in order to knock the monkey (YOUR FRUSTRATION) off, remember 1. This is MY race, 2. It is almost over and 3. FINISH STRONG! I know you can do it!

#### Community Forum: Psychosocial Examples

- Celebrate the birth of a newborn
- Ask advice about interpersonal advisor-advisee relationships
- New Hobbies
- Politics, Environmental Policy Issues
- How to overcome obstacles faced by students of color
- Seasons Greetings
- Favorites

#### Community Forum: Professional Examples

##### Example A

What's up all. I'm off to Hawaii on Monday to do a cruise from Honolulu to American Samoa fishing for large pelagics, then I'm off to Ocean Sciences. Is anyone else going? I know most or all of the VIMSers will be there, who else will be joining us? - Denny

##### Example B

I'm in Washington participating in MIMSUP!!! I'll be in Honolulu, for the ASLO meeting Jose, it will be GREAT to see you there!!! And it's great to hear from you too All! - Much Love, Lucy

In addition to these themes, another important element of the Community Forum is co-creating guidelines for

Forum	Topics	Posts	Last Post
<b>Announcements</b>			
<b>Ivisit Lite</b> Please download and install ivisit to your computer. Ivisit Lite is the application the community will use for video conferencing. <a href="#">Click here to download</a> Moderator <a href="#">shabtes</a>	0	0	No Posts
<b>Community Forum Covenant</b> Members of the MS PHD'S Community Forum collaboratively create guidelines, rules and protocols for virtual discourse. Moderator <a href="#">apyrtle</a>	7	40	Sun Nov 25, 2007 9:21 pm <a href="#">joniqua</a> →
<b>Bulletin Board</b>			
<b>MS PHD'S Inspired Achievements</b> Please post about any programs, REUs, scholarships, honors, opportunities, achievements, epiphanies you have had as a result of participating in MS PHD'S. Moderators <a href="#">Warner</a> , <a href="#">mimayo</a>	15	54	Tue Oct 30, 2007 4:12 pm <a href="#">alisha_johnson</a> →
<b>MS PHD'S Updates</b> View, post or respond to MS PHD'S Community updates on our academic, professional and personal lives. Moderators <a href="#">Warner</a> , <a href="#">mimayo</a>	84	384	Mon Nov 26, 2007 11:50 am <a href="#">Onji</a> →
<b>MS PHD'S 2007-2008 Cohort</b> Please post and respond to someone else	38	90	Thu Nov 29, 2007 12:24 am <a href="#">irenta</a> →
<b>MS PHD'S 2006-2007 Cohort</b> Please post and respond to someone else Moderator <a href="#">apyrtle</a>	41	261	Sun Nov 18, 2007 10:16 am <a href="#">aes2150</a> →
<b>MS PHD'S 2005-2006 Cohort</b> Post and respond to some one else Moderator <a href="#">apyrtle</a>	41	181	Fri Nov 16, 2007 9:25 am <a href="#">epadilla7</a> →
<b>MS PHD'S 2004-2005 Cohort</b> Post and respond to some one else Moderator <a href="#">apyrtle</a>	30	135	Fri Mar 16, 2007 3:47 pm <a href="#">Joan Maria Powell</a> →
<b>MS PHD'S Phases II &amp; III</b> Look for information and share your questions, comments, and/or ideas about Phases II & III. Moderator <a href="#">mimavn</a>	18	85	Tue May 15, 2007 10:17 am <a href="#">jhz1stdaughter</a> →
<b>Funding, Internships and Opportunities</b> Share or learn information about funding, academic and research opportunities in the STEM sciences. Moderator <a href="#">Warner</a>	178	198	Mon Nov 19, 2007 1:18 pm <a href="#">mroman</a> →
<b>Web Cam Conferences</b> Have you set up or used your web-cam? Describe your experiences, lessons learned, make web-cam confessions or set up a conference with someone. Moderator <a href="#">shabtes</a>	19	63	Thu Apr 12, 2007 12:28 pm <a href="#">alxaaleman</a> →
<b>MS PHD'S Community Cookbook</b> Inspired by the MS PHD'S 2004 Cohort Community Potluck, this forum invites you to preview, add and try recipes reflective of our cultures. Moderator <a href="#">mimayo</a>	21	61	Mon Aug 27, 2007 12:19 pm <a href="#">P3 Space</a> →
<b>Ask a Scientist?</b> Ask or answer science related topics such as "Anybody ever used a luminometer before?? How about the LabView software?" Moderator <a href="#">Warner</a>	8	21	Sun Dec 02, 2007 12:43 pm <a href="#">Andreari</a> →
<b>ADVICE</b> This string is for those seeking or giving all types of advice. Moderator <a href="#">Warner</a>	6	23	Thu Sep 27, 2007 10:04 am <a href="#">pspence</a> →

**Figure 4. Community forum.**

usage with participants. To do so, the following prompt was posted:

First, I should say that I appreciate and respect each individual's participation in the Community Forum.

Second, in order to have a successful community, we must have some form of protocols, rules and guidelines so let's make some.

Please post your ideas for how we should run our forum. Suggest rules, guidelines, and protocols for using the forum.

Thank you,  
Moderator

**Troubleshooting Hackers** - After over a year of the development of the Community Forum, hackers became a major concern. These individuals registered on the Community Forum and posted inappropriate messages. The PHDFBB software enables moderators to delete

messages and ban users. Experiences proved that after some time troubleshooting became too much work for one person and a new moderator was added. Engaging users on this issue was a great way to inspire community identity and participation.

The situation about hackers was resolved by adding a moderator to manage inappropriate users or posts. Later, the person in charge of the university web-server implemented a system that users had to be approved by the moderator in order to activate Community Forum participation.

**Evaluation** - As the virtual community develops, a means of understanding and describing the process is necessary. In their text *Frontiers of Human-Centered Computing, On-line Communities and Virtual Environments*, (2001) editors include an insightful article by Jenny Preece entitled "Online communities: Usability, Sociability, Theory and Methods" Preece (2001) maintains that community-centered approaches, strong theory and appropriate research and development methods will produce thriving on-line communities. She asserts that in methodology and measurement it is important to consider the demography of participants, behavior online and characteristics of interaction.

Several systems of evaluation have been created to assess the efficacy of the MS PHD'S PDP virtual community. Participants complete 3 online surveys after each phase of the program. Within each survey, questions about the virtual community are included. Students also self-evaluate their participation in the virtual community noting the frequency and types of virtual interaction they have had.

**Findings** - In 2006, findings from the preliminary research of this project were presented at the 13th Ocean Sciences Meeting, a joint meeting of the American Society of Limnology and Oceanography, the Estuarine Research Federation, The Oceanography Society and the American Geophysical Union. This section of the project examined the quantitative usage of the Community Forum by undergraduate, masters and doctoral students in the program. One of the motivating factors in embarking on this research question was to assess whether course of study has an impact on the number of postings MS PHD'S PDP participants make on the Community Forum. The findings for this question indicate that there is no evidence to suggest that the course of study has an impact on the number of postings. These finding results can inform future programmatic design in that they suggest that participants of different programs of study can receive the same orientation and support for the Community Forum. Exciting new questions emerged like "What does impact students frequency of postings?" In developing responses a theory was developed. A possible theory is that access to technology (X1), technological proficiency (X2), incentives in the form of professional/academic opportunities (X3), motivation(X4), and participant perception of their leadership within the community (X5) all impact the participant's frequency of postings(X6).

**Recommendations** - The experiences of the MS PHD'S PDP virtual community framed in virtual community research has led to several lessons learned. These most important of these lessons relate to motivation, trust, ethics, moderators, technical support, rapid response, purpose, and flexibility.

**Develop Motivation:** In his article "Computer Networks as Social Networks", Barry Wellman (2001) notes that community is now seen as a less bounded social network of relationships that provides sociability, support, information and a sense of belonging. This idea is critical to the MS PHD'S PDP community because it helps to explain some of the motivation for users.

**Establish and Maintain Trust:** Authors Gattiker, Perluz (2001) et al. write about the complexities of the virtual community in their work "The Virtual Community: Building on Social Structure, Relations and Trust to Achieve Value". These authors (2001) assert that without trust, members may use a virtual community but will not risk the exploration of other possibilities. They also contend that developing social contracts (similar to the Virtual World Curriculum, refer to Table 2) is difficult to enforce in a virtual community. In order to inspire trust "a virtual community needs to develop intimacy, social networks, understanding, and interaction amongst its members, thereby making it a community of members who share similar values, submit to similar norms, and allow trust to develop." The Community Forum has been

successful because this trust was established during actual experiences and developed by engaging the entire community in the development of the curriculum and group norms for the virtual community. Positive, authentic relationships are developed during face-to-face interaction and the virtual community is a support for a series of face-to-face interactions.

**Maintain a Sense of Ethics:** Ethics are an important consideration and should be integrated into all elements of the virtual community.

**Provide Moderator(s):** Moderator(s) are necessary to facilitate conversation in the Community Forum, answer questions and troubleshoot problems that arise.

**Provide Technical Support:** Initial and ongoing support is necessary. Managers of the servers are important for technical support, problem solving and overall maintenance of the virtual community.

**Response Rapidly:** There must be a rapid and appropriate response to encourage and stimulate posts on the Community Forum.

**Sustain a Sense of Purpose:** Virtual activities must be purposeful in order to be effective. Conversation prompts are helpful in promoting synchronous conversations. Participant uses of web-cams illustrate the importance of purpose driven interaction. When students are accepted into the program, they receive a web-cam. Participants then apply for IVisit, a free synchronous software. Participants receive prompts and are encouraged to use this CMC to talk to each other and mentors. Overall, less than 20% of participants use their web-cams. Instead, most use the phone, emails or the Community Forum to stay in touch. Web-cam usage dramatically increased when the Dream Team (a group of past-participants that take on leadership roles) began hosting meetings in preparation for face-to-face meetings. With this goal in mind, program participants successfully used their web-cams to collaborate. The lesson learned is that when students are in the leadership positions and have a specific purpose, they are more inclined to use web-cams to promote dialogue.

**Be Flexible:** Flexibility and creativity are important for engaging and maintaining virtual interactions. This medium is not going to work for everyone in the community and that is OK. In addition to developing alternative systems of communication, program leaders should try different methods, prompts and schedules for developing asynchronous talk.

**Limitations of Research** - In their article, "Supporting Peer-Peer and Mentor-Protégé Relationships on the Internet", authors Sheryl Burgstahler and Deb Cronheim (2001) note "to encourage candid participation, research staff who coded messages did not interact with the scholars and volunteer Mentors participating in the study; they also did not share the author names of specific messages with other Do-It staff." In this study, the primary researchers are participant observers and therefore engage in virtual and face-to-face activities. They also code all data. In order to address these issues, researchers are transparent and explicit in regard to positionality as both program staff and researchers. MS PHD'S PDP participants are engaged in the research

process by sharing ideas and asking for input. An informal validation style is implemented throughout the time in the field.

Even though attempts have been made to balance the power dynamic that may exist in these relationships, as participant-observers, researchers have legitimate power. To limit the amount of impact this power dynamic has in data collection, interviews do not begin until students have matriculated from the program and therefore no longer have any formal gains or losses from our interactions.

Participants selected to contribute to the study volunteered and sign consent forms. Kvale (1996) "Ethical Issues of the Seven Research Stages" are used as a guide to ensure ethical guidelines and codes are met. Participants are also engaged in the design and act as evaluators of design and methodology. In the interview situation, issues of research ethics are discussed before and after each interview. Participants are assured of confidentiality during transcription, analysis, verification and reporting. In analysis, participants have a say in how statements are interpreted and validate in this stage. Lastly in reporting, confidentiality is maintained.

### **Areas of Future Research and Visions for the Applications of this Research**

The purpose of expanding this case study is to investigate MS PHD'S PDP participant perception of virtual community, CMC and virtual team building methods as tools for engaging students of color in ESS. This (virtual) ethnographic exploration uses a mixed methods research design. Quantitative examination of website and Community Forum statistics are complimented by qualitative methods such as analysis of participant applications, e-mail correspondences, online Community Forum postings, online survey results, self-evaluation reports, programmatic formative evaluation and annual reports, observations, interview responses and researcher reflexive journal entries. This investigation will result in expanding definitions of virtual community strategies for leveraging CMC in order to develop sustainable communities and methods of effective virtual engagement of students of color in ESS.

The broader impact of this work is a more democratic and inclusive ESS. Levy (2001), in his text *Cyberculture*, contends that new technologies can be perceived with a humanist, activist and utopian perspective. He asserts that "the growth of cyberspace is the result of an international movement of young people eager to experiment collectively with forms of communication other than those provided by traditional media." The case study MS PHD'S PDP provides an opportunity to democratize and reconstruct the scientific community through movement building amongst scientists of color. This can occur through the following process: the celebration of political, social, critical science; development of individual awareness and collective consciousness; visioning; strategy; and movement building. Virtual community building is critical to final stage, movement building because it a medium that enables people to cross time, space and discipline in the announcing a new utopia in ESS.

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