Engaging high school science educators as learners and collaborators to develop instructional materials in a workshop setting

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Delta Internship Report

Spring 2009

ABSTRACT

Educators are often asked to engage as learners with instructional materials (IM) to "teach" them to how to approach the materials to benefit their students, or to learn new content before presenting it in their own classrooms. However, there is less information available regarding teacher engagement as both learners and collaborators during the IM development. Our specific aims were: **1)** determine science educator attitudes about engagement as both a learner and a collaborator in IM development, and **2)** in a workshop setting, evaluate an ecology-themed IM prototype for effectiveness at relaying content knowledge with science educator participants (learners) and potential for classroom application (collaborators).

We hypothesized that our workshop model would: **1)** engage the educators as learners, with evidence of learning gains related to our specific learning objectives, and **2)** engage the educators as collaborators in IM development, with evidence of constructive feedback on the IM components, overall satisfaction in interactions with scientists, and interest in continuing collaboration after the workshop ended. We speculated that teachers' attitudes about their engagement as learners and collaborators would inform us about the effectiveness of our workshop as a model for future IM development, and expect that evaluation of our prototype will allow us to optimally direct our IM improvements to best meet educator needs. We hosted two science educator workshops, and improved our second workshop using the feedback from the first.

Our study is part of a larger outreach/education project with the Global Lakes Ecological Observatory Network (GLEON). This project aims to bolster the public-use aspect of GLEON's mission (www.gleon.org).

INTRODUCTION

Effective collaborations between scientists and teachers are considered to be valuable for increasing scientific literacy, improving understanding of the nature of science and improving elementary through high school science curricula (Caton, Brewer, & Brown, 2000; Chang, Sung, & Hou, 2006; Drayton & Falk, 2006; Morrison, Raab, & Ingram, 2008). However, there are many limitations to the success of such collaborations, from both the educator and scientist perspective.

From the scientist perspective, the literature agrees that scientists generally are dissatisfied with public science education, but also ignorant of basic educational practices or challenges. For example, focus group discussions with scientists conducting long term ecological research frequently pointed to the availability of large scale datasets as opportunities for K-12 educators, but rarely identified the need for frameworks to support their integration into classrooms (R. Bohanan, personal communication). In a survey-based study of both scientists and teachers, Kim 2007 (Kim, 2007) found that scientists were generally unknowledgeable about education practices or pedagogy (and also that science educators felt under-prepared to teach the process of scientific concepts effectively). Taylor 2008 (Taylor, Jones, Broadwell, & Oppewal, 2008) found that among distinguished scientists (Nobel Laureates and other exceptional scientific professionals), some perceived science teachers to be overly focused on fact memorization rather than critical thinking skills, and also generally under-educated in the nature of science. Other scientists in the same study simply had no knowledge as to the quality or status of public science education. Gonzales del Solar 2001 (Gonzales del Solar & Marone, 2001) similarly suggested a lack of emphasis on critical thinking in the science classroom, and an over-emphasis on scientific dogma.

From the educator perspective, Varelas determined that science teachers who had a summer research experience in a laboratory, and therefore developed a more comprehensive perspective of the “daily” scientific process, were afterwards conflicted in choosing between covering science content and bringing the flexibility and exploration that they observed in their respective laboratories to their science classrooms. Drayton 2006 (Drayton & Falk, 2006) performed a comprehensive study of multiple teacher-ecologist partnerships during a year-long

committed research project. The authors determined that though there are multiple "styles" of science-educator collaborations that can be successful, the quality of the experience for the teachers largely depended on the distribution of the ownership of the team's project (e.g. whose questions, interests, and desired outcomes directed the research project). Ultimately, if the scientist was unwilling to forfeit an assumed leadership position or personal goals for the research, the educators became more frustrated and were less likely to consider the experience positive. These studies, and others, suggest an apparent disconnect between science educators, science researchers and their respective goals; this disconnect potentially inhibits necessary science education reform. One point on which scientists and collaborators agree is that science education reform is crucial to the future quality of science in the United States.

Our proposed collaboration with Wisconsin science educators will employ an "engagement-as-learner" strategy. We have chosen this strategy because we recognize that the teachers with whom we collaborate may have varying levels of expertise and experience in lake ecosystem studies, and because the literature suggests that "authentic" learning experiences for teachers can allow for pedagogical reflection and improvement (Klagges et al., 2002; Maor, 1999; Sweetland, 2008).

We chose to use a workshop model to approach the engagement-as-learner strategy. There are a few excellent examples of using the workshop setting to improve teacher understanding of the nature of science, and to spark ideas for instructional materials development (IMD). Wong 2008 (Wong, Hodson, Kwan, & Yung, 2008) used the recent SARS virus outbreak as a societal-relevant focus for an educator workshop on the nature of science. Maor 1999 (Maor, 1999) invited educators to a workshop that used a novel technology for teaching about bird ecology in Antarctica, and found that participants were likely to use this technology in their classrooms afterwards. Despite these successes, it is recognized that workshop success is difficult to evaluate (Connolly & Millar, 2006). Connolly and Millar (Connolly & Millar, 2006) have suggested the following five levels of "Science Technology Engineering Mathematics (STEM) instruction" workshop evaluation: participation, satisfaction, learning, application, and overall impact. The authors suggest that application and overall impact require rigorous follow-up with workshop participants a year or later after the

workshop, and so we do not reasonably expect to achieve these last two goals within the context of this internship.

We expected that teachers' attitudes about their engagement as learners and collaborators would inform us about the effectiveness of our workshop as a model for future IM development, and expect that evaluation of our prototype will allow us to optimally direct our IM improvements to best meet educator needs. We hosted two science educator workshops, and improved our second workshop using the feedback from the first. We aimed to 1) Determine science educator attitudes about engagement as both a learner and a collaborator. 2) In a workshop setting, evaluate an ecology-themed IM prototype for effectiveness at relaying content knowledge with science educator participants (learners) and potential for classroom application (collaborators).

METHODS

In two outside-of-the-classroom workshops, we collaborated with Wisconsin high school science educators to design IM for the high school classroom that focused upon study of lake systems with an emphasis on eutrophication. A novel aspect of our IM was that we utilized an online accessible database of real-time environmental variables collected on local Wisconsin lakes. We invited Wisconsin science educators to our workshop by introducing this real-time database in an informative letter (**Appendix 1**), and welcoming teachers to engage with us both as learners and collaborators to explore IM development with this database as a tool. The letters were distributed through the Wisconsin Department of Public Instruction's Cooperative Educational Service Agency (CESA), and also through personal contacts of the staff at the University of Wisconsin- Trout Lake Station in Boulder Junction (Vilas County, Northwoods), Wisconsin, and the contacts of RB from previous science educator outreach and formal education events.

Our workshops took place at the University of Wisconsin Trout Lake Station, Boulder Junction, WI, in the conference room/library area on 28 February 2008, and at a UW-Madison campus faculty meeting room on 04 April 2009. During the workshops, we asked teachers to engage as learners with an IM prototype, and to provide a constructive evaluation of the

prototype for classroom implementation. Participants completed online front-end questionnaires prior to the workshop (**Appendix 2**), and in-workshop summative questionnaires (**Appendix 3**) before leaving the workshop. The questionnaires were designed to evaluate teacher attitudes about the workshop, their past IM design and collaboration experiences, the potential application of our prototype to their classroom, and their achievement of IM learning outcomes. In addition to the online questionnaires, we also collected in-class artifacts of learning, such as photographs of group conceptual maps, written short-answer responses to a background knowledge probe classroom assessment, and a final reflective statement of learning.

As facilitators, we wanted to encourage group cohesion and team learning. To do this, we focused on the following two topics: 1) knowing the backgrounds of the educators and their implications for learning and 2) drawing upon the diversity of the workshop participants to enrich the learning of all. We began both workshops by sharing our fondest memories of water. This strategy previously was used at a collaborator's related workshop event, and was reported to be effective at putting participants at ease, allowing participants to get to know each other, and bringing broader perspective to the groups' purposes for participating in the workshop.

Our second approach was to promote teaching practices that encourage inclusive learning. In our IM prototype, we used a variety of teaching practices that encompassed a diversity learning styles. For example, we incorporated newspaper readings, an audio podcast, a short video of researchers in action, concept mapping (Hay, 2008), web-based inquiry, inscription interpretation (*i.e.* (Roth, Bowen, & McGinn, 1999)), and individual learner reflection. We hoped that these would appeal to diverse learning styles (reading/aural/visual/kinesthetic, *i.e.* (Tanner & Allen, 2004)). We also tried to be transparent as to our pedagogical goals, briefly stating our rationale for each learning activity so that the educators could both constructively criticize and adapt our use of teaching tools to their own classroom.

Because our sample size was small, we analyzed our questionnaire data using the statistics and summary options provided by the WebSurvey software. The questions on the survey were combination of Likert-scale measurements and short-answers regarding the

strengths and weaknesses of the prototype IM, teacher suggestions for improvement, and learning outcomes gained (Suskie, 1996). We evaluated Likert-scale measurements as ordinal data, and when possible compare front-end and summative IM content questions with t-tests. To evaluate the flexibility of the IM prototype for teachers across a range of experiences, minimal demographic information was also collected, such as educational background and years of teaching experience.

This study was approved (as exempt) by the University of Wisconsin Education Research Institutional Review Board Protocol SE-2008-0760.

RESULTS

Participants

We recruited two participants for the Northern Wisconsin workshop, and eight for the Southern Wisconsin workshop (**Figure 1**). Of these participants, there were two middle school and two early-undergraduate instructors, and the rest were high school instructors. Two participants were visiting scholars from Thailand. Nine of ten total participants completed the front-end questionnaire. The participants were generally experienced educators, with an average of 5 to 10 years of teaching experience per individual, and 88% of participants having taught more than 5 years in the classroom. They taught a broad range of courses, including general biology, chemistry, and physics, as well as a few specialized topics such as marine science, aquatic ecology, Earth science, environmental science, and landscape ecology. Two of the educators taught learners with special needs (both learning talents and challenges). A few of the educators had also conducted research-based graduate work in the sciences, and were experienced in research culture and methods.

An overview of highlighted results (educators as learners, educators as collaborators, anticipated use of the IM, and educator learning gains) is presented in **Figure 2**.

Science educator attitudes about engagement as learners and collaborators

In the front-end questionnaire, 44% of the educators reported that they engage with IM as learners over five times a year and 55% reported between that they engage between 1 and 5

times a year. All participants either agreed or strongly agreed that it benefited their teaching to engage with IM as learners.

In the front-end questionnaire, one of the educators reported that they collaborate with outside groups to develop IM greater than 5 times a year, and one reported that she/he never collaborated with outside groups to develop IM. The rest reported between 1 and 5 times a year. All but one participant either agreed or strongly agreed that it benefited their teaching to collaborate to develop IM. (The remaining participant reported "not applicable.")

The participants reported that although they generally enjoyed engaging as learners with IM and collaborating to develop IM, and 44% and 33% agreed that they do not have time for these activities, respectively. Thus, the majority believed that they had time to pursue learning and collaboration with IM development.

These findings suggest a general positive attitude about both engaging as learners with IM and collaborating to build IM prior to the workshop. As a caveat, our workshop may have selected for some individuals who enjoy these activities because we made our goals explicit (engaging educators as both learners and collaborators) in our informative letter to recruit participants.

After the learning module, the participants' attitudes did not sway far from their initial reported values. One hundred percent of the participants that responded to the summative questionnaire (n=10) found the learning module enjoyable as a learner (**Figure 2A**), enjoyed the workshop collaboration to develop the IM (**Figure 2B**), felt that their professional opinions were valued, and felt positively towards collaborating with outside groups. In the summative questionnaire, we asked participants to respond the open-ended, reflective question "What was especially good about the workshop, and what could have been improved?" Almost all comments were positive, from "(good) group discussion and sharing ideas" to "(good) collaboration with fellow educators" (see **Appendix 4**). From these data, we concluded that our workshop model provoked overall positive attitudes in the educators about engaging as learners and collaborators with scientists to develop IM.

Science educator anticipated use of the IM

Prior to the workshops, 70% of the educators reported that they typically adapt IM that had been developed somewhere else, and 20% reported that they develop their own materials. All participants develop IM at least once a year, and the majority (60%) develop IM greater than five times a year. Everyone agreed that the goals of the workshop were explicit and accomplished, and that they benefited as an educator by gaining new ideas for IM. Eighty percent of participants self-reported that they felt that they benefited as a learner by being introduced to an unfamiliar topic (eutrophication and dissolved oxygen), and the remaining two participants were neutral.

One of the participants indicated that s/he was unlikely to use the IM in the classroom. The others reported that they were either likely or very likely to use all or parts of the IM. The participants were divided as to the setting in which they may use the IM, and were equally likely to use it in laboratory, lecture, or small group work (**Figure 2C**). Educators reported an average of 3.6 classroom hours to cover the materials, but the responses ranged from a few weeks to a two hour class.

Science educator learning gains

The learning gains section of the questionnaire included three short answer and three interpretations of data represented graphically. Of the ten participants, eight completed the questionnaire section relating to learning gains. All but one participant responded correctly to two multiple choice questions that involved interpretations of line graphs similar to data presented in the workshop (**Figure 2D**). One of these questions required learners to apply previous information to a new situation.

At the end of the summative questionnaire, we posed a short answer question: "Over the past fifty years, average atmospheric summer temperatures in Wisconsin has increased by 0.5 degrees C. You want to explore the affect of this temperature increase on dissolved oxygen concentration in lakes. Develop a hypothesis about this relationship, and describe how you would test it."

Of the given answers, only two directly stated a hypothesis. However, four respondents listed ways in which they could test their ideas using either historical data, statistics, or

experiments. Most of the answers developed ideas about temperature and dissolved oxygen, which was the focus of the IM, but two of the answers were about land use and run-off, which were not discussed directly during the IM and tangential. This indicates that although the majority of the educators learned how to ask questions and test their hypothesis in the context of the learning outcomes, a few of the educators held on to preconceived beliefs or knowledge from outside of the IM.

DISCUSSION

Changes to the learning module between workshops

We improved the second workshop to address some of the concerns and suggestions of the educators at the first workshop. Most of the suggestions were about the learning module, and an incorporation of more technology in the learning activities, with specific mentions of a short video of young researchers (graduate students, etc) working on the science questions presented in the IM. One educator suggested that his students would benefit from seeing young researchers to help break the scientist stereotype of "old men in lab coats." He hoped that his students would relate better to a younger face and as a result would be more likely to envision themselves in a science career.

From these suggestions, the second workshop included an audio podcast from NOAA in addition to the newspaper readings presented as background information. This not only offered more media technology, but also hopefully appealed to aural learning styles. We incorporated a five minute video of graduate students conducting related science on the field, a learning activity in which jargon and definitions were explored online before creating a concept map, and we also removed what were (in hindsight) redundant diagram activities.

Educators as learners

Though the survey indicated a general positive learning experience, the observed dynamics during second workshop especially suggested that there was some mild resistance to engaging with the IM as learners. There were a few interjections during the learning module of concerns that the activity would not "work at my school." Educators also seemed distracted from the

learning module, and therefore were less aware of their learning. For instance, because our learning module involved querying an online database, almost every participant had their own internet-connected laptop. Therefore, some participants were browsing outside internet sites during the module instead of focusing on learning. Some other observations of activities that may have distracted from the learning module were frequent cellular phone and side conversations during small group work. One activity during the learning module was creating a concept map as a group. In particular, the educators seemed reluctant to do this as learners, and allowed one willing participant to dominate the concept mapping activity. Indeed, in the second workshop, the participants seemed less clear on the IM content, also as indicated by their short answer responses.

One indication that the educators may have been uncomfortable engaging as learners with the IM was that although all eight participants from the second workshop completed the summative questionnaire, two of them did not answer the questions pertaining to learning goals. This may be because of time (participants had to leave right away), placement of the learning goals questions at the end of the survey (survey was long and participants were bored or impatient), or because they participants did not want to answer these questions (uncomfortable with acting as a learner or uncomfortable generally with the material). As it stands it is difficult to interpret this, but interesting to consider. This observation may be a an indicator that the observed educators' engagement as learners is in conflict with their self-reported value that they placed on this in the questionnaire, and suggests a greater need for more rigorous comparison of these informal observations with self-reported data.

Educators as collaborators

From our post-learning materials group discussion at the end of the workshop, the participants were initially concerned for the extension of the collaboration beyond the workshop. They wanted to know what support would be available for them when they wanted to teach the IM, and also how long their facilitators would be available for wiki/ongoing project and support for the IM. Some educators additionally wanted resources for purchasing ecological monitoring equipment related to the IM, so that their students could have an authentic experience with

sensors as well as interacting with the real-time database. Generally, the educators were enthusiastic as collaborators and desired to have interactions with us as scientists, and their positive responses on the post-workshop evaluation supported this.

Experienced versus novice educator needs and flexibility of the IM.

From the workshop evaluations and discussions, we recognize that the IM will rarely be used as a unit by experienced teachers. Educators indicated that they would find a "toolbox" of materials generally more useful than a ready-to-go learning module (though they also agreed that a few "canned" lessons would be helpful for new teachers or as a starting point). They suggested that we collect artifacts for learning activities (e.g. newspaper articles, podcasts, videos, photos) into a repository for educator use. To foster this ongoing toolbox, we have implemented a temporary wiki page, and allowed participant access of the information and tools posted there.

Suggested improvements to the workshop

Assessment. We suggest including additional assessment questions of specific learning activities to understand how the learning activities compared to each other as so far as effectiveness, enjoyment, and anticipated classroom use. For example, if repeating this workshop, we would specifically ask participants to rank (Likert scale) how much the newspaper reading or video contributed to their learning. We would also require all questions, because many participants did not answer the final questions, perhaps because of time constraints, because the survey was long and they were bored with it, or because they did not know the answer. Our final questions were content-related, and so we are unable to evaluate well the knowledge or skills gained from our module.

Facilitation of the collaborative workshop. We suggest removing some of the redundant group building activities. It was not obvious to us when we were designing the group building activities for the beginning of the workshop that it was likely too much. We almost devoted too much time on two separate group building activities that could have been better spent on

engagement as learners. I suggest keeping the favorite memory of water activity, because this small group sharing promoted rationale for a personal investment in learning about aquatic ecology. Also, table tents and nametag would have allowed for better facilitation of group engagement and less time spent on longer introductions.

As a facilitator, I would also try to establish better group norms of engagement for discussion to prevent dominance and foster self-awareness in the group (Phipps, 2000). Finally, one of the facilitators would be designated to be the "observer", to take notes and reflect upon group dynamics. This would allow for the lead facilitator to focus more on engagement, eye contact, and positive teaching practices. A final thought was that we could omit some of the learning activities that involved readings or browsing web resources by distributing links and readings prior to the workshop. The one major drawback to this, however, would be trusting that the participants would have time to read these materials before hand. In a class situation, though, the educator could effectively assign some parts of the lesson as homework or pre-lecture reading.

Improving the learning module for educator engagement. We reflect that we became distracted by pedagogy in engaging the educators as learners. The educators attended our workshop partially so that they could teach this content comfortably in their classrooms. But, we found that we wrongly compromised some of the time for learning activities in pedagogical discussions. The educators are professionals, and already had an awareness of many pedagogical methods and practices. In our attempt to be transparent about our methods, we discussed with educators how to, for example, facilitate and assess a concept mapping by students. It would have likely been more productive to provide the resources for this instead of discussing it during the workshop. As a result of time constraints, during the second workshop we omitted the hands-on dissolved oxygen measurement of hot and cold water. For some educators, this may have limited the concrete experience necessary for learning.

A front-end inscriptions activity may have also helped us to expose educator pre-conceptions with the learning content. For instance, if we had asked educators to draw a prediction of a relationship between dissolved oxygen and trophic status, we may have been

able to better guide questions during discussion and tailor our focus better on the "foggy" details specific for the participants. We also received a comment that more time was needed for the database exploration to "make observations" of the real time data and develop hypotheses.

FUTURE DIRECTIONS

Next goals for our educator workshops and IM development are to provide workshops for pre-service or novice teachers to evaluate the flexibility of the IM for experienced as well as inexperienced educators. Our workshop was well-attended by dedicated, experienced educators who were likely to adapt IM rather than use resources "right out of the box." We hypothesize that pre-service or novice teachers may be more inclined to desire IM that are ready to go, as novice teachers are under more pressure to develop new curricula for their classrooms.

We would also like to revise the workshop and associated IM to maintain a stronger distinction between learning and collaborating "arms" of the workshop. This may help to prevent the pedagogy from distracting when we ask the educators to engage as learners. We would like to compare learning gains from this revised workshop with the first two workshops.

We hope to initiate a learning community for ourselves and the educators, facilitated by the Wiki, and collect data on which educators uses which resources, how they use them, and how they may be adapted. This would be helpful to determine what was used directly from the workshop and then translated into the classroom. Finally, we would like to explore the possible adaptations and flexibility of the IM for the college classroom in addition to the high school classroom. We would like to evaluate the effectiveness of the IM for both high school and early undergraduate students.

CONCLUSIONS

I hope that this internship project will contribute more broadly to science education by providing a collaborative workshop model that allows high school teachers to have access to real data from researchers. This is important because, as mentioned in the introduction,

productive collaborations between scientists and high school educators can lead to enhanced science learning and teaching in the K-12 system, and therefore increase overall scientific literacy in adults who are engaged and informed citizens. One scientist could reach a few members of the non-science community by visiting a local high school classroom, but if scientists can collaborate with high school teachers to better design inquiry-based IM and disseminate those experiences more broadly, the potential for reaching more citizens can increase exponentially. Just ten science teachers attended our small workshop. Suppose each teacher instructs 20 students in one year. That is 200 students reached from two small workshop events, in one year alone.

There has been a national call for effective innovation in public classroom teaching. We hope that our workshop model can serve this call, and be improved to best achieve effective scientific IM through educator-scientist collaborations.

REFLECTION

Teaching as research

My internship experience has allowed me to practice teaching-as-research. The feedback from the peers and instructors in the internship seminar on my questionnaires (my assessment tools for the internship), and the guest speaker Christine Pribbenow, were invaluable to the improvement and implementation of my assessment. I feel that I addressed my questions, though I now also can critically evaluate my shortcomings in my internship teaching-as-research and have ideas as to how to improve for my next teaching-as-research endeavor. Specifically, I want to break down my hypotheses into more relevant "bits" and address each one in more detail. I feel that the aggregate measures of attitude and engagement as learners and collaborators are not as satisfying as knowing specifically which learning activities or workshop facilitations were most helpful in achieving the overall level of satisfaction with our workshop model. Next time, I will be more conscientious of these important pieces that contribute to the broader picture. My internship experience has emphasized the iterative nature of teaching-as-research, and has instilled in the sister idea that there is never an end to teaching improvement and teaching-as-research, just as there is never an end to quality scientific questions and research. Like my science, my teaching-as-research answers only provoke additional questions that must be addressed with additional experiments.

Learning through diversity

There were three related experiences that I had during my Delta internship that provoked me to reflect more deeply upon diversity in my scientific teaching and research. Though these experiences do not directly reflect upon diversity-promoting activities in my internship project, I think they best describe my journey this semester, and an enhanced awareness of diversity that has incorporated into my scientific teaching philosophy.

The first experience was in my IM Development course, where my internship partners and I refined our IM prototype used during our educator workshops. We had an interesting conversation about diversity in the sciences, and at UW in particular. All of my classmates were given clickers to answer a few questions anonymously about diversity. The first question posed

was “How comfortable are you talking with an individual from an underrepresented background”, and the multiple choice answers ranged from very comfortable to very uncomfortable. The second question was the same, only “talking about science” was added to the end of the statement. I perceived that my class was fairly diverse as far as apparent backgrounds and gender representation. Despite this, over half of the class answered “somewhat uncomfortable” to “very uncomfortable” for both of these questions. Afterwards, we were shown charts of the achievement gap that clearly demonstrated a blatant UW problem in encouraging and retaining individuals from underrepresented backgrounds in the sciences. I was shocked. I was in a *Delta* class of open, engaged, aware, and successful colleagues who were generally uncomfortable with diversity.

Soon after this experience, I was facilitating a mentor training seminar and struggling with initiating a discussion about diversity. I decided to repeat the exercise from the IMD class, and posed the same two multiple-choice questions, using unmarked cards to allow the mentors to remain anonymous. To my surprise, the results were exactly opposite from my IMD class. Almost the entire group of mentors responded that they were very comfortable in both situations. From this, I felt unsuccessful in initiating a discussion because my colleagues seemed to not need a space to openly discuss diversity. For this group, diversity was a given, though it seemed to be an outwardly less diverse group that my IMD class. I was left confused about the general perspective of diversity in science and feeling inadequate as a facilitator. How could I have been so “off the mark” in my preparation?

These two experiences intertwined and resolved during an internship seminar class. That day, we were discussing the idea that diversity was so important but lacking in the sciences that it was sometimes coerced unnaturally into groups, with lukewarm results. The example given was a student who came from a diverse high school, had thrived before in that environment without considering implications of diversity because it was accepted and “working” well. Upon coming to the relatively less-diverse UW-Madison, the student felt that diversity was awkwardly discussed and forced, and this unnatural attention to diversity actually made the student uncomfortable.

I realized from these experiences that diversity has a spectrum of ambiences, and that it

may not always be appropriate to force conversations in spaces that already value and accept the merits of a diverse scientific community. I also realized that group thinking about diversity in itself represents one face of diversity, and that, like individuals, groups differ substantially in their needs and goals for discussion.

Learning communities

I am fortunate to have multiple, overlapping learning communities to support me during the development of our IM and workshop for the Delta internship. Most directly, the Delta Learning Community and my peers in the internship seminar provided valuable feedback and support throughout the process. My peers helped me especially in designing the workshop assessments (front-end and summative questionnaires), where they critiqued survey questions, suggested omission of redundant questions, and offered positive feedback on questions that they thought were effective. The Delta community also served my internship in a separate course I have been taking simultaneously, the IM Development course. This course helped my team to design the IM that was the focus for the workshop, and we hope to make this IM flexible for use in the college as well as high school classroom.

A second learning community has developed with our teacher collaborators. We purposefully attempted to develop this learning community through workshop group building activities. During one of these activities, educators and facilitators shared their favorite memory of water in small groups. We hoped that this exercise would also aid in the forming stage of group-development, so that participants will feel non-threatened and oriented to their goals and to each other. It also allowed us to draw on the participants' experiences as education professionals. An ancillary goal of our project is to develop a portal for iterative, collaborative feedback with teacher volunteers, and we are initiating this through a Wiki developed by my internship partner, Robert Bohanan, for a summer teacher continuing education course he has taught. I am hopeful that a new learning community of scientists and educators has emerged from my internship project.

We initially incorporated this group building exercise at the suggestion of a collaborator who is part of a third larger learning community through the GLEON network. There is a sister

team that has received NSF funding for developing materials to engage citizen scientists with the GLEON database, a similar project that has multiple overlapping goals with my internship. We have been interacting with the leaders of this team, exchanged ideas, brainstormed the effectiveness of various engagement techniques, and contrasted the audiences' needs for each of our related projects.

I am an individual who intensely values feedback and constructive criticism, who requires support from others who care both about the outcome of the projects and my personal development as a teacher and learner. I feel that my internship experience has allowed me grow through these three learning communities, and they have been integral to my experience.

Looking ahead

Finally, my internship has informed my view of teaching and learning as it relates to my future teaching. Most importantly, I have learned that I have much more to learn, reaffirming the philosophy of iterative teaching and learning. Particularly, I recognize that there are things I miss or don't consider, mistakes that I make, preconceptions I hold, and experiences that lack that others have. As a teacher, I am a learner. I am continually learning how to teach. Our educator collaborators, my internship partner, Robert, and my coworker, Emily, and my GLEON and Delta learning communities have supported me and helped me to grow as a teacher. I believe that this experience has made me more self-aware and purposeful in seeking out dialogue and constructive criticism from other "teacher- learners", allowed me to place more value on the iterative process.

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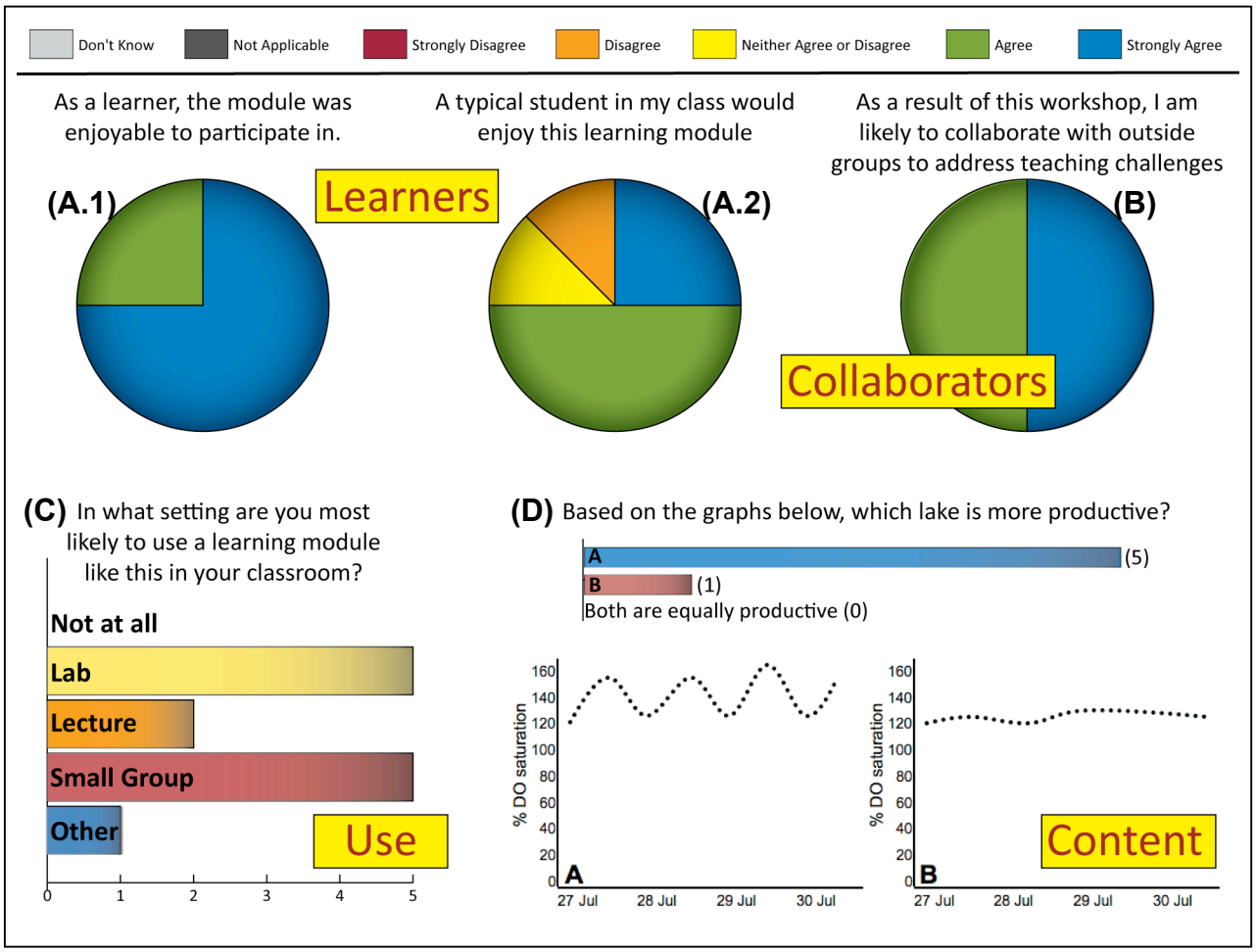
FIGURES

Figure 1. Summary of participants in the study, and their geographic school district location within Wisconsin. One participant from each workshop was a visiting scholar from Thailand.

Figure 2. Highlighted results from the following workshop evaluation topics: A) educator attitudes as learners, B) educator attitudes as collaborators, C) educator anticipated classroom use of the IM, and D) educator learning gains.



SUMMARY OF APPENDICES

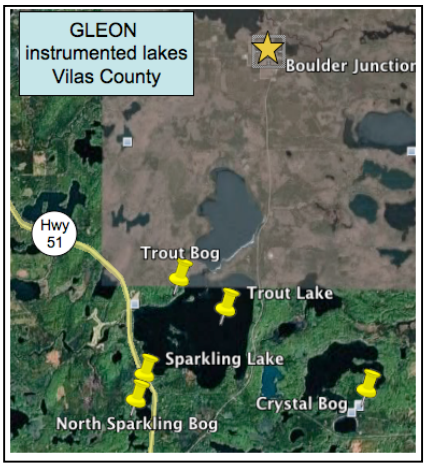
Appendix 1: Informative recruitment letter
Appendix 2: Front-End questionnaire
Appendix 3: Summative questionnaire
Appendix 4: Reflective short-answer responses (Q16 South)

January 22 2009

Dear Wisconsin Science Educator:

My name is Ashley Shade, and I am a graduate student with the University of Wisconsin. I study bacteria in lakes, and how physical, chemical, and biological conditions affect bacteria. I have been working with another student, Emily Kara and Robert Bohanan, from the UW Center for Biology Education, on an outreach project that may be of interest to you.

Emily and I are members of an organization called the Global Lakes Ecological Observatory Network (GLEON,www.gleon.org). GLEON maintains an online database of environmental lake data that are collected using real-time sensors. You may have noticed some of these GLEON buoys that collect these data, such as on Lake Mendota in Dane County. Earlier last year, Emily, Robert, and I surveyed a small group of Wisconsin high school science educators to learn ways in which we could complement their current curricula to better achieve Wisconsin State Educational Standards in ecology-related disciplines. We wanted to develop instructional materials that use these real-time Wisconsin lake data to address learning goals of high school science teachers. We have been constructing a prototype of instructional materials, and anticipate that they will be available on the internet for classroom use. However, we need your expertise to best improve these instructional materials!



In order to develop the learning module, we will host a half-day workshop on April 4th at the UW-Madison campus. All high school science teachers are welcome to attend and join us from 8:30am to 2pm, including breakfast, coffee, and lunch. During the workshop, we will guide you through a preliminary version of the learning module *as learners*. We will ask for your feedback as professional science educators. After the workshop, there will be an optional tour of the Center for Limnology facilities and some of our local study lakes. As an incentive to you, we will provide an introductory college-level limnology or ecology textbook to each participant, and there will be a drawing for additional items at the end of the workshop.

GLEON buoy on Trout Bog, Vilas County

Please join us! We also hope to find collaborators to help implement our learning module in fall 2009, so if this sounds like something you'd find useful in your classroom, please attend. Also, feel free to contact me with questions or concerns.

If you would like to attend our workshop, **simply return the participant form to me via e-mail by March 27th, 2009.** I will contact you with workshop logistics after you submit your form.

I look forward to working with you in April!

Ashley Shade
University of Wisconsin-Madison
Microbiology Doctoral Training Program
shade@wisc.edu
608.469.5313

global lake ecological observatory network

GLEON Wisconsin Educator Workshop
04 April 2009
University of Wisconsin- Center for Limnology
Participation Form

Name:

School:

Years of teaching experience:

Subjects taught:

Contact information:
e-mail:

phone:

Choose one:

_____Vegetarian lunch

_____Non-vegetarian

Do you have special dietary needs? If so, please specify:

Please return to Ashley Shade (shade@wisc.edu) by 27 March 2009.
Thank you!

GLEON pre-workshop survey

GLEON pre-survey workshop

Note: You are currently in preview mode and your responses are being saved. You should be sure to delete your entries before collecting real responses and analyzing your data.

This survey will take approximately 5-10 minutes to complete.

We wish to keep your answers anonymous in order to protect your identity and allow you to answer frankly. The purpose of the first two questions are to create a numerical identifier for your survey, and all future surveys for this project. Please record this number for future use.

1. What was the name of your first pet? * required

2. Please create a four-digit number to identify yourself. Please do not choose your year of birth. No one else will know this number, but it will be linked to your answer in question 1, in case you forget or lose this 4 digit identifier. * required
The value must be between 4 and 4, inclusive.

3. Please the answer that most accurately reflects you and your professional teaching activities.

	strongly disagree / never	disagree / rarely	neutral / 1 time a year	agree/ 1-5 times a year	strongly agree / always (>5 times a year)	not applicable	dont know
How often do you develop new instructional materials?							
How often do you engage as learners with instructional materials?							
How frequently do you collaborate with groups outside of your school to develop instructional materials?							
It benefits my teaching when I engage with instructional materials as a learner.							
It benefits my teaching when I collaborate with groups outside my school to address a teaching challenge.							
I do not have time for instructional materials development.							
I do not have time for collaboration with outside groups to address a teaching challenge.							
I enjoy engaging as a learner with instructional materials.							
I enjoy collaborating with outside groups my school to address a teaching challenge.							
I have a learning community within my school to help me address teaching challenges.							

4. How do you typically approach instructional materials development?

☐ I develop my own materials.

- [ ] I adapt materials that have been developed somewhere else.
- [ ] I use materials that have been developed somewhere else.
- [ ] Other, please specify

5. My school district is in * required
   - ○ Northern Wisconsin
   - ○ Southern Wisconsin

6. I have been teaching for
   - ○ < 1 year
   - ○ 1-5 years
   - ○ 5-10 years
   - ○ 10-20 years
   - ○ >20 years

7. Please list the subject areas you currently teach:
   1.
   2.
   3.
   4.
   5.

8. Please list the levels/grades you currently teach:
   1.
   2.
   3.
   4.

9. What size adult T-shirt do you wear?
   - ○ S
   - ○ M
   - ○ L
   - ○ XL

XXL

10. We are considering audio recording our workshop for note-taking purposes, but we will only do so if participants are comfortable with it. Would you be comfortable with audio recording during the workshop?

-- None --

Thank you for your time! We look forward to the workshop.

Done Cancel

Shade- Internship Report

Appendix 3

WebSurvey@UW

Home | New Survey | Surveys | Libraries | Templates | Email Lists | Reports | Users | My Account | Help | Logout

Modify Survey

Launch | Done

This survey has at least one response. Only limited changes are allowed on a survey with responses. To fully edit this survey, you must first delete all of the responses, which can be done by clicking here.

GLEON workshop summative survey

edit

Note: Only one user at a time may edit this survey. If there is another user in your account who may be editing this survey, please communicate with them. If more than one user edits a survey at the same time there may be data integrity issues.

Page 1 | Page 2 | Page 3 | Page 4 | Page 5 | Page 6 | Page 7 | Page 8 | Page 9 | Page 10

Print Preview of Survey

Enter your anonymous identifyer

Your responses to this survey will remain anonymous.

edit page properties | move page

1. Please enter the name of your first pet (same as the first survey): * required

edit
move
pipe

Evaluation of prototype instructional materials

edit page properties | insert page conditions | remove page break | move page

Enjoyment

edit
move

2. Please choose the response to the statements below that most closely reflects your opinion: * required

edit
move
pipe

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable	Don't know
As a learner, the module was enjoyable to participate in.	○	○	○	○	○	○	○
The learning module portrayed a real-world issue.	○	○	○	○	○	○	○
The learning module made me more interested in local lakes.	○	○	○	○	○	○	○
As a teacher, I would enjoy teaching this module.	○	○	○	○	○	○	○

A typical student in my classroom would enjoy this learning module.	○	○	○	○	○	○	○

3. Please add any comments here, and feel free to explain "extreme" (strongly agree/strongly disagree) rankings.

edit
move
pipe

Evaluation of prototype instructional materials

edit page properties | insert page conditions | remove page break | move page

Content

edit
move

4. Please choose the response to the statements below that most accurately completes the following statement: As a result of the learning module, I can ... * required

edit
move
pipe

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable	Don't know
Find a local lake and navigate through the GLEON database to get lake data.	○	○	○	○	○	○	○
Define eutrophication by linking dissolved oxygen and production to the term.	○	○	○	○	○	○	○
Compare dissolved oxygen patterns across lakes within the GLEON database.	○	○	○	○	○	○	○
Predict a temperate lake's trophic status based on summer dissolved oxygen dynamics.	○	○	○	○	○	○	○
Describe how scientists can test hypotheses by using existing data, in addition to conducting new experiments or studies.	○	○	○	○	○	○	○
Use the GLEON website, Water on the Web, and Google as a resource for finding relevant evidence to support a hypothesis about lake environmental data.	○	○	○	○	○	○	○
Interpret graphs of the dissolved oxygen data.	○	○	○	○	○	○	○

5. Please add any comments here, and feel free to explain "extreme" (strongly agree/strongly disagree) rankings.

edit
move
pipe

Evaluation of prototype instructional materials

edit page properties | insert page conditions | remove page break | move page

Content

edit
move

6. Please choose the response to the statements below that most accurately completes the following statement: After teaching the learning module in my classroom, I anticipate most STUDENTS would be able to ... * required

edit
move
pipe

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable	Don't know
Find a local lake and navigate through the GLEON database to get lake data.	○	○	○	○	○	○	○
Define eutrophication by linking dissolved oxygen and production to the term.	○	○	○	○	○	○	○
Compare dissolved oxygen patterns across lakes within the GLEON database.	○	○	○	○	○	○	○
Predict a temperate lake's trophic status based on summer dissolved oxygen dynamics.	○	○	○	○	○	○	○
Describe how scientists can test hypotheses by using existing data, in addition to conducting new experiments or studies.	○	○	○	○	○	○	○
Use the GLEON website, Water on the Web, and Google as a resource for finding relevant evidence to support a hypothesis about lake environmental data.	○	○	○	○	○	○	○
Interpret graphs of the dissolved oxygen data.	○	○	○	○	○	○	○

7. Please add any comments here, and feel free to explain "extreme" (strongly agree/strongly disagree) rankings.

edit
move
pipe

Evaluation of prototype instructional materials

edit page properties | insert page conditions | remove page break | move page

Application

edit
move

8. In what setting are you most likely to use a learning module like this in your classroom: * required

edit move pipe

- [ ] Not at all
- [ ] Laboratory
- [ ] Lecture
- [ ] Small group
- [ ] Other, please specify

Evaluation of prototype instructional materials

edit page properties | insert page conditions | remove page break | move page

Application

edit move

9. How likely are you to use a finalized prototype in your science classroom? * required

edit move pipe

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

Length

edit page properties | insert page conditions | remove page break | move page

10. How many classroom hours would be appropriate for the content covered by the learning module today? * required

edit move pipe

11. Do think the length was appropriate for the amount and complexity of content? * required

Yes

edit move pipe

12. If you answered "no" to previous question, how would you change the length of the learning module?

edit move pipe

Workshop Experience

edit page properties | insert page conditions | remove page break | move page

13. Please choose the response to the statements below that most accurately describes your experience today: * required

edit move pipe

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable	Don't know
The goals of the workshop were explicit to me.	○	○	○	○	○	○	○
We accomplished the goals of the workshop.	○	○	○	○	○	○	○
This workshop benefited me as an educator by giving me new ideas for instructional materials.	○	○	○	○	○	○	○
This workshop benefited me as a learner by introducing me to an unfamiliar topic.	○	○	○	○	○	○	○

14. Please choose the response to the statements below that most accurately describes your experience today: * required

edit move pipe

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable	Don't know
My opinions and suggestions as an educator were valued during the workshop.	○	○	○	○	○	○	○
As a result of this workshop, I feel positively about collaborating with groups outside my school district to address teaching challenges.	○	○	○	○	○	○	○
As a result of this workshop, I am likely collaborate with groups outside my school district in the future to address teaching challenges.	○	○	○	○	○	○	○

15. Please choose the response to the statements below that most accurately describes your experience today: * required

edit move pipe

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable	Don't know
I would recommend this type of workshop to my teaching colleagues.	○	○	○	○	○	○	○
I enjoyed collaborating to develop instructional materials.	○	○	○	○	○	○	○
I contributed a lot to the improvement of the instructional materials prototype.	○	○	○	○	○	○	○
I feel comfortable contacting the organizers of this workshop with future concerns or questions about the instructional materials or workshop.	○	○	○	○	○	○	○

This workshop benefited me as a learner by introducing me to an unfamiliar topic.	○	○	○	○	○	○	○

Workshop Experience

edit page properties | insert page conditions | remove page break | move page

16. What was especially good about the workshop, and what could have been improved? * required

edit | move | pipe

17. Please choose the best response: * required

edit | move | pipe

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The facilities were comfortable and appropriate for the workshop activities.	○	○	○	○	○
The instructional climate was welcoming.	○	○	○	○	○
The instructional climate inhibited my learning and/or participation.	○	○	○	○	○
The instructors respected differing viewpoints.	○	○	○	○	○
The instructors acknowledged learner differences and capitalize for these differences.	○	○	○	○	○
The instructional resources distracted from the goals of the workshop.	○	○	○	○	○

18. Please add any comments here, and feel free to explain "extreme" (strongly agree/strongly disagree) rankings.

edit | move | pipe

Learning Outcomes

edit page properties | insert page conditions | remove page break | move page

19. In two sentences or less, relate eutrophication, dissolved oxygen, and productivity in lakes. * required

edit | move | pipe

20. In a sentence or two, describe the data below. * required

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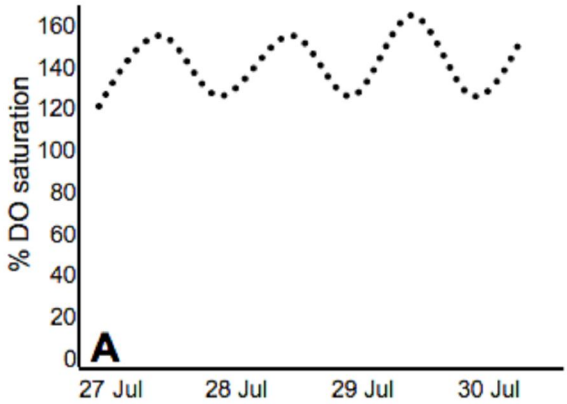

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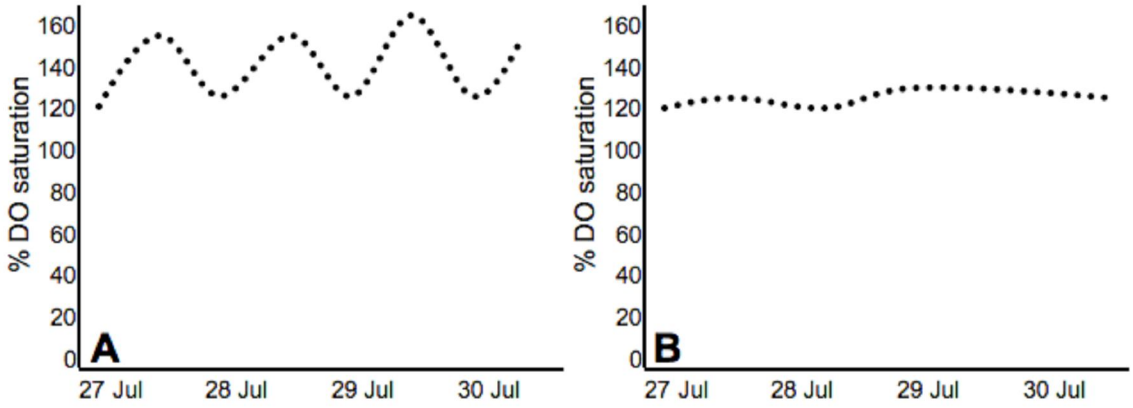
21. Based on the graphs below, predict which lake is more productive. Chose one answer. * required

edit
move
pipe

- A
- B
- Both are equally productive

edit
move



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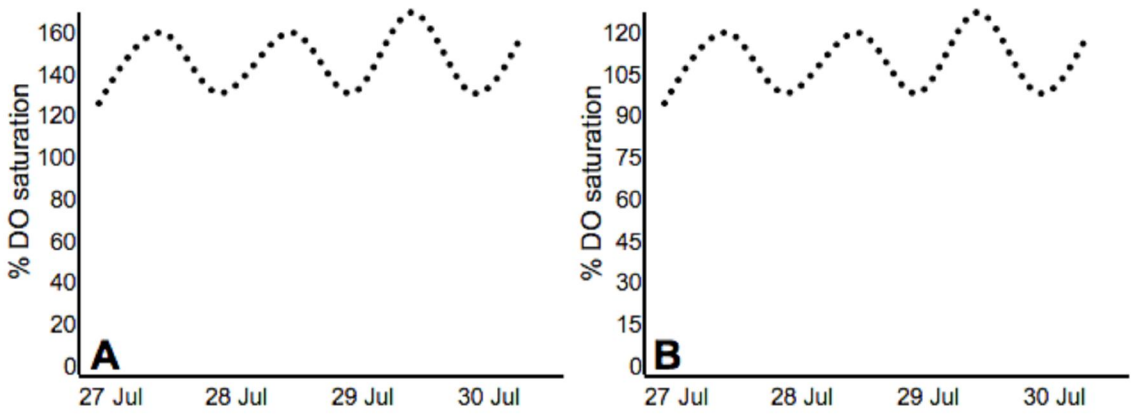
22. Based on the graphs below, predict which lake is more productive. Chose one answer. * required

edit
move
pipe

- A
- B
- Both are equally productive

---

edit
move



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23. In a two sentences or less, describe how you would find information about nutrients in lakes. * required

edit
move
pipe

---

24. Over the past fifty years, average atmospheric summer temperatures in Wisconsin has increased by 0.5 degrees C. You want to explore the affect of this temperature increase on dissolved oxygen concentration in lakes. Develop a hypothesis about this relationship, and describe how you would test it. * required

edit
move
pipe

Launch Done

WebSurvey@UW

Home | New Survey | Surveys | Libraries | Templates | Email Lists | Reports | Users | My Account | Help | Logout

Survey Results -- Details

Results Overview

GLEON workshop summative survey

Respondents:	8	**Status:**	Open
Launched Date:	01/12/2009	**Closed Date:**	N/A

16.	What was especially good about the workshop, and what could have been improved?	**Full Response**
1.	Group discussion and sharing of ideas.	view
2.	esp good = food, info, collaboration, meeting real researchers, the GLEON website, location, networking improvements = credit, start at 10?	view
3.	I really liked hearing the ideas of peers and also the ideas of the instructors of the workshop. I also liked the hands on aspects where I could manipulate the GLEON site to look at data and discuss with a small group.	view
4.	I really enjoyed talking with others who were interested in teaching about lakes, as well as making professional connections with people at the university.	view
5.	I liked the format and the overall atmosphere of the workshop. Very comfortable yet well organized and business-like. I learned a lot and it felt like we got a lot accomplished.	view
6.	Collaboration with fellow educators.	view
7.	The collraboration is the good activity to share ideas and experinces of the participants.	view
8.	good - meeting researchers in the field improve - handout ppt - for notetaking	view

Contact the DoIT Help Desk at 264-HELP or helpdesk.doit.wisc.edu for WebSurvey@UW Support