INFORMATION SEEKING BEHAVOIRS OF EDUCATORS: FOSTERING WEBS OF SHARING AND CO-CONSTRUCTING KNOWLEDGE

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Teacher education research draws a link between teachers' access to resources and effect on planning practices, yet gaps exist in the study of how educator find, access, and use online information. This paper presents study findings from research that investigated the online information seeking behaviors of biology teachers and their perceptions of how their online activities influence their instructional practices. The often overlapping roles of teachers as both facilitators and recipients of information through formal and informal online social networks are discussed. Study findings have potential implications for school library media specialists work with teachers.

Overview

Teachers have traditionally shared information, resources, lesson plans, and support with one another in their school buildings. However, current and emerging information and communication technologies (ICTs) are shaping, and being shaped, by new 21st century sharing practices that expand beyond the walls of the school. Locating materials and resources is routinely cited by teachers as an important activity in the first stages of planning and has been rated as a key aspect of their planning process (Clark and Yinger 1977; Clark and Yinger 1979). Teachers have consistently expressed a need for assistance in locating materials and view their lack of proficiency in this area as a factor that limits their classroom teaching effectiveness (Hedtke et al., 2001; Moore and Hanley 1982). The Internet has made a vast amount of educational resources in a variety of formats available to educators. Some of the resources are of high quality, but others are unorganized and unauthenticated (Fitzgerald, 2001; Roberts & Foehr, 2001), and searching and verifying the information resources pose a challenge to teachers already pressed for time.

This exploratory study collected baseline data on biology teachers' online information seeking behaviors and its influence on their instructional practices through an online survey and ten in-depth interviews. The interviews offered the opportunity to explore in greater detail the consequences of the online information seeking behaviors on

instructional planning practices. Four themes reflecting the consequences of teachers' information seeking practices emerged from the data analysis: Currency of Information; Sparking of Ideas and Gaining Personal Knowledge; Resource Management and the Role of Time; and Webs of Sharing.

This paper will discuss study findings and consider the implications of teachers' engagement in webs of sharing—defined here as formal and informal online social networks—and how these activities are shaped via use of new and existing ICTs. Teachers' roles in these webs of sharing appear to be fluid and dynamic. At times, they may be a producer or sharer of information, other times they may be recipients. A key benefit of participation appears to be the opportunity for knowledge construction around aspects of curriculum content and pedagogy. Electronic discussion groups and digital libraries are two types of ICT resources study participants, though in relatively small numbers, indicated they are leveraging for their instructional planning practices.

Review of Literature

Teachers' Web searching behaviors

Ball and Cohen (1999) draw a link between teachers' access to resources and effective planning practices and argue that "materials influence instructional capacity by constraining or enabling students' and teachers' opportunities to learn and teach" (p. 2). Studies of teacher planning also highlight the shortage of time and the subsequent detrimental influences on their decision-making (Smagorinsky 1999; Sardo-Brown 1990). The pedagogical changes science teachers have made in order to create authentic and active learning environments require access to more resources, but this need, coupled with a lack of time and skill to be able to find and use them, creates a tension for teachers. The Internet, with its seemingly endless array of educational resources, potentially exacerbates the situation.

The Internet offers tremendous access to multi-modal resources, yet there are currently a limited number of studies that address teachers' web searching behaviors. Question types and the user base were examined in a study examining digital reference service to K-12 educators (Lankes 2003). Several researchers (Carlson and Reidy, 2001; Lankes, 2003; Recker et al., 2004) concluded that although there has been a digital libraries research foci there is a gap in understanding how teachers find, access, and use digital learning resources. Recker et al., (2004) argued that what is missing from initiatives to develop online resources is:

> ...a deep characterization and understanding of learning environments, and how digital learning resources may fit into such contexts. Developing this perspective requires adopting teacher and student perspectives, rather than simply focusing on technological concerns. Moreover, ignoring these perspectives risks hampering successful adoption of innovation (Moore

> 1991), and the history of educational technology is replete with such omissions (Cuban 1986). (p. 125)

The Recker et al. study is notable for its examination of how teachers find, access, and use digital learning resources. It does, however, stop short of examining the consequences of these actions on their instructional practices. Recker et al., (2001) acknowledged stopping short of examining the consequences of these actions by calling for further study to "better understand the impact and adoption of emerging digital learning technologies and tools in educational contexts" (p. 123).

The study under discussion in this paper, by going beyond evaluation of the technical skills to use computers and the Internet and considering how the innovation affects practice, may be used to (1) inform and enhance collaborations between SLMS and teachers; and (2) shape course curricula in preservice education, including the integration of information literacy skills development. While the diffusion of the Internet into schools has been studied in some detail, the consequences of teachers' online information seeking practices on their professional practice is an area in need of further understanding and research.

Research Study

Research question

This study addressed the question: "What online information seeking behaviors are biology teachers engaged in and what influence do these practices have on their instructional planning?" Because of existing gaps in the research in this area, the study was exploratory in nature and gathered baseline information. The purpose of the study was threefold:

> 1) To document the online information seeking practices of biology teachers;
> 2) To understand teachers' perceptions of the effect of these practices on instructional planning; and
> 3) To add to the knowledge base of school library media specialists' and teachers' practices in order to inform professional development offerings, pre-service and graduate education.

The study participants were comprised of New York State biology teachers who were currently using, to varying degrees, online resources in their instructional planning.

Theoretical framework - Diffusion of Innovations

The Diffusion of Innovations theory (Rogers 2003) with particular attention to the category of Consequences of Innovation provided a theoretical framework to address the research questions and consider the consequences of the teachers' information seeking

behaviors to instructional planning. Consequences of an innovation are the "changes that occur [in] an individual or social system as a result of the adoption or rejection of an innovation" (Rogers 2003 p. 436).

The three dimensions to the classification scheme Rogers devised to help in the study of the consequences of innovations are: (1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated (p. 442). This taxonomy informed the survey design as well as the choice of independent variables and data analysis methods.

Data collection

There were two phases of data collection in this study. Phase I was an online survey of more than seventy New York State biology teachers. The survey was intended to capture (1) a snapshot of the biology teachers' online information seeking practices during the summer and fall 2004, and (2) their perceptions regarding how their online practices influenced their instructional planning.

72 biology teachers took part in the survey. The first section of the survey used an initial filter question to identify those respondents who used the Internet in their instructional planning during the summer or fall of 2004. 70 respondents indicated use, while 2 respondents indicated non-use. Of the 70 biology teachers who reported using the Internet during the summer or fall of 2004 for instructional planning purposes, there were 40 females and 30 males. Following is the demographic breakdown by district type: 21 (30%) - urban, 14 (20) - rural, and 35 (50%) - suburban.

Teachers'* reported number years of experience ranged from:

Less than 1 year:	4	(5%)
1-5 years:	14	(20%)
6-10 years:	15	(22%)
11-20 years:	17	(25%)
More than 20 years:	19	(28%)

**1 teacher did not report years of experience*

More than half of the survey respondents had 11 or more years of teaching experience and almost 30% had more than 20 years, making this group fairly experienced.

In Phase II, ten study participants were interviewed in order to explore in greater detail the consequences of their online information seeking practices on their instructional planning.10 NYS biology teachers were interviewed: 7 females and 3 males. Breakdown of district types included two urban teachers, two rural teachers, and six suburban teachers. Of the six suburban teachers, they were evenly distributed-that is two each—across districts of low, medium, and high socioeconomic classifications.

Results

This section will present the results of the data collected from the survey and interviews.

Overview of resources used in planning

In five of the six sections of the survey, teachers were asked to consider their information seeking practices with respect to one specific online tool (e.g., search engines, specific websites, digital libraries, online databases, and electronic discussion groups). Some questions also included print resources as an additional choice. A filter question began each section: Did you use [online tool] to access information or resources for information or resources for instructional planning during the summer or fall of 2004? Table 1 summarizes replies of the seventy respondents who reported using the Internet for instructional planning. 99% of the respondents reported using search engines and 89% of them reported use of specific websites. In contrast, only 20% of respondents reported using digital libraries and 24% of respondents indicated use of online databases. 50% of teachers reported using electronic discussion groups, while 50% of them reported no use. Given the number of digital libraries and online databases specifically designed to support educators' teaching and learning needs, the low percentage of use of these tools by the teachers is a notable finding and a potential area for future research. It highlights a key area of potential collaboration between school library media specialists and teachers.

The table below summarizes replies of the seventy respondents who reported using the Internet for instructional planning.

Table 1: Tool Use for Instructional Planning Purposes

Specific Search Engines	Specific Websites	Digital Libraries	Online Databases	Electronic Discussion Groups
Yes – (69) 99%	**Yes – (62) 89%**	**Yes – (14) 20%**	**Yes – (17) 24%**	**Yes –(35) 50%**
No - (1) 1%	**No – (8) 11%**	**No - (56) 80%**	**No - (53) 76%**	**No – (35) 50%**

Perceived influence on instructional planning

The interviews yielded in-depth and detailed responses regarding how these biology teachers seek information and materials online for their instructional planning purposes; what they do with it after the locate it; and what influences it has on their planning process. During the ten interviews, the biology teachers described in detail how their information seeking practices impacted their instructional planning. The participants described a range of influences on several instructional planning components.

Perceptions of proficiency

Overall, teachers perceived themselves as possessing an Average to Excellent proficiency level with online tools to find information or resources for their instructional planning. Teachers reported a strong proficiency with search engines with 86% (n=70) of respondents indicating they possessed a Very Good to Excellent skill level. 80 % (n=70) of teachers reported a Very Good to Excellent proficiency with the use of websites for instructional planning purposes. It is important to remember, though, that this study captured the teachers' perception of their skill level, rather than measuring their ability to use the different online tools.

Teachers rated their proficiency with regard to electronic discussion groups and online databases less highly. 32 % (n=69) of teachers reported a Poor to Fair ability to use listservs for instructional planning purposes and slightly more than 50% (n=70) of respondents reported a Fair to Average ability to use online databases. Although in a previous question, 80% (n=70) of respondents reported not using digital libraries, more than 50% (n=69) of respondents for this question rated their ability to use online databases as Fair to Average. Why the discrepancy between low numbers of use compared to ability to use is worth future study given the role of educational digital libraries in supporting teaching and learning activities.

A variety of questions posed to teachers in the survey and interviews sought to address how the information seeking behaviors engaged in by teachers impacted their access to different instructional planning components. The chart below highlights the relationship between online tool use for information seeking and instructional planning components (e.g., Curriculum Content, Presentation Materials, Personal Knowledge, Models, Graphics, and Lab Ideas) during the summer or fall of 2004 (respondents had the option to select multiple responses). Table 2 reports findings on use related to instructional planning.

Table 2: Use Related to Instructional Planning Components

Q: Did you use [online tool] to find information or resources related to any of the following during the summer or fall of 2004: (Choose all that apply)

Online Tools	**Number of Reported Users out of 70**	**Curriculum Content**	**Presentation Materials (i.e., picture, audio, visual)**	**Personal Knowledge**	**Models**	**Graphics**	**Lab Ideas**
Search Engines	**69**	81% *	90%	75%	48%	86%	75%
Specific Websites	**62**	92%	81%	69%	45%	69%	69%

Digital Libraries	**14**	79%	72%	57%	36%	50%	79%
Online Databases	**17**	77%	42%	47%	12%	29%	41%
Listservs	**35**	74%	40%	69%	26%	66%	11%

* Percentages are of total number that responded

An Under-used resource: Digital Libraries

Typically, education-related digital libraries contain organized and evaluated online resources geared to a specific topic, intended to save teachers time in finding age-appropriate, current and credible information. Mardis (2003) notes in addition to "these rich multimodal resources and services the communication features help to foster and build community and knowledge" (1). She further defines educational digital libraries as linked collections of learning objects that are:

1) accessible from variety of points;
2) descriptions of objects beyond author, title and location;
3) services that add value to the collection and objects;
4) additional features such as community building mechanisms that cannot be represented or distributed in printed formats. (2).

Notably given the potential usefulness of this resource in instructional planning, only 14 of the 70 survey respondents reported using digital libraries for their instructional planning needs during the summer or fall of 2004. Only one of the ten teachers interviewed said they used any type of digital library during this time period and this person reporting using the National Science Foundation's Digital Library (NSDL) about two to three times.

Survey respondents indicated use of the following digital libraries:

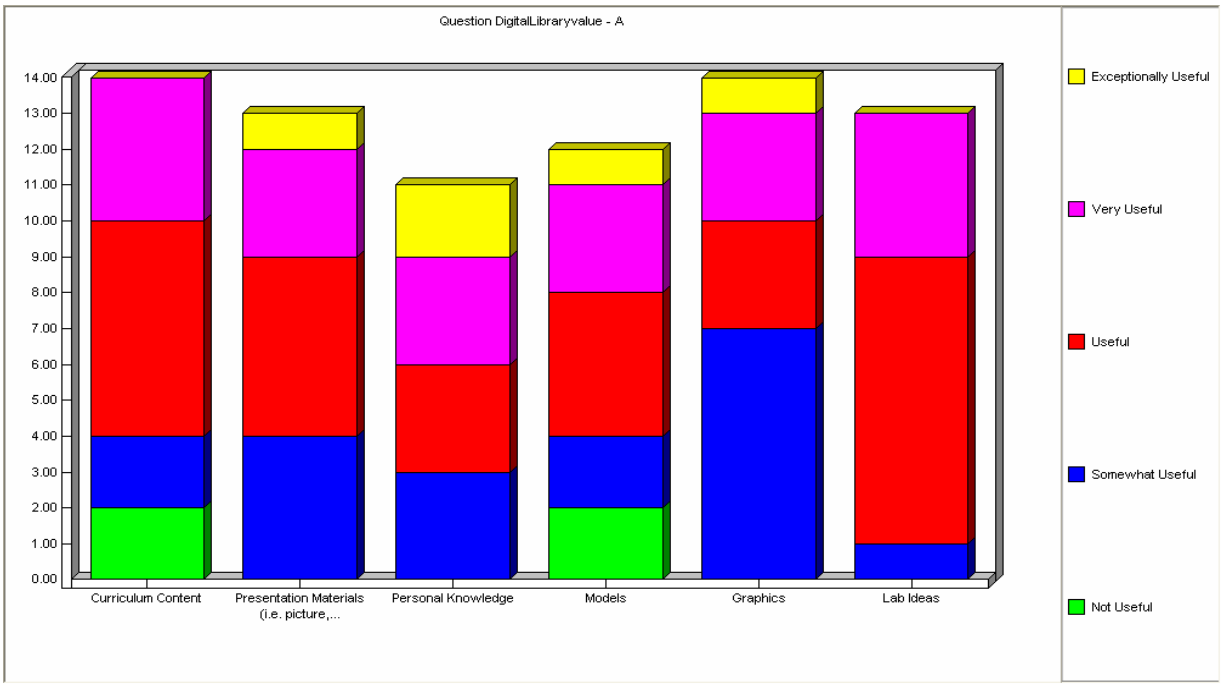
National Science Foundation's Digital Library - 10 responses
Gateway to Educational Materials - 6 responses
Other - 8 responses
Others included:
Eisenhower National Clearinghouse (ENC)
University of Rhode Island/Sea Grant
Medscape

Only one of the ten interview participants had ever used the National Science Foundations' Digital Library (NSDL), a highly developed resource specifically geared to supporting the teaching and learning needs of science teachers. Eight of the ten teachers reported they were unaware of the existence of the NSDL.

14 of the 70 teachers who indicated they used digital libraries reported finding information or resources that most often related to the instructional planning components: Curriculum Content and Lab Ideas. Overall, the fourteen respondents place a high value on digital libraries for instructional planning, such as curriculum content, presentation materials, personal knowledge, models, graphics, and lab ideas. Table 3 summarizes their responses.

Table 3: Perceived Value of Digital Library Use (n=14)

Q: During the summer of fall of 2004, how would you rate the value of using digital libraries to find information and resources for the following components:



Significantly, while these figures indicate that the majority of teachers who use digital libraries find them worthwhile for a number of diverse planning activities, only 20% (n=70) of survey respondents report use of digital libraries. Future research is needed to determine how to bridge the gap between under-use by teachers of this viable teaching and learning resource. Research should also explore how the communication features of these resources can be used in the co-construction of knowledge, as well as positively influencing teaching and learning activities.

Webs of sharing and the co-construction of knowledge

Teachers have traditionally shared information, resources, lesson plans, and support, fostering an "in-house" community of learners that through ongoing exchanges

co-construct both domain and pedagogical knowledge. Findings from the survey and the interviews show evidence of teacher engagement with new types of sharing practices made possible by current and emerging ICTs. Participation in communities of practices that extend far beyond the walls of the schools is now done through electronic discussion groups, digital library activities, blogs, wikis, etc. Participation and exchanges are fluid and dynamic. They may be one shot encounters with information and/or resources flowing in one direction. On the other hand, it might be a mutually constitutive exchange that occurs over a semester when a teacher in England collaborates with a teacher in New York on designing inquiry-based lessons. Sharing might involve 10 or 100 educators – the webs of sharing overlap and inter-twine.

Study participants spoke of their engagement in sharing and receiving information and resources, from both known and unknown colleagues and how it influenced their instructional planning practices. For example, Bonnie (a pseudonym) commented on how she valued access to "great minds" and how she benefits from what others share. She said:

> How did I ever live before I had it? I mean seriously, it's a very heavy influence because it gives instant access to incredibly bright people who have spent their lives putting out the stuff that's on the Internet, where I much rather be, because of the personality I have, I'd much rather be the kind of person reading about this wonderful thing that this person slaved away at that 10-15 frustrating years till finally they came up with this paper and now it's on the Internet and I have read it in a half hour and boy it was great and now I am ready to move on. The instant access it gives me to years and years and years of experience that people have…It also sparks ideas like when I am reading something, it'll be oh yes I can do this and this part is not so hot, I'll change this and do this.

When asked by this researcher if she ever contacted people whose work she used. She replied:

> On a rare occasion, but not usually, but I have. I just did one this Friday. I was looking at this great video site, and the photography was just fantastic for this thing that I am going to use in one of my classes. So I e-mail the guy who is in Holland - I don't know what he is, some guy sitting in his house photographing these weird subjects of produce against dark backgrounds. He wrote back this me long e-mail. He told me about how to do that kind of dark field photography with a microscope and all so that was interesting. But by and large I just don't contact them, I just read their work.

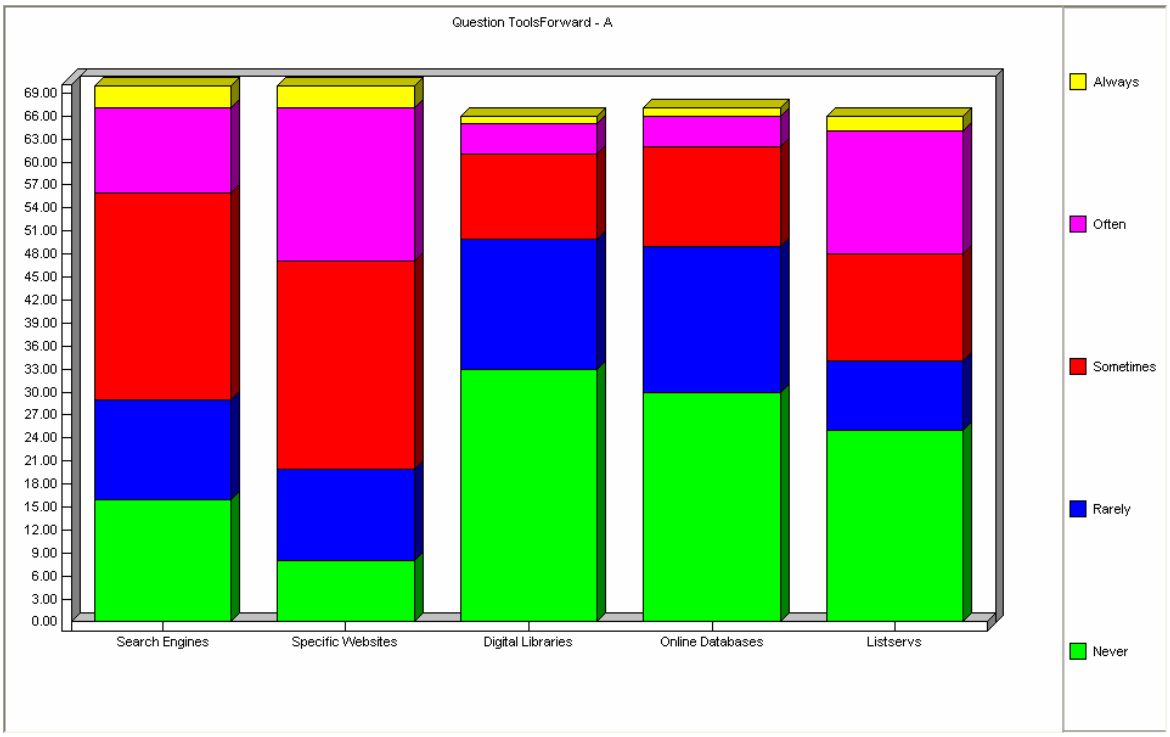
John (a pseudonym) spoke of going to other teachers' websites and using their work. He noted that most people are very generous about sharing their work and said:

> I have one teacher particularly. She does study guides for every chapter and I emailed her to ask permission. She never got back to me, so I have used many of her study guides. They're out there. We're kind of panicky right

> now because she stopped at chapter 42 and we are not at Chapter 49 and the kids are saying: We going to get another study guide? It all depends on … I just kind of dropped the ball and am hoping she'll come back. It really helps me with explanations on concepts.

Table 4 shows results of how often survey respondents forwarded on information or resources that they had found online.

Table 4: Frequency of Sharing Information and Resources
Q: During the summer or fall of 2004, how often did you forward information or resources to your colleagues that you found in the following online resources:



I asked Wanda (a pseudonym) how often she found herself sending, via e-mail, information and resources she found online to other science colleagues,

> **WD:** At least weekly. I don't want to say daily, but for the most part at least once a week.
>
> **AP:** To colleagues in New York State, outside NY State?
>
> **WD:** Yes. I still have contact with people in Oklahoma and we go back and forth quite a bit.
>
> **AP:** Are you aware if what you sent them changed any of their instructional plans?
>
> **WD**: Yes. The teachers I worked with in Oklahoma, we put together a Lego DNA series where we have 3 or 4 labs we've done. We just did it between ourselves and then about 3 weeks ago I just found an online version that was similar but different enough that I sent it off to Steve and he took parts of it to revise ours.

Wanda shares with individuals in a dispersed geographical network and recognized how her own information seeking practices influenced these individuals' instructional planning practices.

Bonnie (a pseudonym) spoke about doing her own research online and finding unrelated items she knew colleagues could use and forwarding them on. When asked how often this occurred and she replied:

> **BD:** Oh frequently… to a few; because admittedly I have very eclectic taste. It's not like I sit down at the Internet and I say ok; I have one ½ hour and I am going to do A,B,C, in groups and then I'm going to lunch. I never do that. I like sit down with a question and then I like go off on this play off on this tangent, and this is exactly what Kim wants, so I copy off this thing ya know and then I e-mail it to Kim and so oh look at this or, so I have maybe two or three people whose work I know closely enough that even though they are not doing the same thing as me, I know what they are involved in and what kind of stuff they like, but I e-mail them stuff a lot.
>
> **AP:** Are they colleagues within the school or outside the school?
>
> **BD:** Both

I asked Bonnie is she ever heard back from colleagues on how they used the material she sent them. Bonnie said that Kim, for example, would let her know how a lab she had sent went and what Bonnie should watch for when she did it with her own students.

Teachers reported roadblocks in their attempts to be part of sharing and receiving loops. Nathan (a pseudonym) mentioned the time he tried to join the AP Biology listserv and was blocked by the admission password not working and he gave up. He said, "You know that's a big thing, whenever you go in and you try to do something and it doesn't work and you go uh, all right then it must not be that important to me." A few times a month, Lincoln (a pseudonym) passes on resources through emails and conversations to a colleague with whom he shares an office. For example, he found what he described as a great virtual dissection on earthworms and he linked it to his website and let his colleague know about it so she could do the same. He said if she finds something she'll tell him and vice versa. Lincoln noted, however, the lack of exchange of information among other biology teachers in the school, a point Barbara (a pseudonym) also raised and which may, in fact, be due to a number of system influences (e.g., social, political, economical, etc.). Lincoln suggested there could be more sharing at monthly department meetings of useful curriculum sites. Lincoln also mentioned how much he values the ability to talk with friends in other schools via email. He said, "I can communicate with my friends in other schools about things that I am doing and sharing and I know in fact that one of my friends referred to my website to explain stuff, so you know so that's cool too."

Barbara described how she found statistics for down syndrome related to age of the mother and knew it would be useful to her colleagues so she made copies of a chart and distributed it to them. Notably, like Lincoln, she is concerned about gaps in the sharing of information. She says, "We are all so separated, half of the biology teachers are up on the 3rd floor and the other half are downstairs. It's really hard because we never

get up there they never come down, so we never see them, they don't go to lunch at the same time. If you don't see them you can't exchange information." I asked if she emailed her building colleagues much and she replied that they had just gotten email access this year and just learned how to create groups with the email program.

Another teacher, Helen (a pseudonym), said she and a close colleague email information and resources back and forth all the time. For example, they send one another pictures from the digital microscopes. While Helen did not recall a time the sharing or receiving of resources changed the direction of a lesson, she did say it has given her clarification on concepts.

Julie (a pseudonym) and other interview participants draw on colleagues' knowledge to help with preparation for new courses. Julie noted that her immediate colleagues may not always have time to sit down with her and help, so instead she goes online and ask for assistance. She also picks up information indirectly by reading responses to questions posed by others in the professional electronic discussion groups. These examples of gaining new knowledge on Julie's part represent both direct and indirect consequences of her information seeking practices.

Several teachers mentioned the advantages of using the Internet to plan for new courses. In the excerpt below, Julie, an experienced suburban teacher, describes how using the Internet to plan a course resulted in more confidence in her personal understanding and created a bigger circle of colleagues from whom to seek help.

> JC: Certainly, having access to the Internet helps build confidence for somebody who is teaching a new course. If you're collaborating with other teachers, you sit down with somebody who has done it for years and you say help me out with it…You don't always have access to people who would be willing to do that. Online, you've got a whole group of people who do that. So that's been helpful. It's given me confidence and helps me save time in the long run.

When asked about some specifics examples Julie described how she goes online to get background information. She stated:

> If I have to teach something and I don't really get it. It will give me the background and actually with the listservs I can go online and say, would you please explain that? They're wonderful. Actually, I learn from other people. I don't always get online, but I've done it a couple of times. Other people asked and someone explained it. They'll ask the question, and then "I get it now!" It's been wonderful for teaching AP.

This study's findings show that teachers are using a greater number and wider range of current and multi-modal resources than pre-Internet and they perceive this as an advantage in creating authentic, inquiry-based learning experiences. A notable discovery was of the under-use by teachers of educational online resources specifically designed to

support teaching and learning activities (e.g., digital libraries, online periodical databases, and electronic discussion groups).

In considering this study's findings, several limitations should be noted. Participants who took part in this study all possessed some degree of proficiency with the Internet, none were reported novices, and all regularly used the Internet. Ravitz (1998) argued that this group of teachers, by their nature, offered perhaps the best perspective on what influenced teachers' and students' Internet use. However, there may have been, for example, more novice teachers who use digital libraries, but not professional electronic discussion groups so they didn't receive the recruitment email for the study. Sample bias is also a consideration, but again, it was useful here to create a snapshot of a specific group of individuals. Sample size of the study was relatively small (72 survey respondents and 10 interview participants), and therefore not generalizable, and participants were all from one state. However, the data is sufficient to understand general trends among biology teachers about their online information seeking practices for instructional planning purposes.

Further limitations include that this study involved perceptions which were self-reported by teachers rather than direct observation. However, the perceptions proved valuable for understanding the nuanced and complex consequences of the teachers' practices. Both this study's limitations and findings serve as catalysts for future study.

Areas for Future Study

How school library media specialists and teachers can serve as models and mentors for their students and help them acquire the skills and knowledge related to advanced information literacy skills is an overarching theme behind a future research agenda in this area of study. It is imperative to address research gaps in this area and to broaden and extend the study of the information seeking practices of teachers and school library media specialists and its affects on teaching and learning activities, and ultimately student achievement. A number of areas of potential future research arose from this exploratory study and are noted throughout the paper. In summary, several are listed below:

- Future research is necessary to extend this study's preliminary findings related to Webs of Sharing and examine the ways in which teachers change their relationships with others as a result of information seeking. Social network analysis could be used to trace: Who were the principle contacts in the pre-digital age? Who is it now? How is it changing? What kinds of people are now included who weren't included in the past?

- Consideration and development of a synergistic collaboration exchange model (Mardis and Perrault 2007) between school library media specialists and teachers

could add a viable perspective to the ongoing theoretical discussions around collaboration and potentially inform practitioner practices related to this key area of interaction with their colleagues that fosters student learning.

- Future research regarding teachers' practices with digital libraries is very important given this study's findings of significant under-utilization of this key education resource study participants.

- Future research regarding teachers' information behaviors with blogs, wikis, social networking sites, and other not yet developed ICT's.

Discussion

This study showed that teachers are thinking about instructional planning in new ways and modeling life-long learning habits in their planning activities. The findings point to a recursive process in which teachers are engaged in ongoing online information seeking practices; continually learning and fostering new knowledge; integrating the learning into their instructional planning practices; changing their teaching strategies; and going back online to search for information and resources and begin the cycle again. They are actively taking the steps to create the active, inquiry-based learning environments, called for in new science standards as evidenced throughout the study's findings. Formal and informal social networks—webs of sharing—are being shaped and leveraged that facilitate knowledge construction and resource sharing around aspects of curriculum content and pedagogy.

However, even with almost unbounded opportunities through the Internet to access information and resources, teachers may not be able to maximize the potential this access to new information and resources offers if they lack the necessary online search skills to efficiently find, and effectively use, the online tools. Steps must be made to support teachers' efforts to refine their information seeking behaviors, in order to empower them to find and use the best and most appropriate resources for their students' learning.

The pedagogical changes science teachers have made in order to create authentic and active learning environments require access to more resources, but this need, coupled with a lack of time, and perhaps the skills, to be able to find and use them, creates a tension for teachers. Professional development for teachers of science is a continuous, lifelong process. It begins in the pre-service stage and continues throughout the teacher's career. The Professional Development Standards (NCR 1996) note that:

> The understanding and abilities required to be a masterful teacher of science are not static. Science content increases and changes, and a teacher's understanding in science must keep pace…Further, we live in an ever-changing society, which deeply influences events in schools, social changes

affect students as they come to school and affect what they need to carry away with them (2).

Technology offers a tool for teachers to achieve the objectives outlined in the Professional Development Standard. But, as with most tools, to achieve maximum benefit a degree of skill is required. Teachers' mastery of online information literacy skills enables them to efficiently find, and effectively use, information via the medium of the Internet. It helps them keep up with the rapidly changing scientific world. Teachers who refine theses skills through ongoing training and use maximize the potential of the teaching and learning resources available online.

Ongoing collaborations with school library media specialists offer a potentially valuable intersection point for formal and informal professional development to occur. Potentially, collaboration among these two groups of educators may foster a synergistic type of relationship where both educators learn something from the other. These study findings may be of interest to school library media specialists because by understanding their colleagues information behaviors they learn about not only potential zones of intervention (Kuhlthau, 1994), but also viable points of collaboration. Study findings are intended to inform graduate education and professional development for both teachers and library media specialists, as well as to expand and enrich collaborative opportunities among the two groups in order help them meet the various approaches to learning by their students.

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