

An Exploratory Study of Biology Teachers' Online Information Seeking Practices

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This study reports on exploratory research that investigated biology teachers' perceptions of their online information seeking practices and how these practices influenced their instructional planning activities. Quantitative and qualitative analyses of the results of an online survey and ten in-depth interviews measuring use of specific online tools (i.e., search engines, specific Web sites, digital libraries, online periodical databases, and electronic discussion lists) were conducted. Key findings show that teachers are using a greater number and wider range of current and multimodal resources than pre-Internet and perceive this as an advantage in creating authentic, inquiry-based learning experiences. However, underuse of educational online resources specifically designed to support teaching and learning activities (e.g., digital libraries, online periodical databases, and electronic discussion lists) was evidenced. 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. Each theme encompassed both the purposeful and the indirect actions by teachers to access knowledge and resources to refine and improve their instructional planning. Study findings have implications for informing the collaborative relationship between school library media specialists and teachers.

The Internet has been increasing teachers' access to a vast amount of resources in a multitude of formats, while concurrently decreasing their dependencies on print resources. Some of the resources are of high quality, but others are unorganized and unauthenticated (Fitzgerald, 2001; Roberts and Foehr, 2001), and searching and verifying the information resources poses a challenge to teachers already pressed for time. Teachers are using online resources in their planning activities (Hedtke, Kahlert, and Schwier, 2001; Recker, Dorward and Nelson, 2004; NetDay, 2005, 2006) and recent research shows evidence of expanding use of online resources by teachers in the area of instruction and for teacher-directed use (Recker, 2006; NetDay, 2005, 2006). Interestingly, a study by Williams, Grimble, and Irwin (2004) found that although teachers recognize that electronic databases are more reliable, they instead frequently turn to the open Internet for information.

Yet even with these shifts in practices, only a handful of researchers within the last few years have gone beyond examining the technical aspects of teachers' use of technology, to attempt to understand how teachers find and use online resources for their instructional purposes (Carlson and Reidy, 2004; Lankes, 2003; NetDay, 2005, 2006; Recker et al., 2004; Recker et al., 2005; Recker 2006). While the Internet provides new resources, the question is whether and how

teachers are able to make use of these Internet resources in their instructional planning and what this means to the collaborative efforts between school library media specialists and teachers.

This exploratory study collected data regarding teachers' online information-seeking practices and how these practices influenced their instructional planning. The study was intended to address the gap in this area of research and uncover potential areas of collaboration with school library media specialists. There were two phases of data collection. Phase I was an online survey of seventy-two New York State biology teachers. The survey captured: (1) a snapshot of the biology teachers' online information seeking practices during summer and fall 2004, and (2) their perceptions regarding how their online practices influenced their instructional planning. In Phase II, ten study participants were interviewed to explore in greater detail the consequences of their online information seeking practices on their instructional planning.

Review of the Literature

The convergence of two major events during the last decade has significantly influenced science education in the United States. First, science curriculum reform suggests that students learn best through active student-centered, inquiry-based learning (National Research Council [NRC], 1996; Wallace, Krajcik, and Soloway, 1996). Second, the shift from an industrial era to an information age offers, through such developing technologies as the Internet, a vast amount of educational resources previously unavailable to educators. The intersection of these two changes influences how teachers plan, instruct, and assess their students and fosters unlimited opportunities for collaboration with school library media specialists to positively influence student learning.

Changing Science Standards

The National Science Education Standards (NRC, 1996) call for teachers to create active, inquiry-based learning environments where students have the opportunity to construct their own knowledge around science concepts (NRC, 1996; Wallace et al., 1996). Teachers operate as facilitators in their students' learning experiences in these inquiry-based learning environments, rather than as transmitters of information. Some teachers have always worked from this pedagogical perspective; however, the development of the National Science Education Standards (NSES) promotes inquiry as a goal for all science teachers.

Science teachers are seeking out all types of multimodal resources and materials they need to support the type of teaching, learning and hands-on activities called for in the Standards (NRC, 1996). Multimodal resources represent texts in print format, as well as the new and evolving modes of communication and expression in multimedia formats (National Council of Teachers of English [NCTE], 2005). Teachers are aware of the possibilities of these online resources and what the possibilities might mean in terms of instructional benefits for them and their students. Many teachers are convinced that the Internet can help with instructional planning and the creation of learning activities for their students (Fitzgerald, 2001; Hedtke et al., 2001; NetDay, 2005, 2006; Recker, 2006). However, teachers describe their experiences with using the Internet for teaching and learning as time consuming, and they express frustration with the quality of results and some are overwhelmed when a search yields thousands of results (Fitzgerald, 2001; Hedtke et al., 2001; Karchmer, 2001; Kuhlthau, 1997; Roberts and Foehr, 2002; Recker et al., 2004; Trotter, 1999; VanFossen, 2001). The mere quantity of resources available is often

overwhelming to teachers since the profusion of online resources began in the early nineties and has continued unabated. Kuhlthau (1997) called the endless stream of resources the “new rules of abundance” (citing McClintock 1996). Although the Internet has the potential to offer the multimodal resources they seek, teachers may not adequately access the information because they lack the necessary online search skills to efficiently find, and effectively use, the online resources that range from digital libraries to electronic discussion lists. Varying gaps in knowledge and skills by teachers with respect to online information seeking and information literacy (Levin and Arafeh, 2002), offer potentially meaningful points of intersection for collaboration with school library media specialists. Traditionally, while subject knowledge and pedagogical knowledge have been key domain strengths of teachers, advanced information literacy skills are a primary domain strength of school library media specialists. In Model D: Integrated Curriculum, one of four collaboration models proposed by Montiel-Overall (2005), both teachers and school library media specialists share degrees of fluency in both domain areas thereby leading to stronger contributions from each to the collaboration and potentially resulting in a more positive outcome on student learning.

Teacher Planning

Teacher planning, also referred to as instructional planning, includes the decisions, activities, and processes that occur before the teacher goes into the classroom. It is also called the pre-active stage (Sardo-Brown, 1993). Teachers’ short- and long-term planning activities typically rely on several sources, including previous lessons, resource files, and ideas drawn from their colleague’s work (Sardo-Brown, 1990). Teacher planning has typically been influenced by the current curriculum and the materials and resources in the immediate vicinity (Clark and Yinger, 1979; Hedtke et al., 2001; McGee and Taylor, 2001; Sardo-Brown, 1993; Venn, 2002). Sources teachers consulted for planning purposes, pre-Internet, varied, but typically included unit notebooks or folders containing items such as lecture notes, handouts, audiovisual material, and tests from previous years (Clark and Yinger, 1979; Hedtke et al., 2001; McGee and Taylor, 2001; Sardo-Brown, 1993; Venn, 2002).

Pivotal Role of New Resources and Sources of Information

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; Turner, 2003). In describing the attributes of successful teachers, Turner (2003) describes the abilities of these teachers to gather content for their courses from multiple sources. However, 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).

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” (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 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. It is not feasible for teachers to spend large amounts of time searching for resources online and, in fact, five in ten teachers say that it is hard to find Web sites to meet their classroom needs (Recker et al., 2004; Trotter, 1999, VanFossen, 2001). The challenge in finding online resources for highly specific topics arises when teachers are searching for curricular materials (Fitzgerald, 2001; Khoo, 2006; Recker et al., 2004; Robertson, 1999; VanFossen, 2001). It is not realistic to assume a quick search in Google will always locate educational, age-appropriate, and credible resources.

Need for Information Literacy Skills

K-12 Teachers and Information Challenges

If educators are to find the teaching and learning materials they need from the vast and often unorganized collection of resources on the Internet, they must possess a mastery of online information literacy skills. Information literacy skills involve the ability to access, evaluate, and use information from multiple sources and are essential skills for teachers to develop to find resources and materials to support the inquiry and project-based learning called for in the science reform efforts (Callison and Lamb, 2006; Callison and Tilly, 2006; Carr, 1998; Doyle, 1998; Bruce, 2002; Roberts and Foehr, 2002). Teachers who refine these skills through ongoing training and use maximize the potential of the teaching and learning resources available online. Importantly, they are then better positioned to serve as models for their students in a world where the premium on information and the ability to find and use it continues to grow.

Teachers' Web Searching Behaviors

Numerous studies in the past decade looked at the information seeking behaviors of specific groups, such as professionals (e.g., Bates, 2001; Choo, Detlor, and Turnball, 2000; Hargittai, 2002) and youth and children (e.g., Bilal, 1999; Chelton, 2004; Cool, 2004; Enochsson, 2005; Gunn and Hepburn, 2003; Kuhlthau, 1993; Leander and Johnson, 2002; Neuman, 1995). And as noted previously, there is a rich body of research examining teachers' use of technology. However, there are currently a limited number of studies that specifically address teachers' Web searching behaviors (Recker et al., 2004). Of three studies of note (Karchmer, 2001; Khoo, 2006; Recker et al., 2004), one examined the Internet's influence on literacy and literacy instruction in K-12 classrooms (Karchmer, 2001). In a second study, part of an evaluation project (Khoo, 2006) by the National Science Digital Library (NSDL) project, teachers rated the impact of their use of NSDL on their educational and research practices. A third study involved a case study of eight middle and high school science teachers. Recker et al. (2004) examined how these teachers use and find online resources. 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, 125)

Recker et al. examined the teacher's perspective of how the innovation (online information seeking practices) influenced a key area of their professional practice, instructional planning. 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 school library media specialists and teachers; and (2) help to avoid pouring more money into technology that will not be used because it does not meet teachers' needs and we did not stop to first find out what their needs are and how it will affect them. The Recker et al. study is one of a very few to examine 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. (2004) acknowledged this by calling for further study to "better understand the impact and adoption of emerging digital learning technologies and tools in educational contexts" (123). 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 Questions

This study addressed the question: "What online information seeking practices 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. The online information seeking practices of teachers was treated as the innovation, not the technology itself. The Diffusion of Innovation theory (Rogers, 2003) has been used extensively to study the adoption and spread of technological innovations in schools. Although the collective data show evidence of a higher skill level with technology leading to more use of it by teachers, the studies often stop short of exploring the online seeking skills of teachers and the subsequent impact on teaching and learning (Becker et al., 1999). Instead, the research on the spread of technology into schools during the past fifteen years tended to focus on the who, what,

and when aspects of use. Diffusion of Innovations research has examined factors such as the rate of adoption, characteristics of the different adopters (e.g., early adopters, laggards, etc.), and through what channels and social networks the innovation spread (Rogers 2003). An understudied area of research is the influence of these innovations on teachers, their instructional planning practices, and on the systems and structures within the school and district (Recker et al., 2004; Rogers 2003).

Consequences of Innovations

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). Although understanding the consequences of the innovation on individuals and the social system is considered valuable, it is nonetheless a relatively understudied area of diffusion research (Rogers 2003).

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 (442). This taxonomy informed the survey design as well as the choice of independent variables and data analysis methods. Direct consequences are “the changes to an individual or a social system that occur in immediate response to adoption of an innovation. Indirect consequences are the changes to an individual or a social system that occur as a result of the direct consequences of an innovation. These are the consequences of consequences” (445-46). Every innovation results in a consequence which impacts the overall system, including the teacher, the students, the classroom, and the school. By using this theoretical framework and particularly the classification dimensions put forth by Rogers (2003) to study the consequences, we can start to understand the influence of teachers’ online information seeking skills, not only on their own practice, but also on the systems of which they are a part.

Research Method

The research question that framed this study was: What online information seeking practices are biology teachers engaged in and how do they perceive the influence of these practices on their instructional planning? This exploratory study employed a combination of interview and survey methods. Quantitative methods applied through the survey allowed for data that filled in the details of the specific practices and captured perceptions of the influence on their instructional planning. Qualitative methods carried out in the interview offered a chance for a concentrated discussion around this topic. Using both methodologies created a data corpus that offered both breadth and depth

There were two phases of data collection in this study.

Phase I--Online Survey

Phase I was an online survey of seventy-two New York State biology teachers. 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. Seventy respondents indicated

use, while two respondents indicated nonuse. Both nonuse respondents indicated No Need for any of the online tools, one of them also noted Lack of Time.

Of the seventy biology teachers who reported using the Internet during summer or fall 2004 for instructional planning purposes, there were:

- forty females and thirty males
- twenty-one (30 percent) from urban districts, fourteen (20 percent) from rural, and thirty-five (50 percent) from suburban

Teachers reported number years of experience ranged from:

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

One teacher did not report years of experience.

More than half of the survey respondents had eleven or more years of teaching experience and almost 30 percent had more than twenty years, making this group fairly experienced.

The survey was intended to capture a snapshot of the biology teachers' online information seeking practices during summer and fall 2004 and their perceptions regarding how their online practices influenced their instructional planning. The survey method was descriptive, essential to capture the yet unexplored perceptions of this group of biology teachers and a convenience sampling process was used to select participants. The online survey was constructed using Perseus software. Issues of authenticity, security, and confidentiality were addressed in part by password protecting the site. The target population was New York State biology teachers and all New York State biology teachers were eligible to participate in the survey. Online resource use was of particular interest and recruitment letters via e-mails and electronic discussion lists. Findings therefore reflect use by teachers who have at least a passing proficiency with the Internet. Survey participants were recruited through direct e-mails and via electronic discussion lists provided for biology teachers. Postcards were mailed as a follow-up to every potential survey participant contacted via e-mail.

The survey queried New York State biology teachers about their online information seeking practices and their perceptions about how it influenced their planning during summer or fall 2004. Descriptive statistics were used to analyze the data collected in the study. Tabular, graphical, and numerical methods were used to summarize the data.

A sample survey question addressing perception of influence can be found in table 1. The data collected from these questions provided not only descriptive statistics, but also helped to uncover along with data from the interviews, evidence of the three dimensions of consequences (direct/indirect; desirable/undesirable; anticipated/unanticipated) offered by Rogers (2003) as a tool for classification and analysis. Table 2 offers an example of a question intended to capture the possible indirect effects of teachers' finding and using online resources.

Table 1. To what degree do you feel your daily lessons during the fall 2004 were influenced by information or resources you obtained from the following online tools:

	Not at all	Very Little	Moderately	Significantly	Greatly
Search Engines					
Specific Web sites					
Digital Libraries					
Online Databases					
Electronic Discussion Lists					
Print Resources					

Table 2. During the summer or fall of 2004, how often did you forward on information or resources to your colleagues that you found from the following online resources:

	Never	Rarely	Sometimes	Often	Always
Search Engines					
Specific Web sites					
Digital Libraries					
Online Databases					
Electronic Discussion Lists					

Phase II--Interview Method

For the interviews in phase II, a purposive sample of biology teachers who taught in the area was used. A purposive sample is generally considered to be a non-representative subset of some larger population, and it is constructed to serve a very specific research need or purpose. However, this sampling approach served the study's purpose because of the specific focus on the online information seeking practices of New York State biology teachers. This group all used online resources to varying degrees thus probably making them nonrepresentative of the biology

teacher population as a whole. They did represent though a cross-sectional group of biology teachers in terms of demographics and use of online resources as evidenced below.

Interview recruitment e-mails were sent directly to forty New York State biology teachers in the upstate New York area to obtain the ten participants:

- seven females and three males
- 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.

The ten in-depth interviews played an important role in this exploratory study; they offered the opportunity to talk at length with the biology teachers and to probe their thinking about connections between their information seeking practices and their instructional planning. The semistructured interviews went beyond the baseline data collected in the survey and resulted in conversations that reflected richness in detail, complexity of self-reflection, and a large body of data for analysis. Interviews offered a means to probe and clarify survey responses. The interviews extended the findings of the survey and explored in more detail the interrelated dimensions of the innovation's consequences. As defined previously in this paper, consequences are the "changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation" (Rogers, 2003, 470).

Interviews were audiotaped, transcribed, and then coded and analyzed using established qualitative research method. Additionally, field notes were recorded after each interview and also analyzed. Transcripts were coded using open coding procedures. Codes were developed and used in accordance with established guidelines (Creswell, 2005) and continuous refinement and revision of the codes occurred.

The emergent concepts were next considered with regard to the dimensions offered in the Consequences of Innovation (Rogers, 2003) framework. Rogers (2003) proposed these dimensions as a taxonomy to assist in classification of the consequences of an innovation: "(1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated" (470). The dimensions were used as a framework in analysis of the data corpus to assist in classifying and understanding the complex nature of an innovation's effects on both the individuals and the systems in which they participated.

Interview questions included:

- How did you use the information/resources you found in your instructional planning? (Direct/Indirect, Desirable/Undesirable)
- Did your use differ from how you thought you would use it? (Anticipated/Unanticipated)
- How did you feel about the results? (Desirable/Undesirable; Anticipated/Unanticipated)

Findings

Limitations

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 lists so they didn't receive the recruitment e-mail 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 (seventy-two survey respondents and ten 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.

Findings

Finding from this study show evidence that teachers are using a greater number and wider range of current and multimodal resources than pre-Internet and they perceive this as an advantage in creating authentic, inquiry-based learning experiences. However, the study findings also highlight:

- underuse by teachers of educational online resources specifically designed to support teaching and learning activities (e.g., digital libraries, online periodical databases, and electronic discussion lists);
- emergence of four key themes from the data: Currency of Information, Sparking of Ideas and Gaining Knowledge, Resource Management and Time, and Webs of Sharing;
- evidence of 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; and
- key areas for synergistic, collaborative exchanges with school library media specialists.

Study findings are detailed below in the following sections: Overview of Resources Used in Planning; Perceptions of Proficiency; Perception of Value; Influence on Instructional Planning: Daily Lessons and Unit Plans; Search Strategies--Finding What They Need or Not; and Reasons for Nonuse of Specific Online Tools

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 Web sites, digital libraries, online databases, and electronic discussion lists). 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 3 summarizes replies of the seventy respondents who reported using the Internet for instructional planning. Ninety-nine percent of the respondents reported using search engines, and 89 percent of them reported use of specific Web sites. In contrast, only 20 percent of respondents reported using digital libraries and 24 percent of respondents indicated use of online databases. Fifty percent of teachers reported using electronic discussion lists, while 50 percent 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 (SLMS) and teachers.

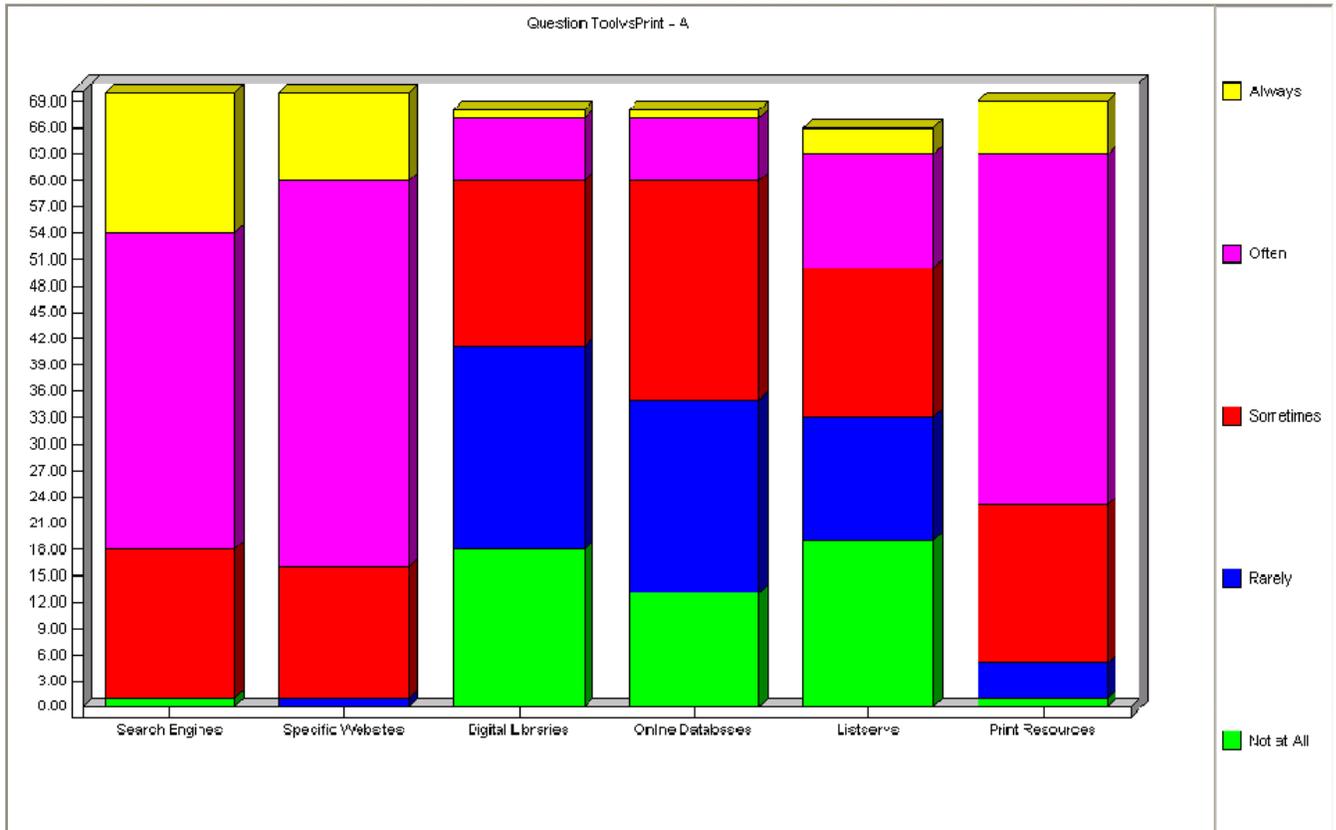
Table 3: Tool Use for Instructional Planning Purposes

	Specific Search Engines		Specific Web Sites		Digital Libraries		Online Databases		Electronic Discussion Lists	
	No.	%	No.	%	No.	%	No.	%	No.	%
Yes	69	99	62	89	14	20	17	24	35	50
No	1	1	8	11	56	80	53	76	35	50

Figure 1 summarizes teachers' answers to the question of how often they used the information or materials obtained from the five online tools for instructional planning during the summer or fall of 2004. Survey respondents reported Sometimes/Often/Always using the information and resources found via Search Engines (99 percent, n=70), Specific Websites (99 percent, N=70), and Print Resources (91 percent, n=69). However, in contrast, a higher percentage of teachers reported Never or Rarely using resources located through searches in Digital Libraries (60 percent, n=68), Online Databases (51 percent, n=68), or electronic discussion lists (50 percent, n=66). It should be noted that the number of teachers who reported use of these three online tools is fairly low (as reflected in the finding reported in the previous table), and so it is therefore possible that those teachers who cited Never or Rarely finding what they needed via the tools for this question, do not in fact use the tools. These findings raise several questions for future study: (1) Is the lower rate of use for some of these online tools due to teachers being dissatisfied with the quality of their search results or because of poor search skills by the teachers? (2) In what ways could online resources better meet the needs of teachers? Again, these findings may be of interest to school library media specialists seeking out not only potential zones of intervention (Kuhlthau, 1994), but also viable points of collaboration. In a possible collaborative scenario both groups of educators bring to the table their respective domain strengths to work on specific teaching and learning activities. In the course of a fluid and dynamic collaboration they form a mutual constitutive relationship where their synergistic exchange of ideas, skills, and dispositions addresses successfully not only the challenge at hand, but enables the respective educators to foster new knowledge and skills from the collaboration.

Figure 1. Frequency of Use of Information or Materials Obtained Online

Q: When you did instructional planning during the summer or fall of 2004 how often did you use the information or materials you obtained from [choice of online tools]:

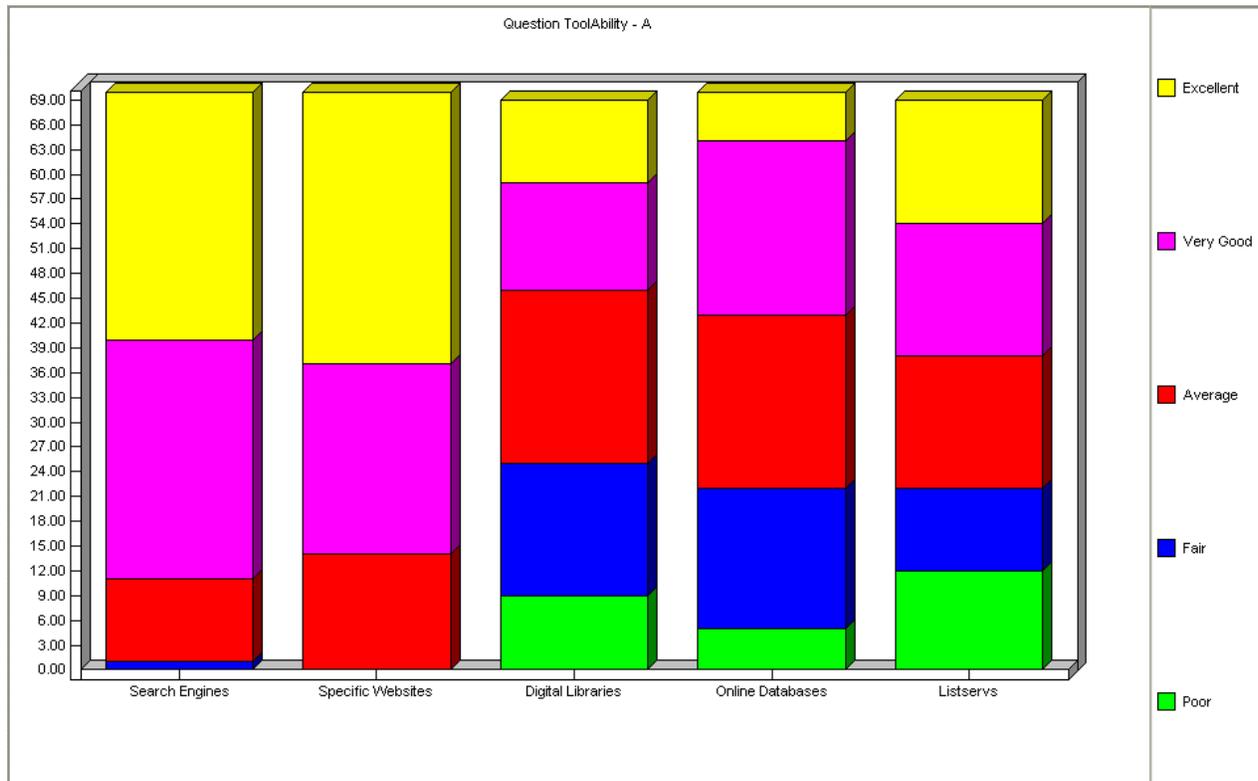


Perceptions of Proficiency

Overall, teachers perceived themselves as possessing an Average to Excellent proficiency level with online tools to find information or resources for their instructional planning (see figure 2 for complete results). Teachers reported a strong proficiency with search engines with 86 percent (n=70) of respondents indicating they possessed a Very Good to Excellent skill level. 80 percent (n=70) of teachers reported a Very Good to Excellent proficiency with the use of Web sites 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.

Figure 2. Perceptions of Tool Proficiency

Q: How would you describe your current proficiency in using the following online tools to find information or resources:



Teachers rated their proficiency with regard to electronic discussion lists and online databases less highly. 32 percent (n=69) of teachers reported a Poor to Fair ability to use electronic discussion lists for instructional planning purposes and slightly more than 50 percent (n=70) of respondents reported a Fair to Average ability to use online databases. Although in a previous question, 80 percent (n=70) of respondents reported not using digital libraries, more than 50 percent (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 practices engaged in by teachers impacted their access to different instructional planning components. Table 4 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). These findings reflect the range of instructional planning components for which biology teachers are using online tools. Although findings show the number of reported users for the different online tools varies from a high of sixty-nine to a low of fourteen, these figures support the point that teachers

are actively engaging in online information seeking for multiple purposes related to planning. It is noteworthy that more teachers report using electronic discussion lists (thirty-five), than either digital libraries (fourteen), or online databases (seventeen), yet the users of digital libraries and online databases indicated broader application of tools related to the various planning components to find information and resources.

Table 4. 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 (%)	Web Ideas (%)
Search Engines	69	81*	90	75	48	86	75
Specific Web sites	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
Electronic Discussion Lists	35	74	40	69	26	66	11

* Percentages are of total number that responded

Following is a discussion of a follow-up question that asked teachers about the value they place on these tools to help them in their search for information and resources for instructional planning.

Perception of Value

After being asked to consider how their use of online tools related to the specific instructional components, survey participants then rated the value they placed on the tools to help them find information and resources for the instructional components. Figure 3 offers an example of respondents' responses to perceived value with respect to search engines, the most commonly used online tool by survey respondents.

Figure 3. Perceived Value of Search Engines for Instructional Planning Purposes

Q: During the summer or fall of 2004, how would you rate the value of using search engines to find information and resources for the following planning components:

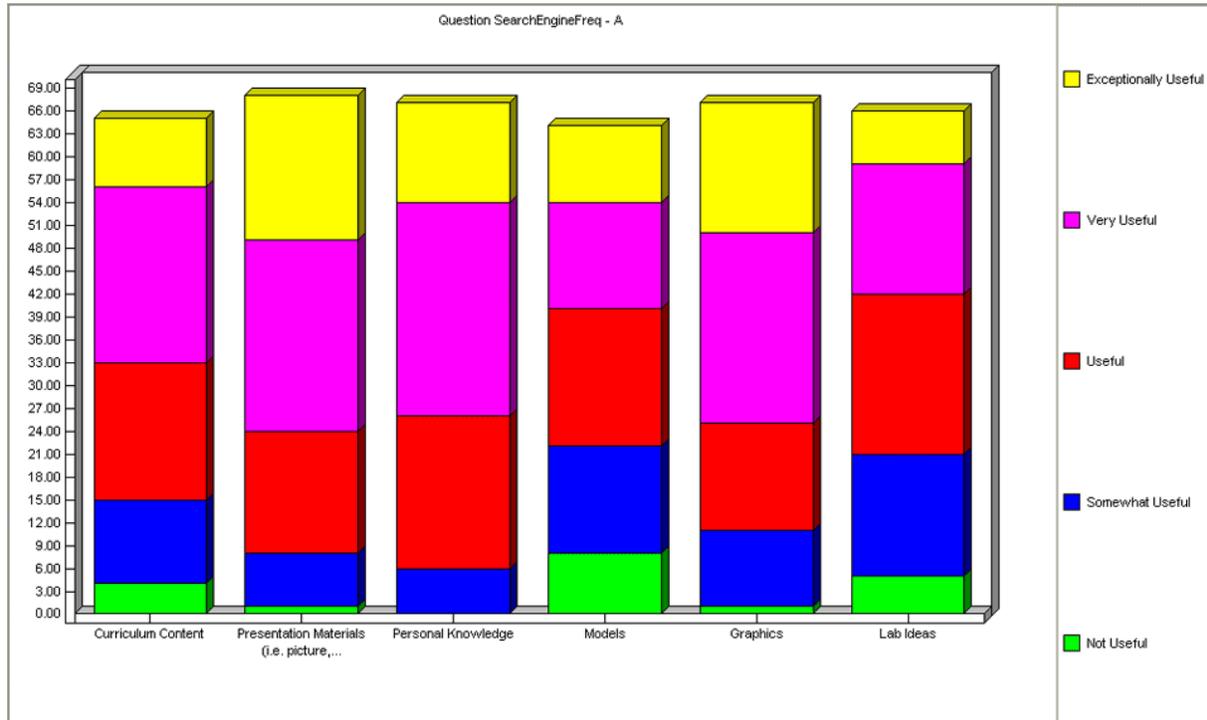


Table 5 shows the percentage of survey respondents who rated search engines either Very Useful or Exceptionally Useful across the six instructional component categories (e.g., Curriculum Content, Presentation Materials, Personal Knowledge Models, Graphics, and Lab Ideas). Almost half of the respondents (46 percent, n=69) cite the value they put on search engines to find curriculum content as Very Useful or Exceptionally Useful. Similarly, 52 percent (n=69) of teachers put a value of Very Useful or Exceptionally Useful on using Web sites to find information or resources that increased their personal knowledge.

Table 5. Perceived Value Rating of Either Very Useful or Exceptionally Useful as Assigned to Instructional Components by Respondents

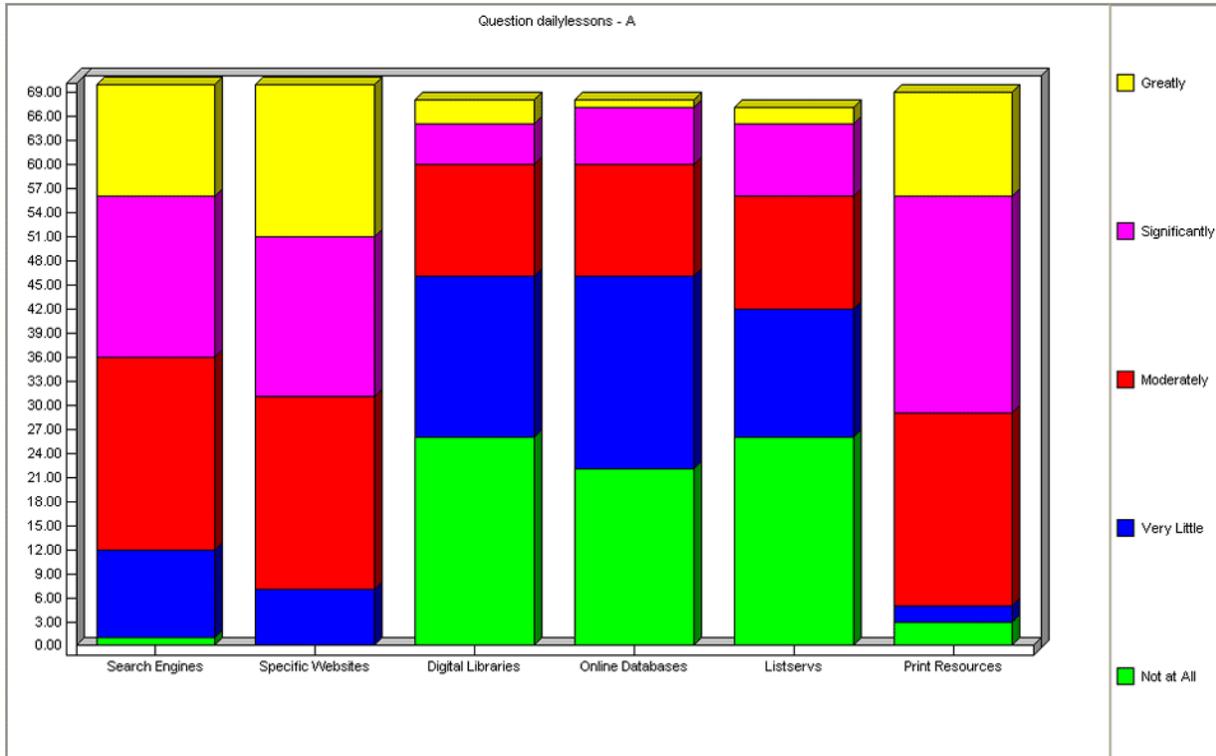
	Curriculum Content (%)	Presentation Materials (%)	Personal Knowledge (%)	Models (%)	Graphics (%)	Web Ideas (%)
Search Engines(n=65)	49 (n=65)	65 (n=68)	61 (n=67)	16 (n=64)	63 (n=67)	24 (n=66)

Influence on Instructional Planning: Daily Lessons and Unit Plans

Teachers were asked to what degree they felt that their daily lesson and unit plans were influenced by information or resources obtained from the five different online sources considered in this study. Results are found in figure 4.

Figure 4. Perceived Influence on Teachers’ Daily Lessons

Q: To what degree do you feel your daily lessons during the fall 2004 were influenced by information or resources you obtained from [instructional planning components]:



Respondents reported a Significant to Great influence on daily lessons resulting from use of:

- search engines: 49 percent (n=70)
- online databases: 12 percent (n=68)
- specific Web sites: 56 percent (n=70)
- electronic discussion lists: 16 percent (n=67)
- digital libraries: 2 percent (n=68)
- print resources: 58 percent (n=69)

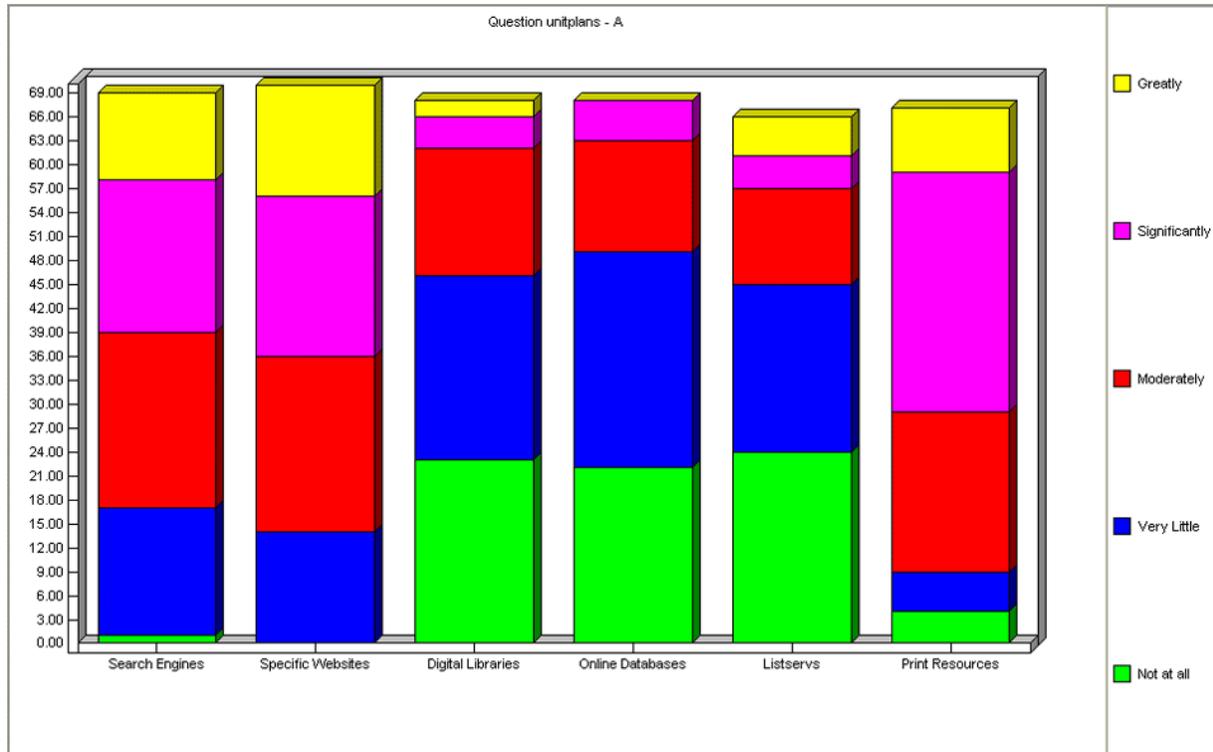
Results showing that respondents rate the influence of using online tools for daily planning as Significantly or Greatly represent notable findings for this study. It presents concrete evidence of the shift in planning practices due to the Internet. The lower influence figures for digital libraries, online databases, and electronic discussion lists perhaps reflect in part, their relatively low use

numbers. Interesting, a number of interview participants specifically mentioned how their use of print resources has decreased and it is no longer always the first source to which they turn.

After rating influence on lesson plans, respondents were asked to rate the influence of the online tools to their unit plans. Results are shown in figure 5.

Figure 5. Perceived Influence on Teachers’ Unit Plans

Q: To what degree do you feel your unit plans during the fall 2004 were influenced by information or resources you obtained from [instructional planning components]:



Respondents reported a Significant to Great influence on unit plans resulting from use of:

- search engines: 43 percent (n=69)
- online databases: 7 percent (n=68)
- specific Web sites: 49 percent (n=70)
- electronic discussion lists: 14 percent (n=66)
- digital libraries: 9 percent (n=68)
- print resources: 57 percent (n=67)

Across the board, for each tool, respondents chose the rating of Significant to Greatly less often than in the lesson plan question. It is worth pointing out that 68 percent of respondents (n=68) indicated no influence or very little influence on unit plans from their use of digital libraries. 72 percent (n=68) of respondents also reported very little to no influence on planning from online databases.

Findings from this study's survey and interviews reflect a pattern whereby the numbers for use of online tools, and the perceived degree of influence with regard to daily lessons and unit plans, measured higher for search engines and specific Web sites versus the lesser used digital libraries, online databases, and electronic discussion lists.

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 they 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. When one teacher, who had between five and ten years of experience and taught in a rural district, was asked to what degree did she feel that the online tools impacted her daily lessons or unit plans, she was quite emphatic in her answer. She replied:

DM: It impacts my daily life (laugh). Significantly! Lately, I would say more. Today, that's where I start with everything with my instructional planning. For everything! (laugh).

A second veteran suburban teacher echoed this point and replied "Greatly" when asked about influence on instructional planning. Teachers plan in a variety of ways and their planning styles can influence, and be influenced, by their Internet use. This point is reflected in BD's comments below when she describes how she plans heavily in advance to meet her students' various approaches to learning.

BD: The method [for planning] I use effects the influence [of her online information seeking practices] heavily because the way that I plan my classes' activities might be a little different than many other teachers. I do a lot of planning upfront; very heavy planning upfront so that I take in to account the very wide diversity of abilities that I have in my classes. From people who are really able to do entry level university work to people that read at a fourth-fifth-grade level and they are all in the same class. I have to be very clear myself on what is the absolute minimum standard that is necessary for my students to learn within the curriculum and to do well on the exam at the same time I don't want the people who are more capable to be short changed. I do want them to be challenged. I do a lot of planning in advance on how I am going to set up my units.

Throughout the interview BD elaborated that the Internet offers her access to key resources that support the instructional planning she believes is crucial to her students' learning and success.

Several teachers mentioned the advantages of using the Internet to plan for new courses. In the excerpt to come, JC, 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 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 specific examples JC described how she goes online to get background information. She states:

If I have to teach something and I don't really get it. It will give me the background and actually with the electronic discussion lists 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 help from colleagues, both known and unknown that JC describes, exemplifies one of the emergent themes from the data analysis: Webs of Sharing.

LC, also a suburban teacher, spoke about how he revamped a nutrition project due to a website he found through his online information seeking activities. He described a nutrition lab, which traditionally took multiple class periods over several days, that was transformed into a one-day project that freed up time for other teaching and learning projects without sacrificing learning objectives. He states:

Like this period we just did a nutrition project which is an interesting site because it's more interactive. You input your diet and voila. You put all the food you eat for a day and it spits out everything you need, it's unbelievable... Well, while we were using books... it doesn't work because you can't have 30 copies of these [the books] and plus how long is going to take to figure out what they have eaten all day and find it in here. It's insane. It's the way we used to do it though... one day I said, "ya know I am getting tired of that and I said the Internet is pretty cool." So I probably just did a search for nutrition analysis, or something like that. and I probably went through a couple Web sites and I found this one. And I was like "oh my gosh." Now this is a lab that we do.

LC was asked how going from a multiday project to a one or two-hour session impacted the overall unit in terms of instructional planning and how he has used the time he gained. He replied:

Well, I mean it's a timesaver. I would be thinking about this over multiple days, it would be taking time from multiple class periods. It's required different resources obviously which we didn't necessarily have, we were very limited with the resources we could, you know you use what you've got. Whereas now with the Internet, I can probably find five sites like that and then pick some of the best ones. So I mean, if it makes it better, if an activity learning the activity saves time, I mean it makes everybody's life easier.

He shared that with the added time "in terms of teaching other stuff... now I am reinforcing something more or I am introducing more information than I could otherwise." The role of time, along with resource management, was a third theme emerging from this study's findings and will also be addressed in later section.

Another teacher, NL, spoke of turning to the Internet when he wanted to create unit guides with key ideas and vocabulary for every unit he taught. He ended up using both a book and the Internet to create what he had in mind. He recounts:

Well, I already had a list of key ideas that I have typed out and I got those, I looked around on the Internet to see if anybody had done that before and I couldn't find one that I liked, so I found the book and I came up with key ideas from there and I changed them to fit my students so that they understand them. But for the vocabulary words I actually went on and I went to a webpage that I know is actually from another school district, where another teacher has taken a bunch of links and one of those links was the vocabulary words broken down into different sections.

The biology teachers interviewed frequently spoke of using the Internet to get ideas. JC stated: "I use it to get to try to get more creative ideas, especially for labs. Is there an easier way to do a lab? If there's a better way to demonstrate a concept, it's usually an activity of some kind." The theme of information seeking practices sparking ideas emerged from the data analysis.

Search Strategies

Finding What They Need or Not?

When asked: "How often when using online tools during the summer or fall of 2004 for instructional planning did you find exactly or very close to what you were looking for?" teachers reported success with their use of search engines and Web sites. 80 percent (n=70) of survey respondents indicated they Often or Always found what they looked for when using search engines. 79 percent (n=70) of teachers reported a success rate of Often or Always when using Web sites. However, such success is not reflected in the teachers' responses for the online tools they used less often.

For example:

- 43 percent of teachers report Never or Rarely finding exactly or very close to what they were looking for when using digital libraries;
- 44 percent of teachers report Never or Rarely finding exactly or very close to what they were looking for when online databases; and
- 50 percent of teachers report Never or Rarely finding exactly or very close to what they were looking for when using electronic discussion lists.

Frustration with not being able to find what they are looking for may be contributing to the relatively low usage of digital libraries, online databases, and electronic discussion lists, as compared to use of search engines and Web sites. Compounding the problem, teachers' infrequent use could result in slower refinement of their information seeking skills than if they regularly used the Internet. Other possibilities for them not meeting with search success include: (1) the resources (i.e., digital libraries) may be poorly designed and this hinders searching, or (2) teachers need further refinement of their information literacy skills.

Some notable discrepancies arose when comparing teachers' self-reported proficiency with their reported frequency of finding exactly or very close to what they were looking for.

Below are several examples:

- 43 percent (n=66) of teachers report Never or Rarely finding exactly or very close to what they were looking for when using digital libraries, yet 64 percent (n=69) of the same group of teachers rate their proficiency with digital libraries as either, Average (30 percent), Very Good (19 percent), or Excellent (14 percent);
- 44 percent (n=66) of teachers report Never or Rarely finding exactly or very close to what they were looking for when using online databases; but 69 percent (n=70) describe their proficiency with online databases as either Average (30 percent), Very Good (30 percent), or Excellent (9 percent);
- 50 percent (n= 66) of teachers report Never or Rarely finding exactly or very close to what they were looking for when using electronic discussion lists, yet in terms of proficiency with electronic discussion lists, 68 percent (n=69) of teachers rated their skills at either Average (23 percent), Very Good (23 percent), or Excellent (22 percent).

These findings show a pattern of teachers rating their search proficiency highly, yet reporting low success rate in the search process. This discrepancy should be addressed in future research and also taken into consideration when developing professional development.

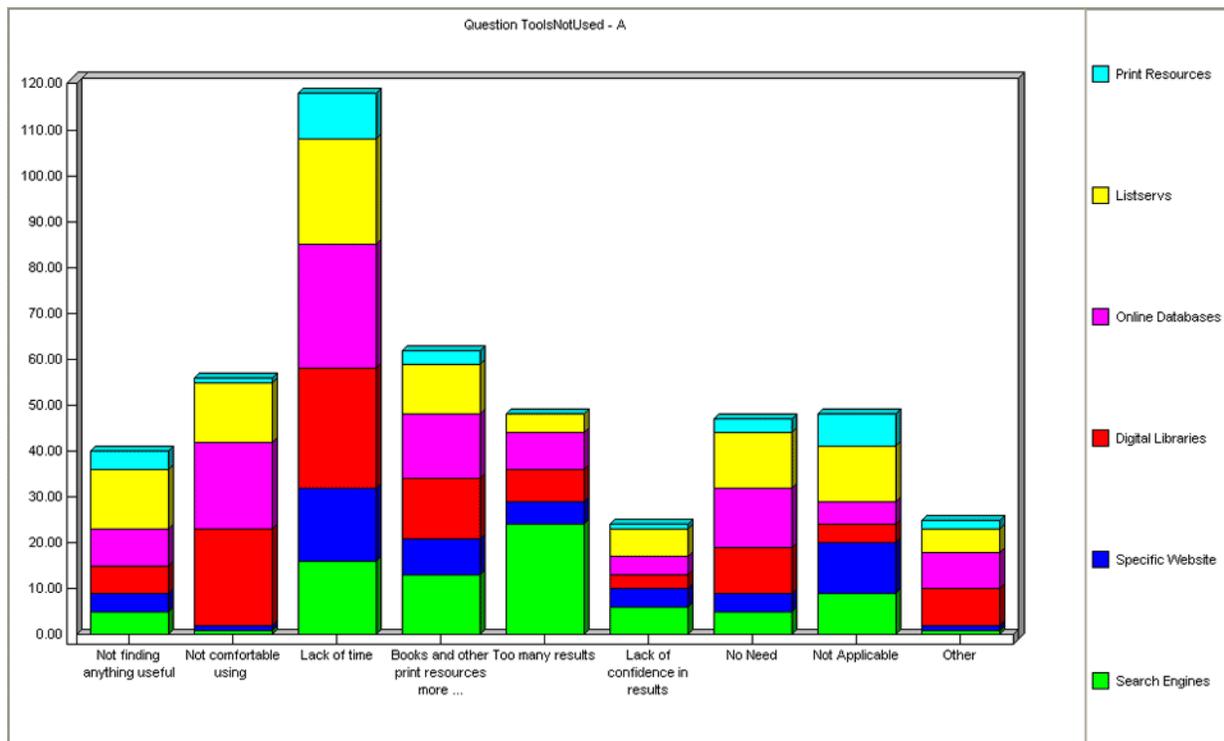
Although findings like this study's inform the work of online resource developers, the researcher intends, first, to use the baseline data collected from the surveys, along with the findings gleaned from the interviews, to inform professional development of in-service and pre-service teachers in the area of information literacy skills.

Reasons for Nonuse of Specific Online Tools

A follow-up question asked the survey respondents what caused them not to use search engines, Web sites, digital libraries online databases, electronic discussion lists, or print resources for planning during the summer or fall of 2004. They could select multiple responses or write in a reason. Results are in figure 6.

Figure 6. Reasons for Nonuse of Tools

Q: What caused you not to use the following tools more frequently for instructional planning during the summer or fall of 2004 (choose all that apply)



Survey respondents (n=70) cited Lack of Time as the primary reason for nonuse of Web sites (23 percent), Digital Libraries (37 percent), Online Databases (39 percent), electronic discussion lists (33 percent), and Print Resources (14 percent). Respondents (34 percent) indicated Too Many Results as the primary reason for not using search engines. Coming in as the second most frequently cited reason for not using any of the listed online tools was the choice: Books and Other Print Resources More Effective.

The reason of Not Comfortable Using was cited for digital libraries, online databases, and electronic discussion lists by more than a quarter of the respondents. It is a notable finding that a relatively high number of teachers report not being comfortable with key resources developed with the intent to support their teaching and learning activities. Results show that:

- 30 percent of respondents indicated Not Comfortable Using as a reason for their nonuse of digital libraries;
- 27 percent of respondents selected Not Comfortable Using as a reason for their nonuse of online databases; and
- 27 percent of respondents selected Not Comfortable Using as a reason for their nonuse of electronic discussion lists.

Responses by interview participants about reasons for nonuse closely mirrored the survey responses, with concerns about time, and comfort level using the resource most often mentioned. For example, HCE, when asked about using online tools in her planning replied it she “was somewhat comfortable and somewhat hesitant.” NL stated:

I think that that’s something I am not proficient with [electronic discussion lists]; something I don’t have a lot of experience with. If I find an on-line database, I will see what’s there and I will try to skim through it but sometimes it’s they themselves that are not very user friendly

As evidenced from the survey and interview findings cited above, the reasons for nonuse of tools ranged from lack of time, to not finding anything useful, to not comfortable using, and to feeling no need to use the Internet for instructional planning. Certainly, one might argue that due to the vast and uncontrolled nature of the Internet, both skilled searchers and novices experience these feelings. However, because a number of digital libraries and online databases contain resources selected, evaluated, and organized specifically to meet educators’ teaching and learning needs, these non-use figures and their causes represent key findings. Digital libraries offer perhaps the most targeted educational resource for teachers and, at this point, are vastly underutilized resources (Fitzgerald, 2001). If indeed, as this study shows, teachers’ lack of time is a strong influence for nonuse of resources, it begs the question as to why almost half of the teachers don’t use resources intended to save them time. Future research could measure what effect professional development has on these findings. Several teachers in the survey wrote-in additional reasons for not using online tools and their reasons appear to point to a gap in skill development, particularly in terms of digital library use.

Discussion

This study’s findings show evidence that teachers’ information seeking practices do, indeed, impact their instructional planning in a variety of ways; and whether the influence is construed as a positive or negative depends on where the teacher is in the planning process. This study’s findings also 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 beginning the cycle again.

Four themes that reflect the consequences of teachers’ information seeking practices emerged from the findings: Currency of Information; Sparking of Ideas and Gaining Personal Knowledge; Resource Management and the Role of Time; and Webs of Sharing. Each theme encompasses both the purposeful and the indirect actions by teachers to access knowledge and resources to refine and improve their instructional planning. This study’s findings show that teachers are using a greater number and wider range of current and multimodal resources than pre-Internet and they perceive this benefit as an advantage in creating authentic, inquiry-based learning experiences.

This study’s research also makes clear the number of instructional planning components (e.g., curriculum content, presentation materials personal knowledge, individualized learning materials, labs, and the like) for which teachers are seeking out online information and resources,

evidence of the steps these teachers as professionals will go to meet students' diverse learning needs, particularly if provided the opportunity and means to do so.

Several additional findings in this study point to how online resources appear to change teachers' instructional planning process. They include:

- use by teachers of a wider variety of resources than pre-Internet, and development of new skills to manage them;
- access to a broader selection of multimodal resources and current information are leading to more dynamic learning activities;
- teachers are taking more steps, and delving deeper via online sources, to find answers to students' questions; and
- lesson plans are changing more frequently with less emphasis on lectures.

There is not yet enough evidence at this point to definitely make the claim that these are trends, yet the findings suggest they are part of a shift in teachers' planning, and further research is needed. This exploratory study is intended as a first step in a long-term research project focusing on teachers' information literacy skills. The study extends recent research that examined "how teacher access, select and use information and communication technologies for use in their professional practice" and answers the call for a deeper understanding of online information behaviors and their consequences (Recker et al., 2004, 1).

Finally, results of this study show troubling evidence that the majority of study participants are limiting their information seeking primarily within search engines and Web sites and not taking full advantage of educational-related digital libraries, online databases, and electronic discussion lists designed to support their specific teaching and learning needs. This is a tangible concern given that these three under-utilized online tools include contain resources selected, evaluated, and organized specifically to meet educators' teaching and learning needs. However, what is encouraging are the study's results, from both the interviews and the survey, which show that regardless of experience level as a teacher or Internet user, the majority of study participants expressed an interest in refining their skills.

Collaboration

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 these skills through ongoing training and use maximize the potential of the teaching and learning resources available online (Williams et al., 2004).

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. The Internet, with its seemingly endless array of educational resources, potentially exacerbates the situation. This situation offers not only a “zone of intervention” (Kuhlthau 1994), but a potential intersection of collaboration for teachers and school library media specialists. The conclusions and finding from this study clearly present a wide-ranging spectrum of potential collaborative opportunities between school library media specialists and biology teachers. There are numerous strategies and models to help foster meaningful and successful collaboration. Flexibility and leadership on the part of the library media specialist can enhance the chances for positive outcomes resulting from the collaboration (Wolcott, 1994). A shared sense of accountability and commitment to the instructional partnership also increases the potential positive influence of the relationship on student learning and achievement (Montiel-Overall, 2005).

Synergistic Collaborations

Both teachers and library media specialists have a professional responsibility to growth and refinement of key areas of knowledge, skills, and dispositions, particularly around changing curricula and pedagogical practices, technology, and advanced information literacy skills. Each group of educators brings specific professional domain strengths to the relationship that have the potential to contribute to, and shape, the collaboration in a mutually constitutive fashion. At the core of these efforts is a synergistic aspect where not only is the outcome of the collaboration marked by positive affects on student achievement, but also an enhancement of knowledge, skills, and dispositions of the two or more participants in the collaboration.

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 to positively influence their lifelong learning 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 might analyze what resources and information seeking skills teachers find most useful, and also track changes in teaching and learning in the classroom with the intent of sharing best practices. Direct observation of individual teachers and their planning process or examination of the ways in which teachers change their relationship with others, including school library media specialists through their information seeking practices could also be studied.
- If indeed, as this study shows, teachers’ lack of time is a strong influence for nonuse of resources, future research could measure what effect professional development or how a

synergistic model of collaboration with the school library media specialists has on these findings.

- Consideration and development of a synergistic collaboration exchange model 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.
- While this study focused on the impact on the teacher, there is much to be gained in future research by also considering the influence on the system in order to understand how to support long lasting positive changes in instructional planning. Searching for information via the Web becomes more complex each day and there are a variety of social, cognitive, economic, political, and physical influences that impact both the users and systems (Rice et al., 2001). Future research on teachers' and school library media specialists' information seeking practices should consider how the inter-play of these factors influences information seeking process and their collaborative relationships.
- Findings from this study can be used to refine online tools (e.g., search engines, Web sites, digital libraries, online databases, and electronic discussion lists) to closely meet educators' teaching and learning needs. Future study can trace the influence of these changes and foster a continuous cycle of improvement of online tools based on users' actual needs.
- Future research regarding teachers' practices with digital libraries is very important given this study's findings of under-utilization of this key education resource study participants.
- 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?

Finally, a research focus in the area of information literacy skills for both school library media specialists, teachers and preservice educators could yield useful data. Study findings of this nature can be used to add to the knowledge base of both teachers' and library media specialists' practices and create targeted and purposeful professional development in the area of information literacy skills.

Conclusion

With almost unbounded opportunities to access information and resources through the Internet, teachers are taking the steps to create the active, inquiry-based learning environments, called for in new science standards, where students have the opportunity to construct their own knowledge around science concepts. This study showed that teachers are thinking about instructional planning in new ways and modeling, through their planning and instructional activities, lifelong learning and information literacy practices. These findings confirm and extend findings of other recent studies in this area (Recker et al., 2005; NetDay, 2005, 2006). However, a finding in this study of concern is the significant underuse of educational online resources specifically designed to support teaching and learning activities (e.g., digital libraries, online periodical databases, and electronic discussion lists).

Underuse of resources by teachers may reflect a lack of the necessary online search skills they need to efficiently find, and effectively use, the online tools. Existing disparities among teachers' online information seeking skills will likely impact their abilities to take advantage of the medium, and in turn, impact how they serve as models and mentors to their students (Levin and Arafeh, 2002).

Steps must be made to support teachers' efforts to refine their information seeking practices, in order to empower them to find and use the best and most appropriate resources for their students' learning. Ongoing collaborations with school library media specialists offer a potentially valuable intersection point for this to occur (Montiel-Overall, 2005; Williams et al., 2004) and can potentially foster a synergistic type of relationship where both educators learn from each other, ultimately benefiting student learning.

It has been long been argued (Brevik, 1998; Carr, 1998; Doyle, 1994; Liesener, 1985) that teachers must be information literate if we expect students to be. Turner (2003) points out that: "school library media specialists are in the right place at the right time to play a significant role in the transformations of teachers as K-12 education is impacted" by the significant and rapid changes in information and communication technologies (232). Henri and Bonanno (1998) raise the concern that:

the very people [teachers] responsible for empowering students to become lifelong learners appear to not understand the information process, let alone information literacy, well enough to be truly effective learners themselves (8).

Mastery of advanced information literacy skills by biology teachers is imperative for them to be able to plan for and teach information age and tech-savvy students and foster meaningful inquiry-based learning environments.

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