Teaching Tip
An Investigation of Digital Literacy Needs of Students

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ABSTRACT

This paper describes the results of a survey of teaching faculty at a medium-sized university in the southeastern United States to determine core curriculum items that should be taught to ensure that graduates have the capabilities and skills to fully participate in the digital society. There was considerable agreement between the colleges regarding the importance of twenty aspects of digital literacy. Application skills continued to be viewed as very relevant. However, our findings also show the need for a greater focus on information literacy skills that go beyond the focus of the current one-credit-hour software applications course designed to achieve computer application literacy. A case can be made for additional topics to be included in the curriculum common to all students such as ethics, security and privacy, and how to validate the relevance and usefulness of data. The study also highlights the need for discipline-specific topics to be embedded in subject-knowledge courses.

Keywords: Curriculum design & development, Computer literacy, Information literacy, Introductory course, Web literacy

1.INTRODUCTION

The top five challenges in teaching and learning with technology include the development of 21st century information, digital, and visual literacies to ensure that students are equipped with the skills needed to succeed in college and future careers (Educause, n.d.). Digital literacy is considered "an essential requirement for life in a digital age" (Bawden, 2008, p. 30). Often used interchangeably with computer or information and communications technology (ICT) literacy, digital literacy or competence, however, is a broader concept and does not automatically follow from the ability to use ICT tools (Ala-Mutka, Punie, and Redecker, 2008). Gilster (1997) first defined digital literacy as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (p. 1). Since then, a plethora of often inconsistent definitions of digital literacy have emerged that range from the technical aspects of operating in digital environments to the cognitive and socio-emotional aspects of work in a computer environment (Eshet-Alkalai, 2004). Such ambiguity obviously poses challenges for the effective design of curricula and courses targeting digital literacy. Determining what specifically should be taught is further complicated by a host of other issues:

- Difficulties with clearly defining what a digital environment entails as rapidly changing technologies represent a moving target (Leu, 2002);
- Lack of a common inventory of digital literacy skills or outcomes expectations;
- Steady shift of introductory college level material to high-school curriculum (Yahya, 2010);
- Disconnect between what colleges expect students to know and what students (often erroneously) think they already know as students' self-efficacy ratings exceed their actual performance scores (Easton, Easton, and Addo, 2006; Morris, 2010);
- Claims that students who have been "born digital", i.e., only know a world that is digital (Palfrey and Gasser, 2008), are radically different and do not have to learn ICT but merely experience it (Nasah et al., 2010);
- Very wide range of computer proficiency and online skills among students depending on factors such as socio-economic background and personal innovativeness (Hargittai et al., 2010; Nasah et al., 2010; Smith and Caruso, 2010);
- Criticisms related to the exclusive use of or focus on products from one vendor, raising the issue of "propagandizing a specific vendor" or having higher education textbook publishers drive what the outcomes of a technology course should be (Hodge and Gable, 2010).

- Concerns about making content relevant to different academic disciplines.

Universities employ different methods to ensure computer literacy of their students including introductory and often required computer skills courses included in the general or liberal studies core (Van Lengen, 2004). In response to concerns about such a one-credit-hour course in software applications required of all students at a medium-sized university in the southeastern United States, a task force was formed in Spring 2010 to develop a better understanding of the digital literacy needs of students and determine core curriculum items that should be taught. Based on a survey conducted by the task force, we sought answers to three basic research questions:

Q1. What are faculty perceptions of *the importance of different aspects of digital literacy*?

Q2. What are the *commonalities and differences between the* colleges vis-à-vis the different aspects of digital literacy?
   a) What aspects of digital literacy need to be known by all students regardless of academic major or college affiliation?
   b) Are there significant differences in the digital literacy needs between the colleges?

Q3. What are the implications of the digital literacy needs as perceived by faculty for course curriculum and course development, specifically the need for or redesign of the current one-credit-hour applications course?

2. BACKGROUND AND MOTIVATION

The university described in this study is a medium-sized comprehensive, private university with an enrollment of approximately 6,200 students. Accredited by the Commission on Colleges of the Southern Association of Colleges and Schools (SACS), the university awards associate, baccalaureate, and master's degrees in 57 academic majors across four colleges: the College of Arts and Letters (CAL), the College of Business (COB), the College of Natural and Health Sciences (CNHS), and the College of Social Sciences, Mathematics, and Education (CSSME).

All undergraduate students are required to take a one-credit-hour course in software applications during their first year to ensure they possess the skills necessary to use the applications in subsequent classes thus enabling focus on the discipline goals of teaching. Students must attain an intermediate skill level in *Word*, *PowerPoint*, and *Excel*. An on-line software package, used by over 3,000 schools in the U.S., both trains and tests students on the software applications. Students can use it on campus or at home. A minimal amount of instructor-led training from Ph.D.-qualified faculty is provided. Lab instructors are MBA graduate assistants. Upon completion of the course, students must take a proctored exam in the lab by an assigned date to demonstrate their proficiencies. Students with sufficient knowledge can demonstrate proficiency by passing a waiver exam using standardized waiver exam software that is used by over 100 schools nationwide.

Both faculty and administrators questioned the need for and content of the current course. There were concerns that students entering college already possess the skills covered by the course, and that schools are moving away from teaching this type of course. A study conducted by a university committee benchmarked the core curriculum against 73 peer institutions and found that only 15% had a specific computer course required of all students as a part of their core curriculum. This is in line with other colleges and universities nationwide who eliminated introductory computer course requirements in favor of moving to a required computer proficiency exam (Morris, 2010).

In addition, some faculty and administrators felt the course should cover topics beyond those described in the previous section to make it more relevant to today's technology environment and/or address the needs in academic disciplines that are currently not met. Hodge and Gable (2010) for example described the revision of an introductory IS course which resulted in expanded course content and new topics such as social networking, cyber-bullying, e-safety, consumerism, digital addiction, and care and maintenance of computers systems. In response to these concerns, a digital literacy task force comprised of representatives from each college and the library was formed to develop an understanding of digital literacy and needed competencies and skills that are aligned with the curricula of different colleges and majors at the university.

3.DIGITAL LITERACY

3.1 Defining Digital Literacy

The task force initially focused on determining what constitutes digital literacy. Regular change as a defining characteristic makes precise definitions difficult (Leu, 2002). A review of the literature (e.g., Bawden, 2008) reveals a myriad of definitions many of which are quite different in nature and often inconsistent (Eshet-Alkalai, 2004; Lankshear and Knobel, 2008). Gilster (1997) introduced the concept of digital literacy as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (p. 1). The California ICT Digital Literacy Assessment and Curriculum Framework provides a more detailed definition of digital literacy as "the ability to use digital technology and communications tools, and/or networks to access, manage, integrate, evaluate, create and communicate information in order to function in a knowledge society" (California Emerging Technology Fund, 2008, p. 3). Similarly, digital competence as used by the European Reference Framework is "the confident and critical use of information technology for work, leisure and communication. … underpinned by basic skills in ICT: the use to computers to retrieve, assess, store, produce, present, and exchange information, and to communicate and participate in collaborative networks via the Internet." (European Communities, 2007, p. 7).

Martin and Grudziecki (2006) identified three levels or stages for digital literacy development: the lower stage of *digital competence* (skills, concepts, approaches, attitudes, etc.), the central and crucial level of *digital usage* (application of digital competence within specific professional or domain contexts), and the ultimate stage of

digital transformation where digital usages are developed to "enable innovation and creativity, and stimulate significant change within the professional or knowledge domain" (p. 259).

Eshet-Alkalai (2004) proposed a five-skill holistic conceptual model for digital literacy that consists of: (a) *photo-visual literacy*, learning to read from visuals, (b) *reproduction literacy*, the art of creative duplication or recycling of existing materials, (c) *branching literacy*, hypermedia and non-linear or multi-domain thinking, (d) *information literacy*, the art of skepticism, and (e) *socio-emotional literacy*.

In summary, many definitions of digital literacy appear to be built on three principles: *"the skills and knowledge to use* a variety of digital media software applications and hardware devices, … ; *the ability to critically understand* digital media content and applications; and *the knowledge and capacity to create* with digital technology (Media Awareness Network, 2010, p. 4). As such, the concept of digital literacy is much broader than computer literacy, and instead represents an umbrella framework for integrating other inter-related sub-disciplines / literacies and skill-sets such as technology literacy, information literacy, media literacy and visual literacy (Covello, 2010; Martin and Grudziecki, 2006; Bawden, 2008).

Aspect	Definitions
1. Information Research and Retrieval	Access needed information effectively and efficiently using library, Internet, and professional organization databases and search engines.
2. Information Validation	Making judgments about the quality, relevance, timeliness, completeness, truthfulness, independence, usefulness, and efficiency of digital information sources.
3. Learning Resources	Using digital resources provided by University administrators (e.g., Blackboard, Spartan Web), academic vendors, and textbook publishers to enhance learning.
4. Using Applications	Employing application and utility software, and Internet technology to calculate, store, update, retrieve, and display data.
5. Data Transmission	Delivering digital data across distances in an acceptable format useable by the intended receiver.
6. Information Communication	Presenting digital information in a useful and understandable format using commercially available packages, such as, word processors, spreadsheets, statistical packages, briefing presentation software, publishing software, and graphic and animation presentation software.
7. Social Responsibility	Understanding the ethical and social consequences of actions, and using digital technology and information in a responsible and ethical manner.
8. Legal Aspects of Digital Information	Ensuring that the access to, use of, and distribution of digital information complies with relevant laws and regulations.
9. Computer Hardware and Software Selection	Determining the computer needs of a user and selecting the appropriate computer hardware and software configuration from an inventory of alternatives.
10. Systems Analysis	Soliciting, interpreting and documenting user digital needs sufficient to design systems to meet those user needs.
11. Systems Design	Designing or selecting data formats, application programs, communication systems, and hardware devices necessary to fulfill those user needs.
12. Application Development	Developing, testing and maintaining application programs for use by others.
13. System Programming	Installing and maintaining the operating system and utility software that allows users to employ the computer hardware.
14. System, Data, and Information Security	Protecting data and information systems from threats such as unauthorized access, destruction, unauthorized alteration of data, or fictitious creation. Detecting and recovering from those threats.
15. Personal, Financial, and Identity Security	Protecting oneself against fraud conducted through digital means, such as, identity theft, impersonation, online predators, and protecting personal and financial information during e-commerce transactions.
16. Database Administration	Installing, updating, documenting, and tuning the performance of database management systems (DBMS). Instructing users in the proper use of the DBMS.
17. Media Library Functions	Preparing, inventorying, storing, backing-up, and making available physical storage devices for digital programs and files.
18. Networking Technology	Possessing technical competence regarding the configuration, management, and security of internal (e.g., local area networks) and external data networks.
19. Computer Technology	Possessing technical competence regarding the physical and logical operation of hardware, software, and data characteristics of information systems, e.g., at the bit and byte level.
20. Digital Video & Photography	Selecting and using the appropriate digital photographic devices, formats, and features to meet user needs.

Table 1. Twenty Aspects of Digital Literacy

3.2 Identifying Aspects of Digital Literacy

To determine what we should teach students, it was necessary to identify specific aspects or competencies (skills, concepts, approaches, etc.) derived from the definitions of digital literacy that would be needed in generating digital usages, i.e., the appropriate application of digital competence within the different academic disciplines (Martin and Grudziecki, 2006). The task force identified the twenty aspects of digital literacy shown in Table 1 through research and personal experience. These items are consistent with an earlier survey conducted by a group of MBA students that emphasized what students perceived they needed to know to properly use technology (Anzalone et al., 2009). In addition to basic technology and information literacy skills, Table 1 also includes ICT digital literacy skills for IT sector college/career pathways (e.g., systems design, networking) consistent with the *Digital Literacy Pathways in California Report* (2010), the *California Basic Elements of ICT Digital Literacy – Continuum of Skills (*CETF*)* and the *Scoping Study – Identifying Digital Literacy Skills* by Innovation & Business Skills Australia Ltd (2010). Appendix B contains greater details related to the definitions for each aspect.

4. METHOD

4.1 Instrument and Administration

A questionnaire was created as an exploratory tool to survey faculty perceptions of the digital literacy needs of students in the various disciplines across the university. Faculty, department chairs, and associate deans were asked via email to complete the survey using *Class Climate*® software. Only one response per individual was allowed. With only minor wording differences, the questionnaires sent to each group were virtually identical.

The questionnaire listed the digital literacy topics from Table 1 along with their definitions. The study presented here is based on one part of the questionnaire, which asked faculty to indicate how well students in their academic major *needed to know each of these digital literacy aspects*. Questions were measured on a four-point Likert-type response scale where *1 = not at all, 2 = low level of knowledge, 3 = at a more technical level of understanding*, and *4 = possess a high degree of expertise*. Faculty members were also asked to indicate the major in which they taught. The format of the questionnaire sent to teaching faculty is provided in Appendix A.

4.2 Data Analysis

All analyses were performed using *PASW Statistics 18* software. Data were screened for missing values and multivariate outliers. Mean responses to each digital literacy aspect were examined to assess which aspects of digital literacy were perceived as most important by faculty. One-way analysis of variance (ANOVA) at the .05 level of significance was conducted to determine whether group means of the different colleges differed significantly for the twenty aspects of digital literacy. Kendall's coefficient of concordance (W), a measure of correlation employed for three or more sets of ranks (Sheskin, 2004), was used to assess agreement between the ranked means of the four colleges.

Exploratory factor analysis using principal components was used to achieve two objectives: data summarization and data reduction (Hair et al., 2010). The goal was to assess underlying dimensions for the twenty aspects of digital literacy that describe the data in a much smaller number of concepts than the original individual variables, and to then use those dimensions in subsequent analyses (Hair et al., 2010) to arrive at meaningful comparisons between colleges.

While factor-analytic studies with small samples are quite common in practice (e.g., Lingard and Rowlinson, 2006; Osborne and Costello, 2005), sample sizes below 100 are often characterized as poor (e.g., Comrey and Lee, 1992). To ensure that factor analysis was appropriate for our small sample of 82 respondents, procedures outlined in Pett, Lackey, and Sullivan (2003, p. 83) were followed similar to Hazari, North, and Moreland (2009). Factor analysis requires some relationships between the variables of interest. Visual inspection of the correlation matrix showed sufficiently strong correlations among the items with the exception of the *Learning Resources* aspect. The determinant was neither an identity matrix nor singular suggesting that the correlation matrix was factorable. Another method to determine the appropriateness of factor analysis is Bartlett's test of sphericity, which is recommended if there are fewer than five cases per variable (Tabachnick and Fidell, 2007). The test was highly significant (938.656, $p < .0000$), indicating that sufficient correlations existed among the variables to proceed. Finally, measure of sampling adequacy (MSA) values must exceed .50 for both the overall test and each individual variable (Hair et al., 2010). The overall Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy of .896 meets the "meritorious" criterion (Kaiser, 1974) and indicates sufficient sample size relative to the number of items in the scale. Variable-specific MSA values from the anti-image correlation matrix (all >.80) indicated that correlations between the items were strong enough to suggest that the correlation matrix was factorable.

Regarding the reliability of extracted factors, tables provided by de Winter, Dodou, and Wieringa (2009) were consulted which showed factor recovery to be reliable with sample sizes smaller than 10 if the number of factors is small and the number of variables is high. Finally, only factors with four or more loadings greater than .6 were considered since they are viewed as reliable regardless of sample size (Guadagnoli and Velicer, 1988).

5. RESULTS AND DISCUSSION

5.1 Descriptive Statistics

Eighty-two of 244 faculty members completed the survey yielding a response rate of 33.61%. Table 2 shows the number of respondents by academic major within colleges as well as majors that did not respond. Faculty members represented 25 of the 57 academic majors (43.8%) available at the university. 39.51% of the respondents came from the College of Business (COB), 23.46% from the College of Arts and Sciences (CAL), 19.75% from the College of Natural (CNHS), and 17.28% from the College of Social Sciences, Mathematics and Education (CSSME).

Means for each digital literacy aspect by college and overall are shown in Table 3 which is sorted in descending

order of overall mean. Aspect means for each college were sorted and ranked, with the average rank being assigned in case of ties as shown in Table 3. Figure 1 shows aspect means and rankings by College, sorted in ascending order of rank by the College of Arts and Letters (CAL).

College	Responding Major	Number of Respondents	Non-Responding Majors
CAL	Advertising and Public Relations	1	Digital Arts\Electronic Media Art & Technology Film & Media Arts Graphic Design Music Education Music Performance Performing Arts (Musical Theatre)
	Art	3	
	Communications	3	
	English	5	
	Music	1	
	Philosophy	1	
	Spanish	2	
	Theatre	2	
	Writing	1	
		19 (23.46%)	
CNHS	Biology	3	Athletic Training Biochemistry Environmental Science Forensic Science Marine Science – Chemistry Public Health Sport Management
	Chemistry	2	
	Exercise Science and Sport Studies	4	
	Marine Science – Biology	1	
	Nursing	6	
		16 (19.75%)	
COB	Accounting	8	Entrepreneurship Financial Services Operations & Systems International Business (all disciplines)
	Economics	4	
	Finance	6	
	Management	5	
	Management Information Systems	6	
	Marketing	3	
		32 (39.51%)	
CSSME	Education, Elementary	1	Criminology Secondary Education (Biology, English, Mathematics, Social Science) History International & Cultural Studies Mathematical Programming
	Government and World Affairs	2	
	Mathematics	3	
	Psychology	7	
	Sociology	1	
		14 (17.28%)	
	Totals	**81**	

Table 2. Respondents by College and Academic Major

CAL = College of Arts and Letters, CNHS = College of Natural and Health Sciences, COB = College of Business, CSSME = College of Social Sciences, Mathematics and Education

Know …	CAL N = 19		CNHS N = 16		COB N = 32		CSSME N = 14		ALL N = 82	
	Mean	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Information Research Retrieval	3.53	1.5	3.56	1.5	3.44	2	*3.36*	1	3.48	1
Information Validation	3.53	1.5	**3.56**	1.5	3.28	3.5	*3.21*	3	3.39	2
Information Communication	*3.00*	4	3.13	5	**3.50**	1	3.23	2	3.27	3
Using Applications	*2.79*	7	3.00	6	**3.28**	3.5	3.00	4	3.05	4
Social Responsibility	3.05	3	2.94	7	**3.10**	5	*2.54*	6	2.98	5
Learning Resources **	2.74	8	**3.31**	3	2.94	6	*2.62*	5	2.91	6
Legal Aspects of Digital Information**	2.84	5.5	**3.19**	4	2.75	8	*2.15*	8	2.78	7
Data Transmission	**2.84**	5.5	2.40	8	2.78	7	*2.38*	7	2.66	8
Hardware Software Selection	2.05	11	2.19	11	**2.41**	11	*1.69*	10.5	2.17	9
System Data Information Security **	*1.50*	18	2.31	9.5	**2.50**	9.5	1.69	10.5	2.13	10.5
Personal Financial Identity Security **	1.67	13	2.31	9.5	**2.50**	9.5	*1.54*	13.5	2.13	10.5
Media Library Functions	2.11	10	2.00	12	**2.19**	13.5	*1.69*	10.5	2.05	12
Digital Video Photography **	**2.61**	9	1.81	13.5	1.84	20	*1.69*	10.5	1.98	13
Systems Analysis **	2.00	12	1.63	15.5	**2.28**	12	*1.33*	18	1.95	14
Systems Design	1.65	14	1.81	13.5	**2.19**	13.5	*1.54*	13.5	1.89	15
Networking Technology	1.59	16	1.56	17	**2.03**	16	*1.46*	15.5	1.75	16
Database Administration **	*1.44*	19	1.50	18	**2.09**	15	1.46	15.5	1.73	17
Systems Programming	1.39	20	1.63	15.5	**1.97**	17	*1.38*	17	1.68	18
Applications Development	1.56	17	1.44	19	**1.91**	18	*1.31*	19.5	1.64	19
Computer Technology	1.61	15	1.38	20	**1.88**	19	*1.31*	19.5	1.61	20

Table 3. Aspect Means and Rank by College and Overall

****** Significant mean differences level between the colleges at the .05 level
Bold Highest aspect mean
Italics Lowest aspect mean

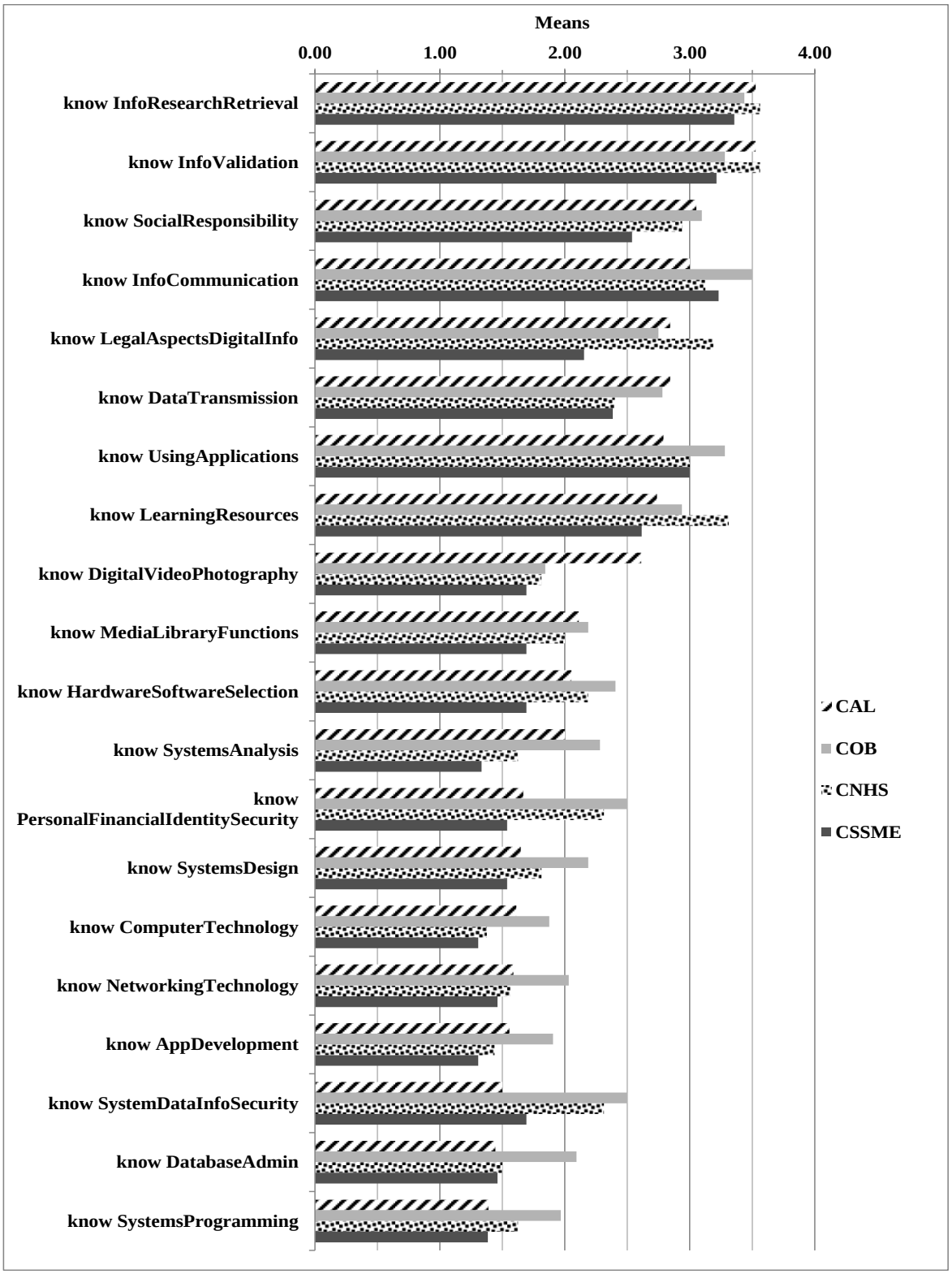

Figure 1. Aspect Means by College (Sorted in Descending Order Based on CAL)

5.2 Factor Analysis

Principal components analysis with varimax rotation resulted in an initial solution of four factors using Kaiser's criterion. *Learning Resources* was dropped because of its low communality (.333) and factor loading, and the analysis was rerun. A subsequent four-component solution using Kaiser's criterion had several loadings below our conservative cutoff of .6 based on Guadagnoli and Velicer (1988), one factor with only two items, and several variables with significant cross-loadings. Following Hair et al. (2010), we systematically evaluated problematic variables for possible deletion based on their factor loadings and conceptual coherence. The model was respecified in several steps to exclude the following three items: *Digital Video Photography*, *Data Transmission*, and *Using Applications*. The final two-factor solution for the remaining 16 aspects shown in Table 4 met the goals of interpretability.

Digital Literacy Aspect	Factor 1 MIS Skills	Factor 2 Information Literacy
Networking Technology	**.885**	.155
Systems Analysis	**.871**	.214
Applications Development	**.870**	.113
Systems Design	**.869**	.245
Database Administration	**.840**	.263
Computer Technology	**.809**	.094
Systems Programming	**.791**	.192
Computer Hardware and Software Selection	**.778**	.220
System, Data, and Information Security	**.688**	.429
Personal, Financial, and Identity Security	**.675**	.374
Media Library Functions	**.661**	.299
Information Validation	.081	**.849**
Legal Aspects of Digital Information	.216	**.757**
Information Research and Retrieval	.100	**.723**
Social Responsibility	.400	**.638**
Information Communication	.229	**.626**
Eigenvalue	8.657	1.964
Percent of variance explained	54.104	12.275
Cumulative % of variance explained	54.104	66.380
Cronbach's alpha (α)	.955	.803

Table 4. Factor Analysis Rotated Component Matrix

Each factor had four or more loadings greater than .6 satisfying reliability criteria by Guadagnoli and Velicer (1988). Eleven of the 16 factor loadings exceeded .72 which is considered excellent (Comrey and Lee, 1992).

Table 4 shows that both factors shared some variables which is not completely unexpected given the inter-relatedness of digital literacy skills discussed earlier. It should be noted that the secondary factor loadings are all at least .23 smaller than the primary factor loadings. The two security-related aspects on Factor 1 were retained as they were most highly correlated with this factor. Similarly, *Social Responsibility* was included with Factor 2 with which it was most highly correlated. Our approach to cross-loadings is in line with a recent study by Harper, Lamb, and Buffington (2008) and appropriate given that our objective was data reduction (Hair et al., 2010). The solution shown in Table 4 has both empirical and conceptual support. Factor 1 (*MIS Skills*) represents the topics typically taught in our introductory *Information Systems* course as well as in our MIS major. Aspects included in Factor 2 focus more narrowly on *Information Literacy* and are closely aligned with the basic elements of digital literacy described in the California ICT digital literacy assessments and curriculum framework (California Emerging Technology Fund, 2008).

Cronbach's alpha (α) was computed to assess each factor's internal reliability. The values shown in Table 4 exceeded the threshold of .70 which indicates acceptable internal consistency (Nunnally, 1978). Dropping any item from either scale resulted in a lower value of α.

Aggregate measures were then computed by summing responses to digital literacy aspects per factor and dividing by the number of items. Descriptive statistics for each factor are shown in Table 5.

	Factor 1 MIS Skills	Factor 2 Information Literacy
Overall Mean (St. Dev.)	1.89 (.81)	3.18 (.60)
Mean CAL	1.73	3.14
Mean CNHS	1.80	3.27
Mean COB	2.20	3.23
Mean CSSME	1.45	2.85

Table 5. Factor Means Overall and By College

The next sections discuss the major findings from our study organized around the three research questions we sought to address.

5.3 Importance of Different Aspects of Digital Literacy

Our first research question was aimed at gaining a better understanding of the importance of different aspects of digital literacy as perceived by faculty. As shown in Table 3, means for *Information Research and Retrieval*, *Information Validation*, *Information Communication*, and *Using Applications* were equal to or greater than 3, i.e., need to be known by students at a more technical level. Also viewed as important with a mean slightly below 3 are *Social Responsibility* and *Learning Resources*. Altogether, all items pertaining to information literacy and applications skills are among the highest-valued aspects by faculty. All aspects in Table 1 that are related to the MIS major or an introductory MIS course (Factor 1, Table 5) are viewed as less important

by faculty as indicated by means near or below 2 (low level of knowledge) and an overall Factor mean of 1.88, shown in Table 5.

5.4 Commonalities and Differences between Colleges

Our second research question was aimed at determining commonalities and differences between the colleges regarding the aspects of digital literacy from Table 1. Table 3 and Figure 1 indicate considerable agreement across the colleges regarding the ranking of digital literacy aspects. The top eight digital literacy aspects that students need to know as perceived by faculty were the same for all colleges. Kendall's Coefficient of Concordance (Kendall's W) was used to assess the extent of agreement between the digital literacy aspect rankings by the different colleges. While there was some variation in the rankings, Kendall's W of .898 was significant (p = .000) and indicates a high degree of agreement (where 1 = complete agreement).

As shown in Table 3 and Figure 1, COB had the highest means for 14 of the 20 digital literacy aspects, while CSSME had the lowest means for 16 of the 20 aspects. Means for digital literacy aspects from all colleges that were equal to or greater than 3 include *Information Search and Retrieval*, *Information Validation*, and *Information Communication.* Other digital literacy aspects at or above a mean of 3 varied by college: *Social Responsibility* (CAL, COB), *Using Applications* (CNHS, COB, CSSME), *Learning Resources* (CNHS), and *Legal Aspects of Digital Information (*CNHS). *Digital Video Photography* was an aspect of greatest interest to CAL (mean = 2.61, rank = 9), while *Systems Analysis and Design, Networking Technology*, and *Database Administration* were uniquely important to COB, particularly the MIS major. Furthermore, *System, Data, and Information Security* was rated particularly low for CAL (mean = 1.5, rank 18) and CSSME (mean = 1.69).

ANOVA analysis indicated that the following digital literacy aspect means (denoted with ** in Table 3) were significantly different between colleges: *Learning Resources; Legal Aspects of Digital Information; Systems Analysis; System, Data, and Information Security; Personal, Financial, and Identity Security; Database Administration*; and *Digital Video Photography*. Post-hoc tests (Scheffe, Bonferroni, Tukey, Games-Howell) show that 6 of 10 significant differences involved the College of Business (COB) (Table 6).

Not surprisingly, one-way ANOVA with Tukey and Bonferroni post-hoc tests found significant differences between colleges for Factor 1 *MIS Skills* as shown in Table 5 (F = 3.298, Sig. = .025), specifically between the College of Business (COB) and the College of Social Sciences, Mathematics, and Education (CSSME). COB offers a major in Management Information Systems as well as a required three-credit-hour *Information Systems* course that covers the topics shown in Table 4 for Factor 1. Colleges did not differ significantly regarding the *Information Literacy* factor, although CSSME's rating of 2.85 was the lowest and the only one below 3.

5.5 Implications for Course and Curriculum Development

Our third research question pertained to the implications of this study for curriculum design and course development in light of concerns about teaching digital literacy skills to students who are (mis)perceived as tech-savvy digital natives. The results presented here indicate that digital literacy education needs to occur across the curriculum and must be broader than the current one-credit-hour course focused on computer literacy. There was considerable agreement among the faculty of four different colleges regarding the digital competencies that students should have, and areas that need enhanced coverage.

At the top of the list are *information literacy skills* (research and retrieval, information validation, social responsibility, and legal aspects) with *Information Research & Retrieval* and *Information Validation* receiving the highest means (3.48 and 3.39) overall. Many respondents commented that students needed to know how to properly utilize databases on campus and how to properly employ search techniques (expand keyword searches, narrow searches to identify relevant data). Faculty remarks also addressed the ability of students to determine the validity and quality of sources, particularly Internet sources. One faculty member wrote: "Wikipedia is not the ultimate source!". Faculty members also made a case for greater coverage of plagiarism and intellectual property laws in the open-ended comment sections of *Social Responsibility* and *Legal Aspects of Digital Information.* The findings reported here are consistent with a two recent studies that investigated aspects of information literacy.

Digital Literacy Aspect	Mean CAL	Mean CNHS	Mean COB	Mean CSSME	Significant Differences
Learning Resources	2.74	3.31	2.94	2.62	CAL-CNHS, CNHS-CSSME
Legal Aspects Digital Information	2.84	3.19	2.75	2.15	CNHS-CSSME
Systems Analysis	2.00	1.63	2.28	1.33	COB-CSSME
System, Data, & Information Security	1.50	2.31	2.50	1.69	CAL-CNHS, CAL-COB, COB-CSSME
Personal, Financial, & Identity Security	1.67	2.31	2.50	1.54	CAL-COB, COB-CSSME
Digital Video & Photography	2.61	1.81	1.84	1.69	CAL-COB

Table 6. Significant Differences between Colleges

One study attempted to assess information literacy competency of 600+ first or second-semester college students using tasks that were designed to capture students' abilities to define, access, manage, integrate, create, and communicate information (Hignite, Margavio, and Margavio, 2009). Students scored just slightly above the 50th percentile on the information literacy exam. Another study examined online credibility assessment among first-year students at an urban public research university using a survey as well as in-person observations and interviews (Hargittai et al., 2010). Several findings from that study are noteworthy. First, students had high levels of faith in their search engine choice and did not feel the need to verify who authored pages or the authors' qualifications. Instead, students perceived material as credible "simply due to the fact that the destination page rose to the top of the results listing of their preferred search engine" (Hargittai et al., 2010, p. 486). The authors also noted that students' self-reported levels of credibility assessment of online information had little to do with their actual tendency to verify information.

Faculty also voiced a high need for teaching *Applications* in the curriculum. Comments regarding this aspect of digital literacy were in line with our experience with basic computer proficiency assessments. Only 3% (26 of 875) students actually elected to take the proficiency exam to attempt waving our introductory software applications course. Of those, 11 students, i.e., 1.3% of the total number of students enrolled in the course actually passed the exam. Our statistics are similar to Morris (2010) who reported that only 3.5% of students attempted to test out of an introductory computer course, and only 1% of the students would have actually passed the course. At the same time, 71% of the students believed they would have passed the test. While students today are relying heavily on computers, cell phones, and the Internet for fast communication and access to information and services (Kennedy et al, 2008), they may not be able to perform the kinds of tasks required in introductory information systems courses (Karsten and Schmidt, 2008). The survey we reported on did not list specific application packages. However, faculty comments indicated the need for software skills beyond MS Office such as statistics software or investment acquisition and management software. Further study is needed to identify specific application packages that should be included in the curriculum beyond those currently taught.

Learning Resources such as Blackboard, textbook resources, etc. represent another important digital literacy skill for inclusion in the curriculum although variations exist among colleges. Our results are consistent with a study of Year 3 students at two UK universities, which found that students did not appear to understand the potential of technology to support learning, but instead looked to their instructors for ideas on technology-enhanced learning (Margaryan, Littlejohn, and Vojt, 2011). Being a member of the Net Generation does not mean students know "how to employ technology strategically to optimize learning experience in university settings" (Kennedy et al., 2008, p. 118). From a course development perspective, it may be feasible to cover learning resources used by all students in a common course, while others need to be addressed from within courses that develop subject knowledge in the discipline. Tables 3 and 6 provide further insights into other topics that may be discipline-specific. For example, *Digital Video and Photography* was most highly valued by the College of Arts and Sciences only.

As of this writing, these results were presented to the University's Faculty Senate, and the digital literacy task force was reconstituted for an additional semester to:

- Determine if the current one-credit-hour course could be enhanced to include essential digital literacy aspects not currently covered.
- Determine what specific digital literacy aspects could be relegated to courses taught in individual academic majors.
- Identify specific application packages beyond those currently taught that should be included in the curriculum.
- Benchmark the resultant curriculum content against other colleges and schools.

6. LIMITATIONS

The smaller than desired sample size, the lack of representation from all majors, and the large representation by the College of Business may have skewed results and reduced their generalizability both internally and externally to other universities. Some respondents also found that the survey contained too many items pertaining to the MIS major as opposed to general digital literacy skills. Furthermore, some respondents indicated uncertainty about some aspects of digital literacy despite the definitions that were provided. Finally, the study does not allow for comparisons between what faculty members consider as important digital literacy skills of students and actual assessments of students' skills.

7. CONCLUSIONS

The present study was motivated by concerns about the current computer literacy course which focused on software applications, and the need to ensure that our graduates develop the capabilities and skills necessary to operate effectively in the digital society. Prior research shows that today's students live and breathe technology, but are far from being digitally literate. Despite elimination of introductory IT courses at some institutions, the survey here does not invalidate a stand-alone course for teaching the more technical aspects of digital literacy. In addition, information literacy skills are seen as crucial. Expanded coverage of topics including information literacy and learning resources appears to be warranted, e.g., as described in Hodge and Gable (2010).

However, it is important to understand that digital literacy "cannot be reduced to a single component, or can it be assessed with just one type of test" (Calvani et al., 2008, pp. 191-192). As such, it cannot be achieved with one course, but must also be developed from within coursework specific to the discipline to provide needed skills and give them content (Futurelab, 2010). A focus on the appropriate application of skills (digital competence), i.e. situational embedding, as opposed to just a mastery of skills is crucial. Ultimately, "digital literacy involves the successful usage of

digital competence within life situations" (Martin and Grudziecki, 2006, p. 256). While it is important to have an understanding of faculty perceptions of what students need, it is equally important to understand the skills entering students possess before adjusting the curriculum (Grant, Malloy, and Murphy, 2009), e.g., via some type of digital competence needs analysis before starting a course (Martin and Grudziecki, 2006).

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APPENDIX A. Survey Questionnaire for Teaching Faculty

The questionnaire is designed for teaching faculty. Please select the single academic major you are referring to while you are answering this questionnaire.

- o Accounting
- o Advertising and Public Relations
- o Art
- o Athletic Training
- o Biochemistry
- o Biology
- o Chemistry
- o Communications
- o Criminology
- o Digital Arts
- o Economics
- o Education, Elementary
- o Education, Secondary Biology
- o Education, Secondary English
- o Education, Secondary Mathematics
- o Education, Secondary Social Science
- o Electronic Media Art and Technology
- o English
- o Entrepreneurship
- o Environmental Science
- o Exercise Science and Sport Studies
- o Film and Media Arts
- o Finance
- o Financial Services Operations and Systems
- o Forensic Science
- o Government and World Affairs
- o Graphic Design
- o History
- o International and Cultural Studies
- o International Business / Accounting
- o International Business / Economics
- o International Business / Entrepreneurship
- o International Business / Finance
- o International Business / Management
- o International Business / Management Information Systems
- o International Business / Marketing
- o Liberal Studies
- o Management
- o Management Information Systems
- o Marine Science – Biology
- o Marine Science – Chemistry
- o Marketing
- o Mathematical Programming
- o Mathematics
- o Music
- o Music Education
- o Music Performance
- o Nursing
- o Performing Arts (Musical Theatre)
- o Philosophy
- o Psychology
- o Public Health
- o Sociology
- o Spanish
- o Sport Management
- o Theatre
- o Writing

Following are twenty digital literacy topics. Please answer the questions asked for every digital literacy topic.

X. Digital Literacy Topic ***[See the list of 20 aspects in Table 1]***

X.1 How well must students in your academic major need to know this digital literacy topic?

- o Not at all
- o Low level of knowledge
- o At a more technical level of understanding
- o Possess a high degree of expertise

X.2 To what extent does your academic major currently teach this digital literacy topic?

- o Not at all
- o Some, but more needs to be taught
- o We adequately teach this topic

X.3 Are there any specific aspects of this digital literacy topic that should be taught, but your academic major currently does not adequately cover it?

[The above three questions were repeated twenty times for the twenty digital literacy topics, where "X" cycled from "2" to "21". The question numbering then totaled to "21.3".]

22. Additional Information

22.1 Thank you for answering the questions for the twenty digital literacy topics. As a final thought, are there any digital literacy topics that you feel should be added? Do you have any questions, concerns, or comments to make? Please make your comments below.

PPENDIX B. Types of Abilities / Activities Implied by the Digital Literacy Aspects

Aspect	Students Should Possess These Abilities or be Able to Complete These Activities
1. Information Research and Retrieval	Recognize that information is lacking, and therefore is needed. Select the appropriate potential source for the research given the purpose and audience. Use library database and search systems. Use the internet to research information. Use discipline unique information sources, such as professional organization databases & search engines. Employ & refine appropriate search strategies, protocols, and logic commands to extract the proper information.
2. Information Validation	Assess the relevance of a source to a specific objective or purpose. Assess the limitations, truthfulness and independence of a source, using methods such as "backtracking" to find the original source. Assess the currency and timeliness of a source. Assess the accuracy and completeness of a source. Assess the degree of review of the content by credible reviewers. Be able to identify "doctored", falsified, or hoax images or information, with tools such as those provided by Symantec or Snopes.com. Compare and contrast differences in content between sources.
3. Learning Resources	Use degree advising online resources to plan academic progress (e.g., Registrar systems). Use course management and communication systems to obtain course-related information, communicate with instructor and other students, etc. (e.g., Blackboard system). Use online tutorial systems to enhance understanding and learning (e.g., textbook support systems). Use online homework systems to self-evaluate degree of learning (e.g., textbook support systems).
4. Using Applications	Select and use the appropriate software application for the task at hand. Technical competence in the proper operation of application software and utilities. Input, update, retrieve and copy digital data. Manipulate, calculate and display data. Adapt, apply, design, invent, and author new information. Ability to transfer current knowledge to new application technology. Ability to use system support resources provided by the operating system to format storage media, search files, set system characteristics, debug problems, etc. Perform essential system maintenance functions such as disk defragmentation, archival, computer infector scanning, periodic version updating of application software, etc.
5. Data Transmission	Properly format and compress data appropriate to digital transmission method used and the needs of the receiver's system. Technical competence in the use of email facilities. Transmit digital data via digital communication means. Access and display digital information after receipt.
6. Information Communication	Briefing presentation software. Graphic and animation presentation software. Word processing software. Spreadsheet software. Publishing software. Statistical software packages. Media streaming Internet technologies.
7. Social Responsibility	Understand the ethical and social consequences of actions when using of digital technology. Use digital technology for the organization's intended purpose versus for personal motives. Digital etiquette, i.e., not use technology for purposes that are intimidating, threatening, or harassing to other persons or organizations. Not use technology for illegal purposes. Not acquire digital information, files, programs, databases, etc., via illegal means. Avoid digital activities that constitute violations of the University's academic integrity policy. Record all pertinent citation information to document the source of information obtained from digital sources.
8. Legal Aspects of Digital Information	Understand the consequences of not complying with relevant laws and regulations. Know enough about and comply with laws and regulations regarding file downloading, the copyright law, medical privacy, USA Patriot Act, 1977 Foreign Corrupt Practices Act, Sarbanes-Oxley Act, Gramm-Leach-Bliley Act, import and export laws, bank regulations, insurance regulations, etc. Legal and regulatory requirements to disclose data security breaches.
9. Computer Hardware and Software Selection	Knowing computer internal characteristics that affect performance and capabilities (e.g., size of memory, types of graphics cards, input/output ports, screen size, CPU model, battery life, etc.) Knowing the differences and capabilities between operating systems and versions. Knowing the various application software systems, their versions, and levels of capabilities.
10. Systems Analysis	Possess relevant technical competence relating to data, software and hardware. Employ proper methods to document user requirements.

APPENDIX B. Types of Abilities / Activities Implied by the Digital Literacy Aspects (cont.)

11. Systems Design	Design computer-based solutions to satisfy user requirements. Document and communicate system requirements to application development, system programming, and database administration personnel. Conduct system development progress reviews.
12. Application Development	Use application-programming languages. Develop and maintain websites. Use file access and data manipulation methodologies. Test proper operation of programs. Install operational applications in user-ready condition. Control program version changes. Develop system, program, and user documentation. Design and conduct user training.
13. System Programming	Install/update operating systems and utilities on hardware platforms. Test, fault find, and patch errors in those systems. Employ various options available for keeping the computer operating system version current.
14. System, Data, and Information Security	Data access mechanisms. User processing permissions. Encryption/decryption methods. Batch totals, checksums and message confirmation. Data backup and recovery methods. System monitoring and system interruption restart (e.g., checkpoint restart methods). Reverse processing (transaction back-out methods). Legal requirements to evaluate and disclose the strength of internal controls. Use applications for computer infector monitoring and removal. Use firewalls and intrusion protection systems. Be able to secure email and instant messaging transactions. Use website danger verification and warning systems. Find and understand website privacy and security policies. Appraise limitations on protection offered by website certification seals.
15. Personal, Financial, and Identity Security	Being able to identify and avoid situations involving online fraud, identity theft, impersonation, etc. Protecting oneself from online predators (e.g., social networks, dating websites, etc.). Knowing how to respond to and report such attempts. Protecting personal and financial information during e-commerce transactions. Protecting personal account numbers, user-IDs, and passwords.
16. Database Administration	Select, install, and update appropriate DBMS. Maintain schema and subschema. Test DBMS proper operation. Define application interfaces via the data definition/access language. Test application proper performance. Maintain the data dictionary. Emergency action planning; backup cold/hot sites, etc. Train users.
17. Media Library Functions	Data/file inventory methods. Media preparation, cleaning, and degaussing. Media retrieval and restoration. On-site and off-site data storage. Emergency action planning.
18. Networking Technology	Install, configure, and manage network technologies: local area networks, intra- business networks, inter-business network, etc. Manage user profiles, access, and processing permissions. Implement electronic data interchange technologies: level 1, level 2, level 3 implementations.
19. Computer Technology	Data representation at the bit/byte level. Binary arithmetic and Boolean logic. Central processing unit and memory components. Physical media storage methods. Data compression methodologies. Computer instructions at the machine level. Compilers and interpreters. Alternative digital graphic representations.
20. Digital Video & Photography	Know benefits, features, & working of a digital camera to select a camera appropriate to the user's needs. Understand the features of different Web video technologies. Manage and edit digital images. Employ the proper output format for digital video. Know & be able to select appropriate features of different types of printers available for printing photos.

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