NMC Horizon Project

Digital Literacy

An NMC Horizon Project Strategic Brief

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Digital Literacy

An NMC Horizon Project Strategic Brief

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Introduction

Digital Literacy: An NMC Horizon Project Strategic Brief was commissioned by Adobe Systems to explore an increasingly pressing challenge for United States higher education institutions: advancing digital literacy among students and faculty. As technology is rapidly proliferating and becoming more ubiquitous in people's daily lives, colleges and universities have become more adept at integrating it into every facet of campus life to enhance course design, course materials, and interactions between learners and instructors.[1] While the first wave of campus technology, such as learning management systems, supported one-way communication from the institution or instructor to students, the latest incarnation of educational technology emphasizes two-way communication along with content creation — cornerstones of digital literacy.

Just because there are more technologies and tools available than ever before, however, does not mean that they are being harnessed effectively. A 2016 Pew Research Center's study indicates that the digital divide in the US is no longer just about access to technology but rather fluency in using it. Socio-economic status is certainly a factor with low-income households unable to afford high-speed broadband and the latest devices, but only 17% of adults report being active learners who are "confident in their ability to use digital tools to pursue learning."[2] Indeed, the productive and innovative use of technology encompasses 21st century skills that are vital for being successful in the workplace and beyond.[3] Higher education institutions must prepare students for a future where learning new digital tools is an intuitive process.

Unfortunately, lack of agreement on what comprises digital literacy is impeding many colleges and universities from formulating adequate policies and programs. Discussions among educators and library professionals have included the idea of digital literacy as equating to competence with a wide range of digital tools for varied educational purposes, or as an indicator of having the ability to critically evaluate web resources — a component of information literacy.[4] However, both definitions are broad and ambiguous, making digital literacy a nebulous area that requires greater clarification and consensus.

The aim of this publication is to establish a shared vision of digital literacy for higher education leaders by illuminating key definitions and models along with best practices and recommendations for implementing successful digital literacy initiatives.

The NMC and Adobe are not alone in the pursuit of advancing digital literacy. The International Federation of Library Associations and Institutions (IFLA) urges governments and intergovernmental organizations, as well as private institutions, to develop policies that advocate for media and information literacy as an emerging field of human rights in an increasingly digital world. While strides have been made toward cultivating frameworks, models, and guidelines, there is considerable variance in digital literacy policies and implementation programs across the US[5] and the rest of the world.[6] As a result, individual institutions are tasked with developing their own initiatives without the benefit of standardized support, and often without strategies that can scale across all departments.

A study conducted by the Association of American Colleges and Universities revealed employers' sentiments that recent graduates should be more prepared as critical thinkers.[7] Many progressive higher education institutions have been unpacking this premise for some time, but there is still work to be done to develop programs and curricula that provide learners with more hands-on, deeper experiences. Part of digital literacy is not just understanding *how* a tool works but also *why* it is useful in the real world and *when* to use it. This concept can be described as digital citizenship — the responsible and appropriate use of technology, underscoring areas including digital communication, digital etiquette, digital health and wellness, and digital rights and responsibilities.[8]

While notions of digital literacy are rapidly evolving, this brief presents the reality of what is happening in the field: current understandings and practices of digital literacy. Today's students would appear to be more digitally literate (fluent at critical thinking, collaborating, being creative, and problem-solving in digital environments) than previous generations because many have grown up immersed in technology-rich environments, but research has shown that this does not necessarily equate to confidence, especially in an educational context.[9]

The Organization for Economic Co-operation and Development's (OECD) most recent survey of adult skills[10] found that millennials in the US — who now comprise one-third of the American workforce[11] — placed nearly last in digital skills (defined as literacy, numeracy, and problem-solving) as compared to the same age group in other developed nations.[12] Underscoring this problem is the Rasmussen College study "Digital Literacy in 2015," which emphasizes the ability to effectively use the internet, reporting that one in four millennials want to improve their digital literacy, but 37% characterize the internet as "scary."[13] Institutions have a social and economic responsibility to help assuage this concern, empowering students to use digital tools to organize, create, collaborate, and learn.

"That's the broader definition of digital literacy — how you can take these tools and recreate and reinvent what it means to learn and educate."

-Jan Holmevik, Associate Professor of English and Co-Director of the Center of Excellence in Next Generation Computing and Creativity, Clemson University

In examining the digital literacy landscape, the NMC also leveraged the expertise and insights of its community of higher education professionals. A survey was created and disseminated to collect data on how the subject is materializing on campuses across the nation, with a special interest in the tools and resources needed to deepen digital learning experiences. More than 450 education leaders, faculty, and staff responded to the survey, collectively generating a clearer picture of how digital literacy is being perceived by and impacting the field. The results are interspersed throughout this publication.

Survey respondents overwhelmingly pinpointed leadership and smart partnerships between campus departments and off-campus entities as essential elements for developing digital literacy infrastructure on campuses. Adobe's support of this publication is significant as their technologies are increasingly being adopted by colleges and universities to foster greater digital literacy, particularly the Adobe Creative Cloud and the design, production, and storytelling apps it encompasses. The Creative Cloud provides leading desktop and mobile apps and workflows, including Photoshop, Illustrator, and InDesign, which help users to design and layout sleek and engaging content.[14]

Adobe Creative Cloud: Tools for Digital Literacy

Creative Cloud Application	Use in Promoting Digital Literacy
Photoshop	Leverage and edit photos/images to visually convey stories
Premiere Pro	Create, edit, and publish interactive videos of instructor lectures and student work
Illustrator	Create vector graphics to share data/content visually, e.g., infographics and diagrams
InDesign	Design pages for reports, poster sessions, and ebooks
Muse	Create code-free, mobile-ready websites to showcase student work
Lightroom	Edit, organize, and share photos at a professional level

A case study featuring Clemson University, Abilene Christian University (ACU), and University of the Arts London depicts the Creative Cloud's role in transforming their students from consumers to creators and enabling staff and faculty to develop more progressive, technology-enhanced learning content.[15] ACU Professor of English Kyle Dickson notes that while today's students may already view themselves as media producers, coders, and makers, "there are opportunities to help sharpen their

awareness of how the core components of audio and video and images come together into something that creates a more carefully crafted message."

Jim Bottum, former CIO and Vice Provost for Computing and Information Technology at Clemson University, asserts that students should be prepared to present their ideas more effectively in business settings: "I think the goal is to equip students with the skills, knowledge, and capabilities to be ambidextrous in the digital world that we live in." Adobe and other technology providers play an important role by providing institutions with affordable tools that encourage this cognitive development around digital content creation and communication.

"The student of the future is what we call a maker, somebody who needs to be able to not just critically understand the problem, but also produce solutions to problems," said Jan Holmevik, Associate Professor of English and Co-Director of the Center of Excellence in Next Generation Computing and Creativity at Clemson University. "The value of that skill carries across all fields of academia. We're repositioning what the student is by providing access to some of the state-of-the-art tools."

Indeed, an overarching goal of supporting affordable campus-wide integration of Adobe tools is to equip all students and faculty with the opportunities and skills to be effective 21st century creators — avid producers of media and rich web experiences that deepen learning and add real value to society. In this picture, students move beyond being mere consumers of knowledge to becoming major contributors to an institution's knowledge ecosystem. This concept feeds into a distinct facet of digital literacy that will be further expanded upon in this report: it is not enough for learners to simply know how to use a technology; they must be able to apply it imaginatively to perform a task or produce an object that would otherwise not be possible without the technology. When students use design apps such as Adobe Photoshop, Illustrator, and InDesign, for example, they are able to turn their creative visions into rich outputs in a range of engaging formats, building on their digital capacities.

How can institutions help students and faculty move from passive, basic use of technology to more intuitive, innovative applications? Developing strategies to bridge the gap requires consensus around key definitions and the desired outcomes of deeper learning. As such, the first section of this report breaks down digital literacy into three different models — universal literacy, creative literacy, and literacy across disciplines — in order to identify the separate parts that comprise the sum of this area. Next, exemplar institutional programs and initiatives are summarized to provide readers with an array of working models for bolstering digital literacy. The report concludes with four recommendations to inform better strategic planning to promote and deeply embed digital literacy in higher education.

Definitions and Models

The term "digital literacy," also referred to as digital fluency,[16] builds on several historic literacy movements. In the 1960s, media literacy encompassed critical approaches to interpret mass media, and information literacy helped users beginning in the late 1980s to navigate the burgeoning internet for information.[17] Digital literacy embodies these precursors' philosophies of skepticism about content and critical thinking, while upgrading them for the digital age. This next incarnation in the evolution of literacy includes addressing users not only as consumers, but also as content producers.[18]

The ALA Digital Literacy Task Force defines digital literacy as the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both technical and cognitive skills.[19] Similarly, Leeds Becket University views digital literacy as a varied set of capabilities underpinned by digital technologies and computer literacy, which leads to the "confident and critical use of information and digital technologies to enhance academic, personal, and professional development."[20] These related definitions are notable because they stress practices instead of tools.

"Going digital with everything in higher education relies on digital literacy skills—productivity, creativity, research, and content creation rather than consumption."
-Director, Center for Instructional Technologies, Public Four-Year University

Even with these frames of reference, applications of digital literacy by higher education professionals have varied as they have divergent conceptions of digital literacy, according to the results of the NMC survey.[21] Some respondents saw social and cultural factors as more important than specific technical skills, yet many viewed technical fluency as essential. There are distinct interpretations across different disciplines as well. One respondent, an assistant professor of creative writing at a private university, noted, "At my technical institute, there does not seem to be a common understanding for what digital literacy means. To those of us in the humanities, it means something very different than to our colleagues in computer science."

Roughly 50% of survey respondents deemed creativity in the form of content production as vital to any definition of digital literacy, while others focused on critical consumption. Web searching and digital media analysis were the two most popular definitional skills, but were followed closely with the use of digital making tools: office productivity apps, digital media creation, and web content authoring. Coding, hardware skills, and animation were areas respondents viewed as the least essential to a definition of digital literacy.

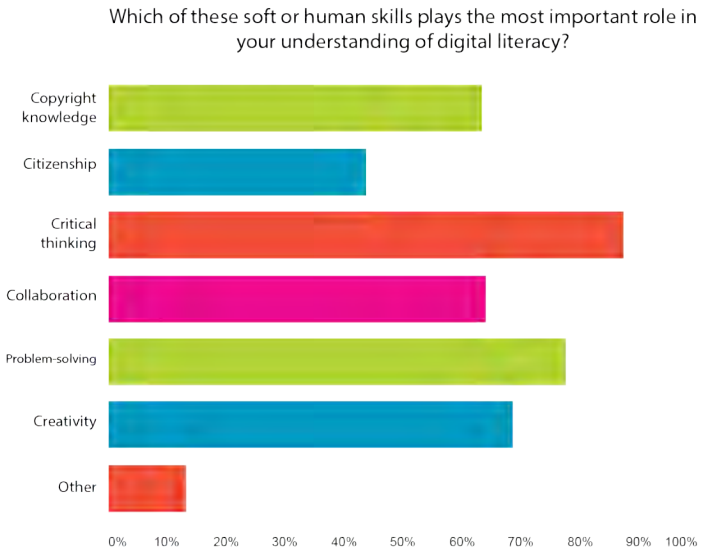
Overall, NMC's research pinpointed a rich landscape of discourse and possibility for digital literacy practices. The term denotes a combined critical and practical understanding of digital technologies in socio-cultural settings, recognizing that users are creators as well as observers. This notion aligns well with previous *NMC Horizon Report* editions' analysis of digital literacy, which described the lack of definitional consensus across educational and cultural heritage institutions.[22] Through the NMC Horizon Project, the NMC has also observed the practical combination of technical and cultural skills teaching in existing digital literacy projects. Indeed, the complexity of the topic and lack of agreement around it suggest that institutions need to experiment further with digital literacy pedagogy, curriculum, and program design — and share their results broadly.

A key finding from both NMC's research and *NMC Horizon Report* series is the growing recognition that students are makers within the digital world. While this is evident to anyone who has taught young learners, recognizing students as producers has not yet fully permeated the education sector. As one responding professor of design illustration and photography put it, "In the 21st century *digital literacy* is now *literacy*; all students must be able to use digital tools to express their ideas." This insight

resonates with some of the most popular literature on digital literacy, such as thought leader Howard Rheingold's observation that digital media tools empower users to become networked creators.[23]

However, when asked their thoughts about the balance between digital consumption (reading, watching, listening) and digital production (making videos, building web pages) in their institutions' digital literacy efforts, more than 66% answered that their unit leaned partly or entirely towards consumption. This may be due to the inherited pre-digital literacies noted above, designed for a time when students were considered to be consumers, or it may be driven by institutional leaders' backgrounds in the mid- and late 20th century — the heyday of the consumer, before what Alvin Toffler dubbed "the prosumer" age.[24] The United States' multi-agency digital literacy portal reveals a similar consumption-oriented stance.[25] However, as the third decade of the 21st century approaches, it is clear that digital tools have democratized creation, as well as made accessible many platforms for sharing one's products.

What technical skills should the digitally fluent exercise in order to be creators? NMC's research and survey found no common ground; rather, a wide range of technical skills was surfaced. Generally speaking, the more popular skills were the lightest in terms of training time. Respondents preferred, in descending order of popularity: web searching, office productivity tools, digital media (images, audio, visual combined) creation, and web content authoring. After this most popular tier, responses shifted to more specific media categories: image editing, video editing, audio editing, and graphic design. Occupying the lowest tier were coding, hardware skills, and animation.



In contrast to technical skills, the socio-cultural aspect of digital literacy can be understood in terms of human skills to be developed through education and practice. With that notion in mind, respondents to the survey valued cognitive skills the most highly, namely critical thinking and problem-solving. Personal and interpersonal skills placed second, including collaboration and creativity. Social or political topics then followed: copyright knowledge and digital citizenship. The survey's text entry option allowed respondents to contribute additional thoughts, and many written responses called for more specifics of group-work, personal interaction, creative approaches, and awareness of socio-technical issues.

Based on the variety and complexity of these results, NMC cannot identify just one model of digital literacy. Instead three different digital literacies are now evident, each with distinct standards, potential curriculum, and implications for creative educators.

Universal Literacy

A baseline set of practices cuts across the diversity of responses. This universal literacy applies to learners and creators of all ages, and is based on inculcating a critical stance towards the increasingly immersive world of digital media. One anonymous respondent advised, "Digital literacy will become a required skill in the workplace and all students will need a high degree of digital literacy to firstly obtain employment, keep employment, and obtain promotions." The onus is on higher education institutions to equip students with this skill.

As Phillip Ventimiglia, Georgia State University's (GSU) Chief Innovation Officer, and George L. Pullman, GSU professor, remind us, "Students now need to learn how to use technology to solve problems in academic and professional settings."[26] Universal digital literacy draws on information literacy in that it teaches users how to find, assess, and make use of information in a networked environment. This is exemplified in scenarios like Abilene Christian University's recent requirement of assigning a digital essay component to all composition classes taught to freshmen.[27]

Universal digital literacy also follows some strands of media and information literacy that positions users as part-time creators — meaning digitally literate people are familiar with using basic digital tools such as office productivity software, image manipulation, cloud-based apps and content, and web content authoring tools. Being familiar with the basics of Adobe's Creative Cloud covers this territory, including audio, image, video, and web content creation and manipulation. Further, because acts of creation and information seeking are social, universal digital literacy teaches users collaboration skills along with basic critical thinking.

Creative Literacy

A different, more challenging literacy complements the universal one, emphasizing the producer side of the producer-consumer continuum. This creative literacy assumes everything in the universal literacy, then adds to it more capabilities. Technical skills in this model are more challenging ones that can lead to the production of richer content, including video editing, audio creation and editing, animation, an understanding of computational device hardware, and programming.

Social skills expand to involve digital citizenship and copyright knowledge, which is essential for producing and/or remixing digital assets. This model of citizenship is quite productive, as it connects many digital practices to civic and even politically controversial topics. For example, the recently published ISTE "Student Standards" require students to be knowledgeable about copyright laws, online ethics, digital identity, privacy, and security.[28] One could view this civic-digital literacy framework as applied to all students in general. However, current research shows no support for this creative literacy model becoming a general literacy, but rather a set of attributes that describe the modern digital creator. In short, creative literacy is a bundle that transcends the mastery of a single skill.

Literacy Across Disciplines

A third way of thinking about digital literacy is as a curricular infusion across the disciplines. Rather than assigning the topic to a single institutional unit (e.g., the campus library), digital literacy as curriculum is diffused throughout different classes in appropriate ways that are unique to each learning context. Computer science and digital media classes can instruct on everything from office productivity applications to programming and video editing, for example. Sociology courses can teach interpersonal actions online, such as the ethics and politics of social network interaction, while psychology and business classes can focus on computer-mediated human interaction. Government and political science classes are clearly well equipped to explore the intersection of digital technology and citizenship mentioned above.

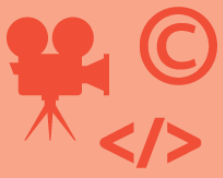
Communication, writing, and literature classes have the capacity to instruct students on producing digital content in the form of stories, arguments, personal expression, posters, and more. Curricular infusion can support campus-wide universal digital literacy, if structured to include all students learning at a given institution, or instead instruct a subset of participating learners in creative literacy. Specific assignments and pedagogical forms would have to be identified or created to fit the distinct needs of the literacy in question. In some ways, digital literacy as curriculum is the most ambitious version of digital literacy as implementing it requires a broad-ranging curricular redesign.

Three Models of Digital Literacy

Universal Literacy

A familiarity with using basic digital tools such as office productivity software, image manipulation, cloud-based apps and content, and web content authoring tools.

Creative Literacy



Includes all aspects of universal literacy and adds more challenging technical skills that lead to the production of richer content, including video editing, audio creation and editing, animation, an understanding of computational device hardware, and programming — along with digital citizenship and copyright knowledge.

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Best Practice Exemplars

While US colleges and universities are challenged to deeply embed digital literacy in program and curriculum design, there are a number of institutions that serve as good examples. Higher education leaders should take note of the following initiatives that prioritize and strengthen campus technology fluency, embodying universal literacy, creative literacy, and/or literacy across disciplines:

Carolina to Provide Students, Instructional Faculty and Staff with Adobe Creative Cloud
go.nmc.org/uncado

As part of a larger campus-wide commitment to digital literacy and supporting students as multimodal creators and communicators, University of North Carolina - Chapel Hill provides students and faculty with access to Adobe Creative Cloud.

"Challenge Accepted" Workshops
go.nmc.org/ryerson

At Ryerson University in Canada, coding is seen as an emerging and important literacy that will cultivate in students the skills needed to define and create the digital tools of the future. In their "Challenge Accepted" workshops, students learn how to create a mobile app in only three hours. Understanding how algorithms apply structured linear thinking to address a variety of problems will be a key workforce skill, even in non-technical fields.

CI Keys
go.nmc.org/cik

California State University Channel Islands' CI Keys project provides faculty and students with open-source content creation tools to integrate into projects so they are able to become familiar with building online portfolios, journals, wikis, and other kinds of digital resources.

A Cross-Institutional Partnership Approach to Information Literacy Enhancement
go.nmc.org/hon

Eight participating institutions in Hong Kong will conduct a cross-disciplinary assessment on the behaviors of university students to identify educational needs for learners' information literacy. This will inform the development of interactive multimedia courseware and an information literacy self-assessment tool.

Digital/Critical
go.nmc.org/digcri

The Digital/Critical initiative at Sonoma State University Library brings together faculty to update traditional paper-based research assignments by integrating digital media tools and empowering students with transferable digital literacy skills.

The Digital Liberal Arts at Middlebury
go.nmc.org/diglibart

Middlebury College's Digital Liberal Arts Initiative is a campus-wide effort to encourage faculty to explore new opportunities in digital scholarship by taking risks, collaborating, sharing, and learning from each other.

Digital Literacy and Multimedia Design Minor at Stockton
go.nmc.org/stock

Stockton University offers a Digital Literacy and Multimedia Design minor to prepare students in any major to design, develop, and evaluate digital content using multimedia technology.

Course options range from creative digital storytelling and documentary options to studies on human-computer interface or artificial intelligence.

Digital Literacy at Deakin University Library
go.nmc.org/dealib

Deakin University offers a framework for assessing students' proficiency in digital literacy, as well as video tutorials, learning activities, and resources for faculty to incorporate into their courses. Their guides help both students and the faculty to articulate the skills needed to appropriately find, use, and disseminate relevant information sources.

Digital Playspace at Massey University
go.nmc.org/digplayspa

The Library at Massey University is collaborating with the Teaching and Learning unit to build a Digital Playspace for academic and professional staff that will provide informal learning opportunities as well as facilitated training to improve digital literacy.

ETSU, Adobe Alliance to Equip Students with Leading-edge Skills
go.nmc.org/etsu

East Tennessee State University is integrating Adobe Marketing Cloud into a number of courses to encourage the development of real-world skills through hands-on application of digital tools in areas including analytics; web and app experience management and creation; testing and targeting; advertising; video; audience management; social engagement; and campaign orchestration.

From Written to Digital: The New Literacy
go.nmc.org/fromwrit

Georgia State University has launched the first phase of its Digital Literacy Initiative. Honors College freshmen are provided personal digital devices, open-source content, and adaptive learning materials to develop a portfolio of work across multiple disciplines that demonstrates experiential digital learning. They are in the process of scaling the initiative to other colleges.

How to Read a Book (Video)
go.nmc.org/readabook

An instructor created a video for her Intro to Visual Media class at Abilene Christian University that describes the latest generation of books, increasingly read on mobile devices. Just because ebooks are more pervasive does not mean students understand how to best digest them. At more than 71,000 views, the video guides learners through the digital transition.

Scaling Up Digital Literacy
go.nmc.org/clem

Clemson University's Adobe Digital Studio exposes students and faculty to a variety of technologies, in a space where they can experiment, problem solve, and create. The university invested in numerous production technologies including a green screen studio with a one-button video recording system, a high-end audio recording station, and access to the full Adobe Creative Cloud.

Student Multimedia Design Center
go.nmc.org/multilit

The University of Delaware's Student Multimedia Design Center is a space within the library that houses resources to guide students through the multimedia design process as they work on their own projects, from pre-production through post-production.

UC Libraries: Ten Initiatives

go.nmc.org/uclib

University of Cincinnati Libraries has undertaken ten initiatives as part of its strategic plan to enhance digital scholarship. Efforts include creating a next-generation repository, expanding digitization, offering informatics programming to advance discovery and innovation in medical care and knowledge, and developing state-of-the-art spaces, services, and programs.

UNIV 200: Inquiry and the Craft of Argument

go.nmc.org/univ200

Virginia Commonwealth University's "UNIV 200: Inquiry and the Craft of Argument" is a blended learning course that takes students through a number of exercises, such as discovering the work of innovators in the digital realm and developing personal learning networks through the creation of websites and social media communities.

University of Delaware Summer Faculty Institute

go.nmc.org/udel

University of Delaware's annual Summer Faculty Institute focused on the evolving nature of information literacy this year, offering workshops on developing innovative assignments that promote cross-disciplinary metaliteracy and prepare students to critically engage with information by placing them in the role of creator.

University of Oklahoma Digital Learning

go.nmc.org/oudl

University of Oklahoma's Digital Learning Team offers OU Create, a user-friendly site that allows students to register a domain and use open-source applications to create a digital identity. The team also hosts an online learning platform and social network called Janux to connect learners from around the world.

University of Wisconsin-Madison Academic Technology Division of Information Technology

go.nmc.org/uwm

DoIT Academic Technology is a University of Wisconsin-Madison division that offers services, tools, workshops, and cross-institutional partnerships to support digital literacy for faculty and students.

USC Annenberg, Pioneering the New Era of Digital Communication (PDF)

go.nmc.org/uscadobe

Through the 21st Century Literacy Initiative, students enrolled in University of Southern California's Annenberg School for Communication and Journalism are learning cross-disciplinary skills. In addition to gaining a better understanding of how to create and publish content across various digital outlets, they are creating audio and interactive videos.

Webster University Announces Global Alliance with Adobe

go.nmc.org/web

Recognizing the ubiquitous nature of digital technology and its growing use across disciplines, Webster University has partnered with Adobe to roll out access to Creative Cloud for their global community of Webster staff, faculty, and students. Users may access Adobe Creative Cloud library, cloud storage, and services whether using university equipment or through their personal devices.

Recommendations

The digital literacy landscape in 2016 is a study in flux as there is little agreement about what constitutes such a literacy. Moreover, institutional responses to the challenge vary significantly. For example, librarians play a role in teaching and supporting digital literacy efforts, drawing on their information literacy background, but libraries are deemed less likely to be important literacy sites, suggesting new, even entrepreneurial roles for the traditional academic library professional.

At the strategic level, institutions are not frequently enough committed to advancing digital literacy in their underlying missions, offering little in the way of campus-wide or considered support. Instead, individuals, or at most, single departments, are the leading players in this field, leading to challenges of scale and consistency. At worst, institutions have no existing digital literacy initiative at all, which is the case for more than 36% of survey respondents.

How can these institutions act now or change their models to meet the literacy demands presented by the modern digital era? The following four recommendations are presented with the goal of advancing digital literacy across higher education:

1. Engage in Strategic Implementations

Colleges, universities, libraries, and museums need to level up their digital literacy work beyond the current state of play, which is resigned to individual units, individual persons, or nothing at all. Once pilots or trials are offered, assessed, and revised, the institution should think more broadly about wider implementation. New policies and projects are best scaled up to the entire institution because they can realize some efficiencies while mainstreaming digital literacy work. At that level, campuses are able to most effectively develop support mechanisms for growing institutional digital literacy capacity.

"A university-wide approach is needed which attempts to involve all faculty and students. Currently there are only a few faculty chosen by IT and the administrators who are asked to participate."
-NMC Higher Education Survey Respondent

Higher education leadership should look to library organizations, which have been instrumental in creating related literacy standards. The Association of College & Research Libraries' (ACRL) "Framework for Information Literacy for Higher Education," for example, provides a cluster of interconnected core concepts, which organize ideas about information, research, and scholarship into a comprehensive whole.[29]

2. Focus on Students as Makers

Colleges and universities must realize that students are increasingly producers and makers, not just knowledge consumers. They will have to create policies and practices that not only recognize, but also celebrate this historical shift. If they select the universal baseline literacy, for example, institutions should determine ways to amplify student work, such as through online exhibitions and campus presentations. Standardizing on Adobe's Creative Cloud should offer a wide range of media production and publishing tools, supported by institutional IT at scale. This will empower the creators and inspire the rest. If a campus instead prioritizes creative literacy, then adhering to this recommendation should be central to curriculum and support. Students can plunge more deeply into Creative Cloud applications, heading towards advanced levels of usage that lead to the creation of sophisticated media and products. The hope is that they will graduate with an entire online portfolio of content they have produced, making them ideal candidates for prospective employers.

Makerspaces, a rising trend in education, are helping to advance digital literacy by providing students and faculty with ample room to learn, experiment, and create with technologies. A group of US

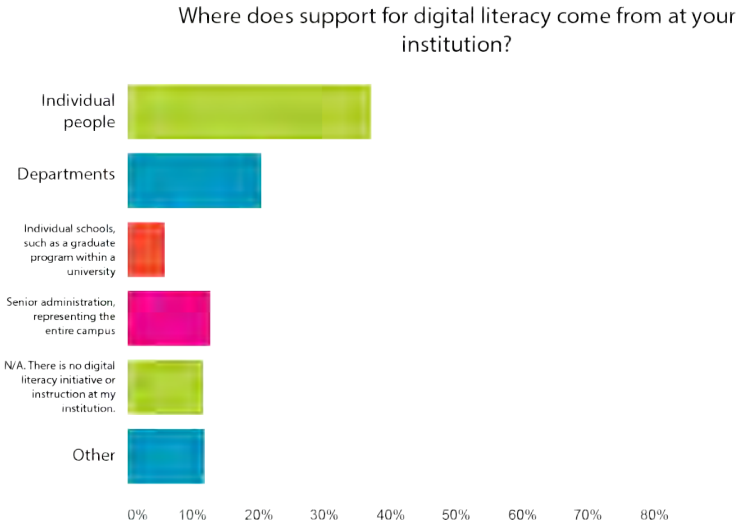
colleges and universities formed the MakeSchools Higher Education Alliance, bringing together institutions to support campus activities that advance the maker movement.[30] Their *2015 State of Making Report* reviewed and analyzed maker education across 40 campuses, noting how makerspaces have fostered the spread of active learning, cross-disciplinary approaches, and creativity in higher education — all essential for bolstering digital literacy.[31]

One example is Case Western Reserve University's makerspace, think[box], a seven-story building with each level arranged around the evolution of project development. The first floor serves as community space, with subsequent floors for ideation, prototyping, fabrication, open workspace, entrepreneurial resources, and incubator space, respectively.[32] The space has encouraged critical examination of learning environments: Jaswig, a standing desk for children, was recently prototyped at think[box].[33]

Indeed, proponents of makerspaces as a pathway to digital literacy believe they present the opportunity for students to partake in hands-on building while practicing critical thinking.[34] At the University of Texas at Austin, a biomedical engineering student used the Longhorn Maker Studio to 3D print a model of a human heart; doctors at the Seton Heart Institute now use the model in pre-surgery patient consultations.[35] Similarly, through a partnership with the Abilene Christian University Maker Lab, graduate students in the Occupational Therapy program printed and assembled 3D prosthetic hands, making modifications as they identified specific needs and patient demographics.[36]

As new technologies continue to expand the ways in which people can connect and create online, the emergence of more virtual makerspaces are a likely outcome. This concept would enable students to connect to a creation-centric environment via their mobile devices and even collaborate with peers on design and production.[37] In a blended model, the making can mostly take place on the web with physical equipment to print 3D models available on campus.

3. Build Industry-Education Partnerships



As evidenced by the NMC survey data (depicted in the figure, right), digital literacy initiatives are predominantly being spearheaded by ambitious individuals on campus who require more formal support. Technology companies and institutions should partner with leaders in industry to better understand ever-changing workforce demands for digital literacy. There must be ample and continuous conversations about digital literacy between all stakeholders. As the digital world continues to advance rapidly and education remains decentralized, it is vital to share and reflect on information. Academic leaders such as deans and provosts should explore digital literacies and implementations thereof with both academic and public libraries, local research centers, faculty, and leading technology companies. Technology companies can help lead the way by forging formal relationships with colleges and universities, providing key preliminary training to students.

In the online higher education realm, for example, Udacity and Coursera have partnered with businesses including Google and Instagram to help people informally further their education in areas

such as mobile app development.[38] These kinds of partnerships should be applied in formal education at brick-and-mortar institutions, which would also set up a direct recruitment channel for students. Regardless of strategy, student voice is paramount in these conversations as they ultimately need a clear understanding of the importance of digital literacy so they can set goals for learning outcomes accordingly.

4. Develop Smart Collaborations

Unfolding technologies and, more importantly, emergent uses and practices require new kinds of collaborations. Governments at all levels (federal, state, and municipal), public and academic libraries, museums, and cultural heritage organizations must work together, from information-sharing initiatives and online communities of practice to developing joint digital literacy projects. The US government recently announced the $100 million TechHire Initiative to provide educational opportunities for the growing number of technology-centric jobs. It is a multi-sector effort that includes software development training and paid internships with technology companies.[39] The Obama Administration also created the Digitalliteracy.gov portal for practitioners who deliver digital literacy trainings to improve the quality of these offerings.

Similarly, campus libraries must be deeply embedded in course curriculum. While libraries have always supported academic institutions, librarians can play a more critical role in the development of digital literacy skills. Historically, these types of programs have been implemented in "one-off" segments, which are experienced apart from a student's normal studies and often delivered in a one-size-fits-all method.[40] However, an increasing number of academic libraries are supporting a more integrated approach that delivers continuous skill development and assessment over time to both students and faculty.[41] This requires deeper involvement with departments and agreeing on common definitions of what capacities should be achieved, and the most effective pedagogical method. Librarians are tasked with broadening their role in the co-design of curriculum and improving their instruction techniques to work alongside faculty toward the common goal of training students to be savvy digital researchers. University of Arizona Libraries, for example, found that a key step in this transition required collaborating on a common instructional philosophy.[42]

Finally, student learning often occurs outside of the formal classroom experience; similar to the previous recommendation, external partners have an opportunity to play a stronger role. For example, a public library could provide a podcast recording space for university students; a clinic and local undergraduates could collaborate on digital stories about health care; a military base and an academic psychologist could produce web resources about the experience of battle; a state historical society could work with a digital humanities class to produce augmented reality site markers.

Recommendations for Improving Digital Literacy

Engage in Strategic Implementations

Upon evaluating digital literacy pilots in one setting, institutions must think more broadly about wider implementation and include their campus libraries in the planning and creation of standards.

Focus on Students as Makers

Digital literacy policies and initiatives must empower students as content and media producers rather than purely knowledge consumers. Makerspaces, both physical and virtual, can provide opportunities for innovation.

Build Industry-Education Partnerships

Technology companies and institutions should partner to better understand ever-changing workforce demands for digital literacy, with ample and continuous conversations that are inclusive of all stakeholders.

Develop Smart Collaborations

Governments, public and academic libraries, museums, and cultural heritage organizations must work together on developing information-sharing initiatives, online communities of practice, and digital literacy projects.

Conclusion

The current generation of students belongs to an age where being an author means understanding how to publish content online in various formats, being a scientist requires the ability to communicate complex information in visual manners, and being an entrepreneur involves sharing the business mission and story as broadly across the web as possible. In this picture, gaining cross-disciplinary digital skills is the lifeblood of deeper learning outcomes that lead to fruitful careers. Higher education institutions must play a crucial role in providing the tools and opportunities that ensure students know how to successfully deliver visual and digital communications that help them attain their goals.

While these current discussions of digital literacy center around the ability to produce rich media and web resources, the rapid pace at which new technologies are developing requires strategic planning to accommodate the social and economic needs of tomorrow. The recent emergence of more sophisticated data science, information visualizations, artificial intelligence, robotics, and virtual makerspaces calls for further thinking, digital tool development, and support from institutions and technology companies. Understanding and working with big data, for example, is an increasingly in-demand skill as institutions are tasked with training next-generation data scientists.[43] Therefore it is important to acknowledge that digital literacy definitions and models will continue to evolve.

"[Students] need to be able to adapt as situations change and be confident in moving across the digital space."
-NMC Higher Education Survey Respondent

In pursuit of advancing fluency in the long-term, the American Library Association has highlighted the evolving concept of digital literacy in light of developments in big data — vast virtual datasets that are difficult to process and analyze. Their 2015 "State of American Libraries Report" explains that big data poses new problems for academic librarians because their quantity and rate of accumulation require the development of new kinds of digital literacy skills.[44] Likewise, a researcher at the University of British Columbia published a paper that discusses the challenges and opportunities of bringing data literacy into libraries. She concludes that data literacy instruction requires cross-institution collaboration, staff training, and a comprehensive plan of action to provide continuous instruction throughout the student lifecycle.[45]

Indeed, the future of digital literacy involves continuously thinking about technology in new ways. Coding, for example, is perceived as an emerging literacy that will give students the skills to define and create the technologies of the future.[46] Institutions have recognized that coding is expanding across various research disciplines and are offering intensive coding boot camps for students. Stanford University Libraries offered four weekend trainings for graduate students. Library staff taught them how to automate repetitive tasks, program in testable ways, and track and share their work.[47]

As the notion of digital literacy is growing to incorporate new skills such as data analysis and coding, higher education leaders must stay in tune with the demands of the workforce. It is not a given that students and faculty will personally keep pace with technological developments. Advancements in artificial intelligence and machine learning, while still years away from mainstream adoption in higher education, are opening up new avenues for greater automation and more genuine interactions. Not only will the next generation of students need to understand this technology, but they will be tasked with further developing it. They need the tools and resources to imagine, design, and build.

The hope is that this strategic brief will serve as a springboard for critical discussions around how digital literacy initiatives can be constructed across colleges and universities to promote deeper learning experiences where learners push the boundaries of creativity to make something truly meaningful and contribute to the world around them — before they ever graduate.

End Notes

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