Recognizing Competencies vs. Completion vs. Participation: Ideal Roles for Web-Enabled Digital Credentials

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Abstract: Open digital badges are new credentials that can contain specific claims and links to web-enabled evidence and can circulate in networks. Badges are helping facilitate broader shifts away from measuring, accrediting, and credentialing *achievement* and towards capturing, validating, and recognizing *learning*. A study of 30 funded efforts to develop badges found that none of the efforts to develop *competency* badges (for demonstration of specific competencies) resulted in thriving badge-based ecosystems, while four of the five efforts to develop *participation* badges (for engaged participation in social learning) resulted in thriving ecosystems. The findings were more mixed for the remaining efforts to develop *completion badges* (for individuals completing projects or investigations) and *hybrid* badges (for multiple types of learning). This suggests that innovators temper their ambition for capturing and recognizing evidence of individual competencies, and consider exploring more social assessments and informal and crowdsourced recognition.

Keywords: digital badges, metadata, constructivism, participation, recognition.

Over roughly a century, the existing systems for credentialing learning via grades, transcripts, degrees, and certificates emerged alongside modern practices for assessing students, testing achievement, and accrediting schools. Because of this co-evolution, current practices for testing, accrediting, and credentialing remain opaque for many stakeholders, and many of the practices are taken for granted. This leads to problems that obstruct progress, such as the way presumed expectations of external accreditors have discouraged some schools from expanding into online courses (e.g., Parker, 2008; Gallagher, 2016) and discouraged others from allowing students to transfer in credits from courses taken online (Schrock, 2010; AACRAO, 2017).

In addition to being opaque, prevailing practices for testing, accrediting, and credentialing are analog, or have only embraced technology as proxies for analog practices. For example, while tests are increasingly administered online, most still employ the same measurement assumptions from decades ago (Timmis, Broadfoot, Sutherland, & Oldfield, 2016). Likewise, while admissions officers or hiring managers are likely to use email rather than phone calls when seeking information beyond transcripts and resumes, such individualized non-networked communication is still quite laborious. Arguably, these practices represent major obstacles for the broad embrace of the many innovative educational technologies of interest to learning scientists and educational innovators. And while the impact is less obvious, these entrenched practices also obstruct efforts to overcome the inequities that plague contemporary education in most countries (e.g., Bowen & Bok, 2016; Carnoy, 2005).

Open digital badges were introduced to address these challenges and help facilitate the shift away from testing, credentialing, and accrediting *achievement* and towards capturing, validating, and recognizing *learning*. Badges can contain detailed claims about learning, evidence supporting those claims, and links to more information like completed work, and can then circulate readily in social networks where they can gain additional meaning. Earners can curate their own collections of badges for specific audiences, and badges can be organized into learning "pathways" that allow learners, educators, and employers to envision broader learning trajectories.

Open digital badges were introduced in 2012 via the MacArthur Foundation's *Badges for Lifelong Learning* initiative. That initiative supported efforts at the Mozilla Foundation to establish the initial metadata standards that made badges *interoperable* (i.e., function across multiple platforms) and *extensible* (i.e., function in more advanced platforms in the future). The MacArthur initiative also funded 30 proposals (from over 600 submissions) to design and build open badge systems (with supplemental funding from the Gates Foundation). Together, these events led to broad media coverage in both mainstream venues (e.g., Carey, 2012) and education-related outlets (e.g., Young, 2012). By 2014, multiple systems for issuing and displaying open badges existed.

Expanded open badge metadata standards were released on January 1, 2017 and were adopted by the IMS Global Learning Consortium, the leading standard-setting organizations for educational technology. Significantly, these new standards include specifications for third-party *endorsements* (Everhart, Derryberry, Knight, & Lee, 2016). Proponents believe that these developments will allow these "e-credentials" to eventually transform education in a similar manner as consumer reviews allowed e-commerce to gradually (but inexorably) transform retailing and publishing starting around 2000.

Contrasting different uses of digital badges

Not surprisingly, digital badges have been taken up in a diverse range of educational programs and learning contexts. Some view them as ideal for motivating and recognizing inquiry-oriented and project-based learning (e.g., Cucciara, Giglio, Persico, & Raffaghelli, 2014; Diamond & Gonzalez, 2016). Conversely, proponents of "gamification" have enthusiastically embraced badges (e.g., Mallon, 2013; Metzger, Lubin, Patten, & Whyte, 2016); some have equated open badges with the movement toward competency-based education (e.g., Blackburn, Porto, & Thompson, 2016; Duncan, 2011). Meanwhile, others have argued for "learning recognition networks" consisting of badges and e-portfolios (e.g., Buchem, 2016) that appear more consistent with newer sociocultural theories of learning and motivation that provided much of the theoretical impetus behind MacArthur's broader initiative (Yowell, 1999, 2014; Brown, 2012). The various chapters in two recent edited volumes confirm the range of this diversity (Ifenthaler, Belin-Mularski, & Mah, 2016; Muilenburg & Berge, 2016).

This diversity of badge uses was represented by the 30 projects funded by MacArthur's 2012 initiative. An extended study of those 30 efforts provided some initial evidence about the apparent appropriateness of digital badges for different types of educational programs. This paper summarizes some of those findings in the context of a follow-up study that examined which of those 30 efforts succeeded in leaving behind a "thriving" badge-based ecosystem two years after the initial funding was exhausted. As will be shown, one type of badge system appeared particularly successful in this regard, while another category of badge system appeared less successful.

The badge Design Principles Documentation project

The initial study of the 30 digital badge systems was known as the *Design Principles Documentation* project. This project ran from 2012 to 2014. The project was organized to capture the "practical wisdom" (Halverson, 2004) that emerged as each of the 30 badge design efforts set out to build and implement their proposed badge system. The project first carried out a content analysis of the 30 funded proposals to identify the *intended* design principles for using digital badges to *recognize*, *assess*, *motivate*, and *study* learning. Once those projects were well underway in 2013, the DPD project interviewed each of the teams to determine which of the intended design principles had been implemented and explored the factors that supported or thwarted each principle. In late 2014, after each of the efforts had exhausted their funds, a final interview explored which of the design principles had been *formalized* and whether the badge system had been *implemented*, *partially implemented*, or *suspended*. These findings were synthesized into a set of principles in a widely distributed report entitled *Where Badges Work Better*. This report included general badge system design principles (8) and more specific principles regarding recognition (12), assessment (7), and motivation (17). Grant (2014) reports additional detailed information about these efforts.

The DPD project report also proposed a framework for organizing research of badge systems. This new framework crosses three dimensions that are relevant to studying badge systems. The first dimension is the *purpose* of the research (i.e., summative research *of* badge systems vs. formative research *for* improving badge systems). The second dimension is *sources of evidence* (i.e., conventional evidence vs. new forms of evidence provided by the contents of the badges themselves). Crossing these two dimensions results in four categories of badges research. Within each of those four categories was additional dimension of research *scope* (i.e., specific *badges*, larger badge *systems*, and broader badge-based educational *ecosystems*).

DPD follow-up study

A follow-up study was carried out in 2015-2016, at the request of a project advisor and the program officer. In late 2015, the DPD project followed up with each of the 30 efforts and searched the web and elsewhere for evidence that each system was *suspended* (i.e., no evidence that the badges were being issued), *existing* (i.e., badges might be issued but no evidence that they were being earned or shared by actual learners), or *thriving* (i.e., a functioning badge-based ecosystem where learners were earning, claiming, and sharing badges). Determining the status of the projects proved to be challenging because some of the teams were still trying to implement their badge system or establish a broader ecosystem. Ultimately, consensus was reached among the research team.

The follow-up study then explored whether the success of the various badge systems was associated with the type of badge systems in terms of the forms of learning that the system intended to motivate and recognize. Only a few of the proposals articulated specific theories of learning. Nonetheless, most of the proposals featured activities and assessments that were generally consistent with one of three widely acknowledged "grand theories" of knowing and learning. These three perspectives are rooted in more fundamental philosophies and epistemologies (e.g., Greeno, Collins, and Resnick, 1996) and are widely embraced by many researchers and theorists. Re-analysis of the original proposals and DPD interviews confirmed that most (but not all) of the 30 proposed badge systems were generally consistent with one of these three perspectives. After substantial

deliberation and additional interviews, each of the badge systems were characterized as *competency-based*, *completion-based*, *participation-based*, or *hybrid*.

Competency-based badge systems

Some of the proposed badge system designs appeared to be most consistent with "associationist" theories. These rather traditional theories (sometimes labeled *didactic* or *empiricist*) assume that knowledge consists of a relatively large number of specific associations. These views of knowledge are rooted in the British empiricist philosophy and are most strongly associated with behaviorism and its focus on stimulus-response associations (e.g., Skinner, 1953). However, associationist perspectives are well represented in the work of many cognitive scientists who focus on cognitive "if-then" associations (e.g., Anderson, 2013). Such modern "information processing" perspectives are appealing to instructional designers who worry about "cognitive load" (e.g., Sweller, Van Merrienboer, & Paas, 1998) that results when too much information is presented to learners. The DPD project concluded that badge system designs that were consistent with associationist perspectives would emphasize (a) badges for self-paced individualized mastery of specific competencies, (b) summative assessments of those competencies, and (c) external and extrinsic forms of motivation. It seemed appropriate to characterize these as *competency-based* badge systems.

Eight of the proposed badge systems were deemed competency-based. This included three proposals that received substantially greater funding as part of the Gates Foundation's Project Mastery initiative. This initiative supported K-12 efforts to implement "proficiency-based pathways," which offer "opportunities for students to engage in a learning experience where they can demonstrate mastery of content and skills and earn credit towards a diploma, certificate, or some other meaningful marker" (Gates Foundation, 2012, p. 7). These efforts included (1) *Pathways to Global Competence* from the Asia Society, (2) *LevelUp* from EffectiveSC and the Adams 50 School District in Colorado, and (3) the *Youth Digital Filmmaker Badge System* proposed by YouTopia and the School District of Philadelphia. All three of the Gates-funded projects were also examined in a comprehensive summative evaluation carried out by the RAND Corporation (Steele et al., 2014).

As elaborated in the RAND report and the DPD report, all three of these badge design teams struggled with technology, validity, and personnel issues. The Pathways to Global Competence badge system was never implemented and the other two badge systems were suspended after pilot implementations. In particular, the badge teams struggled to implement and manage the relatively massive demands for summative assessment of specific competencies from student-generated work. This included gathering all the elements of student work and presenting that work to qualified teachers or experts while keeping track of scores and competencies and representing the resulting evidence meaningfully in digital badges.

None of the other efforts to develop competency-based systems resulted in thriving ecosystems around open badges. The (4) *Sustainable Agriculture & Food System* badge system from Agricultural Sustainability Institute at the University of California-Davis proposed an ambitious degree program featuring sophisticated self-paced e-portfolios and competency badges. This effort stalled in the face of technology challenges, assessment challenges, and personnel changes; a conventional course-based degree was ultimately established. The (5) *Young Adult Library Services Association* (YALSA) succeeded in implementing an ambitious *YALSA Badges* system for youth-serving librarians. The group reported that the requirements for independently attaining and gaining expert endorsement numerous specific competencies was too much work considering the modest value of the badge, and the program was suspended. The (6) *National Manufacturing Institute* succeeded in implementing a single *Computer Integrated Manufacturing* badge within the widely-used *Project Lead the Way* STEM curriculum. The badge ultimately languished and became redundant as it only duplicated the effect of course grades. (7) The National Manufacturing Institute also proposed an ambitious badge system organized around the standardized performance assessments from by SkillsUSA for specific industry-defined competencies. However, that effort stalled when the team was unable to secure a formal endorsement for its badges from employers; without formal recognition, the vocational programs were unwilling to purchase and use the *SkillsUSA* assessments. (8) The startup ScoLab successfully implemented badges within its *BuzzMath* arithmetic drill and practice website. However, privacy concerns with their young learners precluded the implementation of web-enabled *open* badges, and their badges simply served as learning tokens within their popular gamified website.

It is worth noting that the DPD project concluded that the challenge that these efforts encountered went well beyond the decision to implement competency-based badges. Nonetheless, these findings suggest that caution is needed when developing competency-based badge systems. In particular, it seems competency-based systems should anticipate the challenges that the DPD project uncovered as well as the tensions in competency-based education (CBE) implementations reported in the separate evaluation of the three Gates' Project Mastery initiatives (Steele et al., 2014). This includes the challenges of *equating evidence from anytime/anywhere learning with conventional criteria*; *determining who can authorize credit*; *maintaining a common definition of proficiency*;

technical, financial, and logistical barriers to efficiency; and *concerns over equity*. These bolster the concerns about CBE in a report from the Carnegie Foundation (Silva, White, & Toch, 2015), while also highlighting the challenges that learning management systems present for CBE (cf. Leuba, 2015).

Completion-based badge systems

The largest group of proposed badge systems were generally consistent with "constructivist" theories of learning. This broad class of perspectives is rooted in Piaget's (1970) genetic epistemology and is associated with modern learning perspectives that emerged in the 1980s. This perspective is widely embraced by many cognitive scientists (e.g., Glaser, 1984), educational psychologists (e.g., Savery and Duffy, 1995), and teacher educators (e.g., Richardson, 2003). Constructivist perspectives embrace a rationalist theory of cognition which assumes that knowledge consists of broader conceptual schema that the human mind constructs when attempting to make sense of (i.e., "rationalize") new information in the world. Rather than numerous specific stimulus-response or if-then associations, constructivist instruction focuses on fewer "higher-order" competencies and more general competencies such as problem-solving and critical thinking.

The DPD project assumed that badge systems were consistent with constructivist perspectives when they emphasized (a) inquiry-oriented learning, typically via individual completion of projects or investigations, (b) informal formative assessments of that learning via performance and/or portfolio assessment, and (c) more intrinsic forms of motivation associated with curiosity and interest. It seemed appropriate to characterize badge systems that emphasized such features as *completion-based*.

The project concluded that 12 of the 30 proposals were completion-based. Of these 12, four resulted in badge systems that appeared to be thriving in 2015. (1) *NatureBadges* were used to extend exhibits at Smithsonian Natural History Museum using computer-based assessments in partnership with Credly. This system was later renamed *Q?rius*. (2) Intel and the Society for Science and the Public successfully added open badges into its existing Intel Science Fair curriculum and web technology. (3) The Sweetwater Foundations' proposed *AQUAPONS*, an urban aquaponics project that partially implemented a badge system in 2014; after scaling back ambitions portfolio and performance assessment goals, the AQUAPON badge system appeared to be thriving within the Chicago Project LRNG program. (4) The American Social History Project and the Educational Development Center added badges to an existing project-based teacher professional development program known as *Who Built America?* While the project was unable to implement some ambitious peer/expert performance assessments, the badge system was successfully implemented, and badges were approved for New Your City's After School Professional Development Program. Thus, of the four completion-based badge systems that were thriving in 2015, one of them (NatureBadges) relied on computer-based assessments while another (Intel) used an extensive network of existing assessment practices associated with its science fairs. The two other teams that succeeded in creating thriving completion-based badge systems both did so after scaling back their assessments.

Four of the proposed completion-based badge systems succeeded in implementing badge systems by 2014, but no evidence of a thriving ecosystem was found in 2015. This included (5) the *4-H/USDA* badges, (6) the *Starlite Academy Robotics* from Project Whitecard Inc and the Center for Educational Technologies at Wheeling Jesuit University, (7) *Planet Stewards* from 3-D Game Labs, and (8) *My Sash is an App* from the Girl Scouts of Greater Chicago and Northwest Indiana. The four remaining proposals for completion-based badge systems failed in implementing their badge systems. This included the (9) *Wilderness Explorers Badges* from Disney/Pixar, the (10) *Earthworks Rising* badges from The Ohio State University and Digital Watershed, and badge systems for (11) *Roadtrip Nation* and (12) *StoryCorpsU* from Corporation for Public Broadcasting.

While the obstacles for the eight completion-based badge systems were varied, they generally struggled to implement ambitious technology-supported performance and portfolio assessments. These assessment systems were different from the competency-based systems in that they aimed to help teachers or outside experts assess completed projects for evidence of relatively high-level student learning outcomes, typically against detailed rubrics. But this is still a time-consuming process that requires specific expertise with both assessment and the domain, and it likely requires extensive refinement. One interesting observation was that several teams reported that badges fostered transparency (and increased scrutiny) that heightened the challenges that prior constructivist assessment reforms have encountered in using performance and portfolio assessments to generate valid evidence of disciplinary problem solving (e.g., Shavelson, Baxter, & Pine, 1992).

Participation-based badge systems

A few of the proposed badge system designs appeared most consistent with sociocultural theories of learning. This perspective is rooted in the early work of the Soviet psychologist Lev Vygotsky (1980) and emerged in its contemporary form in the 1990s (e.g., Lave & Wenger, 1991). One well-known strand of sociocultural perspectives is called *situated cognition*, which reflects the assumption that knowing is strongly bound (i.e.,

"situated") in the social, cultural, and technological contexts where that knowledge is learned and used. These perspectives are strongly embraced by some cognitive scientists (e.g., Pea, 1993; Greeno, 1998). These perspectives assume that knowledge is primarily represented in social and cultural practices of groups of people, and view learning in terms of increasingly successful *engaged participation* in those social practices. One defining characteristic follows from Collins, Brown, and Newman's (1989) notion of *cognitive apprenticeship*, and the corresponding practices of modeling, coaching, scaffolding, articulation, and reflection, often accomplished within what Lave and Wenger (1991) characterized as a *community of practice*. Sociocultural perspectives were influential in MacArthur's Digital Media and Learning initiative from which open digital badges emerged (i.e., Yowell & Smylie, 1999; Chaplin, 2014). The DPD project concluded that proposed badge systems were consistent with sociocultural perspectives when they emphasized (a) badges for engaged participation in social learning and completion of collaborative projects, (b) peer and "crowdsourced" assessments, and (c) social and cultural forms of motivation. The team decided that it was appropriate to characterize such badge systems as *participation-based*.

The DPD project concluded that five of the 30 efforts resulted in participation-based badge systems. In 2015, evidence showed that four of these five systems were thriving. (1) The *Supporter to Reporter* (S2R) badge system was proposed by MakeWaves in the United Kingdom for its existing youth sports journalism network. S2R had already developed a sophisticated website that included extensive networked peer endorsement and discussion of learner projects (mostly videos). The badges were awarded for completion of projects, and most projects were completed collaboratively by cohorts of students, with particular attention directed at teamwork and cooperation. In 2016, MakeWaves parlayed their success into a standalone open source badge and content management platform known as *Open Badge Academy*. MakeWaves and the platform were acquired by the Cities and Guilds Group, the leading vocational training and credentialing organization in the UK.

(2) The PBS News Hour *Student Reporting Labs* (SRL) badge system was similar to S2R in that it layered badges into an existing curriculum and website for secondary students who completed web-based news articles and videos. The program placed particular emphasis on building communities of learners, both within the participating schools as well as across schools via its website. A sophisticated badge system was implemented in 2013, including a feature whereby the high-level badges were ultimately approved by a producer at the local PBS affiliate. The badge system and program were still thriving in 2015, with over 300 *SRL Superstar* badges issued and the introduction of a new STEM badge, and some badge earners were getting internships at PBS stations.

(3) The badges system at *Mouse Inc.* was proposed to recognize middle and secondary students learning of network and computer management skills by supporting the technology help desk and network managers at their school. The badges that were layered into its existing web-based program included a *Community Win!* badge specifically designed to recognize engaged participation in the Mouse network. The program organized cohorts of students known as "Mouse Squads" to complete workshops and projects together. A sophisticated tracking system allowed each squad to keep track of its collective progress. The badge system was successfully implemented in 2013, and there was ample evidence that the program and the badge system were thriving in 2015.

(4) The *Cooper-Hewitt Design Prep* badge system was proposed by a partnership between the Smithsonian National Design Museum and Cooper-Hewitt School of Design. The teams proposed to layer badges into Cooper-Hewitt's existing DesignPrep program and website. Their goal was helping students from underserved schools in New York gain design, collaboration, and presentation skills while developing a portfolio of designs for their applications. The initial badge system that was implemented in 2012 consisted of competency badges focused on discrete skills and accomplishments. However, few earners claimed their badges; interviews revealed that students were more interested in "pre-professional" badges that focused more on their professional roles. The badge system was revised to offer participation badges. In 2015, the new badges were featured on the new DesignPrep website and were being offered in ongoing programs. While the badges were not as widely claimed and shared as the three previous projects, this evidence appeared sufficient to characterize the system as thriving.

(5) Design for America (DFA) proposed to add badges to its interdisciplinary network of students in engineering and learning sciences at Northwestern University focused on positive social impact by using the needs of community members to inform the design and implementation of "social impact" projects. They succeeded in implementing its *Digital Lofts Badge System* in 2013 and were awarded an NSF Cyberlearning Grant to expand badges and other features of the Digital Loft. While DFA and the Digital Loft certainly appeared to be thriving in 2015, no evidence was found that the badges were still being used. The DFA badge system was deemed *existing*.

Hybrid badge systems

The five remaining badge systems proposed issued two or even three types of badges. Some systems even issued badges that did not fit into any category The research team decided that it was appropriate to characterize them as *hybrid* systems. (1) The *Computer Science Student Network* (CS2N) was a collaboration between Carnegie-Mellon University (CMU) and the Defense Advanced Research Projects Agency (DARPA). They intended to

develop educational systems for computer science and other STEM fields for diverse learning groups ranging from middle school students to adult learners and hobbyists. They intended the badge system to serve as a guided pathway for learners to acquire skills in robotics, computer science, and related STEM content areas using ambitious artificial intelligence systems designed to track and develop learners' progression throughout the program. CS2N included competency badges in robotics and artificial intelligence, completion badges for critical thinking in computer science, engineering, and robotics, and participation badges for some networked social activities. The badge system was only partially implemented in 2014 in the face of challenges associated with automatically awarding competency and completion badges. But further funding and development resulted in a thriving badge-based ecosystem in the Carnegie Mellon CS-STEM network and affiliation with Cities of Learning and Project LRNG.

(2) The Providence After School Alliance (PASA) partnered with after school and extracurricular programs to offer learning experiences to middle and high school students. PASA collaborated with Achievery Inc., a badge-based startup. The effort developed a badge for diverse after-school activities, including self-paced, competency-based activities, cohorted courses, and collaborative projects. A sophisticated attendance tracking and assessment system allowed students to earn course credit for work completed in the after-school programs. As was announced in the national educational media (Ash, 2012), PASA and Achievery successfully implemented its badge system in 2012 and students did indeed begin earning course credit for after school projects. However, the final DPD interview and a detailed ethnography of the program (Davis & Singh, 2015) found that the students felt that awarding of formal credit interfered with and undermined the value of the badges. While the badge system still exists, PASA stopped issuing badges in 2014, and Achievery suspended operations in 2015.

(3) The School District of Philadelphia proposed the *Leverage for Digital On-Ramps* badge system as part of an ambitious program to prepare urban high school students for entry into college and the workforce. They intended to add badges to the Philadelphia Academy's Post-Secondary and Career Readiness Course, a developmental multi-year course designed to provide 21st century and college readiness skills. The courses and proposed badge system included features that were consistent with all three perspectives, including competency-based programs, individual and group projects, problem solving activities, and face-to-face and networked social interaction. The badge system was partially implemented in 2014 but was soon suspended. This effort laid important groundwork for subsequent participation in Cites of Learning project and Project LRNG.

(4) Microsoft proposed to add open badges to its *Partners in Learning Network* (PiLN) for educators and school leaders to promote technological competencies and relevant digital networking skills. PiLN aimed to equip educators with the capacity to teach information and communications technology and 21st century skills. The network included self-paced competency-based activities, cohorted workshops, problem solving activities, and extensive social interaction. While an internal badge system was implemented in 2014 and the network appeared to be thriving in 2015, technology constraints with the existing network prevented PiLN from implementing sharable open badges, and their badges served only as internal tokens within the network.

(5) *Badges for Vets* aimed to connect civilian employers with veterans by translating their skills directly to the workplace. However, veteran organizations and agencies did not cooperate as originally envisioned, preventing the envisioned ecosystem from being established. Rather, the new website took on a social networking function as veterans began to connect with one another. The act of translating military skills to civilian work-ready skills seemed to call on practices that were consistent with multiple perspectives but did not really align with any assumptions about knowing and learning. While a badge system was partly implemented in 2013 and apparently still exists, their badges were never awarded to actual earners.

Discussion and conclusions

Many factors were at play in establishing badge systems that continued to thrive after the initial funds were exhausted. But the challenges of assessing individual competencies or completion of projects were clearly a significant factor. The broader conclusion here is that badge systems that emphasized mastery of numerous specific, measured competencies or project completion towards external credit or recognition appeared to overwhelm the assessment capacity of their broader educational and professional contexts. These challenges seemed to be enhanced with self-paced and individualized learning because they eliminate some of informal assessment that occurs naturally with cohorts of learners. As assessment experts like James Popham (e.g., 1997) have long argued, assessing completed artifacts for evidence of specific competencies and/or higher-order problem solving skills can be remarkably difficult. Doing so requires substantial knowledge regarding (a) the targeted disciplinary competencies, (b) how the competencies can be represented in artifacts, and (c) how those artifacts were created.

To summarize, assessment was a major challenge for the seven competency-based systems that failed to thrive, while the one that did thrive issued an automated non-open badge; the four completion-based badge

systems that were thriving either built on existing assessments or significantly scaled back their assessments of completed projects; the one thriving hybrid open badge system used automated computer-based assessments for their competency and completion badges. These findings lead to the conclusion that **badges work better … where expectations for assessment of individual skills and competencies are modest and manageable**.

To varying degrees, all four types of badge systems included various forms of social interaction among learners. However, those interactions were only emphasized in the participation-based badge systems, and were mostly represented in the other types of badge systems as peer-assessment of individual competencies or projects. The fact that four of the five participation-based badge systems appeared to be thriving and that one led to an entirely new badging platform that is gaining wider use leads to the conclusion that **badges work better … where learning, recognition, and assessment is primarily social**.

To reiterate, the competency-based and completion-based systems aimed to award badges for evidence of specific competencies or more conceptual understanding. In contrast, the participation-based badge systems awarded badges for successful participation in workshops, apprenticeships, and courses, typically with cohorts of other learners. Importantly, most of these badges *did* include claims of specific competencies or higher order skills. But, rather than directly assessing those competencies or understanding, these badge systems left it up to educators or experts to make the judgement that someone who completed the particular program, activity, or course had demonstrated those competencies or understanding. This leads to the conclusion that **badges work better … when awarded for completion of workshops, course, or projects, rather than specific competencies or knowledge**.

Finally, it is important to distinguish between badges awarded for engaged participation in the social practices of learning and badges awarded for mere attendance, which are sometimes inappropriately labeled as "participation badges". Kyle Bowen of Purdue University coined the term "carpet badging" to refer to such practices, while Serge Ravet (2015) characterized this practice as "spray and pray." The widespread practice of awarding such badges for attendance at educationally-oriented conferences started around 2013 and seems to have broadly undermined the value of badges for many potential stakeholders.

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