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Research

Do More Micro-credentials Equal Better Grades?

A Study of Information Literacy Digital Badges and Student Course Grades

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This study investigates the impact of information literacy digital badges on student course grades. Despite the growing popularity of digital badges in higher education, empirical evidence regarding their effect on academic performance remains limited. This research aims to fill that gap by analyzing the relationship between badge earning and student success, addressing the overarching question: What is the impact of badge earning on student course grades? The study utilizes data from over 900 students who participated in the digital badge program, which offered information literacy badges as co-curricular activities. The data analysis examined correlations between the number of badges earned and student grades, as well as differences based on gender and class standing. The findings indicate a significant positive correlation between earning at least one digital badge and higher course grades. The study's findings support the potential of digital badges as a meaningful tool for enhancing student learning and success.

Introduction

Digital badges are a form of micro-credential that serve as a virtual representation of a skill or learning which simultaneously serve to verify and showcase the accomplishment (see Figure 1). There are many unique aspects of digital badges that make them a favorable educational tool, but one hallmark is that they are typically not offered for academic credit. Rather, they complement more traditional learning by highlighting niche or highly desirable skills to make a job applicant more marketable, for example. Another hallmark of digital badges is the metadata generated by earning one, such as the date earned, the issuer, and the evidence submitted by the earner themselves, which can be outward facing and displayed for others to verify, review, and discover on networking sites like LinkedIn. This metadata makes digital badges both data rich and highly transferable to other systems.

Figure 1
An example of a digital badge image

Although they have been slower to take hold as a well-recognized form of learning than originally predicted, the popularity of digital badges and micro-credentials has increased significantly within the last few years (Tenenbaum, 2023). This is in part due to a convergence of adoption in industry by companies gearing micro-credentials toward their own employees to create new career and promotional pathways, as well as adoption by education fields to better prepare learners and fill skill gaps, especially of college graduates entering the work force. Walmart offers a prime example of corporate adoption of micro-credentials for skills development. The company has built a skills-based training program, called Walmart Academy, using digital badges (Trainor, 2021).

In 2013, librarians at Penn State University foresaw a strong use case for digital badges as a pathway to increase learning around information literacy skills for undergraduate students. After creating an initial set of digital badges underpinned by the Association of College and Research Libraries' (ACRL) *Information Literacy Competency Standards for Higher Education* and, later, the *ACRL Framework for Information Literacy for Higher Education*, as well as Raish & Rimland's nationwide survey of employers (2016), two of the co-authors launched a pilot program to test digital badges as a mode of delivery for information literacy instruction.

Between 2016 and the end of 2019, development of the digital badge program and efforts to integrate information literacy skills into relevant courses was steady, as were efforts to analyze the data that this system was generating. As with many projects of that time, the digital badge data analysis at Penn State was slowed significantly by the COVID-19 Pandemic in early 2020. While the situation presented several hurdles to progress and continuity – including the departure of associated graduate assistants – the body of data produced and assessed is worthy of deeper analysis.

Literature Review

Library Impact on Student Learning

There is a strong body of research that notes the value of academic libraries to student success, retention, and learning. Frequently, factors such as resource use, gate traffic, and borrowing have been used to measure the impact on student learning and success (Stone and Ramsden, 2013). Within the scope of student experiences, "the library is in a unique position to bridge the academic and social pieces of the college experience…academic libraries could

capitalize on this role by providing these opportunities through meaningful co-curricular programs that extend beyond the classroom" (Eshbach, 2020). Montenegro et al. found that, generally, use of library resources has an impact on student grades, but not all resources have impact. Their analysis also indicated that undergraduates were more likely to interact with library resources later in their academic careers (2016).

As noted by one empirical research study, students who utilize academic libraries during their first year have a higher cumulative GPA and retention over peers who do not (Soria, Fransen, and Nackerud, 2013). Another exploratory study found that the value of undergraduate library experiences positively relates to student achievement in select areas and provides a positive learning environment for students (Kuh and Gonyea, 2003). Soria utilized existing survey data to assess the importance that students place on libraries and associated research activities, finding that overwhelmingly students consider access to libraries essential or important while many participants also noted the importance of learning research methods (2013). Wong and Webb note that many library assessment practices are not sufficient to demonstrate a relationship between library usage and student academic performance and therefore recommend more empirical research should be conducted by libraries (2011).

Digital Badges and Student Learning

Digital badges can offer specific evidence about learning and skill development with certifiable information that recognizes learning that is not always gleaned from graded experiences and, as such, provide increased potential for learner motivation and empowerment through validation (O'Byrne et al., 2015). Their development emerged as part of gamified applications to meet the needs of self-directed learning across all education levels (Gish-Leiberman, Tawfik, & Gatewood, 2021). Badges have been considered to address the concern about how to differentiate students' learning experiences and achievement and demonstrate the value of those formal and informal experiences for future jobs (Besser and Newby, 2019). Badges afford flexibility for content creation, including multimedia delivery and interactivity, which may benefit a wide audience of learners (Gallegos et al, 2022).

One study suggests that using digital badges as an assessment model in a course benefitted the learners with high expectations but was found to potentially disenfranchise learners with lower expectation values (Reid et al.,2015). Mah suggests using digital badges for generic skills, such as study skills, as a predictive model for student retention because there are demonstrated studies indicating a relationship between these skills and student retention, but recommends further study around student retention and digital badges (2016). Additional analysis shows that first year student success may be increased by assessment through digital badges that measure their adaptation to higher education academic requirements (Mah & Ifelnthaler, 2019). A systematic review examining digital badges' efficacy in terms of student outcomes noted that "the literature appears to support the early predictions that digital badges positively impact learner engagement and motivation" (Roy & Clark, 2019).

In terms of badging in specific discipline contexts, one study reports that nursing students' achievement of digital badges appeared effective in terms of motivation to complete the learning experience, but the researchers indicate that further investigation is required to understand the learner motivations for more applications (Foli et al., 2015). In a more general context, similar findings from exploratory studies that indicate a relationship between earned badges and student grades are present but ultimately point to the need for more large-scale empirical studies to examine the use of badges as assessment tools (Fanfarelli and McDaniel, 2017).

Digital Badges and Information Literacy

Libraries have been implementing digital badges into student teaching and learning to articulate skill development and bring visibility to information literacy skill development (LaMagna, 2017; Ippoliti and Baeza, 2017). Badges have also been used to formalize information literacy programs in the broader curriculum, which has shown

an added benefit towards institutional accreditation at one university (Rodgers and Puterbaugh, 2017). As interest in digital badge use among librarians has increased, efforts in information literacy badging have also extended to high school curriculum (Boyer, 2018).

To contextualize the value of information literacy beyond higher education, researchers surveyed employers to understand how a library issued digital badge would be perceived. Results noted that information literacy is a valued workplace skill and in general employers are interested in tangible demonstration of student skill development (Raish & Rimland, 2016).

A common interest in academic libraries is integrating digital badges into first year student curriculum, ranging from general (Peacock et al., 2020) to writing (Rodgers and Puterbaugh, 2017) to business (Pothier, 2020). These case studies focus on where in the curriculum information literacy may be a good placement, particularly with the addition of a digital badge. Other studies have indicated a need for further research on the motivations for learners earning information literacy badges and to track student learning outcomes (Tunon et al., 2015).

As the use of digital badges in library teaching and learning, particularly information literacy, continues to develop, librarians have expressed interest in stackable badges to demonstrate skill development while helping the learner to articulate their individual skills and how they relate more broadly (LaMagna, 2017; Rimland & Raish, 2017). Rimland & Raish note that stackable badges in libraries can create opportunities for flexible learning pathways (2019). Librarians may also see digital badges as an opportunity to sustainably structure work to address time management challenges (Young, 2024).

The literature indicates a growing interest in using digital badges in academic libraries as a pathway to support student learning and adoption of digital badges beyond libraries. The literature on digital badges to support student learning in library settings is frequently focused on value and implementation. One study indicates that students have positive attitudes towards digital badges, noting that badges helped both their learning and motivation (Watson et al, 2023). More research studies demonstrating data on how student learning occurred in these scenarios is needed.

Project Background

In an initial pilot, information literacy digital badges were offered within the context of relevant credit courses, and undergraduate students completed them as assignments or for extra credit. Many, but not all, of these partner courses were introductory-level general education courses in which enrollees were primarily first- or second-year students. These foundational courses include notable writing and research projects that require beginner level research skills and are the audience for whom the information literacy digital badges were designed. At Penn State Libraries, information literacy skills are baked into these foundational level courses rather than offered as a separate course. The study also included upper-division courses within the Earth and Mineral Sciences college, which joined thanks to early adopter instructors wanting to use the digital badges in their courses.

Once the pilot program proved successful, as evidenced by survey feedback from students and instructors about their experiences, as well as repeated requests by a growing number of instructors for inclusion in the pilot, the Information Literacy Digital Badges program was in full swing and adoption of the digital badges into credit classes steadily increased. More background and context about this program was covered in an *American Libraries* article in 2019 (Rimland). To date, more than 15,000 badges were earned by over 6,000 Penn State University students, in over 200 sections of various courses at multiple campuses. More information about badge titles and descriptions can be found at sites.psu.edu/informationliteracybadges/psu-il-badges/.

The program utilized 25 trained volunteer evaluators who assessed over 37,000 badge steps, with evaluators selecting tasks based on their expertise. To enhance efficiency, an early AI system was developed using funds from a

2018 competition win. This AI tool triaged student submissions by comparing them to past successful entries, providing evaluators with an initial score to streamline the review process. Later, an autofill feature was added for common responses on popular badges, though human evaluators retained final verification authority.

Problem Statement

Several years into this successful digital badge program, the authors were inspired by the work of ITHAKA S+R around student data, as well as the University of Minnesota's work in learning analytics and the impact of library resources on undergraduate learning, which explored the impact of library resources on undergraduate academic success, including degree completion (Soria, K.M. et al., 2017; Slade, 2016). Because information literacy badges help students build needed competencies and skills, and because digital badges are inherently data rich, the authors saw the potential to conduct a deeper analysis of the badge data at the University Libraries. The authors saw two ways this could be achieved—by analyzing the badge data in combination with library use and course grade data—to gain some sense of the badges' impact on learners' academic habits and success. The research study presented here is limited to the influence of information literacy digital badges on student grades.

Early digital badge program assessments at Penn State University demonstrated that the students and instructors who participated in the digital badge program expressed largely positive experiences, but the early analyses did not objectively study the information literacy digital badges' influence on student performance in the courses where used. Combined with the inspiration from colleagues doing work in this area, the metadata from the digital badges, plus relevant data which could be obtained centrally from the university registrar, the authors formulated the following research questions for this study. Please note that a graduate student helped form the research questions as part of the team. In the graduate students' training and coursework in statistics, they were trained to formulate narrow research questions so they can more easily be analyzed. Based on the data that was available, the graduate student recommended the following research questions:

1. Do badges-earning behaviors have an overall impact on student grades in a course, irrespective of the gender and semester standing of the student and the number of badges completed?
2. Is there a significant difference in the impact of information literacy badges on student grades in a course based on the gender of the student, irrespective of the number of badges and student semester standing?

This study's overarching research question was considered: What is the impact of badge earning on student course grades? The researchers attempted to control other factors that might influence this such as gender and class standing in developing the stated research question.

The research presented here faced some limitations, which are discussed in depth in this paper's Limitations section. First, the research questions were developed based on the data that was available at the time of request from the assisting university entities. Three data sets were used, thus analysis was limited by what could be successfully cross-referenced, as well as what was collected by those entities. The data analysis provides the means to correlate student grades to badge earning, but does not enable the researchers to conclude that earning badges causes students to earn better course grades. The study results had to be approached through this lens.

Continuity was also a challenge, especially given the COVID-19 pandemic. Work on this study had to pause while more urgent matters were attended to, and graduate assistants who were integral to the data gathering and assessment graduated from the university.

Methodology

A research team comprised of the digital badge program's founding leaders, the library instruction coordinator, and a graduate research assistant from the field of data analytics conducted the investigation into the two articulated research questions. To accomplish this, the research team collected and analyzed the records of badges attained and course grades earned by Penn State students who used the badge system and earned badges as part of a class for 295 different course sections or groups. The courses included both residential and online courses and some were offered at multiple campus locations. Some of these partnering courses included:

- English 15 - an introductory rhetoric and composition class offered both online and residentially at multiple locations
- Communication Arts & Sciences 100 - a required effective speech class offered both online and residentially at multiple locations
- Information Sciences & Technology 110 – a first-year seminar with multiple campuses participating
- Biobehavioral Health 146 – a first-year seminar in residence
- Earth & Mineral Sciences 302 and Geography 432 – online upper-division Earth and Mineral Sciences courses
- Online students participating in a virtual orientation where the badges were included as an activity

The badges were either assigned or offered as a recommended activity, during the two academic years of 2016-2018 with instructors having liberty to award points or credit as they saw fit.

It's important to note how the badges offered in this program were structured pedagogically into two sets. One set of 10 badges called the Information Literacy Badges addresses information literacy skills based on the ACRL Framework and covers skills and concepts related to searching for information, information ethics and citations, and evaluating information. A second set of 5 badges called Library Connection were designed with online learners in mind and address orientation-level services that the library offers such as requesting course materials, how to access library resources in the LMS, and using course reserves. Instructors were at liberty to choose which badges they assigned to their students in their classes based on the course assignments and what skills were most important to teach. Librarians were also consulted to help match the best badge to the course's desired outcomes.

After securing Penn State IRB approval, the determination was this was a non-human, non-research study and therefore wasn't assigned an IRB number, however it was given an internal study number of STUDY00011313. The researchers worked with the university registrar to securely obtain a dataset that included the student IDs, majors, campus, enrollment status, gender, grade, and semester standing. Meanwhile, the researchers retrieved the records of students' earned badge title(s), date(s), and semester in which badges were earned from the digital badge system. These two datasets were then merged by an honest broker from the library's assessment unit (someone with no stake in the research) to create a unique ID for each student. The honest broker then de-identified the data to protect the students' private information. Only after this step did the honest broker share the fully merged dataset with the research team.

Four primary data sources are used in this research:

- badge system records of students who earned information literacy digital badges, including which badges they completed,
- students' end-of-semester course grades for the course in which they earned at least one badge which was provided by the university registrar,
- demographic data of student badge earners (gender, class standing) some of which came from our instance of Sirsi's Blue Cloud Analytics, and
- course rosters for the classes using the digital badges.

The dataset from the badge system included 970 students who earned at least 1 digital badge and had a record in the registrar's database for the 2016-2017 and 2017-2018 academic years. The registrar's dataset included grades for all students in a course where a digital badge was offered during the study's timeframe, including those who didn't earn a badge in the course. To analyze the data, the graduate assistant used the Python Scientific computing package by SciPy. Python SciPy is a widely used package for scientific statistical computing, which made it a natural choice for this project (see scipy.org/).

First investigated was the correlation between the number of library badges a student earned, irrespective of the student's documented gender, and their final grade earned in the class which employed the digital badges. The researchers examined the earning of information literacy badges and compared the relationship of the number of badges a student earned and their final course grade within male and female subgroups respectively. The researchers used the t-test to determine whether there was a statistically significant difference between the grade performance of male and female subgroups of badge earners.

The second research question involved the impact of badge-earning on student grades in a course, regardless of the student's gender and semester standing, and the number of badges completed. Note that 32 different badges were offered to students during the study, but only 16 badges yielded enough data to review the correlation between course grade and badge completion. The reason for the difference in the number of badges used in the analysis is that some badges' content was modified slightly from the original versions to tailor them to individual classes that had relatively few students in the course.

Findings/Results

The Relationship Between the Number of Badges Earned and Student Grades

To investigate the relationship between students' course grades and the number of badges they earned, the researchers assigned a score to each of the possible assessment levels as follows:

- 'Withdrawal,' 'Late Drop,' or 'Fail': 0
- 'D': 1 (60-69 %)
- 'C-': 2 (70-72 %)
- 'C': 3 (73-75 %)
- 'C+': 4 (76-79 %)
- 'B-':5 (80-82 %)
- 'B': 6 (83-85 %)
- 'B+': 7 (86-89 %)
- 'A-': 8 (90-93 %)
- 'A': 9 (94-100 %)

Note that at Penn State, "Grades are assigned to individual students based on the instructor's professional judgment of the student's scholastic achievement. Instructors should provide written (paper or electronic form) notification of the basis for grades to students on or before the first class meeting" (Penn State, n.d.). This means there is some latitude given to instructors for grade breakdown; however, the typical breakdown by percentage is given above next to the course letter grade. In the data set, there were 4,991 records returned from the University's Registrar with grade information attached. Records where the course was late dropped or no grade was indicated for the course were removed prior to the analysis.

Researchers then created a plot to examine the correlation between the number of badges a student had earned and their course grade (see Figure 2), where 0 corresponds to an F and 9 corresponds to an A. A grade between 6 and

8 on the plot would represent a grade between a B and an A-. It should be noted that among all the 32 badges offered, only the 16 information literacy badges shown here provided enough data to assess correlation between badge completion and course grade.

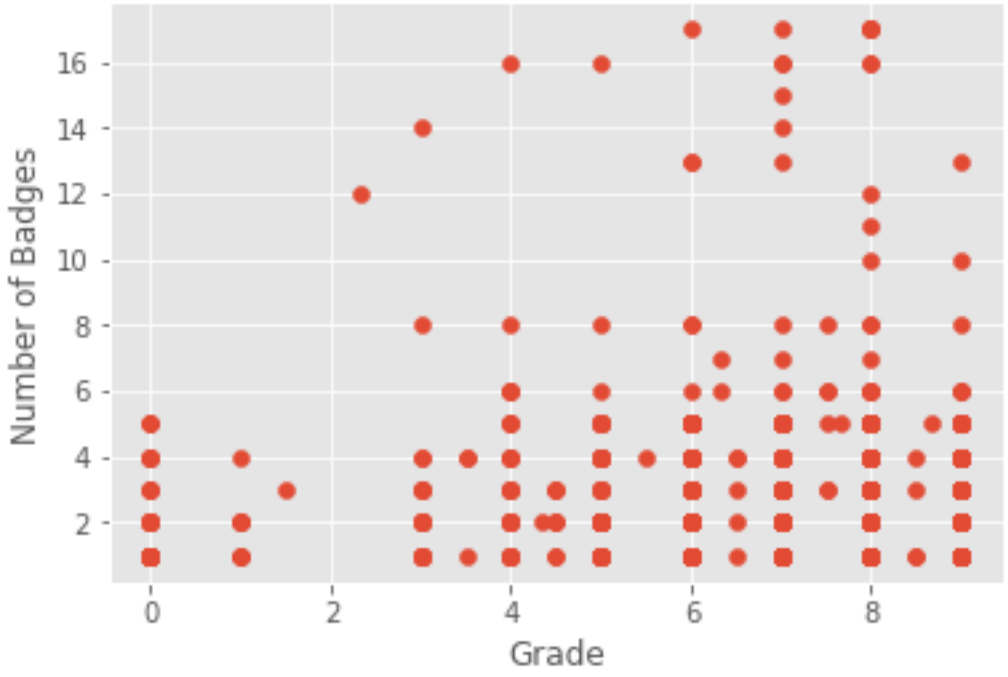

Figure 2

Correlation between student final course grade

The data show that the students who earned at least one badge achieved a significantly higher course grade than those who did not earn any badges ($t = -10.27$, $p = 0.00$). However, among students who earned badges, there is no evidence that earning multiple badges correlates to higher grades. In instances where a student earned more than one badge, the correlation between the number of badges earned and the course grades earned is very low and statistically insignificant (-0.016).

As part of this project, students may have completed one or more of 32 different information literacy badges. These range in topic from evaluating credibility, to using virtual reference service, to understanding the library's information delivery systems such as inter-library loan. To determine whether any of these badges had an extraordinary influence on student grades, the previous analysis was repeated using the separate data sets for each badge the students completed. This analysis supported the finding that there was not a strong correlation between completing a particular badge and the student course grade. This finding was also supported when the researchers examined the completion of each individual information literacy badge in correlation with student course grades. Figure 3 shows the measured correlations between completions of each individual badge and the course grades of the students who completed that badge. Again, this figure reflects data from the 16 badges that provided enough data to assess correlation between badge completion and course grade. Overall, there was no demonstrated strong correlation between earning a particular badge and achieving a high grade for the course in which the badge was offered. The highest correlation score was 0.28 for the Organizer of Information: Organizing Projects badge, which is a weak positive correlation.

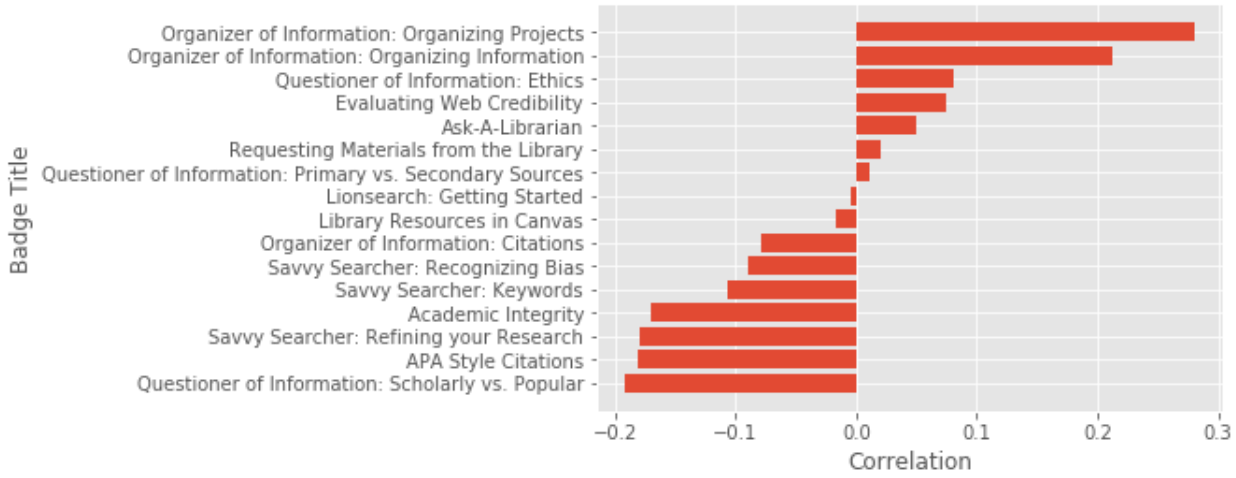

Figure 3

Correlations of 16 specific information literacy badges earned by students to their grades

Badge Earning and Grades by Student Gender

Female (2,241) and male (2,250) students in the research study, as identified in the data received from the registrar, appear to have followed the same trends regarding badge earning and grades. The researchers found no significant correlation between the number of badges earned and course grades for identified female (0.012), or male (0.011) students (See Figure 4). As in Figure 2, 0 corresponds to an F and 9 corresponds to an A.

Figure 4

Correlation between student final course grade and number of badges completed for male students

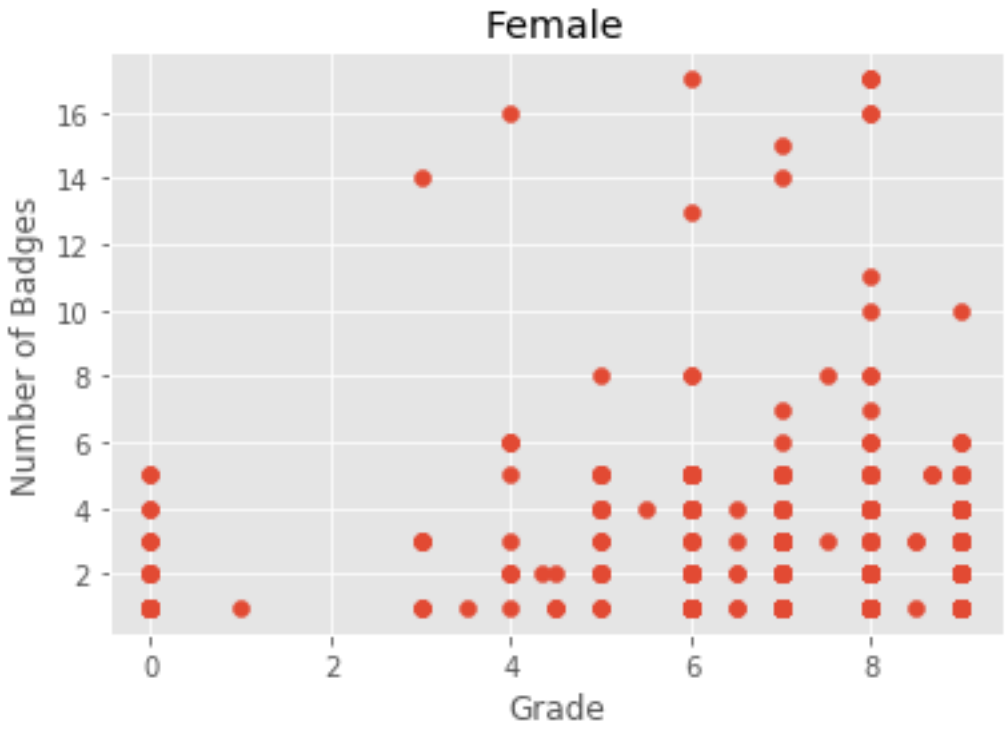

Figure 5

Correlation between student final course grade and number of badges completed for female students

Badge Earning by Student Class Standing

While the combined study data indicated no correlation between a student's gender, badge completion, and grades over the academic year, taking student semester standing into consideration painted a different picture. The semester standing is a snapshot in time of the total population of badge earners in this study, including those who didn't earn any badges or dropped the course. However, this is tricky data to work with because a student's semester standing may not clearly represent their learning progress for a variety of factors, such as not being continuously enrolled in the university, taking a low or high number of credits in any given semester, or other factors. Although many of the students in the study were earning badges in introductory, general education courses, this does not mean they were first-year students. Therefore, instead of class standing in this study, the authors used the students' start semester as a better but still imperfect proxy for class standing. From the Blue Cloud Analytics (BCA) system, the authors matched a student's start date at the University with the timing of taking the course where badges were offered. Remember that this study reviewed courses that offered badges where badges were either assigned or offered as a recommended activity, during the two academic years of 2016-2018.

The breakdown by start date for students in the study, based on registrar data is as follows:

Table 1

Breakdown by start date of the number of students in the study based on registrar data. Source: Authors

BCA Semester Start	Student Count
Fall 2016	136
Spring 2016	350
Fall 2017	2287
Spring 2017	231
Fall 2018	1715

It should be noted that the count used the data from the registrar rather than from the students who went on to complete badges in the course. Using this count, one can generalize and say that most students earning badges were likely in their first or second year at the University, but certainly not all. Significant differences were observed for the statistical relationship between a student's gender and university standing (years), course grades, and number of badges earned ($p = 0.00$). For example, female students who started at Penn State University in Spring 2017, earned a significantly higher number of badges than male students of the same start semester (Figure 5). Male students who began at the university in Spring 2016, completed more badges than female students who started at the same time. The other classes represented do not show as much difference between male and female students' badge earning.

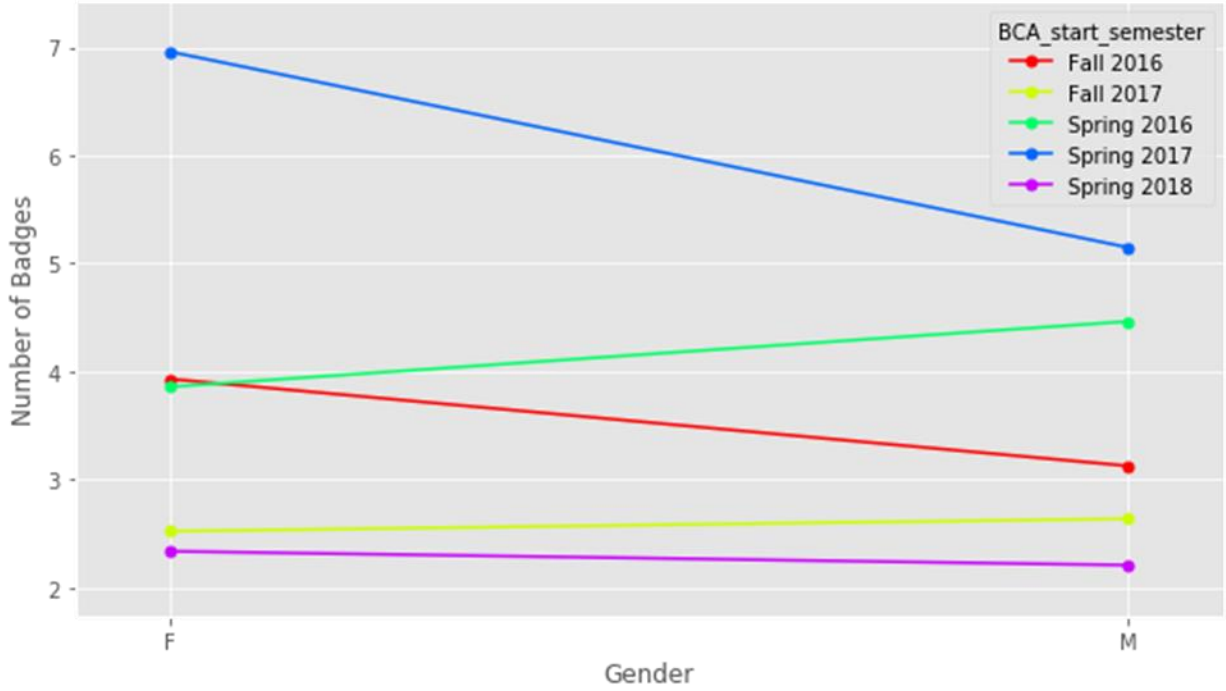

Figure 6

Number of badges earned by male and female students, according to college start semester (class standing), as generated by Blue Cloud Analytics (BCA)

Researchers also analyzed student course grades earned by both male and female students, according to the semester they started attending Penn State (a proxy for class standing). Although the grades of female students are higher than male students' in general (Figure 6), the grade difference for students who started college during the Spring 2016 semester is greater than for the other semesters.

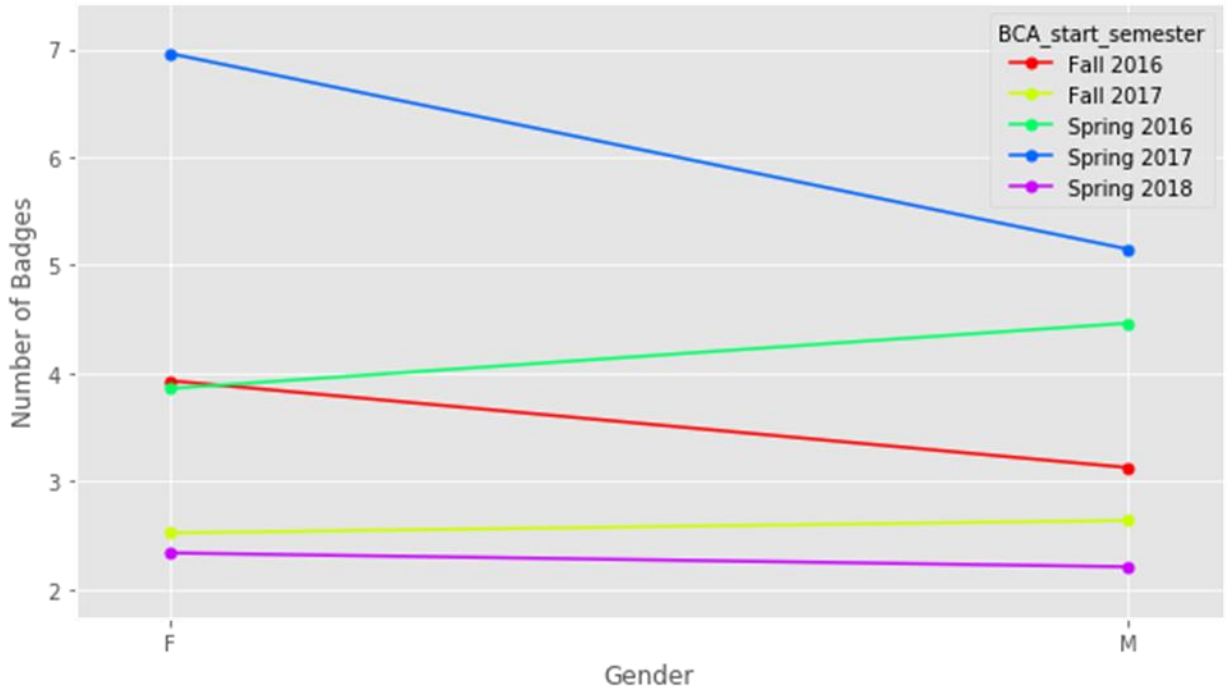

Figure 7

Graph plotting course grades earned by male and female students according to their college start semester

Limitations and Qualifications to Findings and Data

It must be noted that like many other research and scholarly pursuits during the last few years, the Covid-19 pandemic had a significant effect on this project as well. Also, the pandemic had a ripple effect on related work areas beyond research progress, which caused additional publication challenges. In this case, aside from the initial disruption that the pandemic caused to everyone's workflow and capacity, the researchers were also challenged indirectly by changes in personnel when two of the major collaborators on this project moved on to other opportunities and the remaining personnel took on new roles and responsibilities. As a result, the authors were initially unable to have much forward motion until they could regroup and garnered a new collaborator. Thus, the age of the data in this analysis is not ideal and represents a snapshot of the landscape at the time. However, it serves as a basis of comparison for future research in which to contrast future findings.

One of the biggest caveats to our findings is one that is frequently true in much research—that only correlation can be shown between higher grades in a course and completion of an information literacy digital badge. However, correlation does not amount to causation and the authors cannot say that working on information literacy digital badges causes students to earn higher course grades. Additionally, it must be noted that our findings did not show that earning multiple badges in a course had any kind of an amplifying effect—meaning that more badges earned didn't seem to equate to an additional increase in a course grade. Like much of learning analytics (Oakleaf, 2018),

behaviors of students can be tied to higher grades generally, but cannot be pinpointed to being the cause of those higher grades. More likely, it is by some effect that students who earn higher grades in a course tend to do additional activities or are generally more motivated to better their chances of a higher grade.

Furthermore, for this analysis, the authors were limited by the fact that some badges didn't provide enough data to analyze. This was for two reasons. First, some badges were more popular than others because it was dependent on instructor choice as to which badges to place in the course. Therefore, there was an uneven data set for each badge. Additionally, as noted earlier, some badges were tweaked or personalized slightly for specific courses, which lead to them being excluded from the analysis due to an overall low usage rate.

Like many researchers, the authors found themselves limited by the systems, resources, and structures they could access to conduct analysis. For example, while the considerable volume of completed badges offered ample material for analysis, it also imposed limitations on the depth and scope of the investigation due to its scale. Furthermore, the database usage logs obtained from library vendors do not allow for tracking of individual usage by students earning badges. While the data figures don't depict students who earned zero badges, the figures do illustrate that earning one badge vs earning several badges doesn't have a significant difference. If the study were to be repeated, including a comparison and visualization of zero badges would be ideal.

Finally, the authors note that IRB approval for data collection around this research study was not open-ended and concluded in 2018, as noted previously. Due to the timing of the pandemic commencing in late 2019/early 2020, the researchers were caught off guard and didn't extend the IRB approval for the research study, and had to quickly pivot to supporting library patrons virtually. The library heavily used the badges during the time period of 2020-2022 when many learners were remote, however this was not a period in the approved research application. In 2022, the researchers were alerted by the university that the badge platform was being decommissioned due to a lack of resources needed to maintain the systems on which it was built. Unfortunately, this decision was made at a high level and without the team's input, and the platform was not something that the library could maintain independently. Therefore, the information literacy badge program ended in 2023 without the opportunity to collect additional data. Two of the authors continue to seek out other mechanisms for delivering the badge content.

Discussion

Based on the research in this project, the researchers do believe that digital micro-credentials offer a meaningful modality for teaching students information literacy skills. This is supported by our finding that students who earned one or more library digital micro-credentials had significantly higher course grades than those who did not earn any. Although this finding doesn't mean the micro-credentials caused the higher grades, the correlation alone is a reason to consider them meaningful. This finding was also reinforced qualitatively by the large amount of positive feedback from students who completed the digital badges and library employees who evaluated them. Students and library workers expressed through comments that they learned new things from each other by completing the badge work or reviewing the submissions. Student learning topics were focused on information literacy skills while library workers expressed learning about students' knowledge gaps. It would be worth investigating and teasing out the reasons why micro-credentials might be uniquely better than other methods or modes of delivering online information literacy instruction.

The other finding, that earning more badges in a course did not necessarily lead to higher grades, is more challenging to contextualize. The behaviors of students who earn higher grades in a course are hard to pinpoint and outside this study's scope. It could be that the students who earn badges are generally more conscientious or motivated students who make sure they complete most of their assignments on time, thus earning better grades. However, the gamification factors that are inherent in micro-credentials (e.g. "leveling up" after earning more badges or credentials)

may be a contributing factor to students wanting to earn more of them, thereby resulting in more course points and a higher grade. If the gamification aspect wasn't at play here, it could be because the number of badges were assigned by the course instructor, and students didn't feel the need to go above what was assigned because there wasn't an explicit motivating factor. This would also make for an interesting aspect to explore in future research.

As noted in the findings, there were some observed differences in how many badges and what course grades males and females earned over time. This could result from different pedagogical approaches or learning materials implemented across semesters and instructor selection of badges. Additional research is required to fully understand the influencing factors and is a recommended area for future study.

In future research, it could be more expository to examine a student's assignment grade in relation to badge completion rather than course grade. For this research study, the team didn't have the resources to capture and track that level of detail and the tradeoff was to use the students' course grade, which was easier to obtain, but meant the results were less meaningful. Also, the research team was limited when they tried to examine student library checkout and database use data to see if there was a correlation between those data points and badge completion. The hypothesis was that students who earned badges had higher awareness of library resources and therefore may be more likely to use them. However, the researchers ran into barriers with obtaining this kind of data, namely because library circulation data is not tied to a user's account for a usable length of time. Future researchers may have easier or better access to this kind of data to see if there are any connections between completing micro-credentials and using the libraries' materials.

Conclusion

This study adds to a growing body of literature that explores student learning experiences through earning digital badges in information literacy within library instruction, an area of learning that is often underrepresented in credit bearing courses. As expressed in this study and adding to previous research on the topic, digital badges do present a meaningful modality for co-curricular student support. This study didn't compare students who earned zero badges with those who earned one or more. However, it did illustrate that earning one badge versus earning several badges doesn't have a significant difference. While the literature has shown that digital badges and libraries both separately have influence on student success and student learning, this field of research will benefit from further empirical study on how library implementation of digital badges impacts student learning and success.

Further research regarding digital badging in libraries is encouraged to add to the developing body of literature on the topic, particularly studies utilizing qualitative and/or quantitative data collection. Future studies may consider examining the motivation behind student participation with library badges, including the topic of gamification as a learning motivation. Also, gathering quantitative data on library usage and awareness with relationship to earning digital badges and qualitative data from students on their badge earning experiences would be relevant to the literature.

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