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In this issue:

We have bundled together a number of papers on the general theme of information systems program offerings, including a look at autonomous vehicles in IS education, micro-credentials, user experience design in community projects, first-year experience courses, exam complexity, and IS2020 across the curriculum.

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INFORMATION SYSTEMS EDUCATION JOURNAL

Editors

Micro-Credentials in US Higher Education: An Empirical Analysis

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Abstract

Micro-credentials have received renewed attention by universities as a potential pathway to high-demand careers. The goals of this study were to understand the prevalence of micro-credentials offered by universities, the characteristics of universities offering micro-credentials generally and information systems (IS) micro-credentials specifically, and the content of IS micro-credentials. To this end, this study found that only very few universities are currently offering micro-credentials. Specifically, of all 1,860 universities listed on US News & World Report, only 127 (6.8%) offer micro-credentials on Credly, which is one of the largest digital credentialing platforms. However, once universities offer micro-credentials, they do so prolifically. In fact, the 127 universities offer a total of 2,308 micro-credentials, with 114 (89.9%) universities offering more than one micro-credential for an average of 53 micro-credentials offered per university. Moreover, this study found that universities offering micro-credentials or IS micro-credentials are more likely to be tier 1, public universities located in a city, urban, or suburban setting with a higher starting salary of graduates. Lastly, of the 2,308 micro-credentials offered by universities, only 195 (8.4%) are IS micro-credentials addressing competency realms defined in the IS2020 curriculum. The top IS2020 competency realms are technology, data, and development. The most frequently associated skills among IS micro-credentials are cybersecurity, Excel, AI/ML, SQL and HTML, CSS, JS. Future research is needed to understand the longitudinal development of micro-credential offerings among universities (including international universities), on various digital credentialing platforms, possibly leveraging automatic data collection and analysis methods.

Keywords: micro-credentials, digital badges, IS2020

1. INTRODUCTION

While the concept and implementation of digital badges and micro-credentials is not a new phenomenon (e.g., Abramovich, Schunn, & Higashi, 2013; Ahn, Pellicone, & Butler, 2014; Beattie, 2014; Carey, 2012; Rubleske & Cata, 2017), with the reported lack of qualified future computing professionals and the challenges and opportunities afforded by the ongoing COVID-19 pandemic, micro-credentials and digital badges are receiving renewed attention. This is evidenced by a recent call for grant proposals from the Texas Higher Education Coordinating

Board entitled, "Accelerating Credentials of Purpose and Value Grant Program" (THECB, 2022), the purpose of which is:

> the development and/or expansion of the development of short-term postsecondary credentials that incorporate skills and knowledge required by high-demand careers in three broad areas: digital skills, including programming, web and application development, digital project management and cybersecurity programs; data analytics including data analysis and visualization; and front-line healthcare including nursing, medical specialist and technician programs (THECB, 2022, 1).

Further evidence is the growing number of colleges and universities that are now offering digital badges and micro-credentials along with their traditional degree programs. Digital badges "signify accomplishments such as completion of a project, mastery of a skill, or marks of experience" (Casilli & Knight, 2012, p. 1), while a micro-credential represents a verifiable set of competencies in a particular skill or area of expertise (Casilli & Hickey, 2016; Fanfarelli & McDaniel, 2019). Much like the prediction of early adopters that Massive Open Online Courses would revolutionize higher education and take the place of traditional universities and colleges (Ayala, Dick, & Treadway, 2014), early promoters of digital badges and micro-credentials envisioned a similar revolution (Crossley, 2021). While that revolution may not have fully materialized, as institutions of higher education seek to gain competitive advantage and remain relevant in a society becoming ever increasingly hostile toward the value of a four-year college education, micro-credentials and badges have grown increasingly more popular and appear to be a continuing wave of the future. Such that, the number of higher education institutions providing micro-credentials and digital badges continues to grow. As such, the purpose of this paper is to address the following research questions: (1) What is the prevalence of micro-credentials offered by universities?, (2) What are the characteristics of universities offering micro-credentials generally and information systems (IS) micro-credentials specifically?, and (3) What is the content of IS credentials?

2. RELATED LITERATURE

While information systems (IS) education has consistently been concerned with the alignment between IS curriculum and traditional industry-based certifications from well-known organizations such as Microsoft, CISCO, and Oracle (e.g., Gomillion, 2017; Marquardson & Elnoshokaty, 2020; Reinicke & Janicki, 2013; White, 2006), a new trend emerged beginning around 2012 centered on the concept of digital badges (Abramovich, Schunn, & Higashi, 2013; Ahn, Pellicone, & Butler, 2014; Beattie, 2014; Carey, 2012) and later related to the idea of micro-credentials (Damast, 2016; Rubleke & Cata, 2017) continuing into current day (Ermicioi, Liu, & Murphy, 2021; McGovern & Gogan, 2021; Pike, Brown, West, & Zentner, 2020). Gibson, Ostashewski, Flintoff, Grant, and Knight (2015) define a digital badge as "a representation of an accomplishment, interest or affiliation that is visual, available online, and contains metadata including links that help explain the context, meaning, process and result of an activity" (p. 404). While the terms digital badge and micro-credential are often used interchangeably in the literature, Fanfarelli and McDaniel (2019) suggest subtle differences, in that a micro-credential "implies an additional level of validation by a central authority such as an academic institution, professional organization, governing body, or a similar entity with a reputation and a body of expertise to qualify them to do this validation" (p. 11). Casilli and Hickey (2016) emphasize that a micro-credential entails the completion of a sequence or small cluster of courses related to a specific area of expertise. Micro-credentials may be obtained from any number of non-technical (e.g., project management, play therapy, entrepreneurship, etc.) or technical (e.g., cybersecurity, Excel, SQL, data analytics, etc.) areas.

While it was certainly true early on that micro-credentials were primarily the domain of companies such as Coursera, Udacity, and Udemy as opposed to universities (Gallagher, 2016), this is no longer the case as shown by the results of this paper. As universities (e.g., University of North Texas, University of Colorado Boulder, University of Illinois Urbana-Champaign) may be partnering with companies such as Coursera and others, many other universities are offering their own badges and micro-credentials directly to their students. The following literature serves as a representative sample of the ways micro-credentials and digital badges are being implemented in IS education.

Rigole and Hollingsworth (2017) conducted a study on the effect of badges on achievement and engagement in an information technology course in an eLearning environment. Two courses were included in the study, one fully online and the other offered in a hybrid format. The students were afforded the opportunity to earn digital

badges by completing selected topics in digital media fundamentals. The same instructor taught each section and the same learning outcomes, curriculum, and schedule were used. Students earned badges for project-based assignments rather than for merely completing quizzes and discussion postings. In the course, students were able to earn up to six badges each representing one point toward their final course grade. Students were not required to complete the badges and participation was voluntary. However, additional badges were implemented in the course if students scored an 80% or better on the project-based assignments. The final course grade was used to measure engagement and achievement. The results indicated that 65% of students did not increase their final course grade due to completing the optional badges, while 35% did. In sum, the study showed an increase in engagement due to the implementation of badges, but not an increase in achievement by the majority of students.

To meet the needs of the constantly changing IS workplace, Rubleske and Cata (2017) argue that the implementation of an IS micro-credential program at the graduate-level is well suited. The purpose of which is to ensure that graduate IS programs become more focused on a specific area, remain up-to-date, and provide "a credential as an easily shareable and informationally transparent digital object (Rubleske & Cata, 2017, p. 1). In sum, IS graduate programs must become more "agile" in their approach to curriculum development in order to keep up with the rapid change of digital technology such that IS professionals need to gain new skills quickly and IS managers need to have a means by which to quickly and efficiently identify individuals with those skills. As such, Rubleske and Cata (2017) suggest that graduate IS programs "(1) teach the current IS management skills that employers need and (2) certify and describe in detail the credentials behind these skills" (p. 2). To support this notion, four characteristics of university micro-credentials are described and a set of value propositions are identified related to the various stakeholders including IS students, IS departments, and employers.

Cybersecurity is currently one of the fastest growing and popular areas of computing. There is a significant need, therefore, for well-prepared IS graduates. As such, Pike, Brown, West, and Zentner (2020) describe the development of a digital badging and e-portfolio environment in the area of cybersecurity education. The authors suggest that 50% of a student's learning should occur external to the requirements of their degree program through competency-based education, competitions, research, internships, and student clubs in conjunction with support and resources provided by faculty and the university. In an effort to provide such experiences, a student data center (SDC) and security operations center (SOC) were established. Both of these centers provide students with hands-on experience in a real-world environment. To track these activities, the use of digital badges is being explored. The idea is that students may earn badges for completion and assessment of various exercises which will then comprise an e-portfolio.

The basic idea behind the awarding of micro-credentials is to "stack" a series of certificates or courses in a related area. Ermicioi, Liu, and Murphy (2021) demonstrate how a digital badging system can be used to validate stackable certificates for micro-credentials in a graduate-level program. In a similar vein as Rubleske and Cata (2017), the authors apply the concept of micro-credentials to a graduate program in information technology (IT). They argue that "a more practical and sustainable approach" is needed (Ermicioi, Liu, & Murphy, 2021, p. 1). Using a conceptual framework of six forces previously developed by two of the authors (Liu & Murphy, 2012), a case study is developed describing the implementation of a digital badging program at the graduate level. By separating existing concentrations into certificates (i.e., cybersecurity, data science, digital health, digital transformation, project management), students are now able to complete the certificates individually and "stack" them to obtain a graduate-level certificate in a relatively short amount of time, for example, in two semesters. This provides students with a micro-credential before completing their graduate degree and potentially providing a beneficial credential in the event the student does not go on to complete the graduate degree. In essence, there is value-added regardless of completion. The authors conclude, "Given the need for reskilling and upskilling in the fast-moving IT field, digital badging of micro-credentials in the academic community is a must" (Ermicioi, Liu, & Murphy, 2021, p. 8).

The growth of digital badges and micro-credential is nowhere more evident than in the area of computing and technology. With growth in the popularity of data analytics, data science, and cybersecurity, for example, well-known technology companies such as Google have joined the ranks of private companies and universities as those who are now offering badges

and micro-credentials (Katz, 2021). Consequently, IS education is fertile ground for the exploration of digital badging and micro-credentials. Moreover, IS education may be faced with making a decision about whether to compete or collaborate with the micro-credential and digital badge movement. As such, we believe the questions examined and the ensuing discussion and conclusions within this paper potentially make an important contribution to IS education.

3. METHODOLOGY

First, to establish a convenience sample for this study, data pertaining to all 1,860 universities listed on US News & World Report as of March 2, 2022, was scraped. US News & World Report was selected because it is arguably the most comprehensive list of US-based universities, despite questions surrounding its ranking methodology (Hartocollis 2022). The scraped data included the name of each university along with its ranking, funding type (i.e. private non-profit; private for-profit; public), setting (i.e. city, urban, suburban, rural, and unspecified), age, and median starting salary of graduates. While US News & World has one overall ranking, it assigns actual rank numbers based on an institution's classification (e.g. National Universities, National Liberal Arts Colleges, Regional Universities Midwest/North/South/West, Regional Colleges Midwest/North/South/West). Instead of trying to infer rank numbers, we simply grouped the institutions into three tiers based on US News & World's own classification: Tier 1 (national) includes all institutions classified as National Universities or National Liberal Arts Colleges. Tier 2 (regional) includes all institutions classified as Regional Universities Midwest/North/South/West or Regional Colleges Midwest/North/South/West. Lastly, tier 3 (unranked) includes all institutions not classified as either tier 1 or tier 2.

Second, the university names obtained in the previous step were used to scrape the Credly profile page for each university, if it existed. This was possible due to the fact that Credly uses a standardized URL schema in the form of https://www.credly.com/organizations/$university_name/badges whereby $university_name is replaced with the URL encoded name of a university (e.g. grand-valley-state-university for Grand Valley State University). The data scraped from each Credly profile page, if existed, included the number of badges offered as well as the links to each badge offered. In turn, the profile page of each badge offered was scraped to capture the description of the badge and the skills obtained.

Third, we borrowed from the IS competency realms identified in IS2020 A Competency Model for Undergraduate Programs in Information Systems, in order to ground the technology-related micro-credentials within the context of IS education in an effort to increase the relevancy of our study for IS educators. IS2020 represents the latest attempt by the Association of Information Systems (AIS) and Association for Computing Machinery (ACM) to put forth a model IS model curriculum. IS2020 differs from previous IS model curriculum recommendations (e.g., IS2010) by focusing on required competency areas rather than a set of traditional learning objectives. The IS competency realms include: Foundations, Data and Information Management, Technology and Security, Development, Organizational Domain, and Integration (Leidig & Salmela, 2020).

Finally, using content analysis (Berg, 2001) we analyzed the Credly data pertaining to badges in order to separate technology related micro-credentials from non-technology related credentials and to classify technology related credentials according to the IS competency realms. The first step in the analysis process consisted of a review of the micro-credential name. Where there was disagreement between the authors, the micro-credential descriptions were analyzed, and further discussion ensued when necessary. In sum, the authors, through an iterative process, were able to come to agreement on the separation of technology related and non-technology related micro-credentials. The second step in the analysis was to categorize the technology-related micro-credentials according to the IS competency realms. To facilitate this process, the authors first individually categorized the technology related micro-credentials according to the IS competency realms independently of one another. When disagreements arose, the authors discussed in detail to come to a consensus on the appropriate categorization. The findings provided in the Results section reflect the final categorizations. Lastly, the skills obtained from Credly were combined using simple word matching. So, for example, cybersecurity awareness, cybersecurity controls, cybersecurity management, cybersecurity policies were all combined into cybersecurity. Likewise Excel formulas and functions, Excel Pivot Tables, Excel spreadsheets, and Excel VBA were all combined into Excel. This allowed for a slightly higher-order analysis of skills.

4. RESULTS

Prevalence of Micro-Credentials

Of the 1,860 universities listed on US News & World Report, 127 (6.8%) offer micro-credentials on Credly. Of the 127 universities offering micro-credentials on Credly, 53 (41.7%) offer IS micro-credentials. On Credly, 127 universities offer a total of 2,308 micro-credentials. A relatively small number of universities offer a large number of micro-credentials. In fact, of the 127 universities offering a micro-credential on Credly, 114 (89.8%) offer more than one micro-credential. On average, a university on Credly offers 53 micro-credentials (M = 53.31, SD = 43.74). The most prolific universities on Credly are Grand Valley State University (n = 184), followed by University of North Dakota (n = 165), and Northeastern University (n = 150).

Characteristics of Universities Offering Micro-Credentials

Table 1 provides a cross-tabulation of three university tiers (i.e. tier 1 – national; tier 2 – regional; tier 3 – unranked) and the three groups of universities (i.e. all universities listed on US News & World Report; universities listed on US News & World Report that offer micro-credentials on Credly; universities listed on US News & World Report that offer IS micro-credentials on Credly). If universities offering micro-credentials or IS micro-credentials were no different from all universities with regards to the tiers they belong to, then one would expect a similar distribution of frequencies in each of the three columns.

	Number of All Universities	Number of Universities Offering Micro-Credentials	Number of Universities Offering IS Micro-Credentials
	n (%)	*n (%)*	*n (%)*
Tier 1 – National	626 (34%)	67 (53%)	29 (55%)
Tier 2 – Regional	840 (45%)	47 (37%)	19 (36%)
Tier 3 – Unranked	394 (21%)	13 (10%)	5 (9%)
Total	**1,860 (100%)**	**127 (100%)**	**53 (100%)**

Table 1: Comparison of University Tiers

A chi-square test of independence showed that there is a significant association between the three university tiers (i.e. tier 1; tier 2; tier 3) and the three groups of universities (i.e. all universities; universities offering micro-credentials; universities offering IS micro-credentials) ($X^2(4) = 30.84$, $p < .001$). Thus, compared to all universities, universities offering micro-credentials or IS micro-credentials are more likely to belong to tier 1 – national.

Table 2 provides a cross-tabulation of three university funding types (i.e. private, non profit; private, for-profit; public) and the three groups of universities (i.e. all universities listed on US News & World Report; universities listed on US News & World Report that offer micro-credentials on Credly; universities listed on US News & World Report that offer IS micro-credentials on Credly). If universities offering micro-credentials or IS micro-credentials were no different from all universities with regards to their funding type, then one would expect a similar distribution of frequencies in each of the three columns.

	Number of All Universities	Number of Universities Offering Micro-Credentials	Number of Universities Offering IS Micro-Credentials
	n (%)	*n (%)*	*n (%)*
Private, Non-Profit	1094 (59%)	59 (46%)	22 (42%)
Private, For-Profit	58 (3%)	0	0
Public	708 (38%)	68 (54%)	31 (58%)
Total	**1,860 (100%)**	**127 (100%)**	**53 (100%)**

Table 2: Comparison of University Funding Types

A chi-square test of independence showed that there is a significant association between the three university funding types (i.e. private non-profit; private for-profit; public) and the three groups of universities (i.e. all universities; universities offering micro-credentials; universities offering IS micro-credentials) ($X^2(4) = 23.34$, $p < .001$). Thus, compared to all universities, universities offering micro-credentials or IS micro-credentials are more likely to be public.

Table 3 provides a cross-tabulation of five university settings (i.e. city setting; urban setting; suburban setting; rural setting; unspecified setting) and the three groups of universities (i.e. all universities listed on US News & World Report; universities listed on US News & World Report that offer micro-credentials on

Credly; universities listed on US News & World Report that offer IS micro-credentials on Credly). If universities offering micro-credentials or IS micro-credentials were no different from all universities with regards to their setting, then one would expect a similar distribution of frequencies in each of the three columns.

	Number of All Universities	Number of Universities Offering Micro-Credentials	Number of Universities Offering IS Micro-Credentials
	n (%)	*n (%)*	*n (%)*
City Setting	334 (18%)	26 (20%)	8 (15%)
Urban Setting	342 (18%)	31 (24%)	16 (30%)
Suburban Setting	491 (26%)	44 (35%)	20 (38%)
Rural Setting	360 (19%)	16 (13%)	5 (9%)
Unspecified Setting	333 (18%)	10 (8%)	4 (8%)
Total	**1,860 (100%)**	**127 (100%)**	**53 (100%)**

Table 3: Comparison of University Setting

A chi-square test of independence showed that there is a significant association between the five university settings (i.e. city, urban, suburban, rural, and unspecified) and the three groups of universities (i.e. all universities; universities offering micro-credentials; universities offering IS micro-credentials) ($X^2(8) = 26.94$, $p < .001$). Thus, compared to all universities, universities offering a micro-credential or an IS micro-credential are more likely to be located in a city, urban, or suburban setting.

Finally, table 4 shows the average age of the university and average starting salary of graduates for each of the three groups of universities (i.e. all universities listed on US News & World Report; universities listed on US News & World Report that offer micro-credentials on Credly; universities listed on US News & World Report that offer IS micro-credentials on Credly). If universities offering micro-credentials or IS micro-credentials were no different from all universities with regards to their age or starting salary, then one would expect similar averages in each of the three columns.

	All Universities	Universities Offering Micro-Credentials	Universities Offering IS Micro-Credentials
	m (SD)	*m (SD)*	*m (SD)*
Age of the University	123.20 (48.69)	125.43 (42.09)	121.32 (44.49)
Starting Salary of Graduates	$47,342.35 ($10,121.33)	$50,095.04 ($7,120.88)	$51,008.00 ($7,689.67)

Table 4: Comparison of Age of the University and Starting Salary of Graduates

A one-way ANOVA showed that the difference in age of the university between the three groups of universities (i.e. all universities; universities offering micro-credentials; universities offering IS micro-credentials) is not significant ($F(2) = 0.17$, $p = .84$). Thus, compared to all universities, the age of universities that offer micro-credentials or IS micro-credentials tends to be the same.

A one-way ANOVA showed that the difference in starting salary of graduates between the three groups of universities (i.e. all universities; universities offering micro-credentials; universities offering IS micro-credentials) is significant ($F(2) = 7.79$, $p < .001$). A Tukey post-hoc test revealed that the differences in starting salary are significant between all universities and universities offering a micro-credential (Δ = \$2,752.69, $p < .05$) as well as between all universities and universities offering an IS micro-credential (Δ = \$3,665.65, $p < .05$). However, the difference in starting salary between universities offering a micro-credential and universities offering an IS micro-credential is not significant (Δ = \$912.95, $p = .84$). Thus, compared to all universities, the starting salary of graduates at universities that offer a micro-credential or an IS micro-credential tends to be higher.

Content of Micro-credentials

Of the 2,308 micro-credentials offered by universities on Credly, 195 (8.4%) can be considered IS micro-credentials as they address competency realms defined in the IS2020 curriculum. The top three IS2020 competency realms addressed by IS micro-credentials are technology, data, and development. The distribution of IS micro-credentials for each IS2020 competency realm is shown in figure 1 below.

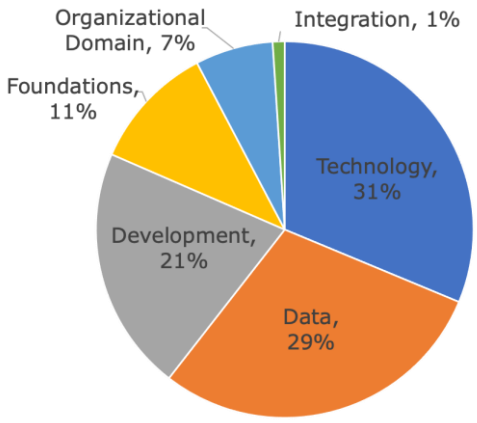

Figure 1: Classification of IS Micro-credentials by IS2020 Competency Realm

Lastly, each micro-credential on Credly has one or more skills associated with it. The most frequently associated skills among IS micro-credentials are cybersecurity (7.4%), Excel (3.9%), AI/ML (3.2%), SQL (2.7%), and HTML, CSS, JS (2.6%).

5. DISCUSSION AND CONCLUSION

Based on the results of this study, it is apparent that only very few universities are currently offering micro-credentials. The few universities that do offer micro-credentials tend to offer numerous micro-credentials. Moreover, the few universities that do offer micro-credentials tend to be highly-regarded and widely-known. These universities can be considered early adopters in diffusion of innovations theory (Rogers, 2003), as they are likely to hold strong positions of opinion leadership among their peers. Interestingly, only a small subset of micro-credentials focuses on IS content as defined in the IS2020 curriculum. Clearly, universities have yet to widely adopt micro-credentials in general and IS micro-credentials in particular. Given the wide adoption of micro-credentials in the private sector, it is likely that the majority of universities will soon follow suit.

Contributions

This study makes several important practical and theoretical contributions. First and foremost, it provides current and in-depth empirical insights into the prevalence, characteristics, and content of micro-credentials in general and IS micro-credentials specifically. These insights can be leveraged by organizations in the private sector, such as digital credentialing platforms and training providers, as well as by universities to develop new or adjust current offerings in the micro-credentialing space. From a theoretical perspective, insights gleaned into the adoption of micro-credentials, which is an innovation in higher education, by certain types of universities, might add to the diffusion of innovations theory (Rogers, 2003).

Limitations

This study is not without shortcomings. First, this study was based on a snapshot of data collected in March 2022. It is possible that universities launched or discontinued micro-credentials shortly before or after the data collection, which wouldn't be captured in this study. Moreover, this study doesn't include longitudinal data and as a result can't analyze the development of micro-credential offerings over time. Second, this study used all 1,860 universities listed on US News & World Report (n.d.) as a convenience sample. While this probably provides a comprehensive sample of US-based universities, it excludes all non-US-based universities. Third, this study cross-referenced all 1,860 universities listed on US News & World Report with the names of organizations that issue digital credentials on Credly (n.d.). Although Credly is one of the world's largest digital credentialing platforms, having issued more than 50 million credentials to 25 million people worldwide, it's certainly not the only one. Hence it's possible that universities in this study's convenience sample use other or additional digital credentialing platforms which wouldn't be captured in this study. Finally, this study used content analysis to categorize micro-credentials into IS2020 competency realms. Though great care has been taken to ensure a repeatable and objective process, it's possible that the authors shared preconceived notions or misunderstandings that led to misclassifications.

Future Research

To address some of this study's limitations, future research may wish to collect longitudinal data. Already capturing just a second dataset and comparing it with this study would allow drawing certain conclusions regarding the development of micro-credentials being offered by universities over time. Moreover, future research should include international universities in order to gain insights regarding differences between geographic regions. Furthermore, future research should collect data from other digital credentialing platforms in order to potentially capture more micro-credentials. Lastly, future research might benefit from using automated data collection and analysis methods that would allow for faster and potentially more objective results.

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