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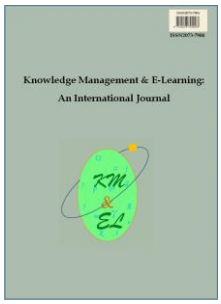

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John P. Girard
Johnathan Yerby
Kevin Floyd
Middle Georgia State University, GA, USA

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Knowledge retention in capstone experiences: An analysis of online and face-to-face courses

John P. Girard*

School of Information Technology
Middle Georgia State University, GA, USA
E-mail: john.girard@mga.edu

Johnathan Yerby

School of Information Technology
Middle Georgia State University, GA, USA
E-mail: johnathan.yerby@mga.edu

Kevin Floyd

School of Information Technology
Middle Georgia State University, GA, USA
E-mail: kevin.floyd@mga.edu

*Corresponding author

Abstract: This research chronicles the development of a capstone experience by a regional comprehensive university. The process began with a multi-year project during which the faculty annually reviewed the results with a view to determining if the class provided the deep learning culminating experiences anticipated. A major measure of success was the desire to replicate the deep learning common in face-to-face classes in the online environment. The results of 166 students were analyzed, 82 online and 84 face-to-face, to determine if a difference existed. A one-way ANOVA tested the score differences among 10 sections and determined the students' scores did not differ significantly. Finally, a two-sample t-test between proportions determined that there was not a significant difference between the online and face-to-face students with respect to the level of assessment scores earned. Given that online and face-to-face students demonstrate the same level of knowledge, does this beg the question, what value does face-to-face class time offer?

Keywords: Capstone experience; Knowledge retention; Online education, Face-to-face education

Biographical notes: John P. Girard, Ph.D. holds the Peyton Anderson Endowed Chair in Information Technology at Middle Georgia State University's School of Information Technology. His current research interests lay at the intersection of technology, leadership and culture, especially how these three combine to create value for organizations.

Johnathan Yerby is a PhD candidate in Instructional Technology at Georgia State University. He has been teaching at Middle Georgia State University since 2009. Through his academic and teaching career he has encountered and studied differences between online and face-to-face courses. He offers hybrid

courses that utilize technology, while still seeking the richness and active learning that some older research suggested.

Dr. Kevin Floyd is an associate professor and program chair in the School of Information Technology at Middle Georgia State University. He teaches in the areas of web development, web programming, and database development. His research interests are in the areas of web development technologies, leadership styles and ethical work climates, and student active learning and engagement strategies.

1. Background

For decades, colleges and universities have been seeking ways to enhance student learning. Most recently many schools have sought so-called high-impact activities that college seniors report as providing deep learning and the opportunity to gain practical knowledge through collaborative learning and student-faculty interaction (Kuh, 2008). Examples of these activities include study abroad, student-faculty research, service learning, and senior culminating experiences. The subject of this article is the latter, which are often referred to as Capstone Experiences or Capstone Classes. According to Kuh (2008), "these culminating experiences require students nearing the end of their college years to create a project of some sort that integrates and applies what they've learned" (p. 11).

This paper chronicles the development of one such capstone experience by a Regional Comprehensive University (RCU). The process began with a multi-year project during which the faculty annually reviewed the results with a view to determining if the class provided the deep learning culminating experiences anticipated. A major measure of success was the need to replicate the deep learning in both the face-to-face and online environments.

2. Literature review

2.1. Capstone courses

A senior capstone course provides students with the opportunity to integrate skills and knowledge that they have accumulated throughout their academic program of study (Henscheid & Barnicoat, 2002). The capstone course is commonly a part of the core requirements in an academic program. As the name implies, a senior capstone course is intended to provide students with a culminating and integrative learning experience (Schwieger & Surendran, 2011). The capstone provides students with the opportunity to synthesize, analyze, and apply knowledge acquired over several years of academic study to a real-world business problem (Kumar, Baker, & Ahmed, 2004). There are different types of capstone courses as noted by Fanter (2006), including field or internship programs, the portfolio-building capstone, the multiple-project course, or a major project course. A successful senior capstone course allows students the opportunity to experience real-world projects from the analysis phase to the implementation and delivery of the information system (R. E. Beasley, 2003). A senior capstone course can add value to an academic program by enhancing the student learning experience, providing an opportunity for faculty to work closely with students, serving as a vehicle for

collaboration between academic programs and the community, and by providing the data necessary to enable faculty and administrators to effectively assess the overall quality of an academic program.

One of the benefits of a senior capstone course is the enhancement of the student learning experience. The value of a senior capstone course for a degree program has been evaluated, tried, and recommended (Magner, 1990; Boyer Commission, 1998). Kumar, Baker, and Ahmed (2004) explained that the capstone course offers students the opportunity to gain an advantage in the competitive marketplace and ultimately lead to successful careers because of the skills acquired by working on a real-world project over the duration of a semester. Similarly, Bruhn and Camp (2004) asserted that a senior capstone course creates useful business products and corporate-ready students. Capstone projects are widely used to provide students with an opportunity to work on a "real life" project (Payne, Flynn, & Whitfield, 2008). According to McGann and Cahill (2005), a capstone course can provide students a comprehensive experience in addressing soft skills, experiential learning, conceptual elements as well as career readiness. With the replication of real-life experiences, students get exposed to the critical need for a disciplined approach to managing their projects.

In some respects, the capstone course serves as a great refresher on skills needed by employers right before students graduate, as well as a valuable integrative experience. The capstone project becomes a vehicle that translates theory to practice (Reinicke, Janicki, & Gebauer, 2013). From a student perspective, senior capstone courses add value to a program of study and provide experiences not available in other courses. In research conducted by Smith, Estep, Zhao, Moinian, and Johari (2014), 94% of students in a team-based capstone course at a regional university in Oklahoma reported that the class and the project was interesting and stimulating. Eighty-three percent stated that they would recommend the course to other students. Seventy-two percent felt they had a stronger interest in their program of study due to the course.

One of the greatest values of a senior capstone course for students is the flexibility in the types of approaches that can be used to cater to the variations in the skill set of the students and the types of learning experiences desired. Approaches include client-sponsored projects, enterprise system based projects, instructor-directed apprenticeships in industry, and cross-discipline focused independent studies (Schwieger & Surendran, 2011). Senior capstone courses provide students with the opportunity to supplement theoretical knowledge with hands-on active learning (S. W. Beasley & Floyd, 2013) which has its roots in constructivism learning theory, whereby effective learning is an active and social process (Vygotskii, 1978).

In addition to the contribution to student learning, senior capstone courses have the ability to generate useful data that can be used in program evaluation. Capstone courses by nature lend themselves to assessment since an expectation of the course is that students will use skills and knowledge learned in previous courses. This can provide administrators with invaluable data often required by regional or national accrediting agencies (Kovalchick, Boff, & Kovacs, 2013). Accrediting agencies such as the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) view capstone courses as an integral part of their Quality Enhancement Plan (QEP) because senior capstone experiences can empower students to evaluate, appreciate, and integrate multiple perspectives in a collaborative project (Reinicke, Janicki, & Gebauer, 2013). Koohang, Floyd, Spiers, and Riley (2009) discussed the design and implementation of a senior capstone course as a means for overall program evaluation and assessment for

purposes of ABET accreditation. (Schwieger & Surendran, 2010) also described the value of using a senior capstone course as a means for assessing program objectives.

2.2. Online versus face-to-face education

Online education has managed to produce higher total enrollment as well as a continuously increasing percentage of students taking online courses. According to the Babson Survey Research Group and Sloan Consortium 2014 survey of more than 2,800 colleges and universities in the United States, more than 7.1 million students, or 33% of total students were enrolled in at least one online course in the fall of 2013 (Allen & Seaman, 2014). Online education is increasingly attractive due to the advantages of scheduling for learners who may not be able or willing to attend a traditional face-to-face course, the time to complete a degree may be reduced depending on the educational program, distance, and access to learning opportunities that may have otherwise been unavailable (Wang & Reeves, 2007). Chief Academic Officers (CAO) recognize the growth of online education as necessary to remain relevant and competitive. Ninety percent of CAOs believe that a majority of students will be taking an online course in the future and two-thirds of the CAOs believe there will be substantial use of student-directed online classes (Allen & Seaman, 2014).

With the growing number of online programs and the increasing rate of enrollment in these programs, a major concern for institutions of higher education and students is whether the quality of the learning compared to traditional face-to-face courses (Yerby & Floyd, 2013). A review of the current research literature finds mixed results.

There have been several previous studies to investigate if there is a difference in online and face-to-face learning. Although the literature is mixed on whether the delivery or medium has a correlation with student learning, the majority of the literature finds that there is no significant difference. One of the most well-known researchers on the topic is Richard Clark's analogy: "The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (Clark, 1983, p. 445). Since Clark's seminal work in 1983 technology has evolved to include powerful search and analytic tools, coupled with social media where learners are now receivers, producers, and distributors of knowledge, rather than simply consumers. Regardless of the advancements in technologies or tools, the benefits gained will depend on the extent to which they are used in ways that are compatible with how students learn. (Clark & Mayer, 2011). Also, of significant importance in the debate about online versus face-to-face is Russell's (1999) meta-analysis of 355 research reports that came to the conclusion that there was no difference based on the way that a learner completes a course. McFarland and Hamilton (2005) examined the level of student engagement as an indicator of quality and found no difference in satisfaction or performance of students enrolled in online versus those students enrolled in traditional courses. The results of a study conducted by Astani, Ready, and Duplaga (2010), indicated that students believe that the quality of online courses offered by traditional institutions is as good as traditional face-to-face learning. In Clark and Mayer's 2011 book *E-learning and the Science of Instruction*, they report that "after more than sixty years of research attempting to demonstrate that the latest media are better, the outcomes fail to support the superiority of any single delivery medium over another." In research piloted by Palloff and Pratt (2001), they found no significant difference in the learning outcomes of students in online versus traditional in class settings.

While many studies found no significant differences in face-to-face versus online education, other research suggests opposing results, which is a reason to continue exploring the subject of this paper. Robert Kozma famously and often challenges Richard Clark's position that media does not matter. In one paper Kozma reframes the debate about media, by suggesting that as instructional technology methods mature, media will have an influence on learning (Kozma, 1994). Shuell (1988) posits that learning is an active, constructive, cognitive and social process by which the learner uses their cognitive, physical, and social resources to create knowledge. A study by Dobbs, Waid, and del Carmen (2010) measured students' perceptions of online course experiences. The participants of the study were 100 students who were attending traditional, "face-to-face" (on-ground) courses and 180 students who were taking online classes. The researchers found that more students perceived the traditional "face-to-face" courses to be easier than online classes. The Institute for Higher Education Policy challenges Thomas Russell's No Significant Difference findings, stating that many of the studies in his meta-analysis were from the 1990s where online education was still developing and several of the studies were poorly designed. The poor design included lack of control groups, non-random selection, and most compared just one technology to conventional face-to-face teaching, instead of the course as a whole (Phipps & Merisotis, 1999). Foreman (2011) reported that on-campus computer information systems students taking a computer literacy course had consistently higher GPAs and success rates than those taking online courses. Beard, Harper, and Riley (2004) cited a lack of interaction, privacy issues, technological difficulties, and a focus on specific technology rather than content as disadvantages of online versus traditional on campus instruction. Jaggars (2014) found that the main problem that students had with online courses was reduced teacher explanation and interaction plus weaker student-to-student interaction.

2.3. Simulation in education

Simulations, games, and serious games have been used in education for thousands of years, but digital versions only started to gain widespread use in the 1980s as CDs, then on the Internet in the 1990s. According to McGaghie (1999) "In broad, simple terms a simulation is a person, device, or set of conditions which attempts to present [education and] evaluation problems authentically. The student or trainee is required to respond to the problems as he or she would under natural circumstances. Frequently the trainee receives performance feedback as if he or she were in the real situation" (p. 9). Digital simulations afford learners conveniences of simulating time, randomizing predictable outcomes, easy to follow scoring, working with complex models, and replicating causes. Removing the distracting menial tasks allows learners to spend more energy on strategy and tactics, where they concentrate on higher order skills (Gibson, Aldrich, & Prensky, 2007). It is crucial that the focus remains on strategy and learning the subject or skills, not the technology. It would be too easy to get lost in using technology for technology's sake. The use of simulators provides an effective mechanism to educate and assess students' knowledge in a very wide variety of skills that may otherwise be dangerous, expensive, or impossible to conduct with the student's current level of expertise. Simulations can involve teamwork, social interactivity, competitiveness with a computer opponent or as seen in many business related simulations, competing with users around the globe to replicate the real-world impact of players set of decisions (Horton, 2012).

3. Methodology

Integral to the capstone course under review is an assessment tool that matches individual students against computer players to take decisions in a variety of management areas. The tool was specifically designed to assess a series of outcomes that are common in many management programs, including the outcomes for the program under review. From these outcomes, the vendor developed a series of questions. In this five-round simulation, students must make their company decisions and at the end of each round they answer a series of multiple-choice questions. These questions are generated from the data produced by their individual performance on the simulation; this ensures that students will only work on their own exam and not in teams. In fact, there is no benefit to working in teams as the questions vary for each student based on the numbers they generate from their company decisions.

A major decision point was the acceptance by faculty that the assessment tool was indeed measuring student knowledge relevant to their program outcomes. To achieve this consensus, the faculty mapped their program outcomes to the vendor's assessment plan. The mapping exercise concluded all of the program outcomes were being assessed by the assessment questions. Ultimately the faculty agreed that capstone students' answers to the questions reflected a fair, accurate and objective evaluation of student knowledge. Table 1 maps the assessment tool objectives with the management program outcomes.

Table 1
Assessment tool objectives

Assessment Tool Objective	**Management Program Outcome**
Develop graduates who can foster innovation in organizations, respond effectively to new circumstances; and through their actions, enable organizations and society to realize the potential of new technologies	Apply innovation and creativity to create value to the organization.
Develop graduates with rigorous understanding of core business functions and with problem-solving skills reflecting an integration of functional perspectives. Graduates should be prepared to assume positions of leadership and contribute immediately to the improved performance of their organizations.	Apply planning activities including analyzing current situations, anticipating the future, determining objectives, deciding in what types of activities the organization will engage, choosing strategies, and determining the resources needed to achieve the organization's goals.
Develop graduates with the capability to organize, describe, and make intelligent inferences from empirical evidence. Graduates should be able to apply sophisticated statistical techniques to data; make informed forecasts of business trends; and formulate, solve, and interpret quantitative business decision models.	Project sales, production operations, market, finance, human and organizational structure.

Recognize opportunities and evaluate potential for business success, and consider implementation issues including financial, operational and administrative procedures involved in running a business venture.	Explain entrepreneurial theory, knowledge, practice, tools and techniques needed by entrepreneurs to start, grow, and harvest a successful venture.
Define markets and apply marketing concepts and principles using a customer focus to effectively sell products and services.	Identify entrepreneurial opportunities.
Interpret and analyze accounting information for internal control, planning, performance evaluation, and coordination to continuously improve business processes.	Apply qualitative and quantitative techniques to evaluate business performance.
Utilize business decision support and productivity tools: Demonstrate ability to utilize spreadsheet technology to enhance analysis and presentation of data related to a specific business issue, the use of computer-based productivity tools to enhance an oral presentation of a business issue, the ability to locate and use internet data sources	Apply qualitative and quantitative techniques to evaluate business performance.

All students were part of the Management Capstone, a required class in the Bachelor of Science in Management program. At this point in their academic career all students have completed a 10-course business core as well as upper division classes in strategy, management, marketing, finance, entrepreneurship and human resources. Students self-selected into either the face-to-face or online version of the class. It is important to note that students had a choice of completing either the online version or face-to-face version of the course. Completion of the online class was not restricted to fully online students.

In order to eliminate a major factor in student learning, all sections under examination were taught by the same professor. The professor worked diligently to ensure that before the final assessment, the same knowledge, experiences, and support were provided in both modes. Throughout the course, all students completed the same assignments and used the same simulation tools. Similarly, all students used Blackboard as the learning management system (LMS). The LMS included a series of bespoke video lecturettes as well as more traditional learning material such as class notes and links to external resources. For the online section, the LMS was the main learning resource support by frequent asynchronous video updates provided by the professor. For the face-to-face section, professor-lead lectures were the main pedagogy supported by the LMS.

In both the online and face-to-face sections students participated in a team-based simulation prior to completing the final assessment that is the focus of this research. The simulation provided an opportunity for students to hone their knowledge and skills in the areas that would be assessed at the end of the course. The team-based simulation demanded a high level of social interaction leading to development of cognition

(Vygotskii, 1978). This high level of inaction invariably helped the students develop their knowledge of the areas to be assessed. The face-to-face students achieved this high fidelity interaction through group meetings while the online students used a suite of synchronous (Skype and Google Hangouts) and asynchronous communication tools (discussion and email).

During each semester, two sections of students (one face-to-face class and one online class) completed the same assessment during the last week of their capstone class. The students answered multiple-choice questions in six categories: Strategic Analysis, Accounting, Finance, Production, Marketing, and Human Resources. The assessment represented 20% of their final grade.

This assessment tool facilitated the comparison of students' performance against other undergraduate business students in a number of countries (N > 4300) as well as between class modes (face-to-face and online). The former was very valuable in program assessment; however, this is outside the scope of this paper. The main concern of this case was whether there was a difference in the competency of online and face-to-face students. Given that much of research in high impact practices has focused on the face-to-face paradigm, this research sought to answer the research question, do students completing face-to-face and online classes demonstrate the same levels of knowledge? This is particularly relevant given that all students had access to the same content and yet the face-to-face students were required to attend three hours of classes each week for 15 weeks. The online students had no attendance requirement.

From this broad question, a single hypothesis (H1) was derived. The purpose of the hypothesis was to test if Online Students (S_{OL}) and Face-to-Face Students (S_{F2F}) achieve significantly different scores on their final assessment. This hypothesis is important because the answer may go some way in explaining if different modes facilitate higher levels of knowledge transfer and/or retention. Armed with this evidence, educators will be able to consider modifications to their pedagogy to achieve the same levels of knowledge transfer and retention. This hypothesis presupposed that there is a relationship between the dependent variable of assessment score and the independent variable of student type, specifically:

H1: *Online Students achieve a significantly lower assessment scores than do Face-to-Face Students*

4. Analysis

The main purpose of the assessment tool was to measure student knowledge based on the program outcomes. This research analyzed the student results for five semesters (10 sections) over the period 2009 to 2014. During each semester there was a single online section and a single face-to-face section. The number of students in each section ranged from 12 to 24 with a mean of 16.72. In this study we are only concerned with the final assessment score, as a percentage, of students as this has the basis of program assessment. The focus of this study is the comparison of means between the online and face-to-face students.

In total, the results of 166 students were analyzed: 82 online and 84 face-to-face. To determine if a difference existed several statistical tests were performed. First, the means of each section were tested for normality using the *Kolmogorov-Smirnov/Lilliefor Test* during which no evidence of normality was discovered.

Next, the 10 sections were compared to see if a difference existed between any sections (see Fig. 1). This review was critical as we wanted to ensure that no single section of students (face-to-face or online) was statically different than the others. The first step of this phase was to plot the data using a box plot developed by McGill, Tukey, and Larsen (1978). A box plot is a useful way to visually assess the similarity of the datasets under comparisons. The "box" top and bottom are the first and third quartile with the median (second quartile) indicated with a line. The red (dotted) line is the mean. The vertical lines, known as whiskers, show the range of data within the1.5 interquartile range (IQR), which is calculated by subtracting the first quartile from the third quartile. Mild outliers are plotted using a small circle.

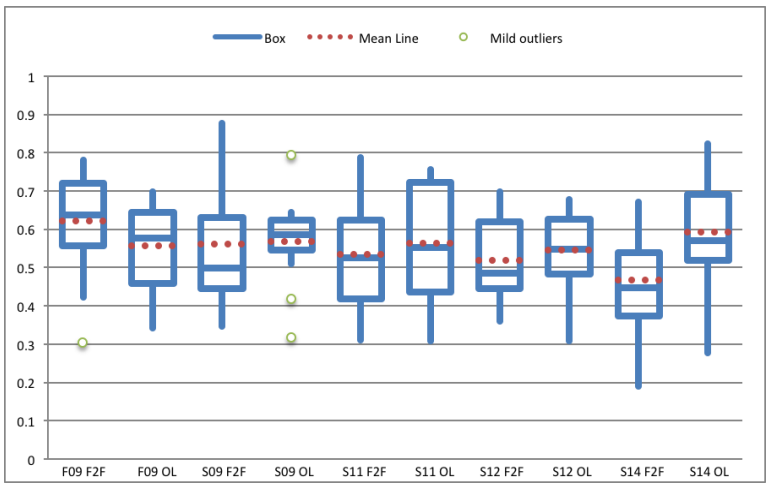

Fig. 1. Box plot: Individual sections

After examining the box plot, a one-way ANOVA was used to test for score differences among 10 sections of students. Scores for students did not differ significantly across the 10 sections, F (9, 156) = 1.39, p = .196. Next, the data for online and face-to-face students was plotted using a box plot (see Fig. 2).

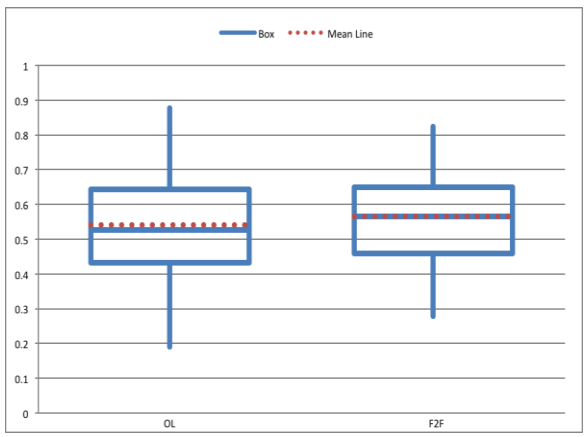

Fig. 2. Box plot: Online (OL) and face-to-face (F2F)

The research question was whether face-to-face and online students demonstrate the same levels of knowledge. The null hypothesis was: *There is no significant difference*

between the assessment scores between the two groups. A two-sample t-test between proportions was performed to determine whether there was a significant difference between the samples with respect to the level of assessment scores earned. Face-to-face students scored slightly higher (M = 0.57) than online students (M = 0.54), but this difference was not significant at the .05 critical alpha level, $t(164) = 1.16$, $p = .247$. Therefore, we fail to reject the null hypothesis and conclude that the difference in online and face-to-face students was not significant.

5. Limitations and recommendations for future research

The major limitation of this project is that all of the data is from one school. Although it includes more than 160 students over a five-year period, it remains very difficult to generalize the findings to other schools. Ideally other researchers will apply the methodology to their students with a view to collecting enough data to generalize the findings.

The results of the research are clear, at the macro level, there was no statistically significant difference between the assessment scores of online and face-to-face students. This finding echoes the findings of other researchers (Dell, Low, & Wilker, 2010; Van den Berg, 2013; Sussman & Dutter, 2010). Nevertheless, additional research is necessary to explain the findings and refine the theoretical position. Specifically, there would be merit in examining particular parts of the overall assessment. The assessment includes questions from six broad areas: Strategic Analysis, Accounting, Finance, Production, Marketing, and Human Resources. It seems prudent to "drill down" to the subject area to see if differences exist.

Given that the students from the online and face-to-face sections demonstrated the same level of knowledge at the end of the class it might beg the question, what value do face-to-face classes add? In other words, if two groups of students consistently demonstrate the same levels of knowledge then what is the value proposition of spending time in face-to-face classes.

This study sought only to investigate the six broad areas from a capstone simulation, not the overall collegiate experience or total academic performance. Finally, it seems prudent to expand this research to consider the issues of technology use in terms of learning management systems and capstone examinations.

6. Conclusion

The purpose of this research was to chronicle the development of a capstone experience by a regional comprehensive university, with a view to sharing the lesson learned. The process began with a multi-year project during which the faculty annually reviewed the results with a view to determining if the class provided the deep learning culminating experiences anticipated. A major measure of success was the desire to replicate the deep learning in both the face-to-face and online environments. The results of 166 students were analyzed, 82 online and 84 face-to-face, to determine if a difference existed. A one-way ANOVA tested the score differences among 10 sections and determined the students' scores did not differ significantly. Finally, a two-sample t-test between proportions determined that there was not a significant difference between the online and face-to-face students with respect to the level of assessment scores earned.

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