Research Article

An Overview of Experimental and Quasi-Experimental Research in Technical Communication Journals (1992–2011)

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***Abstract*—*This study explores a comprehensive sample of experimental and quasi-experimental research within five leading technical communication journals over a 20-year period. Exploratory studies can overview how a method has evolved within a field, highlighting how it has advanced understanding of communication and identifying areas for further inquiry.* **Research questions:** *(1) How has experimental research in technical communication journals developed over the 20-year period? Specifically, how much is being published, which journals publish experiments, what topics are being explored, and what fields are informing this research? (2) What content characterizes experimental research in technical communication? Specifically, how explicit are the research questions/hypotheses, are the results of pilot studies reported, what are the sample sizes and populations used, and what measures do researchers use? (3) Who publishes experimental research in technical communication? Specifically, which authors and affiliates are most associated with experimental research, and how does the sample's gender and authorship distribution compare to existing research?* **Literature review:** *We first address how scholars have assessed research in technical communication and how these findings implicate experimental research. We then review features of other exploratory studies that inform this study's design.* **Methodology:** *We conducted a quantitative and qualitative analysis of 137 experiments, a comprehensive sample identified from a corpus of 2,118 refereed papers published from 1992 to 2011. We coded 14 variables related to the causal relationships that the experiments addressed and who produced the research. We subjected the data to multiple statistical measures, including contingency table analysis and correspondence analysis.* **Results and conclusions:** *Over the 20 years, the journals published experimental research at a consistent rate. This could indicate that these methods have a stable presence in the field, or a discouraging sign that output is not on the rise despite calls from leading scholars.* IEEE Transactions on Professional Communication *(TPC) emerged as a strong producer of experiments, publishing 45% of the sample. TPC was also associated with most recent experiments, assuming this role from* Journal of Technical Writing and Communication, *which was associated with early experiments. In addition, TPC,* Journal of Business and Technical Communication, *and* Technical Communication *correlated with experiments on collaboration, pedagogy, and intercultural communication, respectively. The results also revealed that recent experiments reported significantly more explicit research question/hypotheses and pilot studies, an encouraging sign for the quality of future experiments. Finally, Spyridakis published the most experiments over the past 20 years, and researchers at the University of Washington and the University of Twente were the top affiliates associated with output. The configuration of both of these institutions' programs, which seem to align with a traditional science model, might suggest how the evolution of technical communication programs impacts the type of research that its affiliates produce. Our results are limited by the small, though comprehensive, sample and the exploratory natures of measures like correspondence analysis. Future research could use the proposed framework to investigate the evolution of other research methods in technical communication, strengthening our body of knowledge.*

***Index Terms*—*Correspondence analysis, experiments, quasi-experiments, research methods, technical communication.*

As professional and technical communication stabilizes as an academic discipline, attention on how we conduct our research remains paramount. The field's scholars have called for more rigorous, coherent, and systematic research as well as stronger questions and methods to issues related to the field [1]–[6]. Investigations on the state of research in technical communication have revealed future challenges but have also identified our interdisciplinarity, particularly our methodological plurality, as a positive contributor to the field's scholarship. Nevertheless, experimental approaches to research remain underused and underexplored.

Experiments test causal relationships, and the results help generalize our understanding of communication practices. We define true experiments as systematic investigations into the possible causes of a phenomenon. This process traditionally tests a hypothesis by manipulating at least one independent variable within a group of randomly assigned subjects in a controlled environment [7]. In contrast, quasi-experiments (or natural experiments) consist of already established groups and occur in natural settings, such as a

classroom or a workplace. As a result, researchers must establish between-group equality before introducing a treatment and offer a hypothesis to account for an ineffective treatment and threats to internal validity [8], [9].

Previous research in the field demonstrates an anemic record of experimental output. Less than 1% of the proceedings from the 1972–1991 conferences hosted by the Society for Technical Communication were experimental [10]. None of the 178 technical communication dissertations written from 1989–1998 employed a true experimental design, and only 3.9% employed a quasi-experimental design [11]. Technical communicators recently identified using 25 different methods, but only 8.6% of respondents indicated a use of experimental methods [12]. For this study, we identified a comprehensive sample of 137 experiments, which was 6.47% of all the refereed papers ($n = 2,118$) published over 20 years.

Spyridakis wrote that experiments are important to the topics that we investigate [13] and respond to what Charney defined as the purpose of technical communication research:

> to promote text designs that are easy for readers to use, to acculturate students into professional discourse communities, and to identify and promote effective and ethical communication practices in the workplace. [7, p. 111]

Charney's defined purpose highlights that technical communication must encompass the theoretical and applied perspectives of inquiry, similar to psychology, engineering, and human resources. Technical communication research not only informs our scholarly community and influences our classroom instruction but guides practitioners toward their profession's most effective standards and practices. The professional nature of the field requires that these standards and practices be continuously evaluated, tested, and refined.

A popular means for achieving this goal is through survey, a method that relies on the self-report of participants and often a relatively small sample. MacNealy found that 74% of the proceedings related to Society for Technical Communication hosted conferences included a survey compared to the less than 1% that were experimental [10]. MacNealy reiterated that the public has become saturated with surveys, making it difficult to generalize results. Almost 20 years later, Eaton and her colleagues noted the consistently low survey response rates within technical communication,

citing the dwindling participation in the Society for Technical Communication's Annual Salary Survey [14]. Surveys record necessary and important information on communication trends, but, like any method, offer a single perspective that should be supplemented with other approaches. Alternatively, fields like psychology have historically relied on experimentation to guide their practitioners' best practices.

In this paper, we explore a comprehensive sample of 137 experiments published from 1992–2011 within five leading technical communication journals. Our study identifies features related to the quantity and quality of experimental research as well as how these features contribute to a coherent body of knowledge. Exploratory studies like the present overview how a method has evolved within a field. The results highlight how the method has informed communication practices and identify areas for further inquiry. Though our investigation is limited to experimental rather than all empirical methods, we believe the results provide insight on a necessary contributor to the future of technical communication scholarship.

To guide this exploration, we posed three research questions: (1) How has experimental research in technical communication journals developed over the 20-year period? Specifically, how much is being published, which journals publish experiments, what topics are being explored, and what fields are informing this research? (2) What content characterizes experimental research in technical communication? Specifically, how explicit are the research questions/hypotheses, are the results of pilot studies reported, what are the sample sizes and populations used, and what measures do researchers use? (3) Who publishes experimental research in technical communication? Specifically, which authors and affiliates are most associated with experimental research, and how does the sample's gender and authorship distribution compare to existing research?

This paper has the following structure. The literature review synthesizes recent and relevant discussions on the general research practices in technical communication. The methodology section describes how the study was conducted, beginning with identifying the sample and followed by describing the measures used to explore the sample. The results section reports the quantity and quality characteristics of experimental research in technical communication. In the final section, we examine how our results contribute to the field's

body of knowledge, acknowledge the limitations of the study, and propose directions for future research.

LITERATURE REVIEW

This section first describes the theoretical orientation that guided our approach as well as how we selected the literature to review. We then synthesize the major findings from this literature and relate the broader themes to the presence of experimentation in technical communication. Finally, we describe several exploratory studies within and outside the field that informed the design of the present study.

Theoretical Orientation The design of this study was motivated by the consistent findings on the state of research in technical communication as well as the past histories of related fields like composition. Over the last three decades, scholars have identified technical communication as an evolving academic discipline. As described later in this section, we found that many of these studies offered similar results: technical communication is a methodologically diverse field but could benefit from more focused questions and its researchers from different methods training (such as [2], [4], and [6]).

These study's results also noted concerns among prominent scholars like Charney, who questioned if the field is matching the right method with the right question or defaulting to the method the researcher is more comfortable using [5]. Respondents to a recent questionnaire indicated that most technical communicator scholars primarily employed qualitative research methods that focused on discourse and texts and historical research, suggesting that the field's methodological plurality does not necessarily emphasize quantitative methods [12]. Concerned with similar trends, Haswell traced the decline of replicable data-supported research in NCTE/CCCC, the two flagships of postsecondary education in composition [15]. The absence of empirical methods in writing-based scholarship is pronounced and indicates why some foundational questions remain unanswered. If qualitative methods yield hypotheses and quantitative methods test them, a future technical communication inquiry may need to expand the depth of its methodological plurality. When he launched *Written Communication* in 1984, Stephen Witte warned of the dangers of a methodological imbalance: "A field that presumes the efficacy of a particular research methodology,

a particular inquiry paradigm, will collapse inward upon itself" [15, p. 220].

Selection of Literature to Review We began by re-reading the research that challenged and shaped our own perspectives as technical communication researchers (such as [5], [13], and [15]). These important pieces informed the study's questions but also reminded us of the exigencies these authors placed on enhanced methods training, particularly with quantitative approaches. Using Google Scholar and the electronic databases of the five primary technical communication journals, we then evaluated the abstracts of the articles that cited these important pieces. This approach allowed us to assess how current technical communicators were synthesizing these ideas. We selected relevant literature that was published within the study's designated time period (1992–2011) to contextualize the development of experimental research as reported in the results section. We focused our review on literature published in journal articles because technical communication is arguably a journal-oriented as opposed to a book-oriented field. Collectively, we categorized most of this research as: (a) studies that surveyed the field's thought leaders on general research practices [2], [6], [12]; (b) studies that reviewed the quantity and quality of research output [10], [11], [16], [17]; or (c) tutorials or case studies on specific methods [1], [3], [13].

Findings on Research Practices in Technical Communication The results have revealed related strengths and concerns that implicate the current state of experimental research.

Methodological Plurality: In the most recent overview of the field's research practices, scholars primarily characterized our methodological plurality as a strength [2]. Carliner *et al.*'s study identified a range of methods employed in the research published within four technical communication journals, including experiments, case studies, document reviews, and experience reports [17]. As mentioned earlier, technical communicators identified the use of 25 different method types, primarily qualitative research focused on discourse and texts and historical research [12].

This plurality also extends to the theories and content areas that inform our research. Many academics and practitioners discover technical communication after careers in human factors, human resources, public relations, and business management, and it is common for

these experiences to inform future research [2, p. 82]. Rude acknowledged that technical communicators borrow methods, theories, and content areas but also stressed the importance of establishing a separate identity that solidifies our value to others [4]. She proposed a unique research question centered on texts as well as four areas of related questions to help scholars achieve this goal. Alternatively, Charney expressed concerns about separating too much from fields, such as rhetoric and composition, where many current scholars developed their theoretical and pedagogical foundations [2]. Maintaining the field's encompassing approach to research while simultaneously establishing a unique identity invites its own research challenges.

Research Challenges: Research challenges facing the field can be connected to the general output of empirical research like experiments as well as observations about the general practices and training of our scholars.

Generally, there appears to be a dearth of empirical research in technical communication. In 1992, MacNealy reported that of the 3,479 entries in conference proceedings over the last 20 years, only 148 were empirical. She wrote that the focus of this research was on "personal and often limited experiences and preferences" rather than the quantity, quality, and coherence of this research [10, p. 533]. MacNealy conceded that anecdotal research was common for a developing discipline like technical communication; however, our current scholars are offering the same observations two decades later. Eaton classified a large amount of technical communication research as a collection of "cup of coffee articles" because the results were only as useful as having a cup of coffee with someone and discussing an experience [18, p. 9]. Similarly, Carliner *et al.* recently reported that at least three of the leading technical communication journals published a large amount of first-person experience reports and document reviews, which are often research based but not always empirical [17]. IEEE Transactions on Professional Communication (TPC) was the only journal that consistently published empirical research, primarily experiments, surveys, and tutorials. The types of research we choose to produce can signify how successfully the field has moved toward full professional status.

Professional Status: The goal of obtaining full professional status returns to the idea of technical communication as an evolving discipline in need

of a coherent body of knowledge, which can unite a field and establish its identity [19]. But Charney concluded that the overlap among technical communication projects was "insufficient for either building on or challenging published work" [2, p. 77]. Recent research has focused on the professionalization of technical communication, including the significant strides the STC has made in establishing its own online Body of Knowledge repository [20], [21]. However, at the time this paper was revised, no author had contributed content to the "Quantitative Methods" page, while the "Qualitative Methods" and "Usability Research" pages included substantial content contributions [22].

Features From Exploratory Studies To re-examine how experimental methods could contribute to technical communication's body of knowledge, scholars must first inventory the existing research. Exploratory studies offer insights into how a field or phenomena has evolved. We identified no literature that measured how technical communicators applied a specific method over time. However, several studies within and outside the field have explored bodies of research and identified characteristics related to timeframe, the sample, and authorship that would inform such a study.

Timeframe: All of the exploratory studies that we reviewed investigated a topic within a defined timeframe. For example, Rainey's two studies on doctoral dissertations in technical communication spanned over 30 years, which allowed for a longitudinal review of how research topics and methods evolved [11], [16]. Juzwik *et al.* were more interested in an overview of current writing studies research, so they limited their investigation to a 6-year period [23]. The timeframe for these three studies also allowed the researchers to analyze a comprehensive dataset rather than subject the data to various sampling methods that might reduce the generalizability of the results.

Sample Characteristics: Previous studies have collected a variety of metadata on their sample that might suggest the characteristics inherent to quality research. For example, research topic and method were popular variables to explore because they could suggest scholarly productive areas as well as areas in need of inquiry [17], [23]–[27]. Researchers also identified characteristics of their sample, including information on human subjects, sample size, and population (such as students and practitioners), and the statistical measures reported [23], [24], [26]. Identifying these variables

could help validate a study's results as well as suggest the quality of the research.

Authorship Characteristics: Previous exploratory studies have also focused on the scholars producing research, including author collaboration, gender, and affiliation. Two technical communication studies offered insight into how these variables shaped the research in two leading journals and offer a baseline for exploring the same characteristics in experimental research.

An analysis of a quarter century of TPC papers (identified through stratified random sampling) found that 63% of the papers were single-authored and 37% were co-authored [25]. More authors were male than female (61% compared to 39%), but female authorship increased over this timeframe. This analysis also recorded an increase in international authorship since 1996 as well as a high percentage of university (rather than industry or government) affiliations.

During the five years that Burnett edited *Journal of Business and Technical Communication* (JBTC), most papers were single-authored rather than co-authored (78% compared to 22%) [28]. There was also an uneven gender distribution among authors (62% females compared to 38% males). The slightly increased presence of collaboration in TPC and the reversed gender distribution between both journals are interesting, but not directly comparable due to the timeframes for analysis.

Questions Generated by the Literature Review

In the literature review, we identified several features and ideas that might suggest the quantity and quality of the experimental research published in technical communication journals over a 20-year period. To better organize these ideas, we developed the following questions:

RQ1. How has experimental research in technical communication journals developed over the 20-year period? Specifically, how much is being published, which journals publish experiments, what topics are being explored, and what fields are informing this research?

RQ2. What content characterizes experimental research in technical communication? Specifically, how explicit are the research questions/hypotheses? Are the results of pilot studies reported? What are the sample sizes and populations used? and What measures do researchers use?

RQ3. Who publishes experimental research in technical communication? Specifically, which authors and affiliates are most associated with experimental research, and how does the sample's gender and authorship distribution compare to existing research?

METHODOLOGY

This section justifies our research methodology and outlines the sample selection and collection process. We conclude with a description of the measures used to explore the final sample of 137 experimental pieces.

Choice of Research Methodology   As reported in the literature review, a substantial amount of technical communication research has been categorized as anecdotal, which limits how results can be extended or challenged. Therefore, we devised a quantitative, data-driven study so that the results and the design could inform future research. This approach allowed us to make more confident claims about the development of experimental research in technical communication journals. We also examined the data qualitatively to illustrate the correlations and significant findings of our results.

Choice of Samples to Study   The selection of our sample included identifying the journals, the timeframe for analysis, and the experimental pieces.

We selected five journals for this study: *Technical Communication* (TC), *Technical Communication Quarterly* (TCQ), JBTC, TPC, and *Journal of Technical Writing and Communication* (JTWC). These journals were previously identified as the leading publications in our field [29]; however, other studies have used a different combination of journals for analysis [17], [30].

Next, we identified the timeframe for analysis. Since we focused our inquiry on experimental research published in technical communication journals, we found that the content and arguments offered in Spyridakis' TC tutorial on experimental research, as well as her own record of applying these methods, provided a strong catalyst for beginning our analysis in 1992. Spyridakis' defined audience—current and future experimental researchers and researchers who needed to learn to interpret experimental findings—proved unique and preceded other important scholarship by MacNealy, Charney, and others. We concluded the timeframe

TABLE I
VARIABLE AND VARIABLE LEVELS CONSIDERED IN THE PRESENT STUDY

Variable	Description
Journal	Recorded the journal where the article was published (*JBTC, JTWC, TC, TCQ, TPC*).
Year	Recorded the year the article was published (1992—2011). Years were also categorized into five-year clusters (1992—1996, 1997—2001, 2002—2006, 2007—2011).
Author	Recorded the authors' names (last name, first initial).
Gender	Classified the authors as female or male.
Affiliation	Recorded the affiliation of all authors.
Affiliation Type	Classified the affiliation type (government/military, industry, university).
World Region	Classified the affiliations by world region (Africa/Middle East, Asia, Australia, Central and South America, Europe, North America).
Topic	Classified the topic of each article (assessment, collaboration, communication strategies, comprehension, visual design, editing and style, gender, genre, intercultural communication, information and knowledge management, pedagogy, research design, technology).
Origin	Classified the primary field that inspired the study (business and economics, business and technical communication, communication studies, education, gender studies, human-computer interaction, information and knowledge management, linguistics and language behavior, medicine, STEM, writing studies).
Question/Hypothesis	Recorded if the research hypotheses or questions were explicitly or implicitly stated.
Pilot Study	Recorded yes or no, depending on if the researchers reported the results of a pilot study prior to running the full study.
Sample Size	Recorded each study's sample size. Unreported sample sizes were recorded as undefined.
Sample Type	Classified each study's participants by type (student, practitioner, mixed, other, undefined).
Measures	Recorded the statistical measures used to describe the participants and the study's results. Each measure were also broadly categorized (descriptive, basic inferential, advanced inferential).

in 2011, which, at the time of coding, provided the latest complete volume of each journal.

Finally, we determined what content to include in the sample. We selected only peer-reviewed content, excluding book reviews, editorials, summaries of research published elsewhere, article reprints, and similar types of content that editors did not send for peer review. These parameters yielded a corpus of 2,118 articles, which we then culled for experimental pieces.

Our institution's library housed digital versions of most of the 1992–2011 issues from these five journals (though we did have to locate paper copies of a few early issues of TCQ). One of us identified the experimental sample from reading the article abstract, introduction, and methodology section (if present) of the entire corpus. This approach proved time consuming because authors did not always identify their method appropriately or explicitly. One researcher, for example, described her study as a textual analysis in the abstract but then as an experiment in the methods section. Other researchers clearly employed experimental methods but never identified their approach as such. To account for these discrepancies, one of us then independently cross-checked the sample by identifying experimental pieces via keyword searches in the journals' respective electronic databases. This process entailed searching the full-text of articles for "experiment" and "experimental" as both returned different results. We both discussed every article before including it in the final sample.

These approaches yielded a sample of 137 papers that used experimental methods, including 108 experiments, 11 pilot/exploratory experiments, 10 undefined experiments, and 8 quasi-experiments. The 10 undefined studies included experimental approaches but were not explicitly labeled as such. The total sample equated to approximately seven experimental pieces a year and 6.47% of all refereed content published in the journals within the designated timeframe.

How Data Were Collected   Once we identified the sample, we manually coded the 137 papers for 14 variables: *Journal, Year, Author, Gender, Affiliation, Affiliation Type, World Region, Topic, Origin, Hypothesis/Question, Pilot Study, Sample Size, Sample Type*, and *Measures*. Table I provides a description of each variable and its levels.

These variables and levels were selected based on their presence in previous studies as well as areas we believed important to experimental research [17], [23]–[27], [30]. We each coded half of the sample independently and then coded 20% of each other's sample to ensure reliability. A kappa test identified an overall between-rater agreement of 79.8%. Both of us discussed and reconciled any coding discrepancies.

A category that proved difficult to code was *Topic*. We coded a small sample of articles using four different coding schemas before arriving at the final approach. The topics listed in the STC Body of Knowledge (used in [17]) and the eServer Technical Communication Library (http://tc.eserver.org) were too broad for our purposes. Similarly, we found the topics that authors used to identify their manuscripts for publication consideration in JBTC and TCQ were incomplete and often too specific. Many of the TCQ topics, for example, included the word "theory," matching this journal's editorial scope, but not ours. We devised our own list of 13 topics based on our analysis of the data corpus and discussed each article collaboratively. To establish mutual exclusivity, we only coded the primary topic for each article, which we often determined by identifying the dependent variable in the experimental study.

How Data Were Analyzed The majority of our data were categorical, which limited the types of statistical analyses we could apply. In addition to analyzing the data with simple descriptive statistics, we used contingency table analysis and correspondence analysis. Both measures added greater depth to the results.

Contingency table analyses correlate multivariate frequency distributions, allowing researchers to statistically compare distributions of categorical, or non-numerical, data. We primarily ran binomials, a type of contingency table analysis that tests the statistical significance of deviations from theoretically expected distributions in two categories. Additional measures like Pearson's chi-square then determined whether proportions in the table's cells significantly differ. When a significant chi-square value is found, we conclude the variables being examined are contingent and, therefore, not independent. We also conducted follow-up pairwise tests to examine the nature of significant contingency tables (such as comparing individual cells in the table). Contingency table analyses are a widely used statistical tool for

categorical data and were also used in Martin *et al.*, who studied variables similar to the ones addressed in this study [26].

Correspondence analysis (CA) is a geometric technique used to analyze two-way and multiway tables containing some measure of correspondence between the rows and columns [31], [32]. The approach produces results comparable to principal components analysis (PCA) or factor analysis but is designed for non-numeric data. CA is widely used in corpus linguistic, marketing, and ecological research, but to our knowledge, this is the first time it has been applied in technical communication. Due to its exploratory approach, CA is not a method used to test hypotheses. Instead, it reveals patterns in complex data and provides output that can help researchers interpret these patterns. The most useful component of CA is its ability to visually organize the data in the categories into central and peripheral instances. The increasing distance of any representative of either category from the origin corresponds to a higher degree of differentiation compared with the other members with respect to their co-occurrences with the data in the other category. These analyses were run in R [33], and all CAs were run in R using the "ca" package [34]. We describe all of these measures with more depth in the results section.

RESULTS

This section organizes the results of the study by the three research questions.

> **RQ1.** How has experimental research in technical communication journals developed over the 20-year period? Specifically, how much is being published, which journals publish experiments, what topics are being explored, and what fields are inspiring this research?

We identified a sample of 137 experiments published over 20 years within the five leading technical communication journals. The years 1996, 1999, 2004, and 2006 published the largest amount of experiments ($n = 10$). The least amount of experiments appeared in 2003 ($n = 3$) and were all published in TPC. Overall, TPC published the most experiments ($n = 61$), which also accounted for 45% of the total sample. JTWC published the second most experiments ($n = 32$), followed by TC ($n = 26$), JBTC ($n = 14$), and TCQ ($n = 4$). Table II provides the frequencies of these experiments by the five journals and the 20-year period.

TABLE II
FREQUENCIES AND DISPERSIONS OF THE EXPERIMENTAL SAMPLE ACROSS 20 YEARS WITHIN THE FIVE JOURNALS

Journal	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
TPC	3	1	0	0	1	2	1	4	4	2	5	3	5	5	5	4	8	2	2	4	61
JTWC	2	4	3	2	7	0	2	2	1	2	1	0	0	1	2	1	0	1	1	0	32
TC	1	0	0	0	2	0	3	3	1	1	2	0	5	2	2	3	0	0	0	1	26
JBTC	2	0	0	3	0	2	0	1	0	0	0	0	0	0	1	0	0	1	1	3	14
TCQ	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	4
TOTAL	8	6	4	5	10	4	7	10	6	5	8	3	10	8	10	8	9	4	4	8	137
5-YEAR TOTAL			33					32					39					33			

Journal and Year Due to the size of the sample, we grouped the data into four, five-year periods to reveal more meaningful trends. Nearly all of these periods produced the same amount of research ($m = 34.25$, $sd = 3.20$), with the most experiments appearing within 2002–2006 ($n = 35$). A contingency table analysis of the frequency of experiments for each five-year period found no statistical significance. This indicates that the output of experimental research in journals has remained consistent over the 20 years. The conclusion section addresses this finding in more depth.

To further identify associations between *Journal* and *Year*, we subjected the data to a CA. CA is not an inferential measure and, therefore, does not determine statistical significance. The statistical output provides a chi-square value, but this value relates to the overall interaction between the rows and columns; it is up to the researcher to consult other statistical output to properly interpret the results. Throughout this section, we report only CAs that had a significant chi-square value of ≤ 0.05, but we reviewed other output to determine between-variable relationships.

For illustrative purposes, we describe the output used to interpret the CA between Journal and Year (Fig. 1). In CA, interpretation is typically restricted to the first two dimensions. The eigenvalues for the first two dimensions of Fig. 1 are 84.7% and 14.1%, respectively, indicating that the visualization explains 98.8% of the variation (inertia). The table used to produce this analysis includes many cells. Appendix A provides the numerical summary.

To ensure a reasonable degree of accuracy in the analysis, the quality score of any data set (qlt) should be more than 500. A figure of 500 indicates that 50% of the inertia for that data point lies off
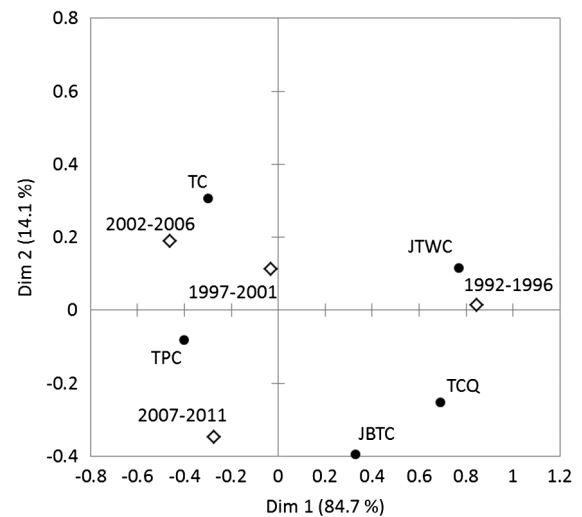

Fig. 1.   Correspondence analysis of *Journal* and *Year*.

principle axes and, therefore, that point is less accurately displayed in the plot. (See [32] and [35] for more details.) A low-quality score for any given row or column suggests that the interpretation of its position on the plot should be appropriately hedged. For example, the output visualized in Fig. 1 included a quality score of 996 (or 99.6%) for the journal JTWC. Likewise, the 1992–1996 year range had a quality score of 998 (or 99.8%). Both scores suggest a strong level of accuracy in their visual display. Similarly, the total inertia values (inr) relate to quality. JTWC has an inertia value of 479. So, given that the plot in Fig. 1 captures 98.8% of the inertia (such as distribution and variation of the data), JTWC then accounts for 48.5% of the structure of the plot ($47.9/98.8 \times 100$). We consulted the quality and inertia scores for the other two CAs reported in this section.

As written before, the strongest correlation in this first CA was between JTWC and the 1992–1996 experiments. The proximity of these two points on
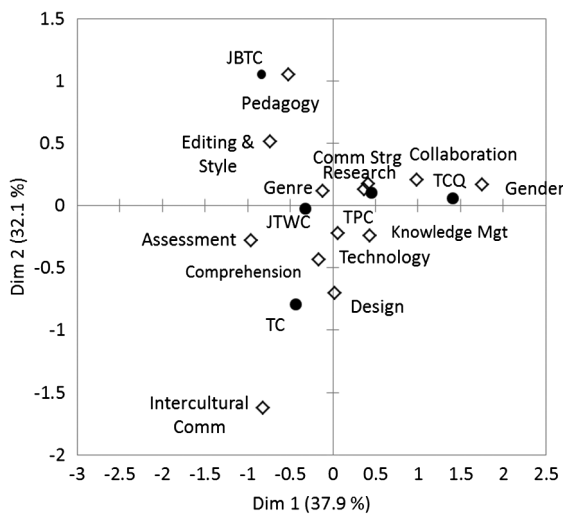
Fig. 2.   Correspondence analysis of *Topic* and *Journal*.

the top-right quadrant of Fig. 1, therefore, indicates a relationship between the variables. JTWC published 18 experiments in these years (Table II), which were the most experiments published in this timeframe. As a comparison, JBTC and TPC were the second most frequent publishers with five experiments each. The experiments published in JTWC during these five years also accounted for 56.25% of the total experiments that the journal published over 20 years.

A second correlation was found between TPC and the experiments published in the last ten years of our timeframe (2002–2006 and 2007–2011). TPC published 43 experiments during these two five-year periods (23 and 20), which accounted for 70.49% of the total experiments this journal published. This correlation in relation to the JTWC/1992–1996 experiments is noteworthy. TPC and JTWC are plotted on opposite sides of Fig. 1. The distance may suggest an evolutionary change; TPC is strongly associated with recent experiments but weakly associated with early experiments and vice-versa for JTWC. Similarly, the isolation of TCQ and JBTC in relation to the other journals and years indicates the strength of their associations with experimental research.

A third correlation was found between TC and the 2002–2006 experiments (top-left quadrant of Fig. 2). TC published the second highest number of experiments during this period ($n = 11$ compared to TPC's 23). However, the three other journals published a combined total of five experiments. TPC and TC appeared to be the leading publishers of experiments during this time.

Topic   We also investigated which topics were being explored with experimental methods and the distribution of the 13 topics across the five journals.

A contingency table analysis determined how evenly distributed the experimental topics were across the sample. We found no literature that weighted the importance of individual topics to technical communication; therefore, the null hypothesis assumed that if all topics were evenly distributed, 10.5 experiments on each topic would have appeared over the 20-year period. This number was derived by dividing the total number of experiments in our sample by the number of topics (137/13). Table III summarizes these topics and their observed frequencies as well as how dispersed the topics were among the five journals.

The contingency table analysis revealed that experiments on comprehension, technology, and genre were published with a higher-than-expected frequency. These three topics comprised 50% of the total sample and were dispersed within four of the journals. To provide more meaningful results on this substantial portion of the data, we subcategorized the experiments on these three topics.

The 24 experiments on comprehension were classified as either visual or text based. Seventy-five percent of these experiments were text-based and covered a variety of ways that readers identified and retained information. For example, Spyridakis and Fukuoka examined American and Japanese readers' comprehension of and preference for expository texts that contained a thesis that was organized either inductively or deductively [36]. Results indicated that Americans recalled information equally well with either organizational structure, but that Japanese readers recalled more information from deductively organized texts. Twenty-five percent of the comprehension experiments were visual based. As an example, Williams and Spyridakis examined how typographical and formatting tools of headings signaled the structure of text and, thus, the author's perspective [37]. Among the results were that readers comprehended visual discriminations among headings with fewer rather than more dimensions, and that size was the most significant visual cue to a heading's hierarchical position.

The 23 technology-themed experiments covered several content areas. A majority of these studies examined how technology informed learning, how technology impacted communication, or how the

TABLE III
FREQUENCIES AND CONTINGENCY TABLE ANALYSIS RESULTS OF *TOPIC* AND *JOURNAL*

Category	Journal					Frequency	*P*
	JBTC	*JTWC*	*TC*	*TCQ*	*TPC*		binomial
Comprehension	0	10	7	1	6	24	0.00*
Technology	1	4	6	0	12	23	0.00*
Genre	2	9	2	0	9	22	0.00*
Collaboration	0	0	0	1	13	14	0.10
Communication strategies	1	2	1	1	7	12	0.88
Editing and style	4	3	2	0	2	11	0.87
Pedagogy	5	2	0	0	4	11	0.87
Assessment	1	1	2	0	0	4	0.04*
Visual design	0	0	2	0	2	4	0.04*
Knowledge management	0	0	1	0	3	4	0.04*
Intercultural communication	0	0	3	0	0	3	0.01*
Research design	0	1	0	0	2	3	0.01*
Gender	0	0	0	1	1	2	0.00*

*Significant at < 0.05 α level

design of technology related to its use. For example, Amare found that technical writing students preferred PowerPoint-based lectures, but students who learned via a traditional lecture format performed significantly better in their coursework [38].

Finally, 77% ($n = 17$) of the genre experiments focused on procedures. One recent study was a quasi-experiment that explored how participants used written instructions prior to contact with the appliance or while carrying out the designated task as well as how different formats impacted how quickly readers completed tasks [39]. The results indicated that 90% of participants consulted the instructions at some point during their interaction with the appliance, and that participants who used text-and-picture instructions completed their tasks in the least amount of time. Other genres explored via experiments were correspondence, forms, reports, and resumes.

A contingency table analysis also indicated that experiments on collaboration, communication strategies, editing and style, and pedagogy were not significantly distributed because the individual frequencies were too close to the expected frequency of 10.5. Therefore, experiments on these topics appeared as expected if each topic was to have equal representation. Combined, these topics comprised 35% of the total sample and were dispersed within the journals with the most variation.

Experiments on assessment, visual design, knowledge management, intercultural communication, research design, and gender were published at a lower-than-expected frequency. Combined, these topics comprised 15% of the total sample and were dispersed within only one or two of the journals.

Topic and Journal Our second CA revealed strong correlations between individual topics and journals (Fig. 2). Since the 2-D analysis accounted for only 70.0% of the inertia (Dim 1: 37.9%, Dim 2: 32.1%), we also considered the third dimension (Dim 3: 15.3%) to represent 85.3% of the inertia. In simple binary CA, additional dimensions should be included if the combination of the first two dimensions is not more than 75% [35]. Fig. 3 illustrates the first two dimensions; illustrations of Dims 1 and 3 and Dims 2 and 3 as well as the numerical summary are supplied in Appendix B.

The strongest correlation existed between pedagogy and JBTC (top-left quadrant of Fig. 2). The journal published only 10% of the experiments in this study's sample, but it published 45% of the experiments on pedagogy. These experiments explored a variety of issues on the process and product of student writing. An early experiment found that inexperienced writers produced higher quality writing via contextualized case assignments than traditional assignments. However, the assignment type did not impact the writing produced by students with previous business-related experiences [40]. In a recent pilot study, engineering students used sentence combining and pattern practice to produce significantly higher quality reports than students in a control group [41].
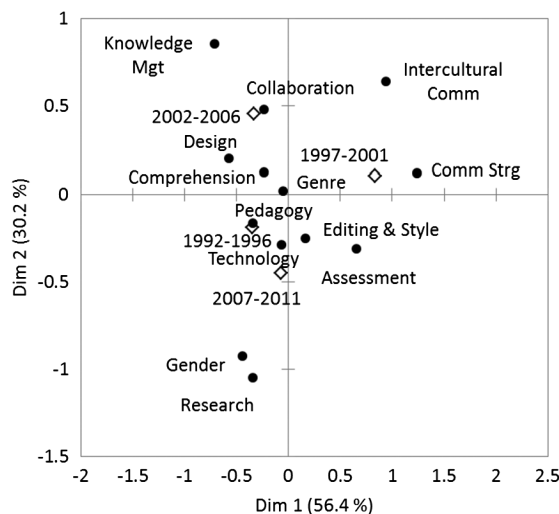
Fig. 3.   Correspondence analysis of *Topic* and *Year*.

Category	Frequency	$P_{binomial}$
Business and Technical Communication	35	0.00*
STEM	31	0.00*
Communication Studies	18	0.10
Human-Computer Interaction	14	0.65
Education	11	0.77
Linguistics and Language Behavior	11	0.77
Writing Studies	6	0.05*
Business and Economics	5	0.02*
Information and Knowledge Management	3	0.00*
Gender Studies	2	0.00*
Medicine	1	0.00*

*Significant at < 0.05 α level

Another correlation existed between collaboration and TPC (top-right quadrant of Fig. 2). TPC published approximately 93% of the experiments on this topic ($n = 13$), and 85% of these experiments focused exclusively on virtual teams ($n = 11$). Virtual teams consist of any dispersed group who uses technology to accomplish an organizational task. These experiments have addressed how various initial meeting modes and the technological complexity of a project impact virtual collaboration [42], [43].

A third correlation was found between intercultural communication and TC (bottom-left quadrant of Fig. 2). Overall, this topic appeared less than expected across the five journals (Table III), but TC published all three of the experiments. The most recent study determined how participants' culture related to the presentation introduction they preferred [44].

Topic and Year   Our final CA showed relationships between individual topics and the five-year periods (Fig. 3). The 2-D analysis accounted for 86.7% of the inertia (Dim 1: 56.4%, Dim 2: 30.2%). Again, this indicates that the analysis is stable and we can interpret the plot with some confidence. The numerical output is supplied in Appendix C.

The strongest correlation related to experiments on communication strategies was published from 1997 to 2001 (top-right quadrant of Fig. 3). A total of 12 experiments were published on this topic, 75% of which were during these five years. These experiments explored a variety of causal relationships, including the effects of document

type and procedure on the quality and ease of translation for Spanish, Chinese, and Japanese speakers; the effects of speaking Ebonics and Standard English in professional settings; and the effects that exordial techniques have in gaining audience attention [45]–[47]. All five journals published an experiment on communication strategies during these five years.

Another correlation existed between experiments on collaboration published from 2002 to 2006 (top-left quadrant of Fig. 3). A total of 14 experiments were published on this topic, 57% of which were published during these five years. As observed earlier, the bulk of these experiments ($n = 6$ or 75%) focused on collaboration within virtual teams. Only TPC published experiments on this topic from 2002 to 2006. Results from the second CA (Fig. 2) also demonstrated a correlation between TPC and experiments on collaboration.

Origin: Finally, we examined the primary field that the experimental researchers cited in their literature review to motivate their own study. Fields that inspired these experiments did not necessarily correlate with the fields associated with the study's researchers. Results offer insight into the fields that derive or are closely associated with experimental research in technical communication. Overall, we identified 11 different origins. Table IV lists these fields and their frequencies.

A contingency table analysis calculated the observed frequencies of the fields of origin across the sample (Table IV). We identified no literature that weighted the fields that inspired experimental research in technical communication, so our null hypothesis again assumed that the fields of origin would be evenly distributed across the sample. This expected frequency was determined by dividing

the total number of experiments by the number of origins ($137/11 = 12.45$).

Results indicated that experiments inspired from business and technical communication and the STEM disciplines, particularly psychology, appeared more than expected. Combined, these experiments comprised 48.2% of the total sample and were dispersed across all five journals.

Experiments inspired from communication studies, human–computer interaction, education, and linguistics and language behavior appeared as expected and were not significantly distributed because the individual frequencies were too close to the expected frequency of 12.45. Combined, these experiments comprised 39.4% of the total sample and were dispersed across all five journals.

Finally, experiments inspired from writing studies, business and economics, information and knowledge management, gender studies, and medicine appeared less than expected. Combined, these experiments comprised 12.4% of the total sample and were dispersed within all five journals.

> **RQ2.** What content characterizes experimental research in technical communication? Specifically, how explicit are the research questions and hypotheses? How are the results of pilot studies reported? What are the sample sizes and populations used? and What measures do researchers use?

Research Questions and Hypotheses:
Experiments are designed to answer research questions or test hypotheses about relationships between variables. Overall, 80% ($n = 110$) of the experiments included explicit research hypotheses or questions while 20% ($n = 27$) implied these features. We also found that 48% of the experiments that included implicit questions and hypotheses were published from 1992 to 1997.

To further explore this finding, we investigated the correlation between *Year* and *Question/Hypothesis*. Results from a cross tabulation revealed that these variables were significantly associated (chi-square $= 14.734$, $p = 0.002$, Cramer's V $= 0.328$). According to Rea and Parker, a value of 0.328 for Cramer's V indicates a moderate association (any value over 0.4 is considered strong) [48]. A series of pairwise tests determined where the variables significantly differed. To control for possible type 1 error, we used Holm's sequential Bonferroni method, which uses a more conservative alpha level for determining significance.

The results confirmed that experiments published from 1992 to 1996 included significantly more implicit research questions and hypotheses than experiments published from 2007 to 2011 (chi-square $= 10.439$, $p = 0.001$, Cramer's V $= 0.398$). This variable association was strong. In addition, experiments published from 1992 to 1996 included significantly more implicit research questions and hypotheses than experiments published from 2002 to 2006 (chi-square $= 8.414$, $p = 0.004$, Cramer's V$= 0.342$). This variable association was moderate.

Pilot Study: The inclusion of a pilot study can also mark the quality of an experiment. Pilot studies are preliminary studies that can test experimental protocols and techniques to ensure they are as effective as possible before the main study begins. If measurement error is reduced, the reliability of the measurement technique is increased. Overall, 27% ($n = 37$) of the experiments included the results from a pilot study. We found that 65% of the pilot studies appeared in experiments published in the last 10 years of our timeframe ($n = 24$).

To further explore this finding, we again ran a cross tabulation on the *Year* and *Pilot Study*. Variables were significantly associated (chi-square $= 8.262$, $p = 0.041$, Cramer's V $= 0.246$), and pairwise tests revealed the significant relationships. The results confirmed that experiments published from 1992 to 1996 included significantly less experiments with pilot studies than experiments published from 2007 to 2011 (chi-square $= 8.250$, $p = 0.004$, Cramer's V $= 0.354$). This variable association was moderate. In addition, experiments published from 1992 to 1996 included significantly less experiments with pilot studies than experiments published from 1997 to 2001 (chi-square$= 4.986$, $p = 0.026$, Cramer's V $= 0.277$). This variable association was moderate.

Sample Size and Population: A sample includes a subgroup of a population. Results from a sample are then generalized back (and used to represent) the population. For such generalization to be valid, the sample must be representative of its population. Therefore, the most important characteristic of the sample is not its size but its similarity to its parent population. Most of the experiments published in technical communication used convenience samples (such as nonrandomized groups like a class of technical writing students), and many of the other studies did not provide enough sampling information to accurately code. We found that the sample sizes used varied from ten subjects to 3,540. Two studies did not define their sample size.

TABLE V
TOP STATISTICAL MEASURES REPORTED BY FREQUENCY AND
BROAD CATEGORY

Measure	Frequency	Broad Category
mean	114	Descriptive
demographic	88	Descriptive
standard deviation	79	Descriptive
ANOVA	71	Basic inferential
frequency	59	Descriptive
t-test	46	Basic inferential
reliability	36	Descriptive
correlation	25	Basic inferential
chi-square	25	Basic inferential
range	17	Descriptive
MANOVA	13	Advanced inferential
Tukey-HSD	12	Basic inferential
Mann-Whitney U	11	Basic inferential

Overall, 20,604 subjects were used across the sample. The distribution of the sample sizes was greatly skewed, and the median value of 73 was the best indicator of central tendency. Sample size is contextual and depends on the statistical power, effect size, and significance level of each individual study. Therefore, we do not provide any additional description of this variable.

All 137 experiments involved human subjects. Seventy-three percent of the experiments used students ($n = 100$), 10% ($n = 14$) used a sample we classified as other, 9% ($n = 12$) used practitioners, 5% ($n = 7$) used a mixed population, and 3% ($n = 4$) used an undefined population. Subjects classified as other included military civilians, senior citizens, and academics [49]–[53]. Mixed samples included combinations of populations, including recruiters and students and professional and student writers [54], [55].

Measures: We coded every statistical measure reported in the sample. Overall, researchers reported 661 total measures and 46 different types. Table V lists the 13 most frequent measures. The first four (mean, demographic information, standard deviation, and ANOVA) accounted for 53% of the total measures reported in the sample. These first three were broadly classified as descriptive; the ANOVA was broadly classified as basic inferential. The additional remaining nine measures accounted for 90% of the total measures reported in the sample. In total, the most frequent measures included six descriptive measures, six basic inferential measures, and one advanced inferential measure. The coding schema we used to broadly classify measures was modified from [24].

The majority of experiments reported basic inferential measures like the ANOVA, t-test, and

correlations ($n = 95$, 69.3%). In addition, 16.8% of the studies ($n = 23$) reported advanced inferential measures such as the MANOVA. Finally, 13.1% of the studies ($n = 18$) reported only descriptive measures such as mean and standard deviation. One study reported no statistics. We performed a series of tests that correlated with the broad measures categories to *Journal, Year, Origin,* and *Topic;* however, no significant relationships were found.

RQ3. Who publishes experimental research in technical communication? Specifically, which authors and affiliates are most associated with experimental research? and How does the sample's gender and authorship distribution compare to existing research?

Author Results Overall, our sample included 309 authorship attributions and 236 different authors. Approximately 84% of the authors contributed to only one experiment, and 11% of the authors contributed to two experiments. Table VI lists the 12 authors who conducted ≥3 experiments.

Spyridakis dominated the output of experimental research in technical communication over the 20-year period. She coauthored 11% ($n = 15$) of the total sample. Her output also demonstrated breadth; she published within all four of the five-year periods and in three of the leading journals—TPC, JTWC, and TC. The majority of these experiments were comprehension-themed ($n = 9$), but she also published on genre, technology, communication strategies, and editing and style.

Overall, we found 57% of the sample's authors were males ($n = 176$) and 43% were females ($n = 133$). In regards to collaboration, experiments included up to six authors, and approximately 74% of these papers were coauthored ($n = 101$) instead of single authored ($n = 36$).

To enhance these results, we also collected information on the top experimental researchers' educational background and their current affiliations. As shown in Table VI, these 12 researchers earned their highest degree from one of six institutions. Half of these institutions were US based; three researchers earned their degree at the University of Washington while researchers from international institutions were evenly split among the University of Leiden, University of Twente, and Utrecht University ($n = 2$ each). Only two researchers earned a degree in technical communication (Ummelen and Fukuoka), and the others earned their degree in a variety of other

fields, including educational curriculum and instruction, management information systems, and sociolinguistics. Currently, these experimental researchers are affiliated with one of nine different institutions. Seven of these institutions are based internationally; three researchers are affiliated with the University of Twente, but they all work in different departments. Only Steehouder (Twente) is currently affiliated with a pure technical communication department; however, Spyridakis and Williams (Washington) produced much of their experimental research as faculty in the Department of Technical Communication (now the Department of Human Centered Design and Engineering), and Gerritsen is affiliated with the Department of Business Communication Studies (Radboud).

Finally, we compared authorship among the five technical communication journals. A contingency table analysis suggested a moderate association between journal and collaboration (chi-square = 10.432, $p = 0.034$, Cramer's V = 0.276). Follow-up pairwise comparisons revealed that TPC published significantly more coauthored experiments than JTWC ($p = 0.039$, Cramer's V = 0.214). TPC also published significantly more coauthored experiments than TCQ ($p = 0.007$, Cramer's V = 0.333); however, this result must be heavily hedged due to the small sample of TCQ experiments.

Affiliation Results Our sample also included 309 affiliation attributions and 108 different affiliations. Table VII lists the 13 institutions that produced ≥5 experiments.

The University of Washington ($n = 38$) and University of Twente ($n = 35$) comprised nearly 25% of the affiliation attributions. Washington researchers produced 17 of the sample's experiments. Spyridakis contributed to 15 of these experiments; however, 18 other researchers from Washington were also represented. All Washington experiments had multiple authors, including researchers from the Boeing Company, Fuji Xerox, and the State University of New York at Binghampton. Washington researchers published experiments throughout all four of the five-year periods and in three leading journals—TPC, JTWC, and TC. These experiments explored six different topics, primarily comprehension.

Researchers at Twente produced 19 of the sample's experiments. Sixteen different authors contributed to these studies, including five of the top experimental producers identified in Table VI (van der Meij, de Jong, Steenhouder,

Gellevij, and Ummelen). Fifteen of the 19 experiments were coauthored, and the Twente researchers also collaborated with researchers from Utrecht University and the Baan Company (the Netherlands). Twente researchers published experiments throughout all four of the five-year periods in four different journals—TPC, JTWC, TC, and JBTC. These experiments explored six different topics, primarily genre.

In addition, 60% of the affiliations were from the US and were represented by 74 different universities, industries, or government and military agencies. Forty percent of the affiliations were international and represented by 34 different universities, industries, or government and military agencies. When classified by the world region, 63% of the affiliations were from North America, including Canada ($n = 193$); 30% from Europe ($n = 94$); 4% from Asia ($n = 13$); 2% from Australia ($n = 7$); and 0.5% from both Africa and the Middle East as well as Central and South America ($n = 1$).

Finally, 92% of the affiliations came from a university ($n = 285$), 7% from industry, and 1% from government and military agencies.

CONCLUSIONS, LIMITATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

The final section concludes with an examination of how this study's results relate within the broader context of the field's growing body of knowledge. We also note the study's limitations and suggest areas for future research.

Conclusions One of the more compelling results from this study was the consistency of the experimental output. The contingency table analysis confirmed no significant shifts in experimental publication over 20 years. This result could suggest that experimental approaches have a stable presence in the field's journals. However, the more discouraging conclusion is that no notable increase in output was found despite calls from leading scholars, tutorials on these methods tailored to the field, and the increased number of researchers with formalized degrees in technical communication. The results of this study revealed ways that the journals' editors and researchers can strategically improve the presence of experimental research in the field as well as encourage findings on the contents of our recent experiments.

TPC emerged as a strong producer of experimental research, publishing 45% of the sample. For

TABLE VI
TOP EXPERIMENTAL RESEARCHERS ASSOCIATED WITH THE SAMPLE

Author	Gender	Frequency	Education	Current Affiliation
Spyridakis, J.	Female	15	U of Washington, PhD in Educational Curriculum and Instruction	U of Washington, Dept of Human Centered Design & Engineering
van der Meij, H.	Male	6	U of Leiden, PhD in Social Sciences	U of Twente, Dept of Instructional Technology
de Jong, M.	Male	5	U of Twente, PhD in Communication Science	U of Twente, Dept of Computer Science
Steehouder, M.	Male	5	Utrecht U, PhD in Humanities	U of Twente (emeritus), Dept of Technical and Professional Communication
Gellevij, M.	Male	4	U of Twente, PhD in Applied Education	Saxion U, Research Centre for Educational Innovation
Lowry, P.B.	Male	4	U of Arizona, PhD in Management Information Systems	City U of Hong Kong, Dept of Information Systems
Ummelen, N.	Female	4	U of Twente, PhD in Technical Communication	Eindhoven U of Technology, Secretary of the University
Fukuoka, W.	Female	3	U of Washington, MS in Technical Communication	Fuji Xerox, Tokyo
Gerritsen, M.	Female	3	U of Leiden, PhD in Sociolinguistics	Radboud U, Dept of Business Communication Studies
Jansen, C.	Male	3	Utrecht U, PhD in Language and Communication	U of Groningen, Dept of Communication and Information Studies
Nunamaker, J.	Male	3	Case Western Reserve U, PhD in Operations Research	U of Arizona, Dept of Management Information Systems
Williams, T.R.	Male	3	U of Washington, PhD in Educational Psychology	U of Washington (emeritus), Dept of Human Centered Design & Engineering

TABLE VII
TOP AFFILIATIONS ASSOCIATED
WITH THE EXPERIMENTAL SAMPLE

Affiliation	World Region	Frequency
U of Washington	North America	38
U of Twente, Enschede	Europe	35
Tilburg U	Europe	16
Utrecht U	Europe	10
Radboud U	Europe	8
Concordia U	North America	6
Brigham Young U	North America	6
Indiana U	North America	6
U of Memphis	North America	5
U of Alabama	North America	5
U of Arizona	North America	5
National U of Singapore	Asia	5
New Jersey Institute of Technology	North America	5

illustrative purposes, if TPC were removed from inquiry, our comprehensive sample would drop from 137 experiments to 76. Instead of publishing approximately seven experiments per year, the average drops by almost half to 3.8. Experiments currently comprise 6.47% of the total refereed papers published across the five journals within the 20-year period ($n = 2118$); that number would drop to 3.56% without TPC.

Interestingly, while experiments dominate current TPC content (alongside surveys and tutorials), the journal's readers prefer case studies, literature reviews, and tutorials [17]. This reader feedback merits further investigation into what makes technical communication less open to experimentation. Cumulatively, these findings could suggest a training issue, which aligns with the general criticisms of our field's research practices. Charney wondered if technical communicators had a deep enough understanding of methods to appropriately match them to their research questions [2, p.80]. She later wrote that experimental approaches, in particular, appeared daunting to the field because of their unfamiliar techniques [56]. In the field's graduate-level research methods courses, Campbell found that experiments and statistics were often covered but that topics related to validity and reliability were

some of the least covered [6]. She argued that these disconnects in methodological training impacted the value of technical communication research and moved the field further away from full professional status. Based on the present study's results, we conclude that experimental research in technical communication journals would suffer significantly if TPC shifted to the readers' preferred editorial focus.

Results from this study also indicated several additional contributions that TPC has made in experimental research: the journal correlated with experiments on the topic of collaboration (Fig. 2), particularly during 2002–2006 (Fig. 3), and was also found to be a more popular venue for coauthored experiments than JTWC and TCQ. While the impact of TPC is evident, this study also found that three other journals contributed to experimental research in meaningful ways.

JTWC was the leading publisher of experiments from 1992 to 1996. However, the journal appeared to change its editorial focus, publishing 17 experiments from 1992 to 1996 but just three experiments from 2007 to 2011. Fig. 1 illustrated this seemingly deliberate shift with JTWC over the 20-year period as well as TPC's evolution into the current top producer of experimental research. Though JTWC did not correlate with any other variables, it published experiments on 8 of the 13 topics and published 32 of the sample's experiments.

TC emerged as a consistent venue for experiments and was associated with experiments on intercultural communication (Fig. 2). Overall, TPC, JTWC, and TC were the three publication venues for the top producer of experiments (Spyridakis) and researchers at the top two affiliations (University of Washington and University of Twente).

In comparison, JBTC and TCQ were weaker producers of experimental research. Combined, both produced 13% of the sample. Neither published many experiments over the 20-year period; however, JBTC was associated with experiments on pedagogy. Due to its small sample size ($n = 4$), TCQ did not correlate with any variables.

When identifying future publication venues, researchers should be aware of how these journals have evolved regarding experimental research. TPC appears to be the leader for current experimental research; however, researchers should also note that TPC, JBTC, and TC were associated with

experiments on collaboration, pedagogy, and intercultural communication, respectively. These journal's editors could use this insight to enhance their editorial focus and better distinguish their scholarship.

Results on *Topic* and *Origin* could also shape future experimental research. Experiments on comprehension, technology, and genre appeared more than expected (Table III), and that technical communicators were mainly inspired by ideas and theories posited in business and technical communication (Table IV). Knowledge from the STEM disciplines, mainly psychology, was the second significant informant of experiments. We noted the field's interdisciplinarity in the literature review. The variety of topics and disciplines that inform technical communication experiments also reflects this idea; however, researchers should be mindful of how these and future studies extend or challenge our body of knowledge. Both Charney and Rude stressed a need for greater agreement on research questions, which will only define our own identity [2], [4]. Results from this study suggest ways experimental research can respond to this call.

In addition to providing an overview of the quantity of experimental research in technical communication journals, we reported results that suggest the quality of the sample. Overall, we found that most experiments included explicit research hypotheses or questions; however, the presence of these elements increased significantly over the 20-year period. Pilot studies appeared in only 37% of the sample, but the inclusion of these studies also increased significantly over the 20 years. Both results indicate improved research designs and experimental training. Similarly, almost 70% of the sample went beyond reporting descriptive measures and included basic inferential measures like the ANOVA, t-test, and correlations. We found no significant relationship among the measures and other variables, suggesting that experimental researchers have remained consistent in how they report results. All of these findings are encouraging signs for the quality of future experimental research.

Finally, the results on the authors and affiliations associated with experimental research merit discussion. Our sample revealed that 57% of the experiments were authored by males and 43% by females. This 14% gender gap is small when compared to previous research. An analysis of 25 years of TPC content included a 22% gender gap

that favored male authors, and an analysis of five years of JBTC content included a 24% gender gap that favored female authors [25], [28]. Similarly, the top producer of experimental research in technical communication was a female, who published across the entire 20-year period and on five different topics.

We also found that two or more authors contributed to 74% of our experimental sample. When considered alongside the available data, it appears that collaboration could be associated with experimental research in technical communication. The earlier-noted TPC and JBTC analyses found that only 37% and 22% of scholarship included more than one author. Perhaps the one discouraging result on authorship was that 96% of researchers contributed to only one (85%) or two (11%) experiments. Identifying why these authors chose not to conduct second or subsequent experiments, or at least not publish them in technical communication journals, might improve the output of experimentation. Finally, researchers affiliated at the University of Washington and University of Twente produced a substantial amount of the sample. The frequency of experimental research produced by the affiliates could correlate to programmatic makeup.

We suggested earlier that the lack of experimentation in technical communication could correlate to training issues; however, barriers to using these methods might also relate to departmental support. Respondents to Blakeslee's questionnaire frequently mentioned their frustrations with acquiring support and recognition from their host departments. One respondent identified her department as "a very traditional literature-based view of English studies" and wrote:

> research that takes a lot of time is not well understood or highly regarded....I feel like I have to walk a very careful line between the more quantitative view of technical writing research and the literature-based world view. [12, p. 137]

Several other respondents expressed concerns about the value their English colleagues attached to technical communication research. Other studies (notably [57]) have questioned if English is a suitable home for technical communication programs. Experiments are arguably more associated with the hard and social sciences, and it is possible that a program's host department dictates the type of research its affiliates produce. Both

Washington and Twente appear more aligned with the science model than technical communication programs housed in literature-based English departments. The graduate programs at both universities are designed to produce high-quality researchers [58], [59]. Graduate students have the opportunity to work in several research labs, which likely facilitates the collaborative nature reflected throughout this study's sample; every experiment affiliated with Washington and most of the experiments affiliated with Twente had multiple authors. We also observed that other technical communication programs that were no longer housed in an English department, such as the Department of Linguistics and Technical Communication at the University of North Texas and the Department of Journalism and Technical Communication at Colorado State University, were more associated with recent experiments (such as [60] and [61]).

Limitations This study explored only experimental research in technical communication journals over a 20-year period. The results cannot generalize the quantity or quality of research of other empirical methods, such as surveys, case studies, or usability studies. We were able to perform a thorough analysis of our sample because of its size; however, the size also reduced the certainty of our findings, especially when some of these variables were organized into multiple levels. Finally, the majority of the variables we coded were categorical, reducing the strength of our statistical analyses. A limitation of contingency table analyses is that its results are often based on hypothesized outcomes when little previous research exists. And though correspondence analysis offers interesting results, the correlations cannot be considered statistically significant.

Suggestions for Future Research We found that many of the general characteristics that make technical communication unique were also reflected in the experimental sample. However, we join in the recommendations that the field could only benefit from a series of universal questions that would provide the overlap necessary to extend or challenge previous findings. Experimental methods are appropriate means for facilitating this type of inquiry.

Future experiments might benefit from content-focused inventories on the specific topics or academic disciplines that inform our research. The experiments on genre, for example, are primarily focused on instructions and how readers find and

use information. A meta-analysis of these findings would yield additional designs that extend this body of knowledge. Additional studies could test these same phenomena in other settings with different populations, or perhaps apply these earlier designs to other genres, such as proposals, grants, or reports. Similarly, researchers should be aware of the experimental topics that appeared less than expected, such as research design and gender. Revisiting this literature might suggest additional studies or determine if an experiment is even an appropriate method for exploring the causal relationships impacting these topics.

Researchers could take a similar approach when choosing the idea or theory that best informed their experiments. As a field, we might need to consider if we are pulling from so many other disciplines that the impact of our research is being diluted or indistinguishable. We might also need to consider which fields we should be relying on most to inform these studies. Charney cautioned from separating too much from rhetoric and composition because its foundations helped shape many technical communicators [2]. Indeed, comprehension and genre-focused experiments were likely published more than expected (Table III) because of their substantial and rich histories in the composition community that predate technical communication.

Charney also noted barriers to initially conducting experiments and Blakeslee noted overall barriers to research, but future investigations should explore why researchers choose not to continue with these methods. Experimental research incurs costs that might not be associated with other approaches, such as paying human subjects and data coders. The STC has dissolved its $10,000 research grant, leaving only one external funding stream through the Council for Programs in Technical and Scientific Communication (up to $1,500). Technical communication is not yet a recognized discipline with federal funding agencies like the National Science Foundation, and the lack of external funding opportunities in our field might deter a greater volume of experimental research. However, the affiliates most associated with experimental output suggest an alternate path to producing more experiments. Additional studies on how the evolution of technical communication programs impact the type of research produced is needed. Likewise, a follow-up study in another 10 or 20 years might reveal a correlation between technical communication programs that have separated from English departments and the types of research produced. Finally, this study only provided a snapshot of the quality of these 137 experiments. An additional study could assess the impact of these experiments, including how often and in which fields they are being cited.

Nearly all academic disciplines go through a maturation process. As technical communication continues its own process, every facet of scholarship is subject to evolve and become refined, including its core philosophies, theories, research questions, and methodologies. All of these characteristics ultimately lead to the quality of research produced. While solely focused on experimental research, we have offered a reliable design that technical communicators could use to explore other research methods. The collection of these data in tandem with the results of the present study will substantially inform the field's body of knowledge as well as outline directions for future experimentation.

Numerical summary of Correspondence Analysis on *Journal* and *Year*, numerical summary of Correspondence Analysis on *Topic* and *Journal*, and numerical summary of Correspondence Analysis on *Topic* and *Year* are shown in Appendices A, B, and C, shown as supplementary downloadable material at http://ieeexplore.ieee.org.

APPENDIX A

NUMERICAL SUMMARY OF CORRESPONDENCE ANALYSIS ON *Journal* AND *Year*

TABLE VIII
PRINCIPAL INERTIAS (EIGENVALUES)

Dimension	Value	Percent	Cumulative %
1	0.251743	84.7	84.7
2	0.041888	14.1	98.8
3	0.003677	1.2	100.0
TOTALS	0.297308	100.0	

TABLE IX
ROW PROFILES

	Journal	Mass	qlt	inr	k = 1	cor	Ctr	k = 2	cor	ctr
1	JBTC	102	971	94	-331	399	44	396	572	382
2	JTWC	234	996	479	-771	975	551	-115	22	74
3	TC	190	969	120	296	468	66	-306	500	425
4	TCQ	29	963	55	-694	852	56	251	112	44
5	TPC	445	991	252	399	950	282	84	42	75

TABLE X
COLUMN PROFILES

	Years	Mass	qlt	inr	k = 1	cor	ctr	k = 2	cor	ctr
1	1992—1996	241	998	583	-847	998	687	-14	0	1
2	1997—2001	234	549	19	30	37	1	-112	512	69
3	2002—2006	285	988	241	462	846	241	-189	142	242
4	2007—2011	241	1000	157	273	384	71	346	616	687

APPENDIX B

NUMERICAL SUMMARY OF CORRESPONDENCE ANALYSIS ON *Topic* AND *Journal*

TABLE XI
PRINCIPAL INERTIAS (EIGENVALUES)

Dimension	Value	Percent	Cumulative %
1	0.281560	37.9	37.9
2	0.238447	32.1	70.0
3	0.113808	15.3	85.3
4	0.109400	14.7	100.0
TOTALS	0.743215	100.0	

TABLE XII
ROW PROFILES

	Topic	Mass	qlt	inr	k = 1	cor	ctr	k = 2	cor	ctr
1	Assessment	29	831	47	-955	763	95	-285	68	10
2	Collaboration	102	910	153	984	871	351	208	39	19
3	Comm. Strategies	88	909	27	419	779	55	171	130	11
4	Comprehension	175	557	92	-166	71	17	-436	487	140
5	Design	29	565	35	19	0	0	-705	565	61
6	Editing & Style	80	935	93	-734	626	154	516	309	90
7	Gender	15	383	160	1756	380	160	164	3	2
8	Genre	161	125	47	-116	62	8	116	62	9
9	Intercultural Comm.	22	774	126	-816	156	52	-1625	618	242
10	Knowledge Management	29	423	23	437	323	20	-244	101	7
11	Pedagogy	80	942	158	-519	184	77	1052	757	372
12	Research Design	22	320	14	368	286	11	127	34	1
13	Technology	168	463	27	59	29	2	-226	434	36

TABLE XIII
COLUMN PROFILES

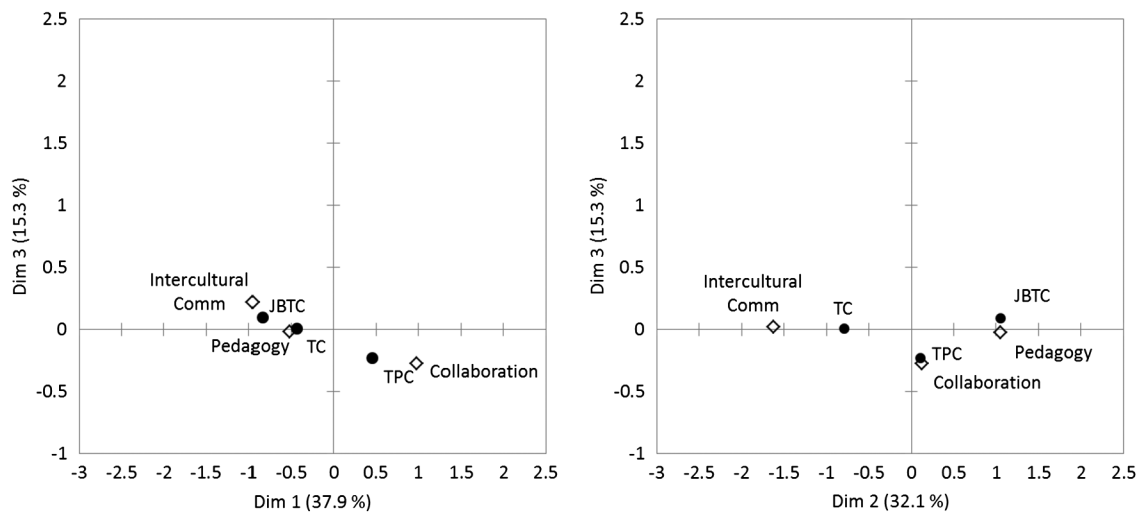|	Journal	Mass	qlt	inr	k = 1	cor	ctr	k = 2	cor	ctr
1	JBTC	102	912	274	-840	354	256	1055	558	477
2	JTWC	234	246	133	-322	244	86	-25	1	1
3	TC	190	886	236	-433	203	126	-793	683	501
4	TCQ	29	401	195	1410	401	206	55	1	0
5	TPC	445	803	162	454	762	325	105	41	21

Fig. 4. Dimensions 1 and 3 (left panel) and Dimensions 2 and 3 (right panel) of the meaningful correlations in the *Topic* and *Journal* Correspondence Analysis

APPENDIX C

NUMERICAL SUMMARY OF CORRESPONDENCE ANALYSIS ON *Topic* AND *Year*

TABLE XIV
PRINCIPAL INERTIAS (EIGENVALUES)

Dimension	Value	Percent	Cumulative %
1	0.223678	56.4	56.4
2	0.119831	30.2	86.7
3	0.052732	13.3	100.0
TOTALS	0.396242	100.0	

TABLE XV
ROW PROFILES

	Topic	Mass	qlt	inr	k = 1	cor	ctr	k = 2	cor	ctr
1	Assessment	29	909	43	661	742	57	314	167	24
2	Collaboration	102	636	115	-233	121	25	-479	515	196
3	Comm. Strategies	88	1000	342	1239	991	601	-115	9	10
4	Comprehension	175	441	70	-234	346	43	-122	95	22
5	Design	29	919	29	-571	820	42	-198	99	10
6	Editing and Style	80	758	24	167	230	10	252	527	43
7	Gender	15	975	40	-439	179	13	925	796	104
8	Genre	161	73	16	-51	65	2	-17	7	0
9	Intercultural Comm.	22	999	71	940	684	87	-639	316	75
10	Knowledge Management	29	1000	91	-710	408	66	-855	592	178
11	Pedagogy	80	919	31	-338	739	41	167	180	19
12	Research Design	22	936	72	-341	89	11	1052	847	202
13	Technology	168	691	54	-62	30	3	290	661	118

TABLE XVI
COLUMN PROFILES

	Years	Mass	qlt	inr	k = 1	cor	ctr	k = 2	cor	ctr
1	1992—1996	241	562	169	-347	434	130	189	128	72
2	1997—2001	234	993	418	833	978	725	-103	15	21
3	2002—2006	285	957	240	-332	330	140	-458	627	498
4	2007—2011	241	735	173	-68	16	5	452	718	410

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