

SECTION A

The Scientific Research Method as a Learning Tool in Higher Education

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ABSTRACT

Research is an important activity in the business and scientific communities as well as in virtually every academic discipline. In all venues, research provides new knowledge that can support problem solving, decision-making, discovery, invention, and conflict resolution. In higher education, learning how to conduct valid research prepares students for their future professional lives, and it certainly enhances the learning process. But valid research is much more than searching, examining and reporting results. The well-proven “scientific method” of research prescribes a specific format for investigation in which a topic area is examined, a problem is identified, a research question is formulated and a hypothetical answer is evaluated. Modern computers and online capabilities greatly enhance the ability of students to conduct research, but the widespread increase in online teaching has also obviously changed teaching and learning methods. Therefore, it makes sense to re-examine current trends in academic research concerning research methodologies, particularly regarding new approaches to the scientific research method. This paper describes a recent small study for which college faculty members provided answers in response to a number of relevant questions that, when analyzed, might indicate trends in the effective use of research as an academic learning tool. The study suggests that a fully-articulated research project would provide valid results that inspire stronger emphasis on research and writing competencies in higher education.

The Goal

The Goal of higher education is to prepare people for life in the real world. In this noble endeavor, institutions of higher learning exist and strive to explore, develop and present bodies of knowledge from a wide variety of disciplines. Many of these disciplines are ongoing, dynamic fields that form major industries in which large segments of the American population are involved professionally. Each of these industries exists with the primary purpose of sustained financial success that affects the people who work in it, invest in it and benefit from its productivity. Our daily lives, our careers, and our entire culture are shaped by the products and services of industries that provide food, housing, transportation, communication and all the many things that we need and want. And those businesses and industries depend to a large degree on the academic institutions that educate and prepare the people who perform the professional work that makes these industries viable.

Writing and Research Are Essential

Writing deepens thinking and increases students' engagement with course material. Good writing assignments prompt students to think more deeply about what they're learning (Hughes, 2000).

It is a two-way street. Higher education is intrinsically linked to the ongoing development of the theories, processes and applications that constitute each professional area. And that includes the arts and pure science disciplines--even the legal profession. The knowledge that exists and is written about in the professional areas forms the basis for academic disciplines and degree programs, and the discoveries and inventions provided by academic research extend into the real world as business evolves to meet the

changing demands of a free society. It is therefore very convenient that higher education has a good model to emulate in the professional world and that the professional world benefits from both the learning and the writing and research that happen in higher education.

To the extent that industry and academe both use the same research methods, each benefit from what the other accomplishes. Industrial research leads to major development efforts into which substantial investment and effort are made and from which significant financial gain is achieved (the goal of business). Academic research enhances students' appreciation of research in the business world; what students learn while conducting research is directly applicable to their future roles in industry. Moreover, the business world provides students with views of reality that give the feedback necessary for valid research activity. Properly done, academic research is an excellent learning tool.

Research in Aviation

Businesses are deeply dedicated to meeting the challenges and demands of a changing world. Research and development projects constitute major sources of new knowledge in every industry, especially in aviation and aerospace. In this industry, extensive research and development must precede actual flight; we do not simply hang wings on something and expect it to fly—especially when someone has to fly it!

Asking the Right Questions

Managers, scientists and engineers know that before answers can be obtained, they must first ask questions. The financial and safety issues involved in everything aeronautical dictate that the research process must contain specific logical steps.

Research in aviation is far more than simply sifting through data from which some

relationship can be identified. It is generally invalid to start with answers and back up into possible questions. Research is the evaluation of answers to specific questions that have not been answered, or perhaps that have not even been previously asked. Therefore, research does not begin simply by asking a question; it usually requires a thorough examination of existing knowledge and past studies to arrive at unanswered questions.

Research in industry is a formal process that proceeds from describing a problem within a specific topic area and verifying that the problem is recognized within the discipline. The immediate objective of research is not a solution to a problem; it is the validation of the existence of a problem, identification of unanswered questions, and evaluation of hypothesized answers to those questions. Thus, industrial research is mostly a way to find and deliver conclusions about specific studies that might aid the problem solver in arriving at a solution. In aviation and aerospace, the environment is usually filled with a surplus of urgency, complexity and uncertainty.

Research in academe resembles industrial research in that it evaluates hypothetical answers to specific questions. Studies show that undergraduate students with a mastery of research skills have increased self-confidence, better intellectual development, and clarification of career goals (Crowe, 2007). Crowe also declared that students who are introduced to the culture of research early in their academic careers are better equipped to use research to solve real-world problems.

While the educational institution is usually not the final user of knowledge gained from research, the findings of academic research projects are often very useful in the industries about which they are conducted. Even within limited budgets and time frames, research conducted in the academic environment is often able to uncover new

information that eventually serves the needs of problem solvers and researchers in industry. Occasionally, major breakthroughs and discoveries are achieved in the university laboratory that truly present new opportunities for industry.

Research Validity

Research in higher education faces the same tests for validity that it faces in the business world. Even when the objective is simply to complete an academic requirement such as a term project or thesis, the overbearing concern is always about research validity. In both arenas, typical challenges exist. Too often, organizational issues take precedence over research priorities; credentials often trump experience, routine learning measurement tools distract both faculty and students from constructing adequate research projects, and format and style sometimes receive more emphasis than research validity. Also, much has been noted recently about students' writing competencies as well as the limitations in time, resources and data access needed to dig into extended research. All of these observations reveal major concerns in academe about whether students actually know how to conduct valid research projects and use them as learning tools.

The bodies of knowledge in all disciplines are dynamic and changing. The old answers may no longer be the right answers. Thus, a primary objective of all higher learning and especially in doing academic research is learning how to ask the right questions. When students only see research as a requirement to pass a course, they stop asking questions and focus on telling the instructor what they think he wants to hear. But there is a "silver bullet" available to researchers that enables them in all venues to generate valid studies that deliver answers with acceptable confidence levels.

Research or Just Search?

Research is the seeking of knowledge about reality; it is the identification of unanswered questions and conducting experiments (tests) to arrive at answers. Research involves deductive reasoning, sometimes called “Aristotelian logic.”

Search, on the other hand, uses inductive reasoning in which data and information are collected and from which someone tries to determine what questions they answer. Search in the computer era is largely “surf and download.” Search is not a useless process, however; quite often, a thorough search will uncover an unanswered question that could be researched. Thus a process of search and research serves a useful purpose in resolving real problems. Too often, a research question is formulated, but evaluation of an answer is not obtained. Many of these disappointments are the result of not knowing where to look for the answer. Fortunately, a more methodical research method is available.

The Scientific Method

To get around the common obstacles to effective research studies, researchers often use a step-by-step approach called the scientific method:

Conducting research involves using the scientific method at its core. Therefore, before any research is undertaken, it is important to be aware of the steps. A very useful internet source covering scientific method research states that “The research methodology has not come up overnight, but has evolved through hundreds of years of science (Experiment-resources.com, 2011).

The 1989 *Oxford English Dictionary* defines the scientific method as “a method of procedure that has characterized natural science since the 17th century, consisting in

systematic observation, measurement, experiment, and the formulation, testing, and modification of hypotheses.” Various researchers and scientists view the steps of this process in somewhat different order, but the essence of all the views is the development of a research hypothesis that is tested by collecting data and conducting an analysis, usually involving statistical methods. A research hypothesis is a possible answer to a research question; analysis of the data arrives at statistical probabilities within a specified confidence level. Although statistical probabilities do not equal proof or disproof, the results are often useful in understanding the research topic and suggesting further study. The scientific method . . . puts guesses (hypotheses) to tests and see how they hold up. All aspects of investigations are public and described in detail so anyone who questions results can repeat the study. Replication is a key component of scientific method (Fraenkel, 2011).

The scientific method permits successful, valid findings that are not certainties, but they still reveal information with a pedigree within statistical boundaries. A very important benefit of the scientific method is that the hypothesis tells the researcher where to look for data; validity is considered before the actual research begins.

Nourse (1969) describes the scientific method as a day-to-day activity we all engage in without knowing; it is an innate process. Further, he believes the time-tested method is heavily relied upon to describe the process of our evolution.

But the big question still to be asked addresses the effects on academic research that result from recent changes in the learning environment: do students who have adjusted learning habits to computers in the classroom, online courses and internet research really know how to use the scientific method to accomplish valid research?

The Academic Learning Environment in a Real World

The preceding assessment of research in business and higher education describes long-standing concepts and well-tested research methodologies in traditional learning environments. In particular, this paper has described and supported positive views and experiences about the scientific method of research. But we know that the learning environment in higher education has been undergoing accelerated changes. Not all college courses are conducted in classrooms inside ivy-covered campus halls. Our teaching and learning environments have changed dramatically! Computers, projectors, slide shows, videos, and simulations have become fixtures in our classrooms. They certainly affect the course delivery methods of today's faculty. Furthermore, online courses--with or without interactive video—constitute a major portion of the courses offered by institutions of higher learning.

Academic research often involves the testing of hypotheses about the real business world. Very often, data is collected through sample surveys of the relevant populations and data sources in the real world that provide information about what it demands, approves, rejects, does, and has learned. Reality brings to a study the experiences of the involved, immersed and informed people who know the domain being studied far better than an outsider taking a brief look at it. The view from ground level is usually more detailed and informative than the view from twenty thousand feet! And quite often, it is said that the devil is in the details. Students and industrial researchers must gather data where it is actually generated and analyze it to determine its meaning and significance in terms of the problems being addressed. The scientific method of

research has consistently provided a ready means of identifying and assessing this information.

As the internet has opened up the entire world to our view and inquiry, it has also made it much more accessible for research. Given that research is a great learning tool, these changes should theoretically make it even more useful. However, we know that new teaching tools have certainly changed teaching and learning methods. We also know that changes in student interests, attitudes, primary and secondary public school problems, internet usage and text messaging have already caused changes in their writing skills. The entire American culture is undergoing major changes.

What We Do Not Know

What we do not know for sure are the effects of new teaching tools and methods and related cultural changes on academic research. A variety of questions that could be asked within today's faculty seem appropriate:

1. How well do current faculty members understand the scientific method of research?
2. How extensively do current faculty members require research as a learning tool in the courses they teach?
3. Do current faculty members believe their students understand the scientific research method and use it effectively?
4. Do current faculty members believe their students have competence in their writing?
5. Are there new technical, cultural or legal issues that hamper data collection?

From these questions, several possible research hypotheses emerge that might provide a view of the experiences, backgrounds and opinions of university faculty on the above questions. This paper addresses several of these questions, using a survey of faculty opinions about students' understanding of the scientific method of research and their use of it to generate valid research studies.

A Research Hypothesis

Based on recent discussion with university faculty, published articles on the subject of student research and writing, and the teaching experiences of this paper's author over the past sixteen years, it could be hypothesized that a significant percentage of responding faculty believe that today's college students are not sufficiently familiar with the scientific method of research and not using it effectively in their academic work.

The Survey

A survey was sent to randomly-selected faculty who teach both undergraduate and graduate courses at nine live classroom centers and online. The author used Survey Monkey© to collect the responses. Following three demographic questions, survey questions 4 through 10 asked educators about their attitudes and opinions concerning research, their understanding and use of the scientific method and their students' capabilities to use it. The survey is attached as Appendix A.

Significant Results

The responses to the survey were tabulated and analyzed in terms of the research hypothesis. The demographics were as expected, with 92 percent of the 45 respondents indicating they have taught in a live classroom in the past three years. More than half of them (54 percent) indicated they have been teaching full-time or part-time for more than

ten years. About 60 percent have taught graduate courses and about 40 percent have taught only undergraduate courses. Half of them have done business research and two-thirds of them have done academic research, which suggests that they know the importance of valid research in both environments and how to do it. Fully 87 percent claimed to be well acquainted with the scientific method of research. Thus, in terms of the topic of this study, respondents are well qualified to provide informed responses.

When asked about research in higher education, about three-fourths (73 percent) agreed that research is an important learning tool in higher education, and yet fewer than half of the respondents indicated they believe research is emphasized sufficiently in higher education.

Fewer than half of all respondents indicated they require their students to conduct research using the scientific method. The result most related to the topic of this paper is that fully two-thirds of respondents believe most students are not familiar with the scientific method of research or capable of using it to arrive at valid results.

A very disturbing result of this study showed that four out of five responding faculty (79 percent) believe that students today lack the writing skills needed to produce a competent, valid research study.

What Does This Study Actually Tell Us?

The study prompted by this paper leaves little doubt that responding faculty members view themselves as fully understanding how the scientific method of research works, and that it can contribute effectively to the learning process. They believe strongly that they are qualified to determine when and how students should conduct academic research, and that they have had ample experience in both the business and

academic venues to do research in both. However, this brief study did not delve into specific parts of the scientific research method and the fine art of arriving at valid conclusions, nor did it examine academic research in the light of its contributions to the business world.

Hypothesis Evaluation

The hypothesis suggested by this study is strongly supported by the responses. The tabulated data from the study's survey shows that a significant percentage of responding faculty believe today's college students are not sufficiently familiar with the scientific method of research and not using it effectively in academic work.

In a related result, a vast majority of responding faculty believe that college students do not have the ability to write a competent paper that expresses the interest, knowledge and belief needed to persuade its readers. This finding is considerably more concerning than those about the scientific method, because the roots of writing competency and literacy problems originate in the earlier years of students' educations when they are still in primary and secondary schools.

Conclusions

The results of this study reveal that a significant percentage (about a fourth) of responding faculty do not agree that research is an important learning tool in higher education. Only about half of them require students to conduct research using the scientific method in which a research question is identified and a hypothesis is developed and tested. The concern regarding these two conclusions is not only that students may not be learning how to do valid research, but that they are not learning about its importance in the business world. Moreover, it raises concerns about the willingness of

faculty to assign and evaluate research projects, especially in distance learning courses and online degree programs that do not bring teachers and students into direct view of one another. It is one thing to proofread a paper and discuss the research and writing aspects of it with a student. It is something very different to try to scroll down the “pages” on a computer monitor, criticize concepts, content, logic, sentence structure, language and paragraph discipline—and ask questions about it all. Apparently, the red pencil trumps the word processor in the proofreading and editing process. And when online editing requires correcting, resending and rereading, the continuity of the research may be lost.

Referring to the general question that prompted this study, it is evident that there are changes in the learning environment and changes in the methods and validity of academic research that may affect students’ research attitudes and knowledge. It is therefore highly appropriate to ask whether students who have adjusted to computers in the classroom, online courses and internet research really understand the scientific method and will use it effectively. This question still needs to be asked and answered.

In conclusion, this study showed that a vast majority of responding faculty indicated their criticism of students’ writing competency. The continuing decline of writing skills observed in successive waves of high school graduates is probably one of the causes for students’ research problems. The causes of this trend are outside the span of control of the university, but its effects are apparent and worthy of serious concern.

Recommendations

There is little doubt that research is an excellent learning tool and nothing in this study suggests otherwise. However, the above conclusions indicate a decline in the

inclusion of full-blown academic research using the scientific method. This is seen not as a weakness in faculty or their ability to conduct and inspire research, but the result of cultural changes in our society. It is evidenced by declining writing competencies amid the growing use of social networks, text messaging, computer gaming, language changes, and rampant plagiarism. In the context of this study, these are at least distractions from the tasks required to conduct research, and at worst, reasons for not learning how to write a decent sentence. Major booksellers like Borders and Barnes and Noble have declared bankruptcy; people are not buying as many books because they have other sources for reading. Perhaps the decline in writing skills is partly the result of a decline in reading. There are no “group solutions” to this kind of problem; it takes individual effort. And faculty who themselves do research are far more qualified and motivated to include research in their academic work.

None of these cultural problems is within the purview of higher education to solve. But if we are to support, inspire and generate good academic research and effective use of the scientific method, it is strongly recommended that universities measure the writing skills of new students and provide writing improvement courses. This will only happen when academe takes the responsibility for repairing the damage. We can cite the flaws and motives of our public schools and teacher unions, but only our direct intervention with each student will give that student the writing competency needed for valid academic research and preparation for life in the real world.

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Appendix A

Research Instrument

1. Please indicate the learning environment(s) in which you currently teach classes or have taught in the past three years.

- Live classroom
- Synchronous interactive online (Eagle Vision, etc.)
- Nonsynchronous distance learning
- Blended learning (live plus online)
- Thesis/capstone committee
- Other

2. How long have you been a full-time or part-time instructor?

- One year or less
- Two to five years
- Six to ten years
- Ten to 15 years
- More than 15 years

3. Please indicate the level(s) of courses you have taught in the past three years.

- Undergraduate
- Graduate
- Both
- Neither

4. Please indicate the personal writing or research experiences you have accomplished in your academic, personal or professional activities.

- Business research
- Academic research

- Published paper
- Published book
- Contributed chapter(s)
- Edited

5. I believe research is one of the most important learning tools in higher education.

- Disagree strongly
- Disagree
- Uncertain
- Agree
- Agree strongly

6. I believe research is emphasized sufficiently today in higher education.

- Disagree strongly
- Disagree
- Uncertain
- Agree
- Agree strongly

7. I believe I am well acquainted with the "scientific method" of research and its basic steps.

- Disagree strongly
- Disagree
- Uncertain
- Agree
- Agree strongly

8. I require that students in many of my courses conduct research using the "scientific method" to evaluate hypotheses.

- Disagree strongly
- Disagree
- Uncertain
- Agree
- Agree strongly

9. I believe most of today's college students are familiar with the "scientific method" of research and capable of using it to arrive at valid results.

- Disagree strongly
- Disagree
- Uncertain
- Agree
- Agree strongly

10. I believe today's college students have the writing skills needed to produce a competent, valid research study.

- Disagree strongly
- Disagree
- Uncertain
- Agree
- Agree strongly