# The Impact of IQ+EQ+CQ Integration on Student Productivity in Web Design and Development

**Jensen J. Zhao**
Department of Information Systems
& Operations Management
Ball State University
Muncie, IN 47306, U.S.A.
jzhao@bsu.edu

**Sherry Y. Zhao**
International Computer Science Institute
Berkeley, CA 94704, U.S.A.

**ABSTRACT**

As the entry-level information technology jobs could be easily outsourced offshore, the demand for U.S. employees who are innovative and productive in information technology (IT) project design, development, and management is growing among U.S. companies. This controlled experiment presents how a model of integrating students' intelligence quotient (IQ), emotion quotient (EQ), and creativity quotient (CQ) into teaching and learning activities has impacted student productivity in Web design and development. The purpose of this research is to provide IT educators with the empirical results they need to decide whether they should consider incorporating the 3Qs integration model into their curricula to prepare a new generation of IT graduates. The findings indicate that (a) at the initial stage, the 3Qs integration model had no positive impact on student time efficiency, but had significantly reduced student errors in Web application design and development; (b) the 3Qs integration model enabled students to continuously improve their time efficiency and error reduction in designing and developing a series of Web applications; and (c) the gender difference did not moderate the positive impact of 3Qs integration on student productivity in terms of time efficiency and error occurrence in Web design and development.

**Keywords:** CQ, EQ, IQ, Integration Impact, Error Occurrence, Time Efficiency, Productivity, Web Design and Development

## 1. INTRODUCTION

With the advancement of the Internet and Web technologies, the global communication and online collaboration become more convenient and less expensive than ever before. This advancement creates an opportunity for companies to maximize their shareholder value by minimizing costs through outsourcing knowledge-based jobs such as online technical support and software programming to overseas at lower prices, which was not possible before the Internet era. A *Business Week* special report indicated that outsourcing is transforming whole industries and changing the way we work (Engardio, 2006).

Coupled with the offshore outsourcing opportunity for U.S. companies, comes the threat of losing jobs to the U.S. information technology (IT) professionals. The U.S. IT workers now face a situation similar to that in the manufacturing industries, which lost jobs over the past several decades, as companies either improved automation or moved manufacturing plants overseas for cheap labor. A Gartner study predicted that as many as 50% of the IT operational jobs in the U.S. could disappear over the next two decades because of advanced technologies and offshore outsourcing (Thibodeau, 2004). As the U.S. Bureau of Labor Statistics reported, from 2000 to 2006, the number of jobs as computer programmers declined by 25.4% and that of data entry clerk went down by 35.5% due to offshore outsourcing, which were ranked at the top of America's most vulnerable jobs list (Blinder, 2007).

However, demands for innovative employees with IT architecture skills as well as project management and communication skills are growing among U.S. companies. It is not just about math and science anymore; it's about creativity, imagination, and above all, innovation (Nussbaum, 2005). Many technology executives want to hire entry-level IT employees who have current technical skills, communicate well, think critically and creatively, and can work in a multicultural world (Gruman, 2004; Hamm, 2007; Overby, 2003; Thibodeau, 2004). IT executives and educators are warning that the U.S. isn't producing IT experts in quantity and quality that it needs to remain the leader of the global IT market (Verton, 2004). At the 2007 Gartner Symposium/ITxpo, a group of Gartner analysts put out the call for IT heroes who are willing to reject mediocrity and embrace innovation. These analysts pointed out that innovation is in short supply inside corporate IT organizations and most IT organizations could not deliver new value because their DNA is fundamentally about control (Claburn, 2007). Similarly, Professor Leah Jamieson, Purdue University's dean of engineering and the 2007 president of IEEE, stated at the 2008 Fortune Brainstorm: Tech conference, "If we're going to foster this age of innovation, we need to do three things: Attract not only the best and the brightest, but the most creative to engineering. Ensure that this creativity is welcome in the universities. And provide a home for this creativity in the technology industry." (Fortune Live Media, 2008, p. S6)

To meet the new demand from the U.S. IT industry, IT educational programs, which include computer science, information systems, and information technology programs, require students to take additional courses such as project management and business communication. Nevertheless, simply adding these courses into IT programs without requiring integrated learning activities would not effectively achieve the new program objectives (Datz, 2004; Cropley and Cropley, 2000; Zhao and Alexander, 2004).

Skills and competencies in technology, innovation, management, and communication are developed from three different types of mental processes or domains: intelligence quotient (IQ), emotion quotient (EQ), and creativity quotient (CQ). While reading, understanding, reasoning, analyzing, and judging are skills and competencies belonging to the IQ domain (e.g., Eysenck, 1994; Nietzel, Berstein, and Milich, 1998; Wechsler, 1944); empathy, leadership, communication, teamwork, and management skills are within the EQ domain (e.g., Barn-On and Parker, 2000; Cooper, 1997; Goleman, 1998; Gardner, 2004; Schutte and Malouff, 1999). In addition, curiosity, brainstorming, commitment, innovativeness, and creative problem solving are in the CQ domain (e.g., Baumgarner, 2003; Feldman, Csikszentmihalyi, and Gardner, 1994; Naiman, 2004). As our educational programs have traditionally been compartmentalized or subject-based, the programs very often give little to almost no room for teaching creativity and facilitating students' integration of IQ, EQ, and CQ for synergy (e.g., Datz, 2004; Forrester and Hui, 2007; Taylor, 1986; Zhao, 2005). To assure that our IT students—the future IT professionals—will be innovative and competent in doing high-level technical work as well as managing people and services around the world through the use of IT, a need exists for introducing innovative, integrative concepts or models for educating a new generation of IT professionals. In addition, developing IT-specific concepts and theories is essential for our growth (or survival) as a discipline that is autonomous of our several reference disciplines (Markus and Saunders, 2007).

## 2. INTEGRATING IQ, EQ, AND CQ FOR SYNERGY

Integration is an important and often overlooked element of designing IT curriculum and courses (Mills, Hauser, and Pratt, 2008). Integration methods include discussions, demonstrations, guest presentations, goal-setting, and hands-on action planning, which help students identify specific areas where changes can be implemented in the workplace or real-world situation (Foxon, 1987). In an IT curriculum, examples of hands-on, real-world projects include the development of an e-commerce site for a Web design or Web-programming course, the development of software systems for a programming course, the development of a database and related queries for a database course, and incorporating ERP into business processes for a system analysis and design course (Mills, Hauser, and Pratt, 2008). Integrating students' IQ, EQ, and CQ in learning activities and hands-on, real-world projects would enable students to explore their potentials in these three domains and spark their innovative ideas for identifying and solving real-world problems.

Empirical studies in psychology, neuroscience, linguistics, and other neighboring disciplines concluded that human skills and competencies are mental representations constructed over time within our minds or brains and they can be reformed, refashioned, reconstructed, transformed, combined, altered, and undermined. They are, in short, within our hands and minds (e.g., Gardner, 2004; Hedlund & Sternberg, 2000). This conclusion implies that integrating IQ, EQ, and CQ into teaching and learning activities would help IT students achieve synergistic successes in their hands-on, real-world projects, which would be not only workable but also innovative, aesthetically appealing, user-interface friendly, cost-saving, and reusable. Specifically, by integrating IQ, EQ, and CQ into IT teaching and learning activities, educators inspire, nurture, and mentor students in continuously exploring their potentials in IQ, EQ, and CQ and applying them to learning activities and hands-on, real-world projects, such as software engineering, systems design, e-business applications development, collaborative project management, report writing and oral presentations.

In order to maintain the U.S. leadership in the global economy, the U.S. Patent and Trademark Office (2004) worked in concert with other Federal agencies, corporations, and associations and developed a national outreach program—the Inventive Thinking Curriculum Project—for schools to promote students' critical and creative thinking and problem-solving skills through activities of identifying real-world problems and creating innovative solutions or inventions. The project integrated three high-order thinking skills models developed by Bloom (1956), Taylor 1(986), and Isaksen and Trefeinger (1985), respectively, to provide opportunities for students to experience the elements described in these models as briefed in the following.

Bloom's (1956) *Taxonomy of Educational Objectives* classified learning and thinking into six levels. The lowest level is *Knowledge*, which is defined as remembering the previously learned material. Above the knowledge level is *Comprehension*, an ability to grasp the meaning of the material or subject. The next level in the hierarchy is *Application*, which refers to the ability to use learned material in new concrete principles and theories, and it requires a higher level of understanding than comprehension. Beyond the application level is *Analysis*, which requires an understanding of both the content and structural form of the material or subject. The fifth level is *Synthesis* that refers to the ability to put parts together to form a new whole. Learning outcomes at the synthesis level represent the formulation of new patterns or structures. The highest of the taxonomy is *Evaluation*, which is the ability to judge the value of the material or subject for a given purpose. The learning outcomes from evaluation are the highest in the cognitive hierarchy because they incorporate or contain elements of knowledge, comprehension, application, analysis, and synthesis. As Bloom concluded, these six levels form the cognitive hierarchy or the IQ domain.

Taylor (1986) introduced a talent skills model, best known as *Talents Unlimited* (Schlichter, 1986), which describes multiple talent skills and processes such as *Productive Thinking*, *Communication*, *Planning*, *Decision Making*, and *Forecasting*. The model promotes that educators implement a multiple talent teaching approach, rather than just to push for academic talent or IQ. *Productive Thinking* promotes thinking of many ideas, varied ideas, unusual ideas, and pollinating those ideas for generating new and innovative ideas. *Communication* enables students to use many varied single words to describe things and feelings; to think of many varied things that are like another thing in a special way; to let others know that they understand how others feel; and to make a network of ideas using many varied and complete thoughts. *Planning* requires that students learn to tell what they are going to plan, what materials they will need, which steps they will need to accomplish the task, and what problems might occur. *Decision Making* teaches students to think of many varied things that could be done; to think more carefully about alternative solutions; to choose one alternative that they believe is the best; and to give many varied reasons for the choice. *Forecasting* requires students to make many varied predictions about a situation, to examine cause-and-effect relationships. Obviously, Taylor's model of five talent skills and processes is more in line with the EQ domain. And Taylor (1986) also claimed that "the IQ is no longer central to total brainpower and to the best education possible" (p. 328).

In their book, *Creative Problem Solving: The Basic Course*, Isaksen and Trefeinger (1985) provided a systematic, six-stage process for creative thinking and problem solving. The six-stage process helps students to think of many possibilities, to experience in various ways, to use different points of view, to think of new and unusual possibilities, to generate alternative solutions, and to select the most workable one.

The first stage, *Mess-Finding*, is for students to identify what situation or "mess" demands their attention and how to choose, prioritize, or select one mess to investigate from a large number of alternatives. Once the mess is defined, the next stage, *Data-Finding*, involves "taking stock:" gathering all available information, knowledge, facts, feelings, thoughts, opinions, or questions about the mess to sort out and clarify the mess more specifically. When data are collected, students move to the *Problem-Solving* stage by considering many possible questions or problem statements. Students need to try to put aside the common assumption that they "already know what the problem is" and try to state the problem in such a manner as to invite novel perspectives on it. Then, in a convergent way, they seek a problem statement that they believe does the best job of expressing the "heart" of the situation. The *Idea-Finding* stage requires that students brainstorm as many ideas or alternatives as possible for responding to the problem statement. The more ideas they can produce, the greater the likelihood that some will represent promising solutions to the problem.

In *Solution Finding*, students first consider many possible criteria for evaluating their ideas and then select the criteria that they decide are the most important or necessary to evaluate the strengths and weaknesses of the ideas. The result of this stage is to identify which idea or ideas offer the greatest potential for solving the problem. Having decided on a solution, students move to the *Acceptance-Finding* stage. At this stage, students first consider the specific elements that will promote successful implementation of their solution, such as what kind of help they will need, what obstacles or difficulties might get in the way. Second, in convergence, students decide what implementation steps are most important. And then they develop a specific, step-by-step action plan that they will take to get rid of that original mess.

These three models developed, respectively, by Bloom (1956), Taylor (1986), and Isaksen and Trefeinger (1985) could be integrated into teaching and learning activities in IT courses to assist students in exploring their potentials in IQ, EQ, and CQ and applying them to learning activities and real-world projects. In addition, the instructor also needs to share with students the new empirical findings in innovation research. For instance, as Jana (2007) reported, after decades of researching patterns of innovation success among leading companies, Harvard Business School professor Kanter noted that winning innovators prioritize and balance their time and efforts in new or improved products and services in a way of a pyramid. Kanter's innovation pyramid features a few big gambles at the top, a wide set of new ventures and fresh prototypes in the development process around the middle, and a broad range of incremental quick wins and continuous improvements at the base of the pyramid. This innovation pyramid would allow students to be aware that innovation starts with many small, incremental, continuous improvements of existing products, services, processes, methods, or mess around us.

Figure 1 presents an illustration of integrating the creative thinking and problem-solving process with multiple skills and competencies from the IQ, EQ, and CQ domains. This study hypothesized that the continuous applications of the IQ+EQ+CQ integration would synergistically transform students into well-rounded IT professionals, who have current technical skills, communicate well, think critically and creatively, and can work in a multicultural world.

To implement the IQ+EQ+CQ integration in IT education, this study used a model for designing and delivering integrated IT courses on the basis of the IQ+EQ+CQ (3Qs) integration (see Figure 2), which was originally proposed by Zhao (2005). The model illustrates that the 3Qs integration for creative thinking and problem solving process (see Figure 1) is designed into an IT course and to be applied through the IT project life cycle, project management and communication activities, as shown in Figure 2. The application of the 3Qs integration infuses into the project management and communication activities for synergistic success. All of these activities are equally important in the project life cycle. This model could be applied to a series of IT courses such as software engineering, Web design and development, systems analysis and design, database design and management, and information systems management, to name just a few. This study was to examine how the implementation of the 3Qs integration model impacts student productivity in designing and developing Web applications for e-business.

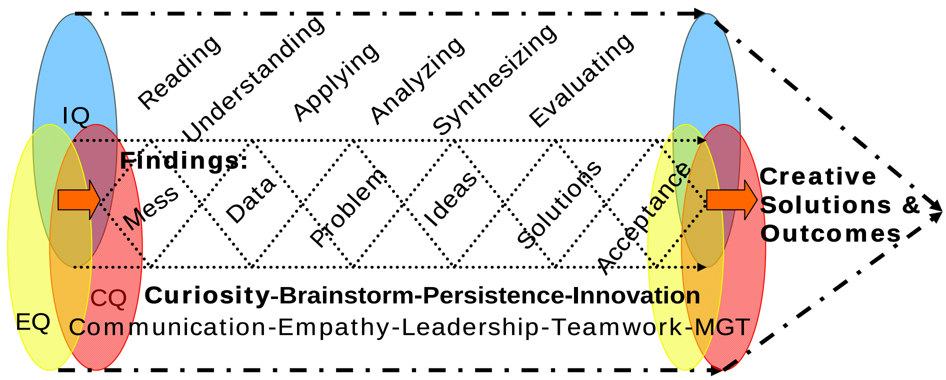


**Figure 1. Creative Thinking & Problem-Solving Process Through 3Qs Integration**

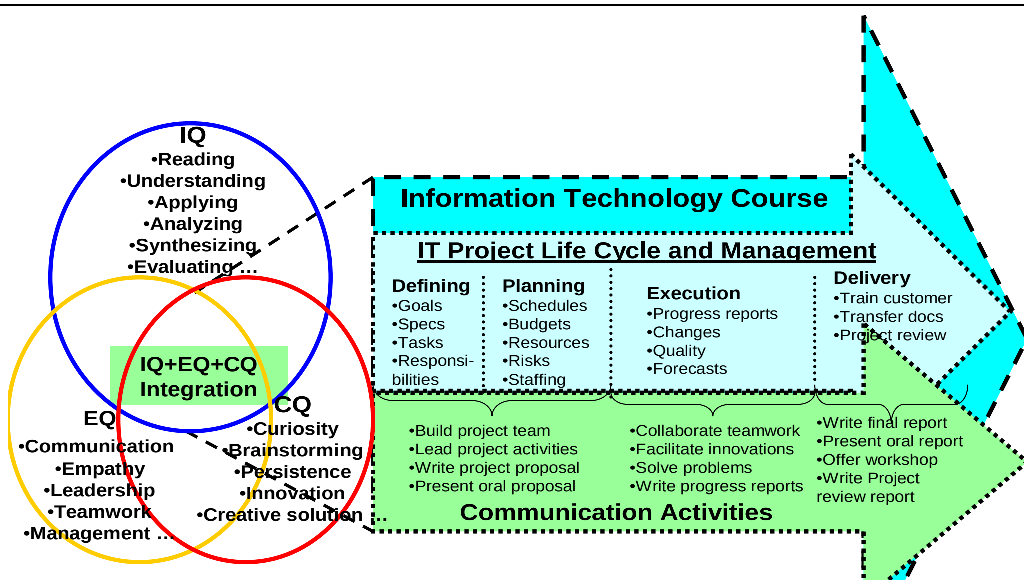


**Figure 2. A Model for Designing and Delivering 3Q-Integration IT Courses**

## 3. PROBLEM STATEMENT AND HYPOTHESES

The problem addressed in this study was to examine how the implementation of the 3Qs integration model impacts student productivity in Web design and development for e-business. Productivity, as commonly defined, referred to the relationship between input and output, or the measure of how creatively resources (e.g., human, technological, and financial) are combined and utilized to produce a desired result (Ivancevich and Matteson, 1996, Schuler, Beutell, and Youngblood, 1989; Werther, Ruch, and McClure, 1986). The productivity or output of Web design and development could be measured by various factors such as (a) time spent in producing a Web application (i.e., time efficiency), (b) usability of the application (i.e., error free or error occurrence rate), (c) aesthetically appealing design, and (d) user-interface friendliness. This study focused on the primary factors of time efficiency and error occurrence in designing, developing, and testing Web applications due to the journal's limit of article length. Therefore, the study would test the following six hypotheses:

$H_1$: The implementation of the 3Qs integration has a positive effect on students' time efficiency at the initial stage of Web development process.

$H_2$: The implementation of the 3Qs integration has a positive effect on students' error occurrence at the initial stage of Web development process.

$H_3$: The implementation of the 3Qs integration facilitates the continuous improvement of students' time efficiency in developing a series of Web-application projects.

$H_4$: The implementation of the 3Qs integration facilitates the continuous reduction of students' error occurrence in developing a series of Web-application projects.

$H_5$: Gender difference moderates the effect of the implementation of the 3Qs integration on students' time efficiency in developing a series of Web-application projects.

$H_6$: Gender difference moderates the effect of the implementation of the 3Qs integration on students' error occurrence in developing a series of Web-application projects.

## 4. PURPOSE OF THE STUDY

The purpose of this experimental research was to provide IT educators with the empirical results concerning the impact of the 3Qs integration on IT students' productivity. With these results, IT educators would be able to decide whether and how they should incorporate the 3Qs integration model into their curricula to prepare a new generation of IT graduates.

## 5. RESEARCH DESIGN AND PROCEDURES

This study used a controlled experimental design that consisted of one independent variable (the 3Qs integration model), two dependent variables (students' time efficiency and error occurrence), and one moderator variable (gender difference). The moderator variable was included to better understand the causal relationship between the independent and dependent variables (Tuckman, 1988). The moderator variable of gender difference in this study would provide some empirical evidence for clarifying a myth among students that men perform better than women in the fields of advanced math, science, technology, and engineering. Such a gender stereotype stands against female students in acquiring a college degree in science and technology (United Nations, 1995). Scholars have voiced concerns about female students' under-participation in math, science, technology, and engineering majors, which then acts as a critical filter to limit their access to many high-status, high-income careers (Watt, 2008). According to the United Nations (1995) report, governments of both developed and developing nations have recognized the need to maximize the creativity and ingenuity of all available human resources and the marginalization of one half of the pool of national talents does not make good sense. An empirical study of female undergraduate students majored in electrical engineering and computer science (EECS) at Massachusetts Institute of Technology (MIT) reported that female students majored in EECS at MIT were just as likely as their male counterparts to receive a B.S. degree in EECS (Abelson et al., 1995). The inclusion of the gender variable in this study would generate findings of how female students differ from their male counterparts in an IT course at a public state university. Such findings would add value to the literature.

Other moderator variables such as students' GPA, motivation, learning style, self-efficacy were not included because (a) the study was conducted in a required course for IT majors and minors in their junior year, who were admitted into the program with at least a minimum GPA of 2.25 on a 4.0 scale and were similarly motivated to the IT program, and (b) the study had a small, randomly selected sample of two sections of 59 students.

The independent variable had two levels: with the 3Qs integration and without the 3Qs integration. While the 3Qs integration model was implemented in the experimental group, the control group used the traditional textbook-based lectures and exercises.

The study was conducted in a Web design and development course at a Midwestern state university with approximately 20,000 students. The Web design and development course was offered in the AACSB-accredited college of business at the university for IT majors and minors. This 3-credit, 16-week course required students to learn (a) how to design corporate Internet sites, intranets, and extranets; (b) how to select and install various servers; (c) how to design and develop interactive, data-driven business-to-employees (B2E), business-to-customers (B2C), and business-to-business (B2B) applications; and (d) how to manage sever farms and security. Two sections were scheduled in the same time frame between 9:30 a.m. – 12:15 p.m. on Tuesdays and Thursdays and randomly assigned to the experimental and control groups, with 30 students in the experimental group and 29 students in the control one. To ensure that each section would have a similar enrollment in terms of student age, gender, major, minor, and race, the university used a computer-based scheduling program to assign students to classes. In addition, the group sample size was statistically appropriate for this experimental study according to Balian (1988), Fraenkel and Wallen (2006). To control the treatment diffusion and expectancy threats, the same instructor taught the control and experimental groups by following the respective teaching scripts.

The major treatment differences between the experimental and control groups included the following. In the experimental group, the instructor started the course in the first class period by pointing out the importance of exploring students' potentials in their IQ, EQ, and CQ and by illustrating how the course was designed based on the 3Qs integration model (see Figure 2) for helping students to excel. Early in the semester, the instructor first inspired students in exploring their IQ, EQ, and CQ potentials by following the creative thinking and problem-solving process (see Figure 1) for finding the "mess" or market needs, collecting data, defining problem, brainstorming innovative ideas for new We applications as solutions to the market needs.

From the second week through the fifth, in addition of learning the principles and technologies for Web design and development by using their intelligent, analytical (IQ) skills, students also learned through real-world examples various thinking skills from the CQ domain for brainstorming innovative ideas. For instance, how companies and inventors used the following thinking approaches to brainstorm innovative ideas for new products, services, methods, and processes: (a) customer-centered thinking, (b) imaginative thinking, (c) associative thinking, (d) combinational thinking, (e) reversal thinking, (f) transplantable thinking, (g) interdisciplinary thinking, and (h) convergence thinking. At the same time, the instructor also introduced Kanter's innovation pyramid to help students understand that there are three types of innovations, which range from small, incremental, and continuous improvements to new ventures and prototypes and to a few big strategic bets. Then, the instructor illustrated specifically how IT professionals have innovatively advanced Web technologies and applications that are changing the way people live, study, work, and do business. Students were required to practice these intelligent, analytical, and innovative thinking approaches to their assignment projects.

Following the introduction stage, the instructor pointed out the EQ skills such as the total quality management (TQM)-based project management and communication activities (see Figure 2) that students had learned in the previous semester or were learning concurrently with this Web design and development course and showed how students could integrate EQ with IQ and CQ for success in school and at work. For instance, how the process innovation of using TQM and the personal software process (PSP) log could enable effective project management; how interdisciplinary thinking and brainstorming could help developers generate innovative ideas and solutions and turn them into new Web applications, such as e-shopping, e-payment, e-auction, e-financial tools, e-collaboration, to name just a few; how the product innovation of developing reusable components could help developers increase productivity; and how communication could facilitate the continuous process and product improvement (e.g., Baumgarner, 2003; Cooper, 1997; Deming, 1986, 1993; Eysenck, 1994; Gardner, 2004; Goleman, 1998). Such mentoring activities would not only help boost students' productivity but also inspire them in brainstorming innovative ideas or solutions and turning them into new Web applications.

By contrast, in the control group, the instructor followed the traditional practice in education that schools are to push for academic talents or IQ, leaving students' other potential talents such as EQ and CQ in dormancy without integration (e.g., Datz, 2004; Forrester and Hui, 2007; Taylor, 1986; Zhao, 2005). The instructor began the course in a traditional way of presenting an overview of the course objectives, textbook, assignments, exams, and grading policy. Throughout the semester, the instructor gave lectures and assignments of the textbook, and students were required to read the book, attend class, and complete learning activities and assignments in the book.

Data were collected from participants' three hands-on projects assigned along the semester and their PSP logs of the projects. The PSP logs recorded details such as (a) dates and time student spent on designing, developing, testing and debugging a Web application, respectively; (b) error occurrences in HTML/XML, sever configuration, and database system; and (c) error occurrences in final product usability test by the instructor and students. Repeated measures were used to assess the dependent variables of time efficiency and error occurrence in the three hands-on projects for measuring the impact of the 3Qs integration between the experimental and control groups and between the genders. The first hands-on project, which had three weeks in time allocation, was a small-scale school intranet including the username and password login, class registration, and grade book applications. The second project (three weeks) was a small-scale online storefront, capable for interactive client-server data-driven business transactions. And the third one was a small-scale back office (three weeks) supporting the storefront site, which served as an intranet with the username and password login and other applications for customers to check their order status and for customer-service employees to view customer orders, payments, and shipping information. The measurement results were analyzed with one-way, two-way, and repeated-measures ANOVAs to identify any statistically significant differences within group (i.e., experiment group or control group), between groups (i.e., experiment group vs. control group), and between genders (i.e., female students vs. male students) at the .05 significance level.

## 6. RESULTS

$H_1$ stated that the implementation of the 3Qs integration has a positive effect on students' time efficiency at the initial stage of Web development process. When designing and developing the first Web-application project, the experimental group spent an average of 218.67 minutes while the control group averaged 191.72 minutes. As the one-way ANOVA in Table 1 shows, the difference of 26.95 minutes between the two groups was not significant (df = 1, 57; $F$ = .17); therefore, $H_1$ was rejected.

$H_2$ stated that the implementation of the 3Qs integration has a positive effect on students' error occurrence at the initial stage of Web development process. The experimental group had a mean of 13 errors whereas the control group mean was 17 errors. As shown in Table 2, this difference of four errors between the groups indicated that the experimental group had significantly fewer errors than the control group had (df = 1, 57; *F* = .013); therefore, $H_2$ was accepted.

$H_3$ stated that the implementation of the 3Qs integration facilitates the continuous improvement of students' time efficiency in developing a series of Web-application projects. On average, the experimental group spent 218.67 minutes on Project 1, 72.33 minutes on Project 2, and 57.17 minutes on Project 3, respectively. In contrast, the control group means were 191.72 minutes on Project 1, 147.24 minutes on Project 2, and 132.59 minutes on Project 3. The repeated measures ANOVA in Table 3 indicated that the experimental group had significantly greater continuous improvement of time efficiency than did the control group (df = 1, 57; *F* = .000); therefore, $H_3$ was accepted.

A follow-up analysis of the time-efficiency difference between the two groups indicated that students in the experimental group integrated the TQM-based project management into their design and development processes of the three projects and also applied the innovative idea of designing and developing reusable components, thereby saving much time for designing and developing the second and third projects. In contrast, students in the control group treated each project as a new, separate project and spent a similar amount of time in designing and developing each of the three projects.

$H_4$ stated that the implementation of the 3Qs integration facilitates the continuous reduction of students' error occurrence in developing a series of Web-application projects. The error means of the three projects for the experimental group were 13.00, 1.63, and 0.53 whereas for the control group were 17.00, 15.28, and 15.28, respectively. The repeated measures ANOVA in Table 4 reveals that the experimental group had significantly greater continuous reduction of error occurrence than did the control group (df = 1, 57; *F* = .000); therefore, $H_4$ was accepted.

| Source of Variation | Dependent Variable | Sum of Squares | df | Mean Square | F | Sig. of *F* |
|---|---|---|---|---|---|---|
| *Between-Subjects Effects:* | | | | | | |
| Between Groups | Time | 10,703.947 | 1 | 10,703.947 | 1.899 | 0.17 |
| Within Cells | Time | 321,360.460 | 57 | 5,637.903 | | |

**Table 1. One-Way ANOVA for Differences Between the Control and Experimental Groups on Time Efficiency in Designing and Developing Project 1**

| Source of Variation | Dependent Variable | Sum of Squares | df | Mean Square | F | Sig. of *F* |
|---|---|---|---|---|---|---|
| *Between-Subjects Effects:* | | | | | | |
| Between Groups | Errors | 235.932 | 1 | 235.932 | 6.605 | 0.013* |
| Within Cells | Errors | 2,036.000 | 57 | 35.719 | | |

* The significance of *F* < .05.

**Table 2. One-Way ANOVA for Differences Between the Control and Experimental Groups on Error Occurrence in Designing and Developing Project 1**

| Source of Variation | Dependent Variable | Sum of Squares | df | Mean Square | F | Sig. of *F* |
|---|---|---|---|---|---|---|
| *Between-Subjects Effects:* | | | | | | |
| Between Groups | Time | 74,829.203 | 1 | 74,829.203 | 16.805 | 0.000* |
| Within Cells | Time | 253,809.780 | 57 | 4,452.803 | | |

* The significance of *F* < .05.

**Table 3. Repeated Measures ANOVA for Differences Between the Control and Experimental Groups on Time Efficiency in Designing and Developing Projects 1, 2, & 3**

As the follow-up analysis of the error-occurrence difference between the two groups revealed, thanks to the integration of the TQM-based project management and the innovative idea of creating and using reusable components, students of the experimental group made very few errors in their second and third projects. By contrast, because each project was treated as a new, separate project, students in the controlled group started their design and development processes of the second and third projects all over again without adding any improved process or reusable component. As a result, many errors in their second and third projects were repeated errors.

$H_5$ stated that gender difference moderates the effect of the implementation of the 3Qs integration on students' time efficiency in developing a series of Web-application projects. There were 19 females and 40 males among the 59 participants. While the experimental group had nine females and 21 males, the control group consisted of 10 females and 19 males. The average minutes spent by the female participants were 207.63, 105.53, and 90.26 on Projects 1, 2, and 3, respectively. By contrast, the mean minutes spent by the male participants were 204.38, 110.88, and 96.13 on three respective projects. The two-way ANOVA in Table 5 illustrated that no significant difference of time efficiency existed between females and males on the three projects (df = 1, 55; $F$ = .792, .336, .239). In addition, although Table 5 showed significant group-by-gender interaction differences on Projects 2 and 3 (df = 1, 55; $F$ = .027, .007), the post hoc Scheffé tests on the projects identified no significant gender difference within the experimental group ($p$ = .844; $p$ = .729) nor within the control group ($p$ = .162; $p$ = .052). Therefore, $H_5$ was rejected.

$H_6$ stated that gender difference moderates the effect of the implementation of the 3Qs integration on students' error occurrence in developing a series of Web-application projects. The female participants had average error scores of 13.26, 6.63, and 6.11 on Projects 1, 2, and 3, respectively. In contrast, the male participants' average errors were 15.78, 9.15, and 8.58 on the three projects. The two-way ANOVA in Table 6 indicated that between the genders, the female participants made significantly fewer errors than their male counterparts on Projects 2 and 3 (df = 1, 55; $F$ = .001, .004). Moreover, Table 6 also showed significant group-by-gender interaction differences in error occurrence on the three projects (df = 1, 55; $F$ = .0447, .004, .006).

| Source of Variation | Dependent Variable | Sum of Squares | df | Mean Square | F | Sig. of *F* |
|---|---|---|---|---|---|---|
| *Between-Subjects Effects:* | | | | | | |
| Between Groups | Errors | 5,155.079 | 1 | 5,155.079 | 103.110 | 0.000* |
| Within Cells | Errors | 2,849.780 | 57 | 49.996 | | |

* The significance of $F < .05$.

**Table 4. Repeated Measures ANOVA for Differences Between the Control and Experimental Groups on Error Occurrence in Designing and Developing Projects 1, 2, & 3**

| Source of Variation | Dependent Variable | Sum of Squares | Df | Mean Square | F | Sig. of *F* |
|---|---|---|---|---|---|---|
| *Between-Subjects Effects:* | | | | | | |
| Between Genders | Time: Project 1 | 381.711 | 1 | 381.711 | 0.070 | 0.792 |
| | Project 2 | 997.388 | 1 | 997.388 | 0.943 | 0.336 |
| | Project 3 | 1,116.295 | 1 | 1,116.295 | 1.414 | 0.239 |
| *Interaction Effects:* | | | | | | |
| Group by Gender | Project 1 | 21,488.445 | 1 | 21,488.445 | 3.945 | 0.052 |
| | Project 2 | 5,429.049 | 1 | 5,429.049 | 5.131 | 0.027* |
| | Project 3 | 6,274.170 | 1 | 6,274.170 | 7.948 | 0.007* |
| Within Cells | Project 1 | 299,594.146 | 55 | 5,447.166 | | |
| | Project 2 | 58,195.881 | 55 | 1,058.107 | | |
| | Project 3 | 43,418.187 | 55 | 789.422 | | |

* The significance of $F < .05$.

**Table 5. Two-Way ANOVA for Differences Between Control and Experimental Groups on Time Efficiency in Designing and Developing Projects 1, 2, & 3 by Gender**

The post hoc Scheffé tests identified the following: On Project 1, no significant gender difference existed within the experimental group ($p$ = .994) nor within the control group ($p$ = .081). Regarding Project 2, the females made significantly fewer errors than their male counterparts did in the control group ($p$ = .000), but no significant gender difference existed in the experimental group ($p$ = .973). And similarly, on Project 3, the females made significantly fewer errors in comparison with their male counterparts in the control group ($p$ = .002), but no significant gender difference existed in the experimental group ($p$ = 1.000). Therefore, $H_6$ was marginally accepted.

## 7. CONCLUSIONS

First, the implementation of the 3Qs integration had no positive effect on students' time efficiency at the initial stage of Web development process. Students in the experimental group actually spent more time on the first Web-application project in comparison with the control group. However, the experimental group made significantly fewer errors than the control group did; therefore, the implementation of the 3Qs integration enabled students to significantly reduce their error occurrence rate at the initial stage of Web application design and development. These findings are in line with the TQM training theory that teaching people to do the right job right the first time requires more time at the initial stage but results in significantly fewer errors (Deming, 1986, 1993).

Second, the implementation of the 3Qs integration facilitated not only students' continuous improvement of time efficiency but also their continuous reduction of error occurrence in designing and developing second and third projects. As the follow-up analyses of time efficiency and error occurrence between the experimental and control groups indicated, the implementation of the 3Qs integration widened students' view and increased their potentials in critical, scientific, and creative thinking, which resulted in their integration of the TQM-based project management and the innovative reusable components into the design and development processes for assuring the product quality and the process efficiency. Obviously, the 3Qs integration appears to be significantly more effective than the traditional solely IQ-based approach for preparing a new generation of IT graduates, who will have current technical skills, communicate well, think critically and creatively, and can work in a multicultural world. This finding supports Taylor's (1986) statement that "the IQ is no longer central to total brainpower and to the best education possible" (p. 328). The finding also proves that the 3Qs integration model is a workable new approach to the IT education, which would enable IT students and professionals to stay on the leading edge of this ever-changing global knowledge- and creativity-based economy (Hamm, 2007; Nussbaum, 2005).

Third, the female participants were as efficient as their male counterparts were in Web design and development within both the experimental group and the control group. This evidence is persuasive that female students are as good as their male counterparts in IT field and it can serve as a good showcase for recruiting female students for the IT programs. Furthermore, regarding the error occurrence, within the control group the females made significantly fewer errors than their male counterparts in the second and third projects. Interestingly, such situation did not happen to the experimental group. This finding suggests that the implementation of the 3Qs integration enabled male participants to become as meticulous as their female counterparts were, thereby significantly reducing their error occurrence rate.

| **Source of Variation** | **Dependent Variable** | **Sum of Squares** | **Df** | **Mean Square** | **F** | **Sig. of *F*** |
|---|---|---|---|---|---|---|
| *Between-Subjects Effects:* | | | | | | |
| Between Genders | Errors: | | | | | |
| | Project 1 | 90.821 | 1 | 90.821 | 2.773 | 0.102 |
| | Project 2 | 129.522 | 1 | 129.522 | 13.570 | 0.001* |
| | Project 3 | 129.424 | 1 | 129.424 | 8.970 | 0.004* |
| *Interaction Effects:* | | | | | | |
| Group by Gender | Project 1 | 139.374 | 1 | 139.374 | 4.256 | 0.044* |
| | Project 2 | 86.040 | 1 | 86.040 | 9.014 | 0.004* |
| | Project 3 | 119.275 | 1 | 119.275 | 8.266 | 0.006* |
| Within Cells | Project 1 | 1,801.308 | 55 | 32.751 | | |
| | Project 2 | 524.978 | 55 | 9.545 | | |
| | Project 3 | 793.597 | 55 | 14.429 | | |

* The significance of $F < .05$.

**Table 6. Two-Way ANOVA for Differences Between Control and Experimental Groups on Error Occurrence in Designing and Developing Projects 1, 2, & 3 by Gender**

.Finally, it is educators' responsibility for inspiring, nurturing, and mentoring students to explore their IQ, EQ, and CQ potentials and to spark innovative ideas and solutions to the real-world problems. IT educators should consider incorporating the 3Qs integration model into their curricula to inspire and nurture IT students' interest in exploring their potentials in the IQ, EQ, and CQ domains and to help them realize the great value of applying their 3Qs potentials synergistically to advance their IT careers.

## 8. RECOMMENDATIONS FOR FURTHER RESEARCH

The generalizability of the foregoing findings and conclusions is limited to the undergraduate IT students of business schools holding characteristics similar to this Midwestern state university. Therefore, a replication of this study should be undertaken in universities on the east or west coast where student body has a more diversified ethnic composition. In addition, further studies should be conducted to examine the impact of the 3Qs integration model on student performance in leadership, collaboration, innovation, and communication when developing and managing large-scale, team-based IT projects.

## 9. REFERENCES


Abelson, H., Adams, T., Braida, L., Hunter, A. Johnson, B., Khan, N., et al. (1995). Women undergraduate enrollment in electrical engineering and computer science at MIT. Boston: MIT. Retrieved January 5, 2009, from http://groups.csail.mit.edu/mac/users/hal/women-enrollment-comm/final-report.html#TOC

Balian, E. S. (1988). *How to design, analyze, and write doctoral or masters research* (2nd ed.). New York: University Press of America.

Barn-On, R. & Parker, J. D. A. (2000). *The handbook of emotional intelligence*. San Francisco: Jossey-Bass.

Baumgarner, J. (2003). Ten steps to a more creative office. Retrieved November 1, 2004, from http://www.jpb.com /creative/office_creativity.php

Blinder, A. (2007, August 20 & 27). America's most vulnerable jobs. *Business Week,* 70.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*. New York: Longman.

Claburn, T. (2007, April 23). Gartner calls on IT heroes. *Information Week*. Retrieved April 24, 2007, from http://www.informationweek.com/story/showArticle.jhtml ?articleID=199200903

Cooper, R. (1997) *Executive EQ*. New York: Grosset/Putnam.

Cropley, D. H. & Cropley, A. J. (2000). Fostering creativity in engineering undergraduates. *High Ability Studies, 11*(2), 207-220.

Datz, T. (2004, October 15). Changing needs, changing curricula. *CIO*. Retrieved November 1, 2004, from http://www.cio.com/archive/101504/school_sidebar_3.htm l

Deming, W. E. (1986). *Out of the crisis*. Cambridge, MA: MIT, Center for Advanced Engineering Study.

Deming, W. E. (1993). *The new economics for industry, government, education*. Cambridge, MA: MIT, Center for Advanced Engineering Study.

Engardio, P. (2006, January 30). The future of outsourcing. *Business Week,* 50-58.

Eysenck, H. (1994). Test Your IQ. Toronto: Penguin Books.

Feldman, D. H., Csikszentmihalyi, M., & Gardner, H. (1994). *Changing the world: A framework for the study of creativity*. Westport, Conn.: Praeger.

Forrester, V. & Hui, A. (2007). Creativity in Hong Kong classroom: What is the contextual practice? *Thinking Skills and Creativity, 2*, 30-38.

Fortune Live Media, (2008, September 29). Fortune brainstorm tech: Is technology making the world a better place? *Fortune, 158*(6), S6.

Foxon, M. (1987). Transfer of training: A practical application. *Journal of European Industrial Training, 11*(3), 17-20.

Fraenkel, J. R. & Wallen, N. E. (2006). *How to design and evaluate research in education* (6th ed.). Boston: McGraw-Hill.

Gardner, H. (2004). *Changing minds: The art and science of changing our own and other people's minds*. Boston: Harvard Business School Press.

Goleman, D. (1998) *Working with emotional intelligence*. London: Bloomsbury Publishing.

Gruman, G. (2004, November 1). Fast track business degrees. *CIO*. Retrieved November 17, 2004, from http://www.cio.com/archive/110104/tl_education.html

Hamm, S. (2007, August 20 & 27). The changing talent game. *Business Week,* 68-71.

Hedlund, J. & Sternberg, R. J. (2000). Too many intelligences? Integrating social, emotional, and practical intelligence. In Barn-On, R. & Parker, J. D. A. (Eds.), *The Handbook of Emotional Intelligence* (pp. 136-167). San Francisco: Jossey-Bass.

Isaksen, S. & Treffinger, D. (1985). *Creative Problem Solving: The Basic Course*. Buffalo, NY: Bearly Limited.

Ivancevich, J. M., & Matteson, M. T. (1996). *Organizational behavior and management* (4th ed.). Chicago: Irwin.

Jana, R. (2007, March 12). In short: Cool tools and the latest trends. *Inside Innovation*. *Business Week*, IN 2-3.

Markus, M. L. & Saunders, C. (2007). Looking for a few good concepts … and theories … for the information systems field. *MIS Quarterly, 31*(1), iii-vi.

Mills, R. J., Hauser, K., & Pratt, J. A. (2008). A comprehensive two-level framework for information systems curriculum design, assessment and improvement. *Journal of Computer Information Systems, 48*(4), 1-14.

Naiman, L. (2004). What is creativity? Retrieved November 1, 2004, from http://www.creativityat work.com/ articlesContent/whatis.htm

Nietzel, M.T., Berstein, D.A., Milich R. (1998). *Introduction to clinical psychology*. Upper Saddle River: Prentice Hall.

Nussbaum, B. (2005, August 1). Get creative! How to build innovative companies. *Business Week*, 60-68.

Overby, S. (2003, December 15). The future of jobs and innovation: U.S. stays on top. *CIO*. Retrieved November 1, 2004, from http://www.cio.com/archive/121503 /jobfuture.html

Schlichter, C. (1986). Chapter XII: Talents unlimited: Applying the multiple talent approach in mainstream and gifted programs. In J. S. Renzulli (Ed.), *Systems and Models for Developing Programs for the Gifted and Talented* (pp. 352-390). Mansfield Center, Conn.: Creative Learning Press.

Schuler, R. S., Beutell N. J., & Youngblood, S. A. (1989). *Effective personnel management*. New York: West Publishing.

Schutte, N & Malouff, J. (1999). *Measuring emotional intelligence and related constructs*. New York: The Edwin Mellon Press.

Taylor, C. (1986). Chapter XI: Cultivating simultaneous student growth in both multiple creative talents and knowledge. In J. S. Renzulli (Ed.), *Systems and Models for Developing Programs for the Gifted and Talented* (pp. 306-351). Mansfield Center, Conn.: Creative Learning Press.

Thibodeau, P. (2004, December 1). Gartner: Half of U.S. IT operations jobs to vanish in 20 years. *ComputerWorld*. Retrieved December 1, 2004, from http://www. computerworld.com/printthis/2004/0,4814,97945,00.html

Tuckman, B. W. (1988). *Conducting educational research,* (3rd ed.). San Diego, CA: Harcourt Brace Jovanovich.

United Nations. (1995). Missing links: Gender equity in science and technology for development. *Gender Working Group of the United Nations Commission on Science and Technology for Development.* Retrieved Jan 5, 2009, from http://www.idrc.ca/en/ev-9359-201-1-DO_TOPIC.html

U.S. Patent and Trademark Office. (2004). *The inventive thinking curriculum project: An outreach program*. Washington, DC: U.S. Patent and Trademark Office, Retrieved March 1, 2005, from http://www.uspto.gov/web/offices/ac/ahrpa/opa/projxl/invthink/invthink.htm

Verton, D. (2004, November 29). Anything but IT: Many students see an advanced degree in IT as a ticket to obsolescence and outsourcing. *ComputerWorld*. Retrieved November 29, 2004, from http://www.computerworld.com /printthis/2004/ 0,4814,97839,00.html

Watt, H. M. G. (2008). What motivates females and males to pursue sex-stereotyped careers? In H. M. G. Watt & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 87-114). Washington, DC: American Psychological Association.

Wechsler, D. (1944). *The measurement of adult intelligence*. Baltimore: The Williams & Wilkins Company.

Werther, W. B., Ruch, W. A., & McClure, L. (1986). *Productivity through people*. St. Paul, MN: West Publishing.

Zhao, J. J. (2005). IQ + EQ + CQ = synergistic transformational success: A model for designing integrated IT courses. *Issues in Information Systems, 6*(2), 70-76.

Zhao, J. J. & Alexander, M. (2004). Impact of business communication education on students' short- and long-term performances. *Business Communication Quarterly, 67*(1), 24-40.

## AUTHOR BIOGRAPHIES

**Jensen J. Zhao** is Professor of Information Systems and Operations Management at Miller College of Business, Ball State University, Muncie, IN, USA. His research articles have appeared in such publications as *Journal of Computer Inform-ation Systems, Journal of Business Communication, Bus-iness Communication Quarterly, Delta Pi Epsilon Journal, Information Technology, Learn-ing, and Performance Journal, Journal of Education for Business, Journal of Business and Training Education,* and *International Advertising.*

**Sherry Y. Zhao** is a post-doctoral fellow at the International Computer Science Institute in Berkeley, CA, U.S.A. She received her Ph.D. in 2007 from Massachusetts Institute of Technology (MIT) and Harvard University, Cambridge, MA, USA. Her research interests are in the interdisciplinary areas of computer science, health sciences, and electrical engineering.

Information Systems & Computing
Academic Professionals

## STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.



ISSN 1055-3096