JUST-IN-TIME TEACHING TOOLS FOR INNOVATIVE INSTRUCTION: AN EMPIRICAL STUDY

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ABSTRACT

This study measures the impact of using web tools as Just-in-Time Teaching tool for a second-level quantitative analysis business statistical course. Development of a JiTT tool is described and measured for success using an adaptation of Doll and Torkzadeh's End User Satisfaction Questionnaire, web-based statistics, student generated web-logs, and random unstructured interviews. The study suggests that students seeking outside assistance on curriculum are significantly better supported through virtual JiTT tools. The number of electronic hours spent using virtual tutors far outweighs the availability of face-to-face contact after class hours. In addition, this study suggests that students are satisfied with a JiTT tool that provides support at any time, adapting to the changing dynamics of student needs. Finally, the study suggests that students with JiTT support tools are better prepared for class and move more rapidly through the course concepts.

Keywords: Just-in-Time Teaching, Virtual Education Tools, Innovative Instruction

INTRODUCTION

As the world becomes flatter, information technology affords international companies and institutions with the ability to transfer ideas, goods and services around the world (Castells and UNRISD, 1999). This new interrelated world requires evolution from a traditional educational model into a more effective, on-demand educational system (Wind and Reibstein, 2000). In the traditional model, passive instruction aimed at heterogeneous classes occurs in a standardized setting with time and place constrains. This model however, limits the students from acquiring the needed knowledge and abilities to apply in a real world business environment. The students' varying degrees of ability, experience and career goals increase this challenge even further. As a result, educators "must be prepared to address various levels of cognition and engage students at many levels of cognition in order to maximize learning" (Hall, 1999; p. 912).

The use of "Just-in-Time Teaching" or JiTT, originally adopted from the Toyota manufacturing philosophy in 1999 by Novak, Patterson, Gavrin, and Christian can be applied to instructional design to

solve current educational challenges and meet the immediate needs of learners by encouraging students to be well prepared for class through its active learning strategies. Under JiTT, as in manufacturing, instructors activate a rapid response to the constantly changing student demands by pre-assessing the student areas of underperformance before the lessons and adjusting the efforts dedicated to those areas. In the same matter, given the flexibility of instruction, it is easier to identify and eliminate areas of instruction that are not important: as students are more engaged and ready for class, less time is spent in introducing the subject matter. Following the JiT philosophy, the instruction methodology fosters far greater synchronous and asynchronous end-user involvement, further contributing to the flow of continuous improvement feedback that can be immediately applied to the curriculum.

RELEVANT LITERATURE

Multiple studies have established the extraordinary benefit that subject-specific, web-based instruction provides in classroom instructional design as a Just-in-Time educational tool. Novak, Patterson, Gavrin, Christian, and Forinash (1999), early contributors to the discipline suggested that JiTT "reduced student attrition by 40% compared to traditional physics courses". Shortly after the study, Novak, Gavrin and Wolfgang (1999) published the first significant and comprehensive contribution in the field titled Just in Time Teaching: Blending Active Learning with Web Technology proposing JiTT as a revolutionary educational tool. Hall (2001) supported Novak's approach to instructional design adding that in order to improve education through technology, curriculum tools should be integrated with the learning environments to create collaboration-oriented instruction.

Marrs and Novak (2004) suggested that JiTT successfully increased classroom interactivity and provided ongoing formative students' assessment. They further suggested that JiTT can improve students' course retention and preparation, citing "decreased attrition rates, increases in student attitudes, interactivity, study habits, and cognitive gains in classrooms using JiTT" (p. 49). Slunt and Giancarlo (2004) conducted an empirical study and concluded that student achievement in courses utilizing JiTT was significantly higher than other student-centered approaches. The authors highlighted the key role of technology in applying this educational approach with the use of Blackboard™ for course management. A key success to this program was noted to be the ability for students to receive instant and continuous feedback about their progress in the course in a non-threatening way. Cashman and Eschenbach (2003) observed that the use of technology in the implementation of JiTT increases student confidence, in-class discussions, as well as the interactions between students and the instructor. Marrs, Blake, and Gavrin (2003) found that by using warm-up exercises on the web, instructors could effectively identify the students' pre-existing knowledge and misconceptions of the material at hand, enabling the reinforcement of class content that was not solidified, while increasing active learning. Gavrin, Watt, Marrs, and Blake Jr. (2004) also suggested that JiTT provided an "effective means of improving student attitudes and performance in a variety of science and mathematics classes" (p. 10).

Simkins and Maier (2004) concurred with others and suggested that the combination of web exercise with related classroom activities in JiTT promoted "a feedback loop that encourages outside-of-class preparation by students, provides prompt feedback on students' conceptual understanding of course material, and informs "just-in-time" modifications of class activities and discussion" (p. 445). Marrs and Chism (2005) further contributed to the literature by testing and concluding that five of Chickering and Gamson's (1987) "Seven Principles for Good Practice in Undergraduate Education" were directly addressed by JiTT. In addition, Gavrin (2006) continued his previous research and concluded that JiTT

helps faculty identify students' strengths, weaknesses, and learning styles encouraging writing as an integral part of the learning process. They further cited higher interest on developing tools supported by virtual technologies that integrate the classroom curriculum for access during off hours. Luo (2008) improved on previous studies by conducting an empirical study of different courses taught with JiTT methodologies over five semesters that examined both, qualitative feedback and quantitative analyses of students' performance and found that JiTT clearly demonstrated to improve students' performance.

Although the JiTT approach to instruction has been suggested to "spur a greater percentage of students to read the assigned selections" it can create "another time burden for faculty…to grade the quizzes and integrate selected responses into the class presentation for the day" (Howard, 2004; p. 388). Nonetheless, this valid drawback documented by Howard can be highly minimized with the use of the technology that is available via integrated web solutions such as Blackboard™, McGraw-Hill's Connect™, and WebCT. More and more platforms are creating collaborating strategies to transform their products into fully-integrated knowledge management platforms where synergy arises from the development and preservation of curricula that is updated with up-to-date relevant material, combined with enterprise student management systems. In July of 2010, McGraw-Hill Education and Blackboard, Inc. announced their full cooperation to integrate their robust digital web platform products to facilitate the creation and sharing of high quality content. This integration has created "seamless access to McGraw-Hill Connect to manage course content, create assignments and track student performance" in the Blackboard™ platform, eliminating instructor's redundancy of effort.

Slunt and Giancarlo (2004) dissented on previously suggested benefits and argued that JiTT imposes a substantial workload on the instructor initially, requiring instructors to produce and examine more assignments right before the class starts. However, the ability to assess students' grasp of the material several times a week rather than a few times a semester benefits both instructor and student. Cashman and Eschenbach (2003) also concurred with this and observed that JiTT would result in an increased effort and preparation time by educators who would have to create the appropriate quiz questions. Lytras and Pouloudi (2001) also contested that the "majority of the currently dominated e-learning platforms seems to be inadequate" (p. 6); however, the innovation that has occurred over the last decade suggest a different spectrum of effectiveness. These studies predate the technology innovations in course content management software that have emerged in the last few years in response to these gaps. McGraw-Hill's Connect™, for example, contains an assignment builder that allows instructors to quickly create assignments from publisher's question banks with arithmetic versions that can be assigned at random to different students, and which can be graded automatically. This innovation drastically reduces the amount of effort and time Slunt and Giancarlo originally observed as a drawback. More importantly, instructors are able to effectively review a class' aggregate performance on a particular exercise and are able to modify the class content to place more focus on areas that are not solidly comprehended by students. This technology supports JiTT principles, without the requirement of exorbitant amounts of time.

Table 1 depicts a summary of the history of the literature on the effectiveness of Just-in-Time Teaching.

TABLE 1. LITERATURE REVIEW

Authors	Findings
Novak, Patterson, Gavrin & Enger (1998)	Proposed JiTT using the Toyota manufacturing approach.
Novak, Patterson, Gavrin & Christian (1999)	JiTT reduced student attrition by 40% compared to traditional physics courses; Normalized student gains on controlled subject by 35-40%.
Hall (2001)	Theory favors a constructivist perspective: web-based/internet based instruction can provide the vehicle for a new era of classroom instructional design.
Gavrin, Watt, Marrs & Blake, Jr. (2003)	JiTT effective means of improving student attitudes and performance in a variety of science and mathematics classes.
Cashman & Eschenbach (2003)	Increased student confidence, in-class discussion, interaction between students and instructor. Drawbacks included reliance on technology, increased effort and preparation time.
Marrs, Blake & Gavrin (2003)	Warm-up exercises can reveal students' prior knowledge and misconceptions in college courses.
Marrs & Novak (2004)	JiTT led to improved pre-test and post-test gains, course retention, class preparation, classroom interactivity, and student study habits.
Howard (2004)	JiTT spurs a greater percentage of students to read the assigned selections but can be burdensome for instructors.
Slunt & Giancarlo (2004)	Student achievement in courses utilizing JiTT was significantly higher than other student-centered approaches, actively engaging the student more effectively.
Gavrin (2006)	JiTT helps faculty identify "students' strengths, weaknesses, and learning styles encouraging writing as an integral part of the learning process.
Petrova & Sutedjo (2004)	Mobile penetration among students exceeds the national average and is very close to 100 % ownership.
Gavrin, Cashman & Eschenbach (2005)	Conference session that provided a practical introduction to the Justin-Time Teaching (JiTT) method.
Marrs & Chism (2006)	Five of the "Seven Principles for Good Practice in Undergraduate Education" are directly addressed by JiTT: increased student-faculty contact, active learning techniques, prompt feedback, cooperation among students, and time on task.
Simkins & Maier (2004)	JiTT techniques blend structured, out-of-class, web-based exercises with related classroom activities that promote active student learning.
Linneman & Plake (2006)	JiTT not statistically significant; recommended using a validated instrument for pre/post comparison; including more assessment items that appraise students' problem-solving skills.
Luo (2008)	Quantitative analyses of students' performance and qualitative feedback over five semesters demonstrate that JiTT improves students' performance.

THEORETICAL FRAMEWORK

Wind and Reibstein's (2000) contributed the New Training Paradigm as a transformational educational method aligned with the JiTT principles that respond to the increasing global interdependencies on information technology, the rapidly changing customer demands and business practices, and the heterogeneity of any student body. The authors suggest that successful training and education training should take a customer-centered approach in which the learner takes a proactive role in the education process. The authors further explain that effective learning can only occur by utilizing information technology resources to facilitate shifting the focus from "training" to "learning" through a proposed paradigm based on three interrelated dimensions: Educational Content, Mode of Learning, and Time and Place. Lytras and Pouloudi (2001) supported a similar approach to education driven with information technology as a means of achieving Just-in-Time education. As a result, the authors proposed the Multidimensional Dynamic e-Learning Model (MDL) to assess the effectiveness of technology as a Just-in-Time tool taking into account three dimensions: Knowledge Management, Application Integration, and e-Learning. Lytras and Pouloudi (2001) detailed the dimensions that must be considered in any "knowledge management systems with embedded e-learning pedagogy and capacity of dynamic integration with other crucial business applications" (p. 5). Historically, higher education has been based on the utilization of pedagogical printed material that is bound by certain standards that can easily become outdated. Like industrial trainings, most courses have standardized sets of material with minimal room for customization. Wind and Reibstein (2000; p. 5) proposed the use of customized educational content through the use of information technology with the purpose of constantly updating materials so that "learning is not simply 'just in time' but the materials are also 'just now' and never out of date" (p. 6).

Wind and Reibstein (2000) also called for a shift from the discrete place and time in which education is conducted. Rather than having fixed locations and schedules for education, they proposed that through the use of technology, education should transcend to a place in which students can learn anytime and anywhere, transforming synchronous courses into asynchronous learning models. Other scholars (Liebowitz 2000, Choo 1996, Lytras and Pouloudi, 2001) proposed that an information technology tool must be measured in term of its ability to manage learning content in various formats, to re-use learning modules and to support knowledge management processes. Such ability should include the customizable systems that can generate different arithmetic versions of a problem, when applicable; with advanced student profiling closely aligned with the pedagogical objectives of the class. A system must be able to manipulate dynamic content by categorizing, enriching and integrating the different learning objectives that establishes knowledge processes in order to be successful. Lytras and Pouloudi (2001) conceptualized this approach under the Knowledge Management Sophistication of their MDL model.

The nature and level of involvement connected in an educational setting are captured in the second dimension proposed by Wind and Reibstein (2000), where a shift "from the traditional, mostly passive learning in a teacher-centered system to an active and interactive experiential learning" (p. 6) is required. By increasing the amount of control learners have over the learning process and the interactivity, well-designed virtual learning materials can be more efficient and effective in enhancing the cognitive gains of students than traditional alternatives. Sipusic, Pannoni, Smith, Dutra, Gibbons, and Sutherland (1999) suggested that students in collaborative learning environments outperform students in non-collaborative environments due to the "collaborative learning effect" phenomena.

Lytras and Pouloudi (2001) concurred with this approach and offered the e-Learning Dimension to measure a system's ability to construct effective learning processes and mechanisms that lead to the

achievement of diverse educational goals. This dimension accounts for a student's different learning styles, and can be related to the ten learning processes that the authors propose as capable of supporting different learning modes: Analysis, Synthesis, Reasoning, Explanation, Problem solving, Collaboration, Case Writing, Evaluation, Presentation and Relation. The authors also proposed an Application Integration Dimension to assess a system's "capacity to collaborate with other business applications…in order to obtain learning content from real business operations". Like other authors, they agree that in order to take advantage of different streams of knowledge a system must be able to support a platform that adheres to global standards of information exchange. In order to assess the effectiveness of the application of JiTT, we borrow the three complementary dimensions from Lytras and Pouloudi's Multidimensional Dynamic e-Learning Model (MDL) originally proposed in 2001 to assess the effectiveness of a JiTT tool in combination with the Wind and Reibstein's (2000) transformational educational model and with the 12-item EUCS instrument by Doll and Torkzadeh (1988).

HYPOTHESES DEVELOPMENT

Linneman and Plake (2006) recommended that future scholarly studies regarding JiTT be measured by a peer-reviewed validated instrument, proposing the use of the Geologic Concept Inventory originated by Libarkin, Anderson, Dahl, Beilfuss, Boone and Kurdziel (2005) for the appropriate comparison of actual benefits. Linneman and Plake's strong argument makes a valid point; multiple scholars in the Information Systems user satisfaction literature (Bailey and Pearson, 1983; Ives, Olson, and Baroudi, 1983; Baroudi and Orlikowski, 1988; Doll and Torkzadeh, 1988) have provided extensive contributions to the field of instruments of user-satisfaction measurement.

Although some recent studies would argue that satisfaction with the system and its information output is "unlikely to be predictive of the use of that system" (Wixom and Todd; 2005, p. 89), it can provide a peer-reviewed methodology to assess user satisfaction, as a factor in the overall success of the application of JiTT technology. A system's success will highly depend on the internal and external variables that include object based beliefs (e.g. system's completeness, accuracy, reliability, integration), and attitudes (e.g. information quality, system quality, information satisfaction, system satisfaction), and behavioral beliefs and attitudes (e.g. ease of use, attitude, and user intentions) (Wixom and Todd, 2005). Thus, it is highly relevant to integrate all of these factors, combined with the three dimensions that were offered by Lytras and Pouloudi in 2001, to properly assess the effectiveness of JiTT.

In addition to the aforementioned critics, most studies conducted on the field involve the application and assessment of JiTT methodologies on introductory courses and not advanced courses (e.g. Novak et al., 1999; Gavrin et al., 2004; Cashman and Eschenbach, 2003; Marrs et al., 2003; Howard, 2004; Slunt and Giancarlo, 2004; Simkins and Maier 2004; Linneman and Plake, 2006). This lack of assessment provides a significant gap in the research of this field.

Building on previous research, we propose the following hypotheses:

> *H1: Students in Junior/Senior level college courses with access to a Just-in-Time Teaching tool will have a higher level of instructional engagement outside the classroom.*
>
> *H2: A higher satisfaction with a Just-in-Time Teaching tool will result in a higher level of instructional engagement outside the classroom.*

RESEARCH METHODOLOGY

A JiTT virtual statistics tutoring program was created supporting a junior-level statistics course. One concept of the statistics course was selected to design, develop, and implement JiTT tutoring tools. The tutoring program focused on the concept of Pert/CPM and the statistical analysis of networks, containing lecture text and video material, a 24-hour blog, and a human-operated virtual tutor that answered questions at scheduled times. Borrowing from Wind and Reibstein's characteristics of the new training paradigm and Lytras and Pouloudi's Multidimensional Dynamic e-Learning Model (MDL), the following describes the characteristics that were considered in the creation of the tool (Table 2).

TABLE 2. THEORETICAL FRAMEWORK CHARACTERISTICS

Wain and Reibstein	Lytras and Pouloudi	Development Criteria	JiTT Tools Chosen
Knowledge base	Knowledge Management Dimension	Open source	Text Tutorial Video Tutorial Problem examples and Solutions
Mode of Learning	E-Learning Dimension	Lowest use of resources	Live Tutor and Study Hall
Time and place	Application Integration	Web-based	Synchronous web-based tutor Asynchronous Blog

The website was embedded with tracking code to collect usage metrics. Also, self-reported use was collected from a distributed form in which the student recorded the daily amount of time spent using the JiTT virtual statistics tutor. The website address was distributed to a test group of 38 students on November 20, 2010. The site was evaluated by the students and suggested changes to the website were made, including web appearance and navigation.

Data Collection

The participants were undergraduate students from two sections of a college junior/senior-level, required course in Statistics, taught during the fall 2010 semester. Test scores and time logs were analyzed and compared. All factors were held constant, including the coursework, except that one section of the course received access to the JiTT virtual tutor tool. The control group consisted of 40 students and the experimental group consisted of 81 students. Both sections of the course were taught in a traditional lecture style, met twice a week for 80 minutes over a 16 week semester, and was taught by the same instructor. The student performance data for the two sections was collected by the course educator and included student test scores. Students in the experimental group who used the tutoring program were administered a satisfaction survey.

The survey consisted of 12 questions adapted from Dolls and Torkzadeh's End User Satisfaction Measurement Survey (1988). The EUCS instrument was chosen specifically because it has been tested

extensively for internal consistency reliability, test-retest reliability, content validity, construct validity, and external validity (Doll, Xia, and Torkzadeh, 1994; Doll and Torkzadeh, 1988; Doll and Xia, 1997; Hendrickson, Glorfeld, and Cronan, 1994; Klenke, 1992; McHaney and Cronan, 1998; Torkzadeh and Doll, 1991; Zmud and Boynton, 1991). Survey questions were measured on a 5 point scale (from 1=almost never to 5=almost always). The survey questionnaire was completed during the final exam meeting of the semester by 74 of the 81 students for a 91% response rate. 7 students reported that they did not use the tutoring program. Students who used the tutoring application self-reported a total of 166.5 hours of use between the dates of November 29th, 2010 and December 7th 2010. Using students log information, we were able to compare the self-reported log time with statistics created by the web tracking program. Web tracking data was collected using StatCounter.com.

Data Analysis

Figure 1 shows the number of page loads and the number of unique visitors for the period of the experiment. The page loads show how many times the website has been visited. Unique-visitor count is based solely on a cookie and measures the total number of visitors to the site. Figure 2 shows the total number and daily average number of page loads and unique visitors.

FIGURE 1. TRAFFIC ACTIVITY

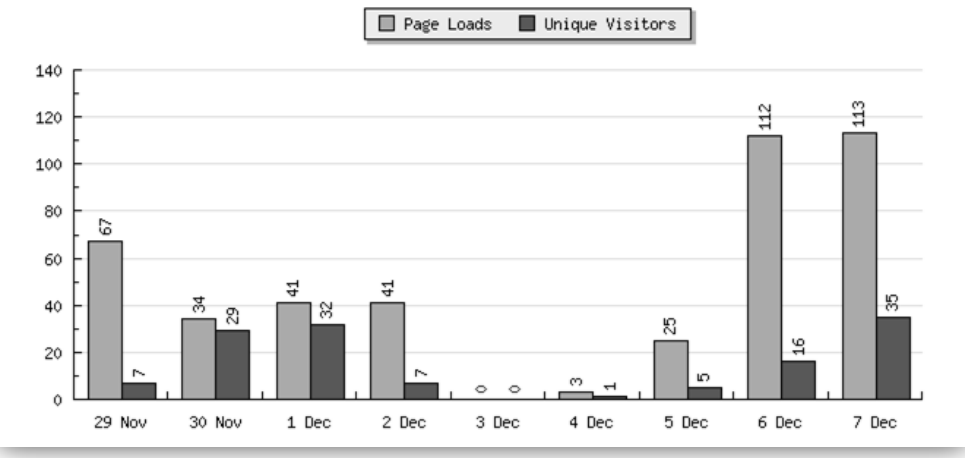

FIGURE 2. DETAILED TRAFFIC ACTIVITY

		Page Loads	Unique Visitors
Total		**436**	**132**
Average		48	15
Day	**Date**	**Page Loads**	**Unique Visitors**
Tuesday	7th December 2010	113	35
Monday	6th December 2010	112	16
Sunday	5th December 2010	25	5
Saturday	4th December 2010	3	1
Friday	3rd December 2010	0	0
Thursday	2nd December 2010	41	7
Wednesday	1st December 2010	41	32
Tuesday	30th November 2010	34	29
Monday	29th November 2010	67	7

Self-reported logs showed that the experimental group used the JiTT virtual statistics tutor a total of 166.5 hours. In contrast, of the control group, five students visited for office hours for a total of 4.5 hours over the same time period. Thus, we observe that the Hypothesis 1 is supported and suggest that college students with access to a Just-in-Time Teaching tool will have a higher level of engagement outside the classroom as opposed to students without access to these tools.

We evaluated the construct validity and the constructs in the EUCS instrument. This was done using reliability statistics and item-total correlation (Doll and Torkzadeh, 1988). The sample size was below the minimum suggested for factor analysis. A sample of 74 usable end users' responses was obtained. Descriptive statistics for the 12-item instrument based on Doll and Torkzadeh's original EUCS instrument is presented in Table 3. The item means ranged from 4 to 4.35 on a five point scale

TABLE 3. DESCRIPTIVE STATISTICS

Item	Mean	Std. Deviation	Analysis N
G1	4.1216	.96447	74
G2	4.1757	.91199	74
C1	4.0946	.95328	74
C2	4.0541	1.08403	74
C3	4.1081	.98714	74
C4	4.1486	.90179	74
A1	4.0676	1.03806	74
A2	4.0000	1.07270	74
F1	4.1216	1.01971	74
F2	4.2703	.89592	74
E1	4.2838	.80274	74
E2	4.3514	.86693	74
T1	4.1622	1.02070	74
T2	4.2027	.96486	74

As shown in Table 4, the alpha coefficient for the 12 items is .975, suggesting that the items have high internal consistency. (Note that a reliability coefficient of .70 or higher is considered "acceptable" in most social science research situations.)

TABLE 4 - RELIABILITY STATISTICS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.974	.975	12

We conducted item-total correlation, examining the correlation score of each item with the total score of all questions. To avoid the spurious part-whole correlation, we subtracted each item score from the total score before conducting the correlation analysis; therefore, we assessed the correlation of each item with the total of 11 items. Table 5 lists the result of the correlation assessment. According to Doll and

Torkzadeh, there is no accepted standard of cutoff threshold; therefore we took the cutoff value of 0.5. We observed that the all-questions coefficient is above the threshold of 0.5. All variables show lower values for the Chronbach's Alpha than shown in the statistics. Therefore none of the variables should be deleted.

TABLE 5. ITEM-TOTAL STATISTICS

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
C1	45.7703	89.138	.882	.846	.972
C2	45.8108	86.238	.920	.917	.971
C3	45.7568	88.899	.862	.820	.972
C4	45.7162	90.535	.850	.824	.972
A1	45.7973	88.657	.828	.892	.973
A2	45.8649	87.899	.839	.894	.973
F1	45.7432	87.919	.887	.813	.971
F2	45.5946	89.779	.904	.858	.971
E1	45.5811	92.219	.847	.852	.973
E2	45.5135	91.815	.804	.770	.973
T1	45.7027	87.828	.892	.871	.971
T2	45.6622	89.651	.840	.787	.973

Results show that end-users were satisfied most of the time with the tutoring application in terms of accuracy, content, ease-of-use, format, and timeliness. We thus observe that Hypothesis 2 is supported and suggest that higher satisfaction with a virtual world JiTT tutor will result in higher levels of student engagement outside the classroom setting.

DISCUSSION

While the subject in this study is based on a second-level quantitative analysis business statistical course, the use of JiTT tools that were implemented at no additional cost to the instructor provide an innovative approach to instruction. Given the development of new tools by book publishers (e.g. Connect) and student information systems (e.g. Blackboard), instructors can opt to use these readily available tools in combination with a JiT approach to instruction. Being able to aggregate performance from a group of 80 students by segregating those items with lower performance records enables instructors to effectively cover material that was not solidly comprehended by the students. In addition, the instructor is able to dynamically separate students into groups based on their areas of low-performance, assigning individuals with higher performance records to those groups based on the submission of online assignments. It is relevant to mention that these tools already have performance monitoring tools that can provide a clear picture of the command of the subject by the aggregated group or by individual students. The ability to analyze student performance in many levels, particularly if the instructor assigns goals and objectives to each assignment items, provides a full command diverse student groups in this new digital era. By aligning outcomes expected of a course with assignment items, an instructor is able to effectively assess on a daily basis whether the students are achieving specific goals for the course.

Students who feel that their instruction is being customized for them will tend to perform better in class and maintain high levels of engagement. Under this structure of instruction, students will engage more effectively, further improving the feedback relationship necessary to foster an effective education in this digital era. Such environment will be greatly reflected in the instructor's evaluation and the overall performance of the class. Given the availability of such systems, instructors are encouraged to adopt course material that can support the philosophy of Just-in-Time Teaching as an effective way of managing larger and more diverse class rooms.

LIMITATIONS AND DIRECTION FOR FUTURE RESEARCH

First and foremost our sample size was very small. Only one section of a course was used to test the program. This affected our ability to test the validity of the questionnaire using factor analysis. The study is the first time that a JiTT application was applied to an advanced level course and not an introductory course. While there are extensive studies on the different types of tools that enable both asynchronous and synchronous communication educational tools, there has been limited investigation of how the combination of tools can contribute to a JiTT application. Further research should be conducted to examine the impact of virtual tools supported with artificial intelligence within fully-integrated educational platforms such as Connect™ or Blackboard™

CONCLUSION

The time that students spend seeking outside curriculum assistance is significantly increased by providing virtual JiTT tools. The number of electronic hours spent using the virtual tutor far outweighed the time spent in face to face contact with the instructor of the course during office hours. The study also shows that students are satisfied with the system based on the results of the satisfaction questionnaire, the self-reported use statistics of the system, comparison of the means of test scores, and comments made through random unstructured interviews. The study supports the use of the JiTT tools in a junior/senior level statistics course. We observe that higher satisfaction with JiTT tool plays a critical role in its adoption rate, which would result in higher level of student engagement outside the classroom setting. Anecdotal evidence from the instructor indicated that students who were in the experimental section were better prepared for class and moved more rapidly through the course concepts than the control group

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