Learning Style Trends and Laptop Use Patterns: Implication for Students in an IT Business School

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Abstract

Recent years have seen a widespread application of information and communication technology (ICT) in learning and teaching across a large number of universities and high schools. The effectiveness of technology-enabled learning very much depends on the extent to which the technologies enhance learning. Despite a number of studies on laptop programs, however, there is little research on whether the application of ICT to assist learning, (e.g., laptops or notebooks) effectively delivers expected learning outcomes. To address this problem, we examined students' learning styles, use pattern, and satisfaction with learning using technology. Two surveys were administered to students enrolled in the laptop program at the School of Information Technology Management (ITM) at Ryerson University. Our findings provide a basis for further research on learning styles in this technology enabled environment. In particular, the impact of this laptop teaching and learning environment on students is the subject of a longitudinal study.

Keywords: Learning Styles, Use patterns, Laptop, Notebook, Index of Learning Styles, Information and Communication Technology.

1. INTRODUCTION

The use of information technology to enhance the learning process is continuing to engage the educational research community. As universities and colleges struggle with a shortage in resources, these organisations look to the use of ubiquitous computing technologies as a means to deliver a variety of programs. In the educational circles, it is a generally accepted notion that the advancement in technology contributes significantly to the improvements in learning and instruction. For instance, Demetriadis, Pomportsis and Traintafillou (2003) emphasize that in many countries the introduction of Information and Communication Technology (ICT) into schools has been praised as the necessary course of action for the qualitative improvement of teaching and learning methodologies.

Some other researchers have commented on the integration and use of technology in education (Penuel, 2006; Connolly, 2005; Christensen & Knezek, 2002). Empirical studies have shown the advantages of using wireless technologies and mobile devices in learning environments. Noted benefits include accessibility and availability of the networks (Gay et al., 2001; Katz, 2002), engaging students in learning-related activities in diverse physical locations, supporting group work on projects, and enhancing communication and collaborative learning in the classroom (Gay et al., 2001), and increased amount of hands-on work and exploratory learning (Barak, Lipson and Lerman, 2006).

Despite the enthusiastic acceptance of advanced technologies by educational institutions, however, the extent to which the schools exploit these technologies for learning is rather uncertain (Connolly, 2005; Rutherford, 2004). In a study of computer use in K-12 schools, Rutherford found this tool was not utilized in ways that maximized its full potential (Rutherford, 2004). For example, some teachers, with a positive attitude towards computers in the classroom, eagerly integrate these technologies into teaching strategies and curriculum development (Kosakowski, 1998; King, 2002; Christensen & Knezek, 2002; Morales & Roig,

2002). Some other instructors, however, concerned with training and a potential increase in preparation time, tend to be negative and therefore reluctant to apply new technologies in classrooms (Hua & Lehman, 2003; Crawley, 2000).

From a learning perspective, an equally important yet unexplored issue is the extent to which students embrace advanced technologies (e.g., laptops) as a complimentary component to learning styles. Despite a wide claim that the new technologies enhance learning (Verillon 2000; Beyth-Marom, Chajut, Roccas, & Sagiv 2001; Newhouse, 2000), paramount questions such as "Do students apply the technologies to learning-related activities?" and "Are they satisfied with learning using the technologies?" remain unanswered. As each individual's learning is guided by his/her learning style, it is essential to understand the students' learning styles and whether advanced technologies facilitate or impede students' learning.

The objective of the paper is threefold: (1) to explore how students apply advanced technologies to learning-related activities, (2) to understand dominant student learning styles, and (3) to uncover student satisfaction with learning using technologies. To achieve the objectives, we conducted a survey across 195 students who were enrolled in the laptop program implemented by the only information technology management business school in Canada. In this paper, term laptop computer is used interchangeably with notebook computer. By investigating students' laptop use pattern, learning styles, and learning satisfaction, we hope to uncover whether the laptop environment facilitates or impedes learning by examining students' learning activities using laptops (use pattern) and students' satisfaction with learning using laptops.

The paper is organized as follows. We first present a theoretical background by reviewing existing literature on applying ICT for teaching and learning, and then describe research methodology. After presenting survey results, we discuss theoretical and practical implications of our study.

2. THEORETICAL BACKGROUND—LEARNING STYLES

Researchers have sought to describe clearly identifiable, qualitative distinctions in student learning styles. Several definitions of learning styles have been identified. Morrison, Ross and Kemp (2004) define learning styles as the characteristics individuals demonstrate when undertaking learning tasks and processing information. Kolb (1976) contends that learning styles are the unique learning method that learners demonstrate during the learning process. Biggs (1994) identifies learning styles as the way in which students go about their academic tasks, thereby affecting the nature of learning outcome.

For the purpose of this paper, we adopt Felder and Silverman's (1988) definition of learning styles, which is denoted as preferences in the manner that individuals receive and process information. An individual's learning style is an indication of the person's needs, motivations, attitudes, expectations, and emotions when in a learning environment. For example, one individual may learn more effectively when there are sounds and images with the content being presented. In contrast, another person may learn better in a situation where the opportunity exists to read printed material on the subject matter. Still, others may prefer to work in small groups while collaborating on a project. Learners have more than one learning style, but there will be certain strengths and weaknesses related to each one.

Individuals with different learning styles engage in different learning activities. Liegle and Janicki (2006) discover that individuals who prefer reflective observation like to follow steps in web navigation while individuals who prefer experimentation tend to jump over pages. Baldwin and Sabry (2003) indicate that individuals with sequential learning style tend to follow logical and step-by-step instructions, and some other individuals prefer visual representations.

As a result, it has been strongly proposed that a learning environment has to match an individual's learning style to enhance learning outcomes (Baldwin & Sabry, 2003; Leigle & Janicki, 2006). As argued by Bostrom, Olfman, and Sein (1990, 1993), in the design of training, it is essential to match training methods to individual difference variables. In other words, individuals with the sequential learning style should be accommodated by offering orderly and logical instructions and visual learners should be provided with visual demonstrations (Baldwin & Sabry, 2003).

However, the existing literature offers no decisive finding that certain styles perform better in laptop enabled learning. Neither do research reports show inconsistent results of performance among the different learning styles. Gunawardena and Boverie (1993) studied interaction among method of instruction, learning styles, and computer-mediated communication in distance learning. Their results show that learning styles do not influence how students interact with media and method of instruction. However, Accommodators or (active learners in our study) were the most satisfied and Divergers (reflective learners in our study) were the least satisfied with class activities. In essence, many factors might lead to such results. Kolb (1984) posits that learning style differences may occur depending on factors such as learning task, environment, time, and student demand level. Sein and Robey (1991) uncover that Convergers performed better than individuals with other learning styles in computer training methods. It remains uncertain which learning style produce the most satisfying outcomes. For this reason, Loo (2002)

supports the notion that it is beneficial for learners to adopt a flexible learning style.

A variety of learning style inventories are available to assess how students learn, what educational strategies are most appropriate for each style, and how students deal with ideas and concepts (Felder & Silverman, 1988; Felder & Soloman, 1991; Kolb, 1976; Myers, 1978). These instruments are used in an effort to improve the learning outcomes of students by attempting to identify how students learn and consequently tailoring teaching methods and techniques to help promote those particular styles. The Index of Learning Styles (ILS) (Felder & Soloman, 1991) was used for the purpose of this study due to its clarity, ease of scoring, and research supported validity and reliability (Felder & Spurlin, 2005). There is considerable agreement that ILS provides educators with an effective means of assessing the various ways in which students prefer to learn (Zywno, 2003; Livesay, Dee, Nauman, & Hites, Jr., 2002).

3. METHODOLOGY

To understand the learning styles of business students and the effectiveness of laptop programs, we conducted two surveys. The first survey captured the learning styles of the students. The second survey was developed for this research and it collected laptop use pattern data across undergraduate students enrolled in the Learning Edge program at Ryerson University.

3.1. SCHOOL CONTEXT AND PROGRAM DESCRIPTION

The ITM *Learning* EDGE (see http://www.ryerson.ca/itm/edge/) is an educational and economic model designed to meet the needs of all stakeholders in the new knowledge economy. The program leverages the capabilities of information and communications technologies to extend the classroom beyond Ryerson University's physical infrastructure. Students have continuous access to course materials, faculty, school administrators and their peers. The *Learning* EDGE offers a four-year curriculum leading to a Bachelors of Commerce (B.Comm) degree that blends business fundamentals with information technology. It provides students with five options:

- Applications Development
- Digital Media Solutions
- Enterprise Systems and Organizations
- Knowledge and Database Management
- Telecommunications and Networking

These options offer a broad-based teaching and learning environment that prepares students with highly desirable skills to enter challenging IT careers in today's competitive marketplace.

The hardware/software platform for the program is configured on IBM's ThinkPad products (e.g., laptop) and wireless network to meet the need of the program options listed above. Each student in the ITM *Learning* EDGE leases a ThinkPad from Ryerson, renewable at 2-year intervals.

Laptop has been applied in all courses to support a wide range of academic activities including accessing course materials on-line, submitting assignments and projects, taking on-line tests, and posting/viewing/changing grades online. In addition, students use their laptops to participate in discussion forums, chat, carry out research, and perform hands-on activities (e.g., programming) in class using their laptops.

3.2. SURVEY INSTRUMENT

In this study, it is crucial to ascertain the students' learning styles and their use of laptop computers. Accordingly, the methodology used to examine the first research question was a survey technique using the ILS. This 44-question instrument (see https://www.runner.ryerson.ca/ilssurvey/sample/APPENDIX_C.pdf) was designed to assess learning preferences on four dimensions (Felder & Silverman, 1988). The ILS consists of four scales, each with 11 items: sensing-intuitive, visual-verbal, active-reflective, and sequential-global. Felder and Spurlin (2005) summarize the four scales as follows:

- "*sensing* (concrete, practical, oriented toward facts and procedures) or *intuitive* (conceptual, innovative, oriented toward theories and underlying meanings);
- *visual* (prefer visual representations of presented material, such as pictures, diagrams, and flow charts) or *verbal* (prefer written and verbal explanations);
- *active* (learn by typing things out, enjoy working in groups) or *reflective* (learn by thinking things through, prefers working alone or with one or two familiar partners);
- *sequential* (linear thinking process, learn in incremental steps) or *global* (holistic thinking process, learn in large leaps) (p. 103)."

The instrument's scoring sheet is included as an algorithm in the online version of the questionnaire that automatically produces the student's ILS Report. Each scale in the report was coded (see https://www.runner.ryerson.ca/ilssurvey/sample/APPENDIX_D.pdf) in order to facilitate processing in SPSS. For instance, on the ACT/REF the values "1" and "2" will represent a strong preference for active learning and "5", "6" or "7" will represent a fairly balanced preference on the ACT/REF scale. On the other hand, "11" and "12" will represent a strong preference for reflective learning.

A use pattern survey was used to examine the second research question. The student questionnaire (see https://www.runner.ryerson.ca/ilssurvey/sample/APPENDIX_D.pdf) was designed and deployed using Quask on-line survey software (http://www.quask.com/en/home.asp). There are 35 questions that include 3 demographic questions regarding gender, program year and level of computer experience. The instrument also contains 15 questions regarding use of laptop for specific classes (11 ITM classes and 4 non-ITM classes), 5 questions on satisfaction with or importance of various aspects of the hardware including battery life, weight and performance, 2 questions regarding functionality or applications, 2 questions on technical support, 2 questions on cost issues, 2 questions regarding implications for learning, 2 questions regarding the overall program effectiveness, and 2 opened-ended questions for additional comments.

Although there are no specific questions that ask for subject identification, the system registers responses by email address so the questionnaire was not considered anonymous. However, the email addresses were removed from the responses and a number assigned for each participant to ensure that no one would link individual students to the surveys. This approach provided anonymity and confidentiality for students in the study, and it allowed the researchers to code and analyze the data.

3.3. SURVEY ADMINISTRATION

Subjects for this study were all students registered in the ITM laptop program for the academic year 2005/2006 (n=1437). Every effort was made to ensure that each student participated in the surveys once. The students were invited to participate in the study through an email to each prospective participant that included an Informed Consent document with ethics approval details. This activity was completely voluntary and students were provided with the links to the web-based instruments. The interface for each instrument allowed the students to "Agree" or "Disagree" to take part in the survey. The data was subsequently exported to SPSS 12.0 statistical software and analyzed.

4. RESULTS

4.1. POPULATION

This population (n=1437) includes full-time students who have been enrolled in the learning edge program. The population also consists of 78 percent males and 22 percent females. Their ages range from 18 years to 38 years with an average age of 20.8 years. The average age of the population (approximately 21 years) suggests that these students should be computer savvy.

4.2. DOMINANT STUDENT LEARNING STYLES

The response rate to the ILS survey was 30.2% and the response rate to the Laptop Use Pattern questionnaire was 14.05%. A total of 406 students responded to the Learning Style survey and 195 students responded to the Laptop Use Pattern questionnaire. The surveys were administered towards the end of the academic year 2005/2006 when the students were preoccupied with preparations for their final examinations. It was necessary to administer the surveys at this time in order to allow the 1st year students enough time to adjust to the program. However, this strategy resulted in a response rate that was lower than anticipated.

For the purposes of this paper, we divided the four scales of the learning style instrument into "A" type preferences (L_a) and "B" type preferences (L_b). The L_a learners show a preference for Active, Sensing, Visual and Sequential learning styles. This polar dimension is denoted as *asvs*. The L_b learners display a tendency for Reflective, Intuitive, Verbal and Global learning styles. This polar dimension is denoted as *rivg*. The learning style preferences of the ITM undergraduate students (see Table 1) showed that a majority of the sample (66%) reported a learning style preference in the L_a dimension. Whereas, only 5.2% of the students indicated a preference in the L_b dimension. This revelation raises some interesting questions regarding the effective use of notebook computers for learning in the ITM program. For example, what types of teaching strategies must teachers employ to engage these students? What program delivery retrofit is required to adapt to the unique characteristics of the notebook computers? How can teachers effectively manage the students' laptop use expectations from one course to another?

Table 1
Strength of Learning Style Preferences

Learning style	Frequency	Percent
Strong asvs	101	31
asvs	115	35.3
Strong rivg	6	1.8
rivg	11	3.4
Balanced	23	7.1
Mixed	70	21.5
Total	326	100

4.3 LAPTOP USE PATTERN

The laptop use patterns were accessed by the use of the laptop for learning, and the use of the laptop for specific course related activities. We consider these activities to be specific to the students' academic support and they include word processing, spreadsheet/database work, taking notes, researching information on the Internet and so on. The expected levels of laptop use in the ITM program are shown in Appendix B.

In the skill level category (see Table 2), 53% of the students reported that they are "expert", and 45% indicated that they are "intermediate". We consider the

students' frequency of daily use of their laptops as an indicator of its usefulness. Table 3 shows the activities in the category of "very often per day". It is interesting to note that research (63%) and in-class chat (51%) emerged as the activities that attract the highest level of laptop use. In contract, and somewhat surprisingly, only 11% of the students reported using the laptop for programming.

Table 2
Student Computer skills

Skill level	Frequency	Percent
Novice	1	5
Beginner	3	1.5
Intermediate	88	45.1
Expert	103	52.8
Total	195	100

Table 3
Laptop usage – very often per day

Activity	% of Students
Word processing	41%
Spreadsheet/Database	16%
Note Taking	34%
Organizing Information	43%
Research	63%
Presentation	16%
In-class or Online work	39%
In-class Chat	51%
Programming	11%

4.4. LEARNING SATISFACTION

We evaluated learning satisfaction and satisfaction with the laptop program as proxies of learning outcomes. That is, learning is enhanced when students feel satisfied with learning using technology (Penuel, 2006; Barak, Lipson & Lerman, 2006). As shown in Table 4, a little over 50% of 195 students feel very or somewhat satisfied with learning using technology. Almost one quarter of students are very or somewhat dissatisfied with learning using technology. Students' overall satisfaction is also moderate—only half of students are very or satisfied with the laptop program.

We further explored the learners' satisfaction with the laptop by considering learning styles (see Table 5) and laptop usage for courses (see Table 6) appealing to L_a style, L_b style, and mixed style. We categorize courses by examining each course outline, course evaluation, and session-by-session plan. Courses involving extensive use of laptops are categorized as appealing to L_a, courses mainly relying on lectures are classified as appealing to L_b, and courses integrating a balanced use of laptops and lecturing are grouped in the category mixed style.

Table 4
Satisfaction Levels

Satisfaction with learning	**Frequency**	**Percent**
Very satisfied	40	20.5
Somewhat satisfied	68	34.9
Neutral	39	20
Somewhat dissatisfied	26	13.3
Very dissatisfied	22	11.3
Total	195	100
Overall satisfaction	Frequency	Percent
Very satisfied	19	9.7
Somewhat satisfied	80	41.0
Neutral	50	25.6
Somewhat dissatisfied	26	13.3
Very dissatisfied	20	10.3
Total	195	100

Table 5
Course Targeted Learning Styles

Satisfaction Levels	ASVS Learners	RIVG Learners	Mixed Learners
Very Satisfied	20.8%	19.2%	25.6%
Somewhat Satisfied	28.5%	34.4%	43.5%
Neutral	18.7%	20.6%	25%
Somewhat Dissatisfied	13.9%	14.4%	16.6%
Very Dissatisfied	11.4%	11.5%	14.1%

Table 6
Laptop Usage by Courses

Laptop Usage	Courses
Low	ITM400, ITM405, ITM420, ITM505, ITM700
Moderate	ITM100, ITM305, ITM315, ITM410, ITM500
High	ITM100, ITM310,ITM320, ITM525,ITM600, ITM721

As shown, (see Table 5) courses with the L_a (ASVS) learning style appeal has 20.8 percent of students feeling very satisfied with learning using technology, and 35.3 percent of students somewhat satisfied. Courses with the L_b (RIVG) learning style appeal has 19.2 percent of students very satisfied with learning using technology, and 34.4 percent of students somewhat satisfied. It appears that courses appealing to two different learning styles exhibit a similar pattern of student satisfaction with learning. In contrast, courses with a balanced deployment of laptops and lecturing show the highest satisfaction percentage: 25.6 percent of satisfied students and 43.5 percent of somewhat satisfied students.

5. DISCUSSION

Our survey results of learning styles, use patterns, and student learning satisfaction offer several important findings.

First, the undergraduate students in the business school that responded to the surveys exhibit diverse learning styles. Sixty-six percent of students show a strong or moderate active, sensing, visual, and sequential learning style. By contrast, only 3.4 percent of students exhibit a strong or moderate reflective, intuitive, verbal, and global, and 7.1 percent of students with a balanced learning style. One fifth of the respondents possess a mixed learning style, which has not yet been reported in previous findings.

Our survey results confirm the assumption held in the existing literature that the dominant learning style among the undergraduate student body is asvs (Felder and Spurlin, 2005). That is, students raised in the networking and computing era tend to learn by doing and through visualization (Felder & Spurlin, 2005; Zywno, 2003; Livesay, Dee, Nauman, & Hites, Jr., 2002).

Second, our survey results show a low to moderate laptop utilization for learning. The use of notebook computers for researching received the highest percentage (63%) of student engagement; programming has the lowest, with other learning activities (e.g., note taking, presentation) receiving 30 to 40 percent of student engagement.

This finding is surprising--given the fact that a majority of the students are active, sensing, visual, and sequential learners, students are expected to apply laptop extensively to learning-related activities.

Third, are students satisfied with learning using technology? The examination of learning satisfaction across all respondents indicates that approximately 50 percent of students are satisfied or somewhat satisfied. This finding seems to correspond to the findings from the laptop computer use pattern. The discovery that students do not use the laptops as much as they are expected, suggests that students may have other demands that have not been met through learning with laptops.

By looking at learning satisfaction statistics across different types of courses, we discover that asvs-type courses receive a similar satisfaction rate as rivg-type courses. This finding is intriguing as the existing literature assumes that learning is enhanced when training/teaching methods fit individual learning styles. In other words, as the majority of the students are active, visual, sensing, and sequential learners, they are expected to be more satisfied with learning using technology than those who are reflective, intuitive, verbal, and global.

The finding that courses with a balanced application of laptop and lecturing receive the highest learning satisfaction is worth noting. It suggests that students feel that learning is enhanced when content is accompanied by active practice.

6. CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

An increasing number of educational institutions have adopted advanced technologies to facilitate and enhance learning. Empirical studies, however, report the application of these technologies varies and may not support learning activities. To explore whether advanced technologies enhance learning, we conducted two surveys across students who were enrolled in the school of information technology management. In particular, we investigated student learning styles, laptop use pattern, and satisfaction with learning using technology. Our findings from the surveys, while confirming that the majority of the students are active, sensing, visual, and sequential learners, suggest that much is to be learned regarding the effect of advanced technologies on learning enhancement. In particular, we make several suggestions for future studies.

We uncover the low to moderate laptop utilization rate. Further studies should be conducted to understand why the utilization rate is not as high as expected. What are other moderating factors that contribute to this situation?

Future studies should also explore several other academic institutions to investigate how laptops are utilized to facilitate learning for different subjects. By doing that, researchers can answers why the mixed style courses receive the highest satisfaction than the other two types of courses. In addition, future studies can explore the differences in performance among students with a dominant asvs, a dominant rivg, and a mixed learning style.

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APPENDIX A

Computer Skill Level

How would you rate your overall skill in using computers?

- Novice: I can turn the computer on, but I do not really know how to use many programs
- Beginner: I am able to use some basic functions such as word processing and the Internet
- Intermediate: I am able to use many programs and I have some experience with them
- Advance: I am able to use many of the programs and I have had a great deal of experience
- Expert: I am able to teach others how to use some programs and I am to fix minor problems with my computer

Laptop Use

Please indicate how often you use your laptop computer in-class versus out-of-class for the following courses: (I do not take this class, I do not use laptop for this course, I use laptop only during class, I use the laptop during this class + less than 1 hr per week, I use the laptop during this class + 1-2 hrs per week, I use the laptop during this class + greater than 3 hrs per week)

- ITM100
- ITM320
- ITM405
- TIM505
- ITM525
- ITM700
- ITM721

Please indicate how often you use your laptop to do the following activities: (Never, Once per week, A few times per week, Once per day, Very often during the day)

- Word processing
- Working with spreadsheets/databases
- Taking notes
- Organizing information
- Researching information on the Internet
- Taking quizzes/tests/assessments
- Creating presentations and other multimedia projects

Satisfaction with the Laptop Program

Please use the Likert Scale to indicate your level of satisfaction with aspects of the program. 1 = Very Satisfied 2 = Somewhat Satisfied 3 = Neutral 4 = Somewhat Dissatisfied 5 = Very Dissatisfied

- How would you rate your satisfaction with the use of the laptop for learning?
- How would you rate your satisfaction with the use of the laptop for personal activities outside of the class?
- How would you rate your overall satisfaction with the laptop program?

Effect of Laptop Use for Learning

Compared with your learning experience without a laptop such as in High School, what is the effect of having a laptop on your ability to learn the course material?

- The laptop hinders my ability to learn the course material
- The laptop does not make any difference
- The laptop enhances my ability to learn the course material

APPENDIX B

Courses and Laptop Usage

	Course code	Laptop usage	Rationale
1.	ITM 100 Business Information Systems	Moderate to high	Use quizzes and games
2.	ITM505 Managing Information Systems and Telecommunications	Low	Mainly use case studies
3.	ITM420 IS Security and Control	Low	Objectives are mainly to understand different security and control mechanisms
4.	ITM445 Multimedia	High	Intensive usage of laptop as evidenced in exercises
5.	ITM500 Database Analysis and Design	Moderate	Exercises using laptops
6.	ITM600 Data Communications: Network Analysis and Design	High	A lot of exercises using laptops
7.	ITM700Information Technology and Strategic Management	Low	Intensive use of case studies
8.	ITM721 E-learning	High	Intensive use of laptops
9.	ITM320 Database Design	High	Heavy laptop usage
10.	ITM525 Advanced Internet Application Development	High	Intensive laptop usage
11.	ITM410 Business Process Design	Moderate	Use laptops for exercises
12.	ITM310 Introduction to Network Technology	High	Lots of hands-on projects
13.	ITM315 Introduction to Network Administration	Moderate	40% exercises
14.	ITM405 Internet Applications Development	Low	10% exercises
15.	ITM400 Telecommunications Technologies and Applications	Low	Low level use of laptops. Mainly focus on telecommunication technologies
16.	ITM305 Systems Analysis and Design	Moderate	Some quizzes