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Research Trends in Technology-based Learning from 2000 to 2009: A content Analysis of Publications in Selected Journals

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ABSTRACT

This paper provides a content analysis of studies in technology-based learning (TBL) that were published in five Social Sciences Citation Index (SSCI) journals (i.e. *the British Journal of Educational Technology, Computers & Education, Educational Technology Research & Development, Educational Technology & Society, the Journal of Computer Assisted Learning*) from 2000 to 2009. A total of 2,976 articles were cross-analyzed by three categories including research topic, research sample group, and learning domain. It was found that “Pedagogical design and theories” was the most popular research topic, “Higher Education” was the most utilized sample group, and “Non-specified” and “Engineering/Computer sciences” were the most selected learning domains in the last decade. However, topics in “Motivation, Perceptions and Attitudes” drew more attention in the latest five years, while the number of articles in “Digital game and intelligent toy enhanced learning” and “Mobile and Ubiquitous Learning” grew significantly between 2005 and 2009. Furthermore, the Chi-square analysis results showed that there were significant associations among these three categories. The results of the analysis provide insights for educators and researchers into research trends and patterns of technology-based learning.

Keywords

Research trends, Technology-based learning, Content analysis

Introduction

Technology-based learning is increasingly important in the 21st century. However, studies in analyzing its appropriateness, its application and practices, and its influence on today’s education are still under debate and discussions (e.g. Chan, Hue, Chou, & Tzeng, 2001; Shih, Feng, & Tsai, 2008). Besides, numerous studies in this area have explored a wide range of topics, such as the improvement in technology-based learning environments, the effectiveness of web-based instruction, and the integration of new technology into classrooms. Therefore, reviewing the research trend of technology-based learning may help the researchers in related fields to identify their research interests and design considerations. Besides, the study will also provide policymakers with a reference to make plans in the future. Hence, it is important and meaningful to examine the technology-based learning research trends at this point.

This study intends to investigate the research trends of technology-based learning from 2000 to 2009. Five major research journals were selected for analysis, namely the British Journal of Educational Technology (BJET), Computers and Education (C&E), Educational Technology Research & Development (ETR&D), Educational Technology & Society (ET&S), and the Journal of Computer Assisted Learning (JCAL). The research questions addressed by this paper include:

1. What research topics related to technology-based learning were published in these selected journals from 2000 to

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2009? And what were the topic variations between the first five years (2000-2004) and the second five years (2005-2009)?

2. What research sample groups related to technology-based learning were selected in these published articles from 2000 to 2009? And how did the sample group selections shift between the first five years (2000-2004) and the second five years (2005-2009)?
3. What research learning domains related to technology-based learning were adopted in these published articles from 2000 to 2009? And how did the learning domain shift between the first five years (2000-2004) and the second five years (2005-2009)?
4. Is there any significant association between the research topic and the selection of the research sample group for these publications from 2000 to 2009?
5. Is there any significant association between the research topic and the adoption of the learning domain for these publications from 2000 to 2009?

Reviews of TBL research trends

The prevalent use of computing and communication technologies has increased in education and thus, learning is no longer limited to the traditional environment. Communication technologies such as the Internet, digital programs and systems, Personal Digital Assistants (PDA), and simulation games have been integrated into instruction to support learning. As a result, technology-based learning refers to the process of learning constituted with electronic technology (Cavus & Kanbul, 2010).

As more technological innovations are developing, their applications to education are also believed to be evolving. For example, Yengina, Karahocab A., Karahocab D., and Ozcinarc, (2010) have predicted that more technology-based learning (TBL) will occur with the newly developed devices or concepts, such as personalized and adaptive e-learning, portfolio collections, and more advanced online mind tools. In addition, the new web-based social networking tools such as Facebook, Twitter, YouTube, or wiki will also expect to become an integral component of TBL (e.g. Clark & Mayer, 2008). As a result, examining what previous TBL research has accomplished and emphasized may help researchers to identify the research trends or design criteria. For example, Waight, Willging, and Wentling (2004) clarified e-learning reports published by government, business, and associations to understand the impacts and the focus of e-learning in the United States from 1999 to 2003 and the identified trends were: lifelong learning, improvements in technology, demand for high level skill workers, pervasiveness of computers, globalization, new ways of learning from new technologies, and improvement of the learning quality via the technology. A similar study conducted by Shih, et al., (2008) was to investigate the research trends of cognitive studies in e-learning from 2001 to 2005. Five journals were selected for analysis (i.e. *the Journal of Computers and Education*, *the British Journal of Educational Technology, Innovations in Education and Teaching International*, *Educational Technology Research & Development*, and *the Journal of Computer Assisted Learning*.) that the first three ranked research topics were "Instructional Approaches," "Learning Environment," and "Metacognition"; the studies in "Instructional Approaches," "Information Processing," and "Motivation" received the highest citation counts, and the research data tended to be gathered from learners' electronic log files or online-messages.

Furthermore, with a focus on a topic of interaction, Karatas (2008) examined three research journals (*American Journal of Distance Education, Quarterly Review of Distance Education, & Distance Education*) from 2003 to 2005 and concluded that (1) publications related to interaction were most frequently conducted in the years 2003 and 2004, (2) most of these articles were published in the journals of *American Journal of Distance Education* and *Quarterly Review of Distance Education*, (3) Articles in "*Evaluation*" of distance education was the most used topic. Like Karatas's study, Zawacki, Bäcker, and Vogt (2009) selected 695 articles from five research journals (i.e. *Open Learning, Distance Education, the American Journal of Distance Education, the Journal of Distance Education, the International Review of Research in Open and Distance Learnin*g) to find the research trends in distance education from 2000 to 2008 based on the articles' research areas, methods, and authorship patterns. The results revealed that research in distance education was dominated by studies that focus on interaction and communication patterns in computer-mediated communication, instructional design issues, learner characteristics, and educational technology.

Taken together, all of these studies utilized systematic content analysis methods and provided some insights into the research trends of TBL. This study, however, extends the previous studies' frameworks to analyze the TBL research trends according to three categories, namely the major research topics, the research sample groups, and the learning domains. Five research questions were raised in accordance with the aforementioned literatures and the panel discussions of four experts in educational technology. Besides, the current study selected major TBL journals and conducted a longitudinal analysis for a ten-year-period to present an all-inclusive overview. As it is difficult to include all of the relevant journals for analysis, four experts in educational technology were consulted to select the five major journals in this study. The selected journals were also similar to Shih, et al.'s study (2008) and the selected period which contains ten-year analysis should represent as a complete TBL research review for a decade. Moreover, the current research further analyzes the trend by examining the associations among the three identified categories and compares their changes between the first and the last five years. For instance, this study explores how the research topic may be related to the adoption of the research sample. Such a trend issue has not been carefully addressed by previous review papers. Overall, the current study contributes a more complete and comprehensive report of the TBL research trends compared to the previous studies.

Methods

This study examines papers relevant to TBL in the SSCI database from 2000 to 2009. The five selected journals were: *the British Journal of Educational Technology (BJET)*, *Computers and Education (C&E)*, *Educational Technology Research & Development (ETR&D)*, *Educational Technology & Society (ET&S)*, and *the Journal of Computer Assisted Learning (JCAL)*. These journals are widely accessed and recognized as high impact factors as released by the Institute for Scientific Information (ISI) Journal Citation Reports.

There were a total of 3,655 document items from 2000 to 2009 published by these five journals. Only papers that were identified as being of the type "articles" in the SSCI were analyzed. Publications such as "book reviews," "letters," and "editorial materials" were all excluded from this study. A further comprehensive review was then carried out. Finally, a total of 2,976 articles were selected for the analysis. In other words, this review only excluded publications which were not categorized as research "articles." It included all of the remaining papers published in these journals without utilizing other filtering criteria. Hence, it is expected that this review can provide a more thorough view of TBL research.

Research topics

One of the major purposes of this study was to categorize research topics in TBL research to help identify the research trends from 2000-2009. After conducting several rounds of expert panel discussions, some important conferences and handbooks were selected for developing a framework of analyzing the research topics. The included conferences and handbooks were the 5th International Conference on e-Learning (ICEL 2010), the eLearning Forum 2010, the 10th IEEE International Conference on Advanced Learning Technologies (ICALT 2010), the Technology Enhanced Learning Conference 2009 (TELearn 2009), the 2010 International Conference on e-Education, e-Business, e-Management and e-Learning (IC4E 2010), the ICCE Conference on Technology, Pedagogy and Education (ICCE 2009), and the 5th International Conference on Open and Distance Learning (ICODL 2009), as well as Handbook: A Comprehensive Guide to Online Learning (Carliner & Shank, 2008), and the SAGE Handbook of E-learning Research (Andrews & Haythornthwaite, 2007). By integrating the conference themes and handbook chapters, the experts then formed a framework and concluded thirteen sub-categories for the research topics, as presented in Table 1.

Table 1. The TBL research topic sub-categories and sample topics

	Research Topic Sub-category		Sample Topics
1.	Development of Learning Systems, Platforms and Architectures	(1)	Online Learning System Development
		(2)	Online Learning Material Development
		(3)	Learning Management System and Learning Content Management System Development
		(4)	Intelligent Tutoring System Development
		(5)	Digital Content Creation
2.	Evaluation of Learning Systems, Platforms and Architectures	(1)	International Alliance for Open Source, Open Standards, and Federated Repositories
		(2)	Evaluation of Learning Technology Systems

		(3)	Emerging and Best Practice
3.	Pedagogical Design and Theories	(1)	Rethinking Pedagogy in Technology-Enhanced Learning
		(2)	User Prior Knowledge and Background Analysis
		(3)	Innovative Pedagogical Models
		(4)	Next Generation Learning Strategies
		(5)	The Potential of Brain Science and its Impact on Learning
4.	Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management	(1)	Learner Centered Strategies
		(2)	Critical Thinking and Problem Solving Development
		(3)	E-Library and Learning Resources
		(4)	Learners Diversity, Inclusiveness and Inequality
		(5)	Supporting Students Experience
5.	Artificial Intelligence in Education	(1)	Intelligent Educational Systems
		(2)	Ambient Intelligence and Smart Environments for Learning
		(3)	Semantic Web and Ontology for Learning Systems
		(4)	Data Mining and Web Mining in Education
6.	Computer Supported Collaborative Learning	(1)	Web 2.0 and Social Computing for Learning and Knowledge Sharing
		(2)	Collaborative and Group Learning
		(3)	On-line Dictionaries and Language development
		(4)	Collaborative and Social Technologies
7.	Mobile and Ubiquitous Learning	(1)	Wireless, Mobile and Ubiquitous Technologies for Learning
		(2)	Pervasive Computing for Learning
		(3)	U-Computing in Learning
		(4)	Context-Aware U-Learning
8.	Digital Game and Intelligent Toy Enhanced Learning	(1)	Gaming, Simulation and Virtual Worlds
		(2)	Identity in Gaming to Learn: Roles and Role-Playing - Collaboration, Competition and Community
		(3)	Non-Visual Senses (Smelling, Touching, Hearing)
		(4)	Game-Based Learning/Training
		(5)	Multiplayer and social game design
		(6)	Virtual Characters, Virtual Storytelling and Game Narrative
9.	E-Assessment and New Assessment Theories and Methodologies	(1)	E-Assessment Strategies
		(2)	Automatic e-Assessment
		(3)	Collaborative e-Assessment
		(4)	E-portfolio Implementation and Impact
10.	Special Needs Education	(1)	Technology enhanced Special Needs Education
		(2)	Learning Disabilities
		(3)	Technology Enhanced Learning for Students with Special Needs
11.	Motivation, Perceptions and Attitudes	(1)	Technology Acceptance of Technologies in Education
		(2)	Readiness of Technologies in Education
		(3)	Sociological and Psychological Dimensions of Technology-Enhanced Learning
		(4)	Self-regulation and Metacognition
12.	Learning Behaviors, Usage Patterns and Discourse Analysis	(1)	Social Networking and Interactive Participation
		(2)	Learning Culture
		(3)	User Attitude and Technology Acceptance
		(4)	Analysis of Asynchronous or Synchronous Interaction
		(5)	Reflective Discourse
13.	Policies, Social Culture Impacts and Trends for Technology-Enhanced Learning	(1)	Policy Issues in Technology-Enhanced Learning
		(2)	Organizational Policies and Strategies for Technology-Enhanced Learning Implementation
		(3)	Global Trends in Technology-Enhanced Learning

(4)	Faculty Development and Support
(5)	Academia-Industry Collaboration
(6)	International Challenges

Research sample groups

After the four experts' discussion and consensus, seven sub-categories for the research samples were identified. The finalized sub-categories were: 1. Elementary school, 2. Junior and Senior high school, 3. Higher education, 4. Teachers, 5. Adults, 6. Others, and 7. Non-specified.

Research learning domains

The same experts discussed the usage of the sub-categories for the learning domains. The learning domain for each paper included in this review was categorized into one of the following sub-categories: 1. Science (e.g. Physics, Chemistry, and Biology, Medical and Sport Science), 2. Mathematics, 3. Arts & Language, 4. Social Studies, 5. Engineering (including Computers), 6. Others, and 7. Non-specified.

Data coding and analysis

This study used all of the empirical research articles published in BJET, C&E, ETR&D, ET&S, and JCAL from 2000 to 2009 (ten years) to examine the research trends in the TBL field. Content analysis was utilized to classify the research topics, sample groups, and learning domains of the articles.

It is noted that many research articles addressed more than one research topic or sample group; therefore, the research topic and sample group category was coded into two levels. The primary matched sub-category was coded as "the first research topic" or "the first sample group" and the preceding matched sub-category was considered as "the second research-topic" or "the second sample group." The matched sub-categories after the "second research-topic" or "the second sample group" were excluded. If the article had only one research topic or one sample group, the field of the second research topic or second sample group was coded "none." For example, if an article aimed to evaluate whether a new learning system enhanced the learning motivation of fourth grade students, the article's first research-topic would be coded "2" (i.e., *Evaluation of Learning Systems, Platforms and Architectures*) and the second research-topic would be coded "11" (i.e., *Motivation, Perceptions and Attitudes*).

Finally, a one-level coding process was involved in categorizing the learning domains, as based on our pilot coding for about 200 papers, most of the papers did not involve more than one learning domain. Articles with only one major learning domain were coded to the designated learning domain, and articles with more than one major learning domain or other than the aforementioned learning domain sub-categories were accounted as "Others." However, only around 5% of the papers were coded as "Others" for the learning domains (presented later).

The coding process was undertaken manually by the researchers. Seven doctoral students majoring in educational technology helped to categorize the articles based on the aforementioned categories (research topics, research sample groups, and learning domains). Two post-doctoral researchers then randomly selected 401 articles and followed the same coding process to compare the coding results by research topic. The results reached an agreement of 0.88. Since the research sample group and learning domain information was less ambiguous in most of the articles, the researchers only randomly located 100 articles to compare the coding results. The results of both categories reached the same agreement of 0.90.

After the classification, the researchers proceeded to assign weighted scores to each article. First, a score of 1 was given to "Regular articles" (n = 2,806) and a score of 0.5 was applied to "Short articles" (that is, the "Colloquium" articles in BJET, n = 170). The total weighted score was 2,891. Then, a score of 0.6 was assigned to the first research-topic and a score of 0.4 was allocated to the second research-topic when an article covered two matched research topic sub-categories. If the article solely had one matched research topic, this topic received a total score of 1 (for the "short articles", the score of the first research topic was 0.3 and the score of the second research topic was

0.2. The articles with only one research topic received a score of 0.5).

Similarly, a score of 0.6 was assigned to the first sample group and a score of 0.4 was allocated to the second one when an article included two matched sample group sub-categories. If the article had only one matched sample group, the identified sample group received a total score of 1 (for the "short articles", a score of 0.3 was applied to the first sample group while a score of 0.2 was assigned to the second one. The articles with merely one sample group had a score of 0.5). Finally, since only one learning domain was assigned to each article, a score of 1 was given to articles based on the specified learning domain (for the "short articles", a score of 0.5 was applied to the designated learning domain.)

After the initial coding process, a descriptive statistical analysis was then employed to report the data. Pearson's Chi-Square analysis was also used to investigate if there were significant associations among these three categories. For the categories of research topics and research samples, the Chi-Square analysis was conducted based on the first matched sub-category. A cell number of less than or equal to 5.0 was excluded for analysis. A post hoc test in obtaining the adjusted residual values was then utilized to examine the difference between the expected values and the actual values for the factors that contributed to the associations. That is, when the confidence interval was 95%, the adjusted residual values were compared to the standardized z-value ($z = 1.96$ or -1.96). If the absolute values of the adjusted residual values were larger than 1.96, the factors were considered to contribute to the associations.

Results

Research question 1: What research topics related to technology-based learning were published in these selected journals from 2000 to 2009? And what were the topic variations between the first five years (2000-2004) and the second five years (2005-2009)?

Based on the aforementioned score allocation, the score under each sub-category of research topic is presented in Figure 1. From 2000 to 2004, the most published research topic was "*Pedagogical Design and Theories*" (249.4), followed by "*Policies, social culture impacts and trends for technology-enhanced learning*" (153.9), and "*Development of New Learning Systems, Platforms, and Architectures*" (138.3). The least published research topic was "*Digital Game and Intelligent Toy Enhanced Learning*" (8.8). On the other hand, from 2005 to 2009, the most published research topic was "*Pedagogical Design and Theories*" (501.7), followed by "*Motivation, Perceptions and Attitudes*" (240.8), and "*Development of New Learning Systems, Platforms, and Architectures*" (176). The least published research topic sub-category was "*Special Needs Education*" (19.4). Furthermore, only the number of articles in "*Policies, social culture impacts and trends for technology-enhanced learning*" reduced from 153.9 to 120.9 between the two periods.

The results of the Pearson's Chi-Square analysis also revealed that the published research topics were significantly different between the initial five years (2000-2004) and the latest five years (2005-2009) ($\chi^2 = 89.52$, $p < 0.05$). The major difference was that the "*Policies, social culture impacts and trends for technology-enhanced learning*" research sub-category showed a declining trend (from 14.13% to 6.71%), while researchers demonstrated more interest in "*Digital game and intelligent toy enhanced learning*" topics (from 0.81% to 3.82%) between the two periods. Furthermore, the issues in "*Pedagogical Design and Theories*" increased from 22.90% to 27.84% and the topics in "*Mobile and Ubiquitous Learning*" also grew from 1.40% to 2.59% between the two periods. However, the research in "*Development of New Learning Systems, Platforms and Architectures*" dropped from 12.7% to 9.77%, and the topics in "*Evaluation of Learning Systems, Platforms, and Architectures*" also reduced from 10.13% to 7.99% between the two periods. In sum, the more recent TBL researchers were inclined to focus on personalized learning experiences by integrating the latest innovations into pedagogical practices (e.g. game-based learning, m-learning, and u-learning). Nevertheless, they expressed less interest in general TBL issues such as TBL policy impacts or learning system build-up than in the first period (2000-2004).

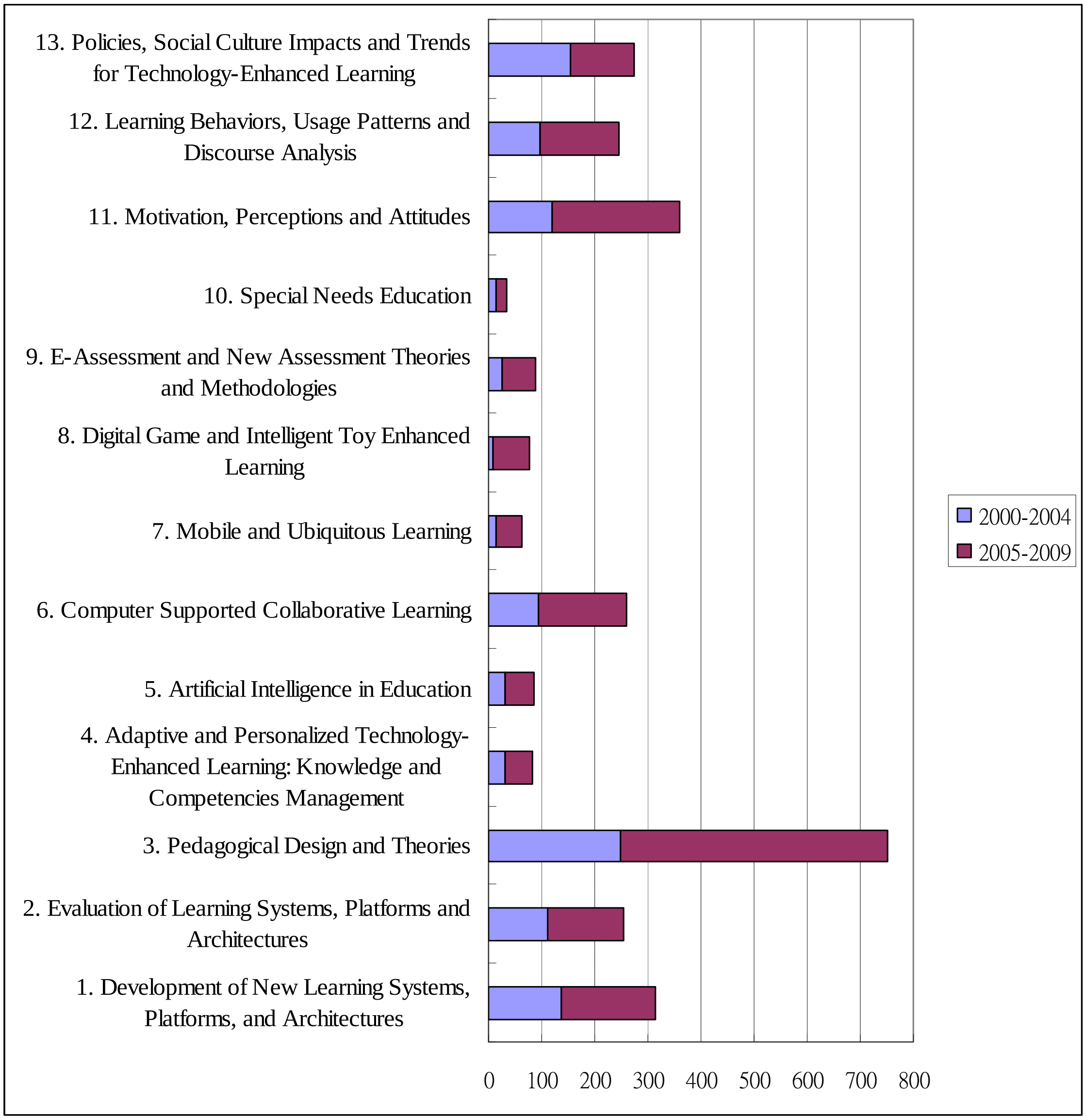

Figure 1. Scores and research trends of TBL research topics from 2000 to 2009

Research question 2: What research sample groups related to technology-based learning were selected in these published articles from 2000 to 2009? And how did the sample group selections shift between the first five years (2000-2004) and the second five years (2005-2009)?

This paper analyzed the publications by research samples and the results are displayed in Figure 2. From 2000 to 2004, research samples in "*Higher Education*" were utilized most (399.8), followed by "*Non-specified*" (301.1), "*Junior and Senior High School*" (104.4), "*Elementary School*" (98.1), and "*Teachers*" (90.2). The least employed research sample was "*Others*" (13.0). From 2005 to 2009, research samples in "*Higher Education*" were still used for most of the TBL research papers (830.1), followed by "*Non-specified*" (269.0), "*Junior and Senior High School*" (215.2), "*Teachers*" (199.7), and "*Elementary School*" (171). However, the number of articles in the "*Non-specified*" group reduced from 301.1 to 269 between the two periods.

The results of the Pearson's Chi-Square analysis also showed that the research sample groups were significantly different between the initial five years (2000-2004) and the more recent five years (2005-2009) ($\chi^2 = 84.24$, $p < 0.05$). The major difference was that the sample group "*Non-specified*" declined from 27.65% to 14.93% and the recruited samples in "*Higher Education*" increased from 36.71% to 46.07% between the two periods. Furthermore, this study also revealed that the trend of using "*Junior and Senior High School*" and "*Teachers*" sample groups increased from 9.59% to 11.94% and from 8.28% to 11.08%, respectively. On the other hand, the percentage of the studies on "*Adults/Working Adults*" dropped from 7.57% to 5.29% between the two periods.

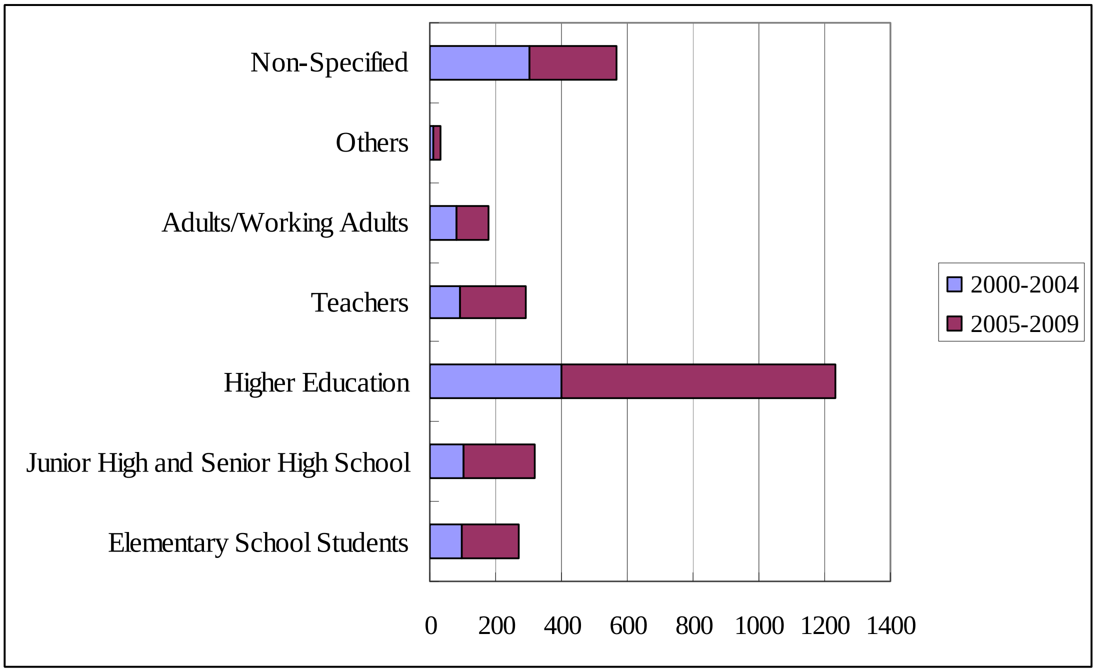

Figure 2. Scores and trends of TBL research sample group selections from 2000 to 2009

Research question 3: What research learning domains related to technology-based learning were adopted in these published articles from 2000 to 2009? And how did the learning domain shift between the first five years (2000-2004) and the second five years (2005-2009)?

This paper analyzed the publications by the learning domains involved in TBL research, and the results are displayed in Figure 3. As found in Figure 3, the results of the content analysis showed that from 2000 to 2004, the "*Non-specified*" learning domain was found in most of the TBL publications (n = 501), followed by "*Social Studies*" (n = 153), "*Engineering*" (n = 136), "*Science*" (n = 130), "*Arts & Languages*" (n = 76), "*Others*" (n = 47), and "*Math*" (n = 46). From 2005 to 2009, the number one ranked learning domain was still "*Non-specified*" (n = 644.5), followed by "*Engineering*" (n = 378.5), "*Science*" (n = 218), "*Social Studies*" (n = 211), "*Arts & Languages*" (n = 133.5), "*Others*" (n = 109), and "*Math*" (n = 107.5).

The results of the Pearson's Chi-Square analysis also reported that the adoption of learning domain was significantly different between the initial five years (2000-2004) and the later five years (2005-2009) ($\chi^2 = 56.42$, $p < 0.05$). The major difference was that the research trend in "*Engineering*" increased from 12.49% to 21.0% while the "*Non-specified*" learning domain decreased from 46.01% to 35.77%, even though the number of published articles in the "*Non-specified*" learning domain increased between these two periods (from 501 to 644.5). Additionally, studies in "*Math*" and "*Others*" also had more growth between the two periods (from 4.22% to 5.97% and from 4.32% to 6.05%, respectively).

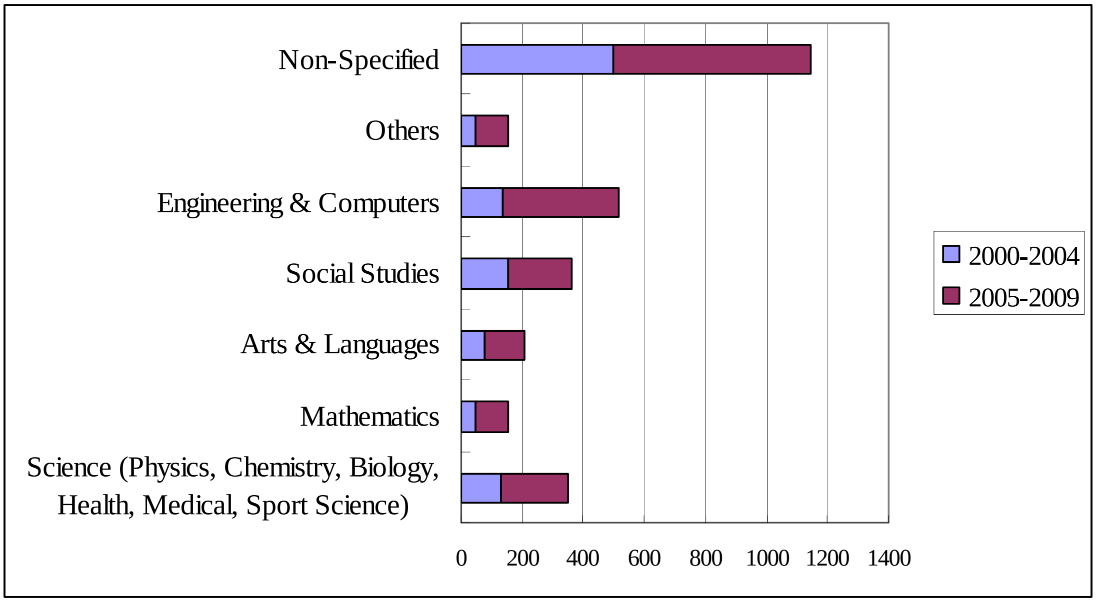

Figure 3. Scores and trends of TBL research learning domain utilization from 2000 to 2009

Research question 4: Is there any significant association between the research topic and the selection of the research sample group for these publications from 2000 to 2009?

The findings of the content analysis showed that most of the published articles with different research topics preferred to utilize research sample groups in "*Higher Education*" (n = 1269). Pearson's Chi-square analysis was then used to find the associations between the research topics and the research sample groups. The analysis was made based on the first matched sub-categories.

The results revealed that in the last decade (from 2000 to 2009), the research topics were significantly associated with the selections of the sample groups ($\chi^2 = 448.30$, $p < 0.05$). The post-hoc test results of obtaining residuals were used to explain the possible association. The Chi-square cells with significant adjusted residuals are presented in Table 2. As shown in Table 2, the adjusted residual values indicated that the topics in "*Policies, social culture impacts and trends for technology-enhanced learning*" with the "*Non-specified*" sample group had the fastest growing trend (residual = 13.9), followed by the "*Motivation, Perceptions, and Attitudes*" with the "*Teachers*" sample group (residual = 6.1), and the "*Digital Game and Intelligent Toy Enhanced Learning*" with the "*Elementary School*" sample group (residual=5.6). Besides, studies concerning "*Special Needs Education*" with the "*Adults/Working Adults*" sample group increased in the past ten years (residual = 3.3). The research topics in "*E-assessment and New Assessment Theories and Methodologies*" with the "*Junior and Senior High school*" sample group also showed climbing trends. Similarly, the research issues in "*Computer Supported Collaborative Learning*", "*Learning Behaviors, Usage Patterns and Discourse Analysis*" and "*Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management*" with the "*Higher Education*" sample group (residuals = 4.5, 3.1, 2.0, respectively) and the research issues in the "*Mobile and Ubiquitous Learning*" with the "*Elementary School*" sample group (residual = 2.9) were explored more frequently over the last ten years.

On the other hand, research in "*Motivation, Perceptions, and Attitudes*" with the "*Non-specified*" sample group (residual = -8.2) showed a declining trend, followed by the "*Policies, social culture impacts and trends for technology-enhanced learning*" with the "*Higher Education*" sample group (residual = -7.8), and the "*Computer Supported Collaborative Learning*" with the "*Non-specified*" sample group (residual = -4.9). Besides, the topics in "*Digital Game and Intelligent Toy Enhanced Learning*" and "*Artificial Intelligence in Education*" with the "*Higher Education*" sample group (residuals = -3.5, -2.2, respectively), the issues of "*Evaluation of Learning Systems, Platforms, and Architectures*" with the "*Teachers*" sample group (residual = -2.4), and "*Learning Behaviors, Usage Patterns and Discourse Analysis*" with the "*Non-specified*" sample group (residual = -2.8) implied a decreasing tendency for the last decade.

Table 2. Significant associations between research topics and research sample groups from Chi-square analysis (2000-2009)

Research Topics	Research Sample Groups
2.Evaluation of Learning Systems, Platforms and Architectures	Teachers (AR = -2.4)[a] (n=13)[b]
4. Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management	Higher Education (AR = 2.0)(n=50)
5.Artificial Intelligence in Education	1. Non-specified (AR = 3.1) (n=30) 2. Higher Education (AR = -2.2) (n=28)
6.Computer Supported Collaborative Learning	1. Higher Education (AR = 4.5) (n=146) 2. Non-specified (AR = -4.9) (n=23)
7.Mobile and Ubiquitous Learning	Elementary School (AR = 2.9) (n=15)
8.Digital Game and Intelligent Toy Enhanced Learning	1. Elementary School (AR = 5.6) (n=25) 2. Higher Education (AR = -3.5) (n=24)
9.E-Assessment and New Assessment Theories and Methodologies	Junior/Senior High School (AR = 2.4) (n=18)
10.Special Needs Education	Adults (AR = 3.3) (n=6)
11.Motivation, Perceptions and Attitudes	1. Teacher (AR = 6.1) (n=63) 2. Higher Education (AR = 2.9) (n=169) 3. Non-specified (AR = -8.2) (n=12)
12.Learning Behaviors, Usage Patterns and Discourse Analysis	1. Higher Education (AR = 3.1) (n=113) 2. Non-specified (AR = -2.8) (n=28)
13.Policies, Social Culture Impacts and Trends for Technology-Enhanced Learning	1. Non-specified (AR = 13.9) (n=149) 2. Higher Education (AR = -7.8) (n=60) 3. Junior/Senior High School (AR = -3.1) (n=15)

Notes. Pearson's Chi-Square = 448.30, degrees of freedom = 72, $p < 0.05$
[a] (AR): Adjusted residual values (AR with absolute values larger than 1.96 are presented.)
[b] (n): Total number of articles

Research trends for the first five years (2000-2004) and the latest five years (2005-2009)

To better understand if the research topics were significantly associated with the selections of sample groups between the two five-year-periods, Pearson's Chi-Square analysis was conducted again to examine the association by the two periods, respectively. The Chi-square test results supported that the research topics were significantly associated with the selections of sample groups for the two respective periods ($\chi^2 = 203.98, 294.99$, respectively, $p < 0.05$). A post-hoc test was also conducted to get the adjusted residual values for further analysis, as shown in Table 3.

Table 3. Significant associations between research topics and research sample groups from Chi-square analysis in the two five-year-periods

	Research Sample Groups	
Research Topics	2000-2004	2005-2009
2. Evaluation of Learning Systems, Platforms and Architectures		1. Adults (AR = 2.1)[a] (n = 13)[b] 2. Teachers (AR = -2.6) (n = 6)
3. Pedagogical Design and Theories		1. Higher Education (AR = -2.1) (n = 220) 2. Non-specified (AR = 2.4) (n = 100)
4. Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management		Higher Education (AR = 2.9) (n = 36)
5.Artificial Intelligence in Education	1. Higher Education	

	(AR = -2.1) (n = 7) 2. Non-specified (AR = 3.1) (n = 18)	
6.Computer Supported Collaborative Learning	1. Higher Education (AR = 2.8) (n = 50) 2. Non-specified (AR = -3.3) (n = 14)	1. Higher Education (AR = 3.6) (n = 96) 2. Non-specified (AR = -3.7) (n = 9)
7.Mobile and Ubiquitous Learning	Elementary School (AR = 2.9) (n = 6)	
8.Digital Game and Intelligent Toy Enhanced Learning		1. Elementary School (AR = 5.0) (n = 22) 2. Higher Education (AR = -3.5) (n = 24)
11.Motivation, Perceptions and Attitudes	1. Higher Education (AR = 3.0) (n = 54) 2. Teachers (AR = 2.1) (n = 14)	1. Teachers (AR = 5.7) (n = 49) 2. Non-specified (AR = -5.7) (n = 7)
12.Learning Behaviors, Usage Patterns and Discourse Analysis	1. Higher Education (AR = 2.4) (n = 43) 2. Non-specified (AR = -2.1) (n = 16)	1. Higher Education (AR = 2.1) (n = 70) 2. Non-specified (AR = -2.1) (n = 12)
13.Policies, Social Culture Impacts and Trends for Technology-Enhanced Learning	1. Higher Education (AR = -5.9) (n = 26) 2. Non-specified (AR = 8.2) (n = 88)	1. Higher Education (AR = -4.4) (n = 34) 2. Junior & Senior High School (AR = -2.2) (n = 7) 3. Non-specified (AR = 10.3) (n = 61)

Notes. 2000-2004 Pearson's Chi-Square = 203.98, degrees of freedom = 72, $p < 0.05$
2005-2009 Pearson's Chi-Square = 294.99, degrees of freedom = 72, $p < 0.05$
[a] (AR): Adjusted residual values (AR with absolute values larger than 1.96 are presented.)
[b] (n): Total number of articles

As presented in Table 3, the results indicated that the number of papers in "*Computer Supported Collaborative Learning*" and "*Learning Behaviors, Usage Patterns and Discourse Analysis*" with the "*Higher Education*" sample group maintained an increasing trend from the first period to the second period (residual values all larger than 2). Similarly, the published articles in "*Policies, social culture impacts and trends for technology-enhanced learning*" with the "*Non-specified*" sample group maintained a growing trend for the two periods (residuals were 8.2 and 10.3, respectively). Additionally, although the issues in "*Motivation, Perceptions, and Attitudes*" gained more attention during the second period, the used sample group changed from "*Higher Education*" to "*Teachers*" (residuals = 3.0, 5.7, respectively). Besides, in the first period, the research topics in "*Artificial Intelligence in Education*" showed a stronger association with the "*Non-specified*" sample group, while issues concerning "*Mobile and Ubiquitous Learning*" were examined mainly with the "*Elementary Education*" sample group (residuals = 3.1, 2.9, respectively). In the recent five years (second period), the topics in "*Evaluation of Learning Systems, Platforms, and Architectures*" gradually emphasized the "*Adults/Working Adults*" sample group (residual = 2.1) while the "*Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management*" issues were mainly investigated with the "*Higher Education*" sample group (residual = 2.9). Finally, the publications related to "*Digital Game and Intelligent Toy Enhanced Learning*" also started to proliferate in the "*Elementary School*" field in the past five years (residual = 5.0).

Conversely, the topics in the area of "*Policies, social culture impacts and trends for technology-enhanced learning*" with the "*Higher Education*" sample group (residuals = -5.9 and -4.4, respectively) and the sub-category of "*Computer Supported Collaborative Learning*" with the "*Non-specified*" sample group revealed a declining trend (residuals from -3.3 to -3.7, respectively) for the two periods. Overall, it is interesting to note that from 2000-2004, the topics of "*Motivation, Perceptions, and Attitudes*" were mainly conducted with the "*Higher education*" sample group, and no significant number of articles about "*Digital Game and Intelligent Toy Enhanced Learning*" with the "*Elementary school*" group was included. Therefore, the research trends in selecting the sample groups for these topics have altered in the recent five years.

Research question 5: Is there any significant association between the research topic and the adoption of the learning domain for these publications from 2000 to 2009?

The results of the content analysis showed that "*Non-specified*" was the most commonly used learning domain for the published articles with different research topics in the past ten years (n = 1198). Besides, Pearson's Chi-square analysis was used to find the associations between the research topics and the research sample groups. Again, the data was analyzed only based on the "first" matched sub-categories, and the results are displayed in Table 4. The results indicate that during the last decade, the research topics were significantly associated with the learning domain selections ($\chi^2 = 368.46$, $p < 0.05$). A post-hoc test was also administered to acquire the adjusted residual values for more detailed analysis.

The adjusted residual values revealed that the topics in "*Policies, social culture impacts and trends for technology-enhanced learning*" had the highest proportion in the "*Non-specified*" learning domains (residual = 13.2), followed by "*Computer Supported Collaborative Learning*" in "*Social Studies*" (residual = 5.4), and "*Development of New Learning Systems, Platforms, and Architectures*" in "*Arts & Languages*" (residual = 4.8). Besides, the topics of "*Artificial Intelligence in Education*" and "*Pedagogical Design and Theories*" showed a growing trend in the "*Mathematics*" learning domain (residuals = 4.5, 2.9, respectively). Similarly, the research issues in "*Mobile and Ubiquitous Learning*" were addressed more in the "*Arts & Language*" domain (residual = 2.8) and the topics in "*Motivation, Perceptions, and Attitudes*" and "*Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management*" in the "*Engineering*" learning domain gained much attention from researchers over the last ten years (residuals = 2.1, 4.4, respectively).

On the other hand, the research in "*Computer Supported Collaborative Learning*" with the "*Non-specified*" (residual = -5.7) learning domain, "*Pedagogical Design and Theories*" with the "*Engineering*" learning domain (residual = -2.5), and "*Development of New Learning Systems, Platforms, and Architectures*" with the "*Non-specified*" learning domain (residual = -2.3) were explored less frequently during the last decade.

*Table 4.*The significant associations between research topics and learning-domains from Chi-square analysis (2000-2009)

Research Topics	Learning Domains
1.Development of Learning Systems, Platforms and Architectures	1. Arts & Languages (AR = 4.8)[a] (n = 47)[b]
	2. Non-specified (AR = -2.6)(n = 119)
3.Pedagogical Design and Theories	1. Math (AR = 2.9)(n = 56)
	2. Science (AR = 2.6)(n = 114)
	3. Others (AR = 2.4)(n = 54)
	4. Engineering (AR = -2.5)(n = 115)
	5. Non-specified (AR = -2.3)(n = 289)
4.Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competences Management	Engineering (AR = 4.4)(n = 33)
5.Artificial Intelligence in Education	Math (AR = 4.5)(n = 14)
6.Computer Supported Collaborative Learning	1. Social Studies (AR = 5.4)(n = 60)
	2. Non-specified (AR = -5.7)(n = 62)
7.Mobile and Ubiquitous Learning	Arts & Languages (AR = 2.8)(n = 12)
8.Digital Game and Intelligent Toy Enhanced Learning	Others (AR = 2.3)(n = 10)
11.Motivation, Perceptions and Attitudes	1. Engineering (AR = 2.1)(n = 74)
	2. Math (AR = -2.0)(n = 10)
13.Policies, Social Culture Impacts and Trends for Technology-Enhanced Learning	1. Non-specified (AR = 13.2)(n = 219)
	2. Science (AR = -4.8)(n = 9)
	3. Engineering (AR = -4.3)(n = 24)
	4. Social Studies (AR = -2.6)(n = 22)

Notes. Pearson's Chi-Square = 368.46, degrees of freedom = 72, $p < 0.05$

[a] (AR): Adjusted residual values (AR with absolute values larger than 1.96 are presented.)

[b] (n): Total number of articles

Research trends for the first five years (2000-2004) and the latest five years (2005-2009)

Similarly, Pearson's Chi-Square analysis was conducted to investigate if the research topics were significantly associated with the adoption of the learning domain between the two five-year-periods. Again, the Chi-square results supported that the research topics were significantly associated with the selection of learning domain between the two periods ($\chi^2 = 182.77, 271.83$, respectively, $p < 0.05$). A post-hoc test was also conducted to obtain the adjusted residual values in order to illustrate the sources of the associations, as shown in Table 5.

Table 5. The significant associations between research topics and learning domains from Chi-square analysis in the two five-year-periods

	Learning-domains	
Research Topics	2000-2004	2005-2009
1.Development of New Learning Systems, Platforms, and Architectures	1. Engineering (AR = 2.2)[a] (n = 28)[b] 2. Non-specified (AR = -2.2) (n = 61)	1. Arts & Languages (AR = 4.6) (n = 30) 2. Non-specified (AR = -2.0) (n = 58)
2.Evaluation of Learning Systems, Platforms and Architectures		Arts & Languages (AR = 2.3) (n = 18)
3.Pedagogical Design and Theories		1. Science (AR = 2.3) (n = 77) 2. Math (AR = 2.3) (n = 41) 3. Engineering (AR=-3.4) (n = 82) 4. Non-specified (AR = -2.5)(n = 104)
4.Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management		Engineering (AR = 4.9)(n = 26)
5.Artificial Intelligence in Education		Math (AR = 3.4)(n = 9)
6.Computer Supported Collaborative Learning	1. Social Studies (AR = 3.0) (n = 24) 2. Non-specified (AR = -4.1) (n = 27)	1. Social Studies (AR = 4.5) (n = 36) 2. Non-specified (AR = -4.1) (n = 35)
7.Mobile and Ubiquitous Learning		Arts & Languages (AR=3.6)(n = 11)
12.Learning Behaviors, Usage Patterns and Discourse Analysis	Arts & Languages (AR = 2.2) (n = 11)	1. Others (AR = 3.3) (n = 16) 2. Non-specified (AR = -2.5) (n = 33)
13.Policies, Social Culture Impacts and Trends for Technology-Enhanced Learning	1. Non-specified (AR = 9.0) (n = 127) 2. Social Studies (AR = -2.3) (n = 13) 3. Engineering (AR = -3.6) (n = 6)	Non-specified (AR = 8.8) (n = 92)

*Notes.*2001-2004 Pearson's Chi-Square = 182.77, degrees of freedom = 72, $p < 0.05$
2005-2009 Pearson's Chi-Square = 271.83, degrees of freedom = 72, $p < 0.05$
[a] (AR): Adjusted residual values (AR with absolute values larger than 1.96 are presented.)
[b] (n): Total number of articles

As presented in Table 5, the proportion of papers in “*Policies, social culture impacts and trends for technology-enhanced learning*” remained high in the “*non-specified*” learning domain from the first period to the second period (residual values = 9.0, 8.8, respectively). Additionally, the learning domain in the “*Development of New Learning Systems, Platforms, and Architectures”* topic changed from “*Engineering*” (first period) to “*Arts & Languages*” (second period) (residuals = 2.2, 4.6, respectively).

Besides, over the second period, the research topics in “*Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management*” attracted more attention in the “*Engineering*” learning domain (residual = 4.9), while “*Mobile and Ubiquitous Learning*” and “*Evaluation of Learning Systems, Platforms, and Architectures”* began to be addressed in the “*Arts & Languages*” field (residual = 3.6, 2.3). In addition, the topics in “*Computer Supported Collaborative Learning”* expressed an increasing tendency in *“Social Studies”* (residual = 4.5) while the sub-categories of “*Pedagogical Design and Theories*” and “*Artificial Intelligence in Education*” showed a gradually increasing tendency in the “*Mathematics*” learning domain (residuals = 2.3, 3.4, respectively). Furthermore, the researchers who were interested in the “*Science*” learning domain paid more attention to the topics in “*Pedagogical Design and Theories”* over the last five years (residual = 2.3).

Discussion

This study aims to explore the research trends for the TBL research articles based on their research topics, the sample group selections, and the learning-domain adoption. The results are discussed as follows:

The trends of TBL in research topics, sample selections, and learning domain adoption

The findings from content analysis show that the “*Pedagogical Design and Theories*” was the most popular research topic studied from 2000 to 2009 for the published TBL articles. Earlier TBL research was involved in debating whether the technology influenced learning (Clark, 2001; Kozma, 1991) and what factors might affect the instructions with various media representations (e.g., Mayer, 2001). Based on these valuable groundworks, many follow-up studies have suggested that pedagogical design is the major factor impacting learning in the TBL environment (Bernard, Abrami, Lou, & Borokhovski, 2004; Sitzmann, Kraiger, Stewart, & Wisher, 2006). As more relevant studies were apparent, the initial TBL theoretical frameworks and instructional design models have been established for enhancing and utilizing the TBL outcome (Koehler & Mishra, 2005; Clark & Mayer, 2008; O'Neil & Perez, 2006). It is expected that more research will examine the effectiveness of these pedagogical models for different TBL contexts in the future.

Additionally, the articles about “*Motivation, Perceptions and Attitudes*” have also increased between the two five-year-periods. Research about individual difference and preference toward different technologies have been studied since early twenty century and were limited in the traditional media such as texts, pictures, and video (Paivio, 1986; Salomon, 1984). After the prevalence of computers and online tools, related research extended their efforts to the advanced contexts such as animations, games, and Web-based learning. For example, learners' preferences or acceptance with respect to the online learning activities and their expression of persistence in the cyber learning environment were explored (Gan, 2005; Chen, Chen & Tsai, 2009; Yang & Tsai, 2008). Besides, a growing trend in studying the topics of “self-regulation” and “metacognition” should also be expected (Chu & Tsai, 2009) as more learner control functions are available from these latest advances than from traditional media.

The current study also shows that topics such as “*Digital game and intelligent toy enhanced learning”* have gained more attention in the recent five years. The result implies that students today are facing more advanced gaming experiences and educators started establishing a similar learning environment to help students maintain their attention on the learning tasks. However, how the pedagogical principles and the entertainment aspects can be well integrated will be a challenging issue to solve for future research (Harteveld, Guimarães, Mayer, & Bidarra, 2007).

By and large, the analyses of research topics by this paper (see Figure 1) suggest that in the last decade, the TBL research tended to develop more appropriate pedagogical and motivation models to enhance TBL learning. In addition, a small portion of research is increasing in finding whether learners' personalized learning experiences can be strengthened by integrating the latest innovations into pedagogical practices (e.g. m-learning, u-learning).

Compared to the publications in 2000-2004, the articles in 2005-2009 addressed less general TBL issues (e.g. TBL policy impacts or the development of wide-ranging learning systems) but more specific contextual applications (e.g. game-based learning).

Moreover, the present study also found that "*higher education*" is the major sample group employed the most in the TBL articles, while "Adults/Working adults" is the least employed. This finding implies that most of the TBL research is still being conducted by academic scholars. These experts have direct access to postsecondary students' responses or performance results as research data and may have obstacles finding support from other institutes. However, as universal learning is emphasized in the US National Educational Technology Plan (US Department of Education, 2010), future research should put more efforts into adults or community learning outside the academic setting.

Finally, the findings reveal that the "*Non-specified*" learning domain was used most for the TBL studies in the past ten years. However, the percentage of articles in the "*Non-Specified*" learning domain has dropped in the recent five years. "*Engineering*" was the field which increased the most since 2005. These findings infer that the early TBL studies may have been reluctant to emphasize the research design based on domain-specific knowledge structure. However, the trend has changed such that more researchers have projected their TBL research in accordance with their particular interests in specific learning domains. The results also imply that more technical designers or engineers have started to cooperate with educators to include research-based learning theories into their application design, making the learning more effective.

The cross analysis among research topics, sample, and learning-domain selections

The current study indicates that "*Higher Education*" is the sample group utilized most in the TBL publications. However, the results of the Chi-square analysis show that the articles with topics in "*Motivation, Perceptions, and Attitudes"* and the "*Teachers*" sample group, "*Digital Game and Intelligent Toy Enhanced Learning*" and the "*Elementary School*" sample group increased the most in the nearest five years.

As revealed from the aforementioned literatures, most of the studies reviewing TBL trends from 1999 to 2008 concluded that the feature of communication innovations created by the new technologies played an important role in the TBL development (e.g. Waight et al, 2004; Karatas, 2008; Zawacki et al., 2009). The interaction methods and the design of instructional activities under the new TBL environment are different from traditional classroom environment that teachers and learners are required to adjust (Bernard et al., 2004). Therefore, the issues of "motivation, perceptions, and attitudes" were worth more investigation under TBL learning context. Early studies mainly focused on these topics from learners' perspective (e.g. Northup, 2002) while the current finding reflects that the trend has been shifted to teachers in the recent five years (e.g. Mahdizadeh, Biemans, & Mulder, 2008). As more personalized communication advances become available, the motivation research in related to TBL learning is expected to be emphasized for other groups of learners, such as adult and special education.

Besides, the present result indicates that game-based learning has gained more attentions in the latest five years (2005-2009) and most of the relevant research was employed in elementary education. The result infers that children in the current era habitually play games in their daily life that they may be easily attracted by the game-related activities. Therefore, game-based learning may be more suitable for young children (e.g. Ke, 2008) and educators may hope to use game as "... a way to create relevant learning experiences that mirror students' daily lives and the reality of their futures " (US Department of Education, 2010, p. 9).

Furthermore, this study also reveals that the topics in "*Policies, social culture impacts and trends for technology-enhanced learning*" with the "*Non-specified*" learning domain, "*Computer Supported Collaborative Learning"* with "*Social Studies*", and "*Development of New Learning Systems, Platforms, and Architectures*" with "*Arts & Languages*" have increased during the last decade. Additionally, the topics of "*Adaptive and Personalized Technology-Enhanced Learning: Knowledge and Competencies Management"* with "*Engineering," "Mobile and Ubiquitous Learning"* and "*Evaluation of Learning Systems, Platforms, and Architectures"* with "*Arts & Languages," "Pedagogical Design and Theories"* and "*Artificial Intelligence in Education"* with "*Mathematics," "Pedagogical Design and Theories"* with "*Science," and "Learning Behaviors, Usage Patterns and Discourse Analysis"* with "*Others"* have more growth in the recent five years. Clark and Salomon (1986) proposed that the knowledge representations were associated with different domains or disciplines. As a result, different instructional methods embedded in the media presentation are necessary to be adapted for efficiently represent the information, which should compensate the learners' cognitive representations. The assertion may help explain our current findings that the TBL researchers gradually target their research interests into specific learning domains for utilizing the instructional methods with the supported technologies. For instance, the computer-supported collaborative learning and group discussion may be applied as major instructional methods in the social studies learning domain; well-designed platforms or learning systems may be crucial to enhance arts and language learning. Moreover, these findings also infer that TBL implementation is not a domain-general task. In the last decade, studies in "*Policies, social culture impacts and trends for technology-enhanced learning*" seemed to provide essential guidelines or domain-general solutions for TBL practices. However, based on the current findings, it is predicted that adopting technologies in different domains will be a trend and also a challenge for the schools to face (Johnson, Levine, Smith, & Stone, 2010). Policy administrators, educators, or system developers need to carefully examine the specific TBL issues in different learning domains and provide the necessary support for future TBL development.

Conclusion

The present study examines the technology-based learning research trends between 2000 and 2009 from five major journals. Within this decade, TBL research trend has evolved from technology comparison to TBL-related pedagogical design theory development, from learners' motivational issues to the teachers', from Internet or learning system-based TBL to individualized and universal learning experiences, and from domain-general considerations to domain-specific advertency. The analysis shows that TBL context has become a common setting that educators are expected to deliver their instructions via technologies no matter to which learning groups or in which academic domains. Thus, policy makers and administrators should allocate more efforts and resources to develop better TBL implementation plans for the academy. For example, teacher education or training program should educate the teachers how the technologies should be used to enhance learners' cognitive engagement and to represent good quality of TBL instructions. The recent development of TPACK (Technological Pedagogical Content Knowledge, Chai et al., 2010, 2011) model in helping teachers to design TBL-based curricular has started responding to such demand and inquiry.

Finally, this study excludes the relevant conference proceedings and other TBL related journals (e.g., IEEE publications) for analysis. It is suggested that future research should expand the data sources for more deliberate analysis. Additionally, this study is limited in including the relevant research in year 2010 for only providing a complete review of the TBL studies for a decade (2000-2009). Future research is encouraged to conduct similar studies with more current information and research data.

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References

Andrews, R., & Haythornthwaite, C. (2007). *The SAGE Handbook of E-learning Research.* London: SAGE.

Bernard R. M., Abrami P. C., Lou Y., Borokhovski, E., Wade, A., …Huang, B. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*(3), 379–439.

Carliner, S. & Shank, P. (2008). *The E-Learning Handbook: A Comprehensive Guide to Online Learning.* San Francisco, CA: John Wiley & Sons

Cavus, N. & Kanbul, S. (2010). Designation of Web 2.0 tools expected by the students on technology-based learning environment. *Procedia Social and Behavioral Sciences, 2*(2), 5824–5829.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Educational Technology and Society, 13*(4), 63-73.

Chai, C.-S., Koh, J. H. L, Tsai., C.-C., & Tan, L. W. (2011). Modeling primary school pre-service teachers' Technological

Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education, 57*(1), 1184-1193.

Chan, T. W., Hue, C. W., Chou, C. Y., & Tzeng, O. J. L. (2001). Four spaces of network learning models. *Computers & Education, 37*(2), 141–161.

Chen, Y., Chen, N.-S., & Tsai, C.-C. (2009). The use of online synchronous discussion for web-based professional development for teachers. *Computers & Education, 53*(4), 1155-1166.

Chu, R. J., & Tsai, C.-C. (2009). Self-directed learning readiness, Internet self-efficacy, and preferences for constructivist Internet-based learning environments among higher aged adults. *Journal of Computer Assisted Learning, 25*(5), 489-501.

Clark, R. C. & Mayer, R. E. (2008). *E-Learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. San Francisco, CA: Pfeiffer

Clark, R. E. & Salomon, G. (1986). Media in teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 464-478). New York: Macmillan. (Reprinted by permission of the Gale Group)

Gan, S. (2005). *An evaluation of perceived task value, self-efficacy, and performance in a geography blended distance course* (Unpublished doctoral dissertation).University of Southern California, Los Angeles, CA.

Harteveld, C., Guimarães, R., Mayer, I., & Bidarra, R. (2007). Balancing pedagogy, game and reality components within a unique Serious game for training levee. *Lecture Notes in Computer Science*, 4469, 128-139. Berlin, Germany: Springer.

Johnson, L., Levine, A., Smith, R., & Stone, S. (2010). *The 2010 Horizon Report.* Austin, TX: The New Media Consortium.

Karatas, S. (2008). Interaction in the Internet-based distance learning researches: Results of a trend analysis. *The Turkish Online Journal of Educational Technology, 7*(2), article 2.

Ke, F. (2008). A case study of computer gaming for math: Engaged learning from gameplay? *Computers & Education, 51*(4), 1609–1620.

Koehler, M. J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of Computing in Teacher Education, 21*(3), 94–102.

Kozma, R. B. (1991). Learning with Media. *Review of Educational Research, 61*(2), 179-212.

Mayer, R. E. (2001). *Multimedia learning.* New York, NY: Cambridge University Press.

Mahdizadeh, H., Biemans, H., & Mulder, M. (2008). Determining factors of the use of e-learning environments by university teachers. *Computers & Education, 51*(1), 142–154.

Northup, P. T. (2002). Online learners' preferences for interaction. *The Quarterly Review of Distance Education, 3*(2), 219-226.

O'Neil, H. F., & Perez, R. S. (2006). *Web-based learning: Theory, research, and practice.* Mahwah, NJ: Lawrence Erlbaum Associates.

Paivio, A. (1986). *Mental representations: A dual coding approach.* Oxford, England: Oxford University Press.

Salomon, G. (1984). Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributions. *Journal of Educational Psychology, 76*(4), 647-658.

Shih, M., Feng, J., & Tsai, C.-C. (2008). Research and trends in the field of e-learning from 2001 to 2005: A content analysis of cognitive studies in selected journals. *Computers & Education, 51*(2), 955–967.

Sitzmann, T., Kraiger, K., Stewart, D., & Wisher, R. (2006). The comparative effectiveness of web-based and classroom instruction: A meta-analysis. *Personnel Psychology, 59*(3), 623-664.

US Department of Education, Office of Educational Technology, National Educational Technology Plan (2010). *Transforming American Education: Learning Powered by Technology*. Retrieved from the U.S. Department of Education website: http://www.ed.gov/sites/default/files/NETP-2010-final-report.pdf

Waight, C. L., Willging, P., & Wentling, T. (2004). Recurrent themes in E-learning: A narrative analysis of major E-learning reports. *The Quarterly Review of Distance Education, 5*(3), 195-203.

Yang, F.-Y., & Tsai, C.-C. (2008). Investigating university student preferences and beliefs about learning in the web-based context. *Computers & Education, 50*(4), 1284-1303.

Yengina, I., Karahocab, D., Karahocab, A., & Ozcinarc, Z. (2010). Being ready for the paradigm shifts in e-learning: Where is the change happening and how to catch the change? *Procedia Social and Behavioral Sciences, 2*(2), 5762–5768.

Zawacki-Richter, O., Bäcker, E. M., & Vogt, S. (2009). Review of Distance Education Research (2000 to 2008): Analysis of research areas, methods, and authorship patterns. *International Review of Research in Open and Distance Learning, 10*(6), 21-50.