

A Framework for Evaluating and Selecting Learning Technologies

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Abstract: This paper considers some of the major issues in the field of learning technology selection. It presents a framework towards the development of selection criteria that aim at improving technology selection process to avoid the technological problems. The variables like gender, age, and race of the participants are not examined. To find out the criteria, which have high impact on learning technology selection, three groups (faculties, IT specialists & students) and two control groups (faculties working as IT specialists & students working as IT specialists) are selected from three Gulf universities (Arabian Gulf University, Bahrain University and Kuwait University). Initially, 19 criteria are used; the groups' independent opinion is collected for analysis and organized according to the weighted average. The top criteria (over mean) are retained and the others are canceled. Seven criteria show high impact on learning technology selection process in general. These criteria are feedback capability, student/instructor satisfaction, student motivation and self-learning, ease of access, use and revision, professional development, usability and reliability and instructional time.

Keyword: Learning technology, technology selection criteria.

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1. Introduction

The rapid technological changes, the rapid expansion of available information and the diverse of people demand and conditions, have created new opportunities and challenges to provide nontraditional learning delivery systems and institutions. Distance learning is a delivery system of teaching and learning, when the teacher and the student are separated by physical distance and time. Distance Learning (DL) sometimes described as Distance Education (DE) [11]. It is divided into two main categories: same time, different place which is called synchronous learning, and different time, different place which is called asynchronous learning. These delivery education systems give students the greatest possible control over time; place and pace in education, but it have many barriers or problems. Galusha categorized the learning technology problems into three main groups as follows [6]:

- *Student Barriers:* Costs and motivators, feedback and teacher contact, student support and services, alienation and isolation, lack of experience, and training.
- *Faculty Barriers:* Lack of staff training, lack of support systems designed for distance learning, and inadequate methods for faculty selection and training.
- *Organizational Barriers:* Infrastructure and technology problems, training, and management.

Cucek added another five barriers as follows [1]:

- *Course Related Barriers:* Lack of interaction, poorly structured courses, and difficulty in accessing resources.
- *Time Related Barriers:* Lack of time, competing personal commitments, and course work that requires an excessive amount of time.
- *Personal Issues:* Concentrated on motivation and self discipline.
- *Technical Problems:* Lack of expertise.
- *Administrative Problems:* Cost, course availability, obtaining course materials, and administrative support.

Whereas, Dabaj and İşman categorized the barriers exist in distance learning technology in three main categories [2]:

- Insufficient technology skills and difficulties to use.
- Human interaction.
- Time constraints and restrictions.

This paper focuses on learning technologies and presents a framework towards the development of selection criteria that aim at improving technology selection to avoid the technological problems mentioned by Galusha, Cucek, and Dabaj and İşman [1, 2, 6].

2. Learning Technologies (LTs)

In the past, technology focused on the infrastructure and hardware, such as how to wire universities or whether to put the computers in the classroom or a

separate laboratory. Today the field has matured sufficiently to focus on how to use the technology to improve teaching and learning. Technology may make learning available to a wider audience and has the power to promote more equal access to learning for as large and diverse group as possible. Seels and Richey defined learning or instructional technology as “the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning” [14], whereas Michael defined learning technology as “a variety of electronic tools, media, and environments that can be used to enhance learning, foster creativity, stimulate communication, encourage collaboration, and engage in the continuous development and application of knowledge and skills” [16], and Finnis defined learning technology as “any application of technology, particularly computer and information technology, which contributes to the learning process” [3]. Moore and Thompson defined distance-learning technology as any instructional arrangement where the teacher and learner are geographically separated [4]. Finally, distance learning technologies can be defined as any technologies used in teaching and learning, when the teacher and the student are separated by physical distance and time.

Learning operations have evolved through the following five generations [2, 3, 9, 13, 14, 18, 19, 21]:

- *Traditional Media (TM)*: Print, slides, audiotape, videotape, audioconferencing, television and cable, models and mock-ups.
- *Interactive Video Teletraining (IVT)*: Interactive Video Teletraining (IVT), Interactive Television (ITV), Video Teleconferencing (VTC).
- *Internet-Based Instruction (IBI)*: Text, multimedia, virtual conferencing.
- *Interactive Multimedia Instruction (IMI)*: Interactive Courseware (ICW), Intelligent Computer Assisted Instruction (ICAI), Electronic Performance Support System (EPSS)/ Job Performance Aid (JPA), computer simulation.
- *Computer-Mediated Communications (CMC)*: Audiographics, computer-mediated, conferencing/ collaborative computing.

3. Evaluation Criteria for Learning Technology

3.1. Evaluation Criteria

Evaluation is defined as the process of determining the merit or worth of a product, process, or program. All selection techniques are based on a number of criteria, tangible (technical or economic) and intangible (analytical). Traditionally, the essence of all economic evaluation is a discounted cash flow analysis. However, in carrying out such an evaluation, it will be essential to remember that correct selection of the

discount rate may be crucial. Its choice can easily change the ranking of items, making one or another appears best depending on the rate used [6].

To define the evaluation criteria used in selecting learning technology, there are critical questions should be answered:

- How can learning technology be used to accelerate conventional learning as well as transform what students are learning and understanding?.
- How can technology contribute to the acquisition of information as well as to the ability to assess reliability of findings and to synthesize incomplete but relevant data across several disciplines?.
- How can technology enable students to demonstrate high standards of performance?.
- What is the appropriate role of the new technologies in education?.
- How can the evolution of technology be directed efficiently and effectively toward improving student learning for all?.
- How can what is known be shared and developed further?.

Mark Hawkes defined four criteria that can be used in selecting learning technologies as follows [7]:

- *Technical Criteria*: Those that are concerned with equipment requirements and specifications. Variables related to the technology criteria include: Ease of use, speed of access, level of graphical realism, audio/video output & flexibility.
- *Instructional Criteria*: Those that are concerned with the delivery and access of instructional materials and their outcomes on learners. Some variables on which instruction can be evaluated include: Interactivity, integrative capacity, learner control, learner/instructor attitudes and learner achievement.
- *Organizational Criteria*: Those that are concerned with the day-to-day use of the distance learning technology along with the support mechanisms and in-service necessary to sustain the use of the technology. Some variables include: Technical maintenance, space and time feasibility, support systems availability, staff development & community partnerships
- *Ethical Criteria*: Those that are concerned with technology access.

The US Air Force head quarter defined 10 criteria that can be applied to select the appropriate type of instructional (learning) technology in distance learning as follows [17]:

- *Development Effort*: The time, effort, and/or resources required to plan, design, develop, implement, and evaluate the instruction.
- *Convenience of Instruction*: The extent to which the participant is allowed to control or determine the

time, place, pace, or duration of instruction, and/or accessibility of the instruction.

- *Student Motivation*: The ability of the instructional system/media to motivate and/or involve the student when used as the primary vehicle for instruction.
- *Equipment and/or Support Requirements*: The degree to which special equipment or other support systems are required for delivery of the instruction.
- *Instructor Requirements*: The degree to which instructor involvement is required during delivery of the instruction to employ the medium effectively.
- *Level of Interactivity*: The potential level of engaged response/interaction between the student and the medium provided or supported by the medium.
- *Feedback Capability*: The type and nature of student feedback supported by the instructional medium.
- *Ease of Revision*: The complexity of revising or updating the medium to accommodate changes in course content.
- *Ease of Use*: Comfort of the instructor and the student with the medium; degree to which time must be spent familiarizing users with the technology.
- *Versatility*: The ability of the medium to support instruction and/or supplement other technologies.

Shay and Rees [15] and Williams [21] highlighted some issues that can be used as criteria in selecting learning technologies as follows:

- *Student Issue*: Includes criteria concerned with the ability of the instructional technology to motivate the student to achieve most if not all the courses' objectives, and any technical problems should be resolved quickly and satisfactorily.
- *Course Issue*: Includes criteria concerned with the ability of course design, learning opportunities and the interaction between student and faculty.
- *Instructor Issue*: Includes criteria concerned with the interaction between faculty and instructional support teams, faculty and student, and access to web resources.
- *Technology Issue*: Includes criteria concerned with the multimedia used, the ease of use, and the degree of achieving course functions smoothly, quickly and satisfactorily.

Monsef Y. in a study prepared for ESCWA and UNESCO, summarized the criteria used by students, teachers and parents when selecting learning software technology as follows [11]:

- Cost.
- Reliability.
- Appropriate human-machine interface.
- Simple training requirements.
- Ease of installation.
- Quality of service.

Whereas, Lee M. suggested another four criteria as follows [9]:

- *Student Learning Objectives and Performance Criteria*: Clear student learning objectives, clear performance criteria.
- *Active Learning Criteria*: Active learning, opportunity for student-to-student interaction, opportunity for student to instructor interaction.
- *Online Organization and Delivery Criteria*: Homepage, course outline, course schedule, information provided to guide student through the learning process (help), ease of navigation through course components, navigation through content, etc.
- *Student Support Criteria*: Course orientation provided, communication tools used in the course, consideration of different learning styles, opportunities for remediation, opportunities for student advisement, etc.

Based on the previous review, 19 independent criteria are suggested in this work to use in technology selection evaluation process. These criteria are as follows:

- Ease of access, use and revision.
- Feedback capability.
- Versatility.
- Technology life cycle.
- Maintainability.
- Technical skills needed.
- Compatibility with users' expectations and preferences.
- Compatibility with existing systems,
- Usability and reliability.
- Instructional time.
- Instructional practices and materials.
- Development and upgrading efforts.
- Professional development.
- Student/instructor satisfaction.
- Cost.
- Student motivation and self-learning.
- Level of interactivity.
- Student support.
- Administration/organization/communication.

3.2. Weighted Criteria Matrix

The weighted criteria matrix is a valuable decision-making tool that is used to evaluate alternatives based on specific evaluation criteria weighted by importance. By evaluating alternatives, a value for the alternative can be identified. The values for each alternative can then be compared to create a rank order of their importance related to the criteria as a whole. The tool is important because it treats the criteria independently, helping avoid the over-influence or emphasis on specific individual criteria.

In this work, the weighted criteria matrix is constructed with nineteen criteria listed along one side and reviews its importance in selecting different learning technologies. An evaluation scale is established for the whole matrix (*NA* = Not Applicable, 1 = strongly disagree, 2 = disagree, 3 = neither agree/nor disagree, 4 = agree, and 5 = strongly agree). The ranking of the criteria based on its impact on selection process and the total scores are then available to use in ranking learning technologies.

4. Research Methodology

4.1. Sampling Method

Quota sampling is a type of stratified sampling in which selection within the strata is non-random. In this work, quota sampling is used for these reasons: cheaper, used when sampling frame is not available, useful when population is widely dispersed, used in exploratory studies, and used in obtaining an idea of the range of responses on ideas that people have.

4.2. Data Collection

In this work, three groups dealing with learning technologies (faculties, IT specialists, and students) are involved in measuring the impact of the suggested criteria in technology selection process. Two control groups (faculties working as IT specialists and students working as IT specialists) are used to check the other groups. The designed weighted criteria matrix has been distributed to 75 participants (15 in each group) via mail and email or by interviewing.

4.3. Data Analysis

Initially, the 19 criteria are used and the groups' independent opinion is ranked according to the weighted average. To facilitate calculations, the top criteria (over mean) are retained and the others are canceled. 13 criteria are retained in faculty group, 12 in student group, 11 in IT group, 13 in faculty/IT group & 10 in student/IT group as shown in Appendix (I).

To find out the criteria, that have high impact on selecting learning technology, three analysis approaches are used:

4.3.1. Calculating the Total Rank Using Groups' Independent Opinion

In this approach, the total weighted average for each criterion in all groups is calculated using the following empirical equation:

$$TWA_J = \sum_{i=1}^5 R_i * W_i$$

Where:

TWA_J : Total weighted average for every criterion (J).

i: Group.

R: Criterion rank in each group (i).

W: Weighted average for every criterion in each group (i).

The criteria are organized according to the total weighted average. The criteria over mean were retained and the others were canceled. This method gives seven criteria that have high impact on selecting learning technology as shown in Table 1.

Table 1. The groups' independent opinion total rank.

Total Rank	Technology Selection Criteria	Total Weighted Average
1	Feedback capability	164.41
2	Student/instructor satisfaction	143.34
3	Student motivation and self-learning	141.32
4	Ease of access, use and revision	117.66
5	Professional development	128.58
6	Usability and reliability	108.19
7	Instructional time	107.24

4.3.2. Calculating the Total Rank Using Accumulated Participants' Opinions

In this approach, all participant's opinions are accumulated regardless the groups. Table 2 shows the total weighted average and the total rank. The criteria over mean were retained and the others were canceled. This method gives twelve criteria have high impact on learning technology selection.

Table 2. The accumulated participants' opinion total rank.

Total Rank	Criteria	Total Weighted Average
1	Student motivation and self-learning	3.77
2	Feedback capability	3.77
3	Student/instructor satisfaction	3.75
4	Professional development	3.67
5	Usability and reliability	3.67
6	Ease of access, use and revision	3.64
7	Level of interactivity	3.62
8	Instructional time	3.61
9	Student support	3.56
10	Compatibility with users' expectations and preferences	3.53
11	Instructional practices and materials	3.51
12	Versatility	3.5

4.3.3. Calculating the Total Rank of Each Learning Technology

In this approach, all participants' opinions about individual technologies are taken into consideration. The criteria over mean are retained and the others are canceled. The results show that there are some differences in ranking the selection criteria according to its priorities in each group of learning technologies as shown in Table 3.

Table 3. Comparison between leaning technologies' total rank.

General Rank	Leaning Technology Selection Criteria	Total rank				
		TM	IVT	IBI	IMI	CMC
1	Ease of access, use and revision	4	8	NA	1	3
2	Usability and reliability	1	2	11	5	NA
3	Feedback capability	5	3	10	4	1
4	Professional development	9	4	3	6	NA
5	Student/instructor satisfaction	3	5	7	8	7
6	Student motivation and self-learning	10	1	2	9	8
7	Instructional time	7	7	8	7	4

5. Discussion

From the previous analysis, there are seven criteria that can affect the learning technology selection process. These criteria are:

- “Ease of access, use and revision”, is very important in interactive multimedia instruction.
- “Usability and reliability“, is the most important criterion in traditional media.
- “Feedback capability”, is the most important criterion in selecting computer mediated communications technologies.
- “Professional development”, is important in Internet-based instruction.
- “Student/instructor satisfaction”, is important in traditional media.
- “Student motivation and self-learning”, is the most important one in interactive video teletraining.
- “Instructional time”, is important criterion in computer mediated communications.

These differences are due to the differences in the total weighted average for every criterion and its impact on learning technology selection process.

6. Conclusions

Learning technology is currently attracting intense interest due to the rapid increases in technological capability and in the size of the audience able to access it, and also due to the increasing demands upon the education system as the need for lifelong learning becomes reality. Technology can provide quality learning to a mass audience, and by offering greater learner involvement and a more personalized learning experience can deliver the kind of learning most suited to the information age. The right selection of technology will avoid the technological problems and barriers. Technology selection process should fully realize the strengths and weaknesses of each learning technology and should be understood by learning providers and decision makers.

The technology selection criteria can be used as guidelines when creating and improving programs that

use learning technology. They are useful for policymakers deciding on what sorts of technology programs they want to create or adapt, what sorts of implementation issues must be considered, and what sort of assessment will be effective and persuasive. Also, it can be used to explain how is technology currently being used for student learning? Is equity addressed consciously and sufficiently? Are systemic supports in place, and are more supports needed?

Appendix (I)

Faculties' Opinion

Criteria	Learning Technologies					Weighted Average
	TM	IVT	IBI	IMI	CMC	
	Degree of Importance					
Student Motivation and Self-Learning	4.4	3.2	4.6	3	2.8	3.6
Student/Instructor Satisfaction	4.6	3	4.4	3	2.8	3.56
Technical Skills Needed	3.4	4.2	4	3.2	3	3.56
Versatility	4.4	3.2	4.6	2.8	2.8	3.56
Ease of Access, Use and Revision	3.8	3	4.4	3.4	3	3.52
Usability and Reliability	4.6	3.4	4	3	2.6	3.52
Instructional Time	3.6	3.4	4.2	3.2	3	3.48
Feedback Capability	3.2	3.6	4.2	3.2	3	3.44
Level of Interactivity	3	3.2	4.6	3.2	2.8	3.36
Compatibility with Users' Expectations and Preferences	4	3	4	2.8	2.8	3.32
Instructional Practices and Materials	4	3.4	4	2.6	2.6	3.32
Compatibility with Existing Systems	4	2.6	4	3.2	2.6	3.28
Professional Development	3.8	3.4	4.4	2.6	2.2	3.28

Students' Opinion

Criteria	Learning Technologies					Weighted Average
	TM	IVT	IBI	IMI	CMC	
	Degree of importance					
Student Motivation and Self-Learning	3	4.38	4.25	4.25	4.13	4
Student Support	3.38	4	4.13	4.13	4.13	3.95
Professional Development	3	3.75	4.25	4.5	4	3.9
Student/Instructor Satisfaction	3.13	4.13	3.88	4.25	4	3.88
Administration/ Organization/ Communication	2.75	3.75	4.38	4.13	4.25	3.85
Maintainability	3.13	3.88	3.63	4.25	4.38	3.85
Level of Interactivity	3.5	3.63	4.25	3.5	4.25	3.83
Feedback Capability	3.75	3.75	3.88	3.75	4	3.83
Usability and Reliability	3.25	3.75	3.75	4.25	3.75	3.75
Instructional Time	3.13	3.88	4	4	3.75	3.75
Development and Upgrading Efforts	3.63	3.88	4.25	3.63	3.38	3.75
Technology Life Cycle	3.25	3.63	4.13	3.88	3.75	3.73

IT Specialists' Opinion

Criteria	Learning Technologies					Weighted Average
	TM	IVT	IBI	IMI	CMC	
	Degree of Importance					
Feedback Capability	3.6	3.9	4	4.2	4.4	4.02
Professional Development	3.3	3.8	4.2	4	3.8	3.82
Student/Instructor Satisfaction	3.3	3.8	4.1	4.1	3.7	3.8
Ease of Access, Use and Revision	3.4	3.5	3.7	4.3	3.9	3.76
Usability and Reliability	3.6	3.7	3.9	4	3.5	3.74
Student Motivation and Self-Learning	2.8	3.8	4.2	4.1	3.7	3.72
Level of Interactivity	2.7	3.4	4.4	3.6	4.2	3.66
Instructional Time	3.3	3.3	4	3.7	3.8	3.62
Compatibility with Existing Systems	3.2	3.3	3.9	3.9	3.8	3.62
Compatibility with Users' Expectations and Preferences	3.3	3.5	3.6	4.1	3.5	3.6
Student Support	2.8	3.4	4.2	3.7	3.9	3.6

Faculties/IT Specialists' Opinion

Criteria	Learning Technologies					Weighted Average
	TM	IVT	IBI	IMI	CMC	
	Degree of Importance					
Ease of Access, Use and Revision	4.5	3.5	4.5	5	4	4.3
Feedback Capability	4.5	4.5	4	4	3	4
Compatibility with Users' Expectations and Preferences	4.5	4	4.5	4	2	3.8
Usability and Reliability	5	3.5	4.5	3.5	1	3.5
Instructional Time	4.5	3	4.5	3.5	2	3.5
Versatility	5	3.5	5	3	1	3.5
Professional Development.	4.5	3.5	5	3	1	3.4
Student/Instructor Satisfaction	4.5	3	5	3	1	3.3
Student Motivation and Self-Learning	4.5	3	5	3	1	3.3
Student Support	4.5	3	5	3	1	3.3
Technical Skills Needed	3	4	4	3.5	2	3.3
Compatibility with Existing Systems	4.5	2.5	4	4.5	1	3.3
Instructional Practices and Materials	5	3	4	3	1	3.2

Students/ IT Specialists' Opinion

Criteria	Learning Technologies					Weighted Average
	TM	IVT	IBI	IMI	CMC	
	Degree of Importance					
Administration/Organization/Communication	2.25	4.25	5	5	4.75	4.25
Instructional Time	3.5	4	4	4.25	4.75	4.1
Feedback Capability	3.25	4	4.25	4.25	4.5	4.05
Maintainability	3	4.25	3.5	4.75	4.75	4.05
Professional Development	3	4.25	4	5	4	4.05
Development and Upgrading Efforts	3	4.25	4.5	4.25	3.75	3.95
Instructional Practices and Materials	2.75	4	3.75	4.75	4.25	3.9
Student/Instructor Satisfaction	2.75	4.5	3.75	4.25	4.25	3.9
Student Motivation and Self-Learning	2.5	4.5	4	4.25	4	3.85
Usability and Reliability	2.75	4.25	3.75	4.5	4	3.85

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