HCI and E-Learning: Developing a Framework for Evaluating E-Learning

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Abstract

This chapter developed a framework for evaluating e-learning for use in Human Computer Interaction (HCI). A systems approach was used in the study; input, processes and output. It discussed the different assumptions about how people learn; behaviorism, cognitivism and constructivism. Further, it examined the common threads in the definitions of e-learning and the literature on evaluation of e-learning models. Nine categories of evaluation of e-learning were identified but five categories were reviewed because the remaining four overlapped with the five categories used. Two separate evaluations were reviewed under each category, making a total of ten reviews. The reviews showed that the evaluations were not conducted in the same way even within the same category making comparisons difficult. The framework was developed from the highlights in the review. The developed framework can be used to evaluate different e-learning modules along common lines making it easy to compare evaluations. It is hoped that over the next few years, a consistency in evaluations of e-learning would be achieved for use in HCI.

Keywords: Evaluation, Behaviorism, Cognitivism, Constructivism, Systems, Scriven, Stufflebeam, Kirkpatrick, Patton, Framework, Miller

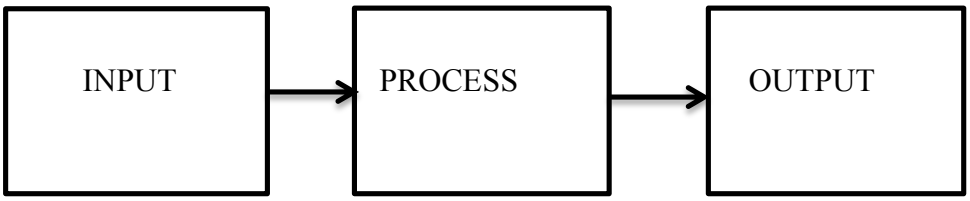
Introduction

This chapter would develop a framework for evaluating e-learning for use in Human Computer Interaction (HCI). Before an evaluation can be done, there must be an input, some

processes and an output. How do we know that the output is actually the desired outcome? How do we know if the process we are using is actually the correct process? If the process is correct, can the input be wrong?

This chapter will attempt to answer some of these questions by developing a framework for evaluating e-learning. However, before examining different models of e-learning, the inputs, processes and the outputs in Human Computer Interaction will be examined (see Figure 1). The HCI process takes place in a system.

Figure 1 Input, Process and Output in a System

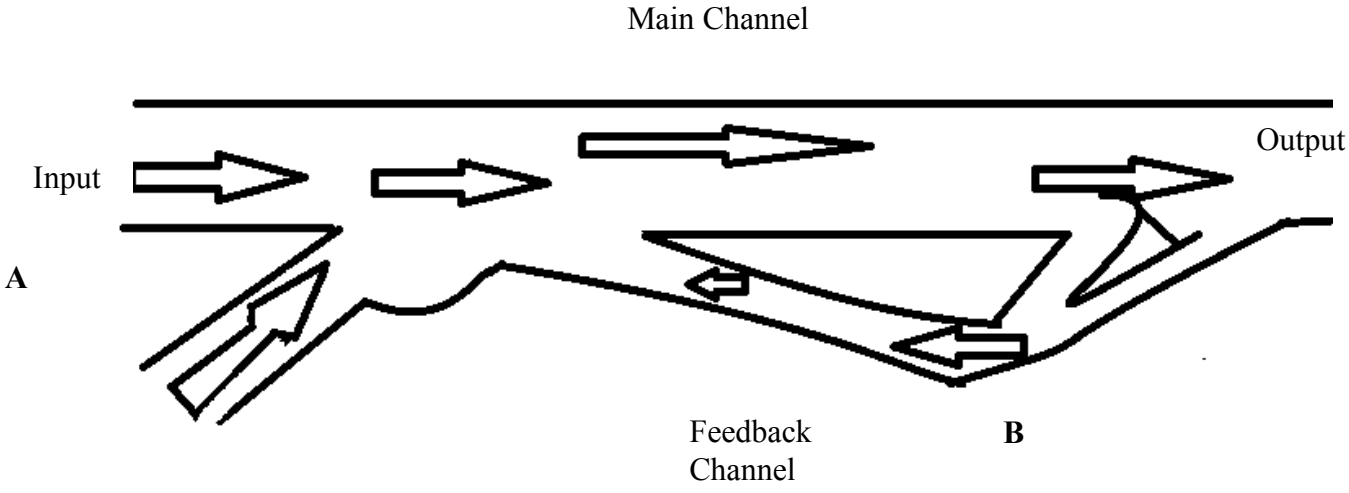


"A system is a set of objects together with relationships between the objects and between their attributes" Hall & Fagan (1956).

"---we propose that a system be taken as a nested network, with the underlying structure of a nested graph" Harary & Batell (1981).

Miller (1956) described a system as an entity that has common properties, constraints and the parts within the system are dependent on parts within and outside the system. The common thread in the three definitions is the inter and intra connections of all the parts.

Figure 2 Illustration of a Feedback System



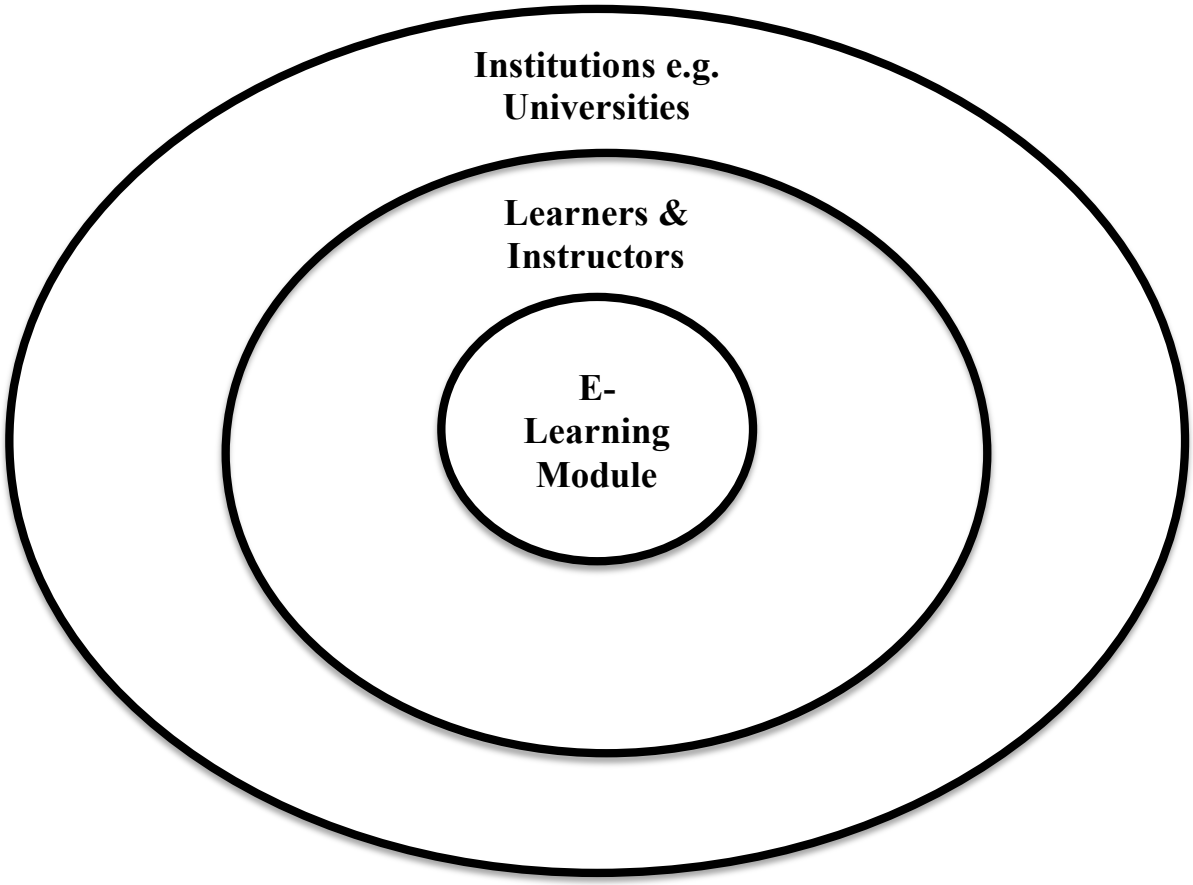
In systems theory, the system consists of the inputs, the processes, the outputs and the feedback (Richey, 1986). The interactions in the system could be the processes, the constraints, the instructions and the feedback (Miller, 1965; Richey; 1986). The feedback can be negative or positive. The negative feedback does not connote a bad process. The negative feedback is what keeps the system the same. As illustrated in Figure 2, the information from A goes back into A through channel B so that the system remains the same. This is a negative feedback. When the inputs from A keep increasing in steady amounts, this is a positive feedback. "Positive feedback alters variables and destroys their steady state" (Miller, 1965 p. 35).

A system can also be affected by the supra system. The supra system has control over the system. The environment can be the immediate environment or the total environment (Miller, 1965). The immediate environment includes the system without the supra system. The total environment includes the immediate environment and the supra system. An example of a system is a university. The university makes use of an e-learning platform. Inside the system, there are

subsystems. Each subsystem carries out similar functions. In each system, there is an echelon of processes that are arranged in hierarchy. Systems contain levels of different functions. The e-learning model/module is affected by learners' and instructors' interactions. Similarly, the policies of the institutions would affect how the learners and instructors interact with the system.

The goals or learning outcomes in human computer interaction depend on the learning theory or the objectives. The objectives would be the input. In using a general systems theory to evaluate e-learning, the framework must align with the inputs, processes and outputs.

Figure 3 Illustration of Systems in E-Learning



Assumptions About How People Learn

Collins, Greeno and Resnick (1996) grouped these assumptions into three groups; empiricist, rationalist and pragmatist-sociohistoric. Mayes and de Freitas (2004) grouped these assumptions into (1) associationist/ empiricist or learning as activity (2) cognitive perspective or learning as achieving understanding and (3) situative perspective or learning as social practice (constructivism). This chapter would use the categorizations by Mayes and de Freitas (2004) because theirs is a more recent categorization than that of Collins, Greeno and Resnick (1996) although they are both similar.

The Associationist Perspective

Behaviorists have the associationists' perspective. They believe that learning occurs by making connections in the activities. Learning takes place through a behavior that is learned by stimuli and responses. The learned behavior is observable and is now applied to similar situations. The connections that determine the behavior can be strengthened or weakened. The associationist perspective is used in programmed instruction.

The Cognitivist /Rationalist Perspective

Collins, Greeno and Resnick (1986) identified three traditions to be the cognitive vies; Gestalt psychology, constructivism and symbolic information processing. The Gestalt psychology stresses on the insight in learning and perception. Some researchers classify the symbolic information processing as associationist because symbolic information processing operates through networks. The two separate views of seeing the symbolic information processing as behaviorist on one hand and as cognitive on another hand shows that these classifications are not absolute. The boundaries are fluid.

Further, learning through the symbolic processing system is based on the acquisition of schemas. The developments of schemas ultimately lead to automacity. Metacognitive models, mental models, problem solving problems and general competencies for thinking come under symbolic information processing (Mayes & de Freitas, 2004).

The Situative Perspective

Learning is acquired through interaction with members of a community of learners. The members of the community become active participants in the community and they learn through their interaction in the community of practice. The situative perspective pays attention to procedures and completion of tasks. It views acquisition of knowledge through different levels of participation in the community of practice. As the learner moves from one level of practice to a higher level, the learner's responsibility increases.

Application of the Systems Theory to Human Computer Interaction

Using the systems theory, a comprehensive analysis can be done to determine if the theory or objectives applied to e-learning matches the pedagogy. Instructional tutoring systems and e-training models can be evaluated on a systems approach. For this chapter, e-learning model and e-learning module are used interchangeably and refer to an e-learning platform like a learning management system or an e-learning course that can be a class lesson or a training course.

Summary of Associationist, Cognitivist and Situative Perspective

The associationist perspective is akin to the behaviorist approach that observes the activities of the outcomes for the learners. The cognitivist perspective analyses the processes and relies on schema formation. The cognitivist and associationist perspective can take place with one learner or a group of learners. The situative perspective cannot take place with one learner. The learner must be in a community of learners. Learning becomes a social interaction in the situative

perspective. As some members of the community of practice leave at graduation, a new set of learners join. They move along different trajectories (Driscoll, 2000). A comprehensive evaluation of e-learning models or modules can be conducted by applying the systems theory.

Evaluation of E-Learning Models

An evaluation of e-learning models in a standard, measurable way will determine if the consumers of e-learning are getting the desired results. There are many models of e-learning and each one claims to be better than the previous ones. It is imperative that there should be a consistent, uniform method of evaluating all the existing models of e-learning. In the literature, there is so much diversity in the descriptors of e-learning that using descriptors like online-learning, distance education, distance-learning, e-learning, mobile-learning, web based learning on search databases would bring up millions of results. The diversity of results cuts across all disciplines.

Method of Selecting Research Articles

The databases of research publications in PsycINFO, ERIC, Google Scholar, Summons and EBSCO Host were surveyed for peer-reviewed articles on evaluation of e-learning models. The reference lists of relevant articles were also surveyed to broaden the search base for articles relevant to the search. The search words used were e-learning, evaluation, model of e-learning, distant learning, online learning, web- based learning and distance education. There was no custom range for the years in which the articles were selected. Only articles that were relevant to the search were selected.

Grouping the different types of evaluation methods used in evaluating e-learning into categories would help in developing a framework for evaluating e-learning models or modules.

Attwell (2006) categorized the evaluation of e-learning into nine groups. These were case studies of specific e-training programs, comparison with traditional learning, tools and instruments for evaluating e-learning, meta-analysis of data on the effectiveness of e-learning, benchmarking models, return on investment reports, product evaluation, performance evaluation and handbooks for the evaluation of e-learning.

For brevity, this chapter used five categories; benchmarking models, return on investment reports, product evaluation, performance evaluation and handbooks for the evaluation of e-learning as some of the categories used by Attwell (2006) overlapped. In addition, under each category two evaluations for e-learning were examined for use of theory.

If theory was not used, the criterion that was used was explored. Further, the variations and similarities in the evaluations for each category were examined. The objectives in the evaluations for e-learning were also examined. The highlights from each category were extracted. At the end of the chapter, a framework was developed using the highlights from each category. The developed framework can be used to evaluate any e-learning module.

E-learning

Although there are many definitions of e-learning, a common thread in the plethora of definitions is the use of technology to learn. Some authors have tried to separate e-learning from distance education by affirming that e-learning is strictly through the internet and distance education can be through hard copies (Ruhe & Zumbo, 2009).

E-learning attracts a lot of research and development and funding (Attwell, 2006). Researchers have focused on different parts of e-learning. Some evaluated only the inputs. Others focused on processes and some evaluated the learning outcomes (Attwell, 2006; García, & Jorge

2006; Kathawala & Wilgen, 2004; Masoumi & Lindstrom, 2012; Mayes & de Freitas, 2004). According to Ibis Capital (2013), Europe has over 3000 plus e-learning companies. The e-learning market is the fastest growing market in education and made a revenue of 91 billion dollars in 2012. Internet use has tremendously expanded to 2.4 billion users from the year 2000. Forty percent of the global 500 Fortune companies use e-learning to train their employees. Considering the statistics on the trends on the use of the internet and e-learning, it is obvious that there is no shortage of e-learning.

Evaluation

Evaluation is a systematic investigation to determine the merit and worth of a set of activities (Ruhe & Zumbo, 2009). The etymology of the word evaluation is from the French word "évaluer to find the value of, from é-out (see ex-) + valuer (see value)" Online Etymology Dictionary (n.d). Evaluation means to find the value out of something. It is the means by which evidence is gathered and interpreted to determine how well the instructional product or system performs (Gagne, Briggs & Wager, 1992).

Evaluation became important in the 1920's when the government wanted to measure the cost effectiveness of its health and educational programs (Owston, 2008). Evaluation started as far back as the Chinese and Egyptian empires when their ministers were evaluated Scriven (1991). When evaluation is conducted in education on a variety of events and groups of students, teachers and administrators, it is an educational evaluation (Gagne, Briggs & Wager, 1992).

Scriven (1974) proposed the goal free evaluation in which the evaluator is not restricted to the stated objectives but can evaluate any of the outcomes. According to Scriven (1974) an educational program or product can be evaluated as follows; need, market, performance in field

trials, consumer performance, performance comparison, performance long term, performance side effects, performance process, performance causation, performance statistical significance, performance educational significance, costs and cost effectiveness and extended support.

Stufflebeam's (1974) educational evaluation methods were goal based. His model was based on context, input, process and product, the CIPP model. The context assesses the needs. The input would assess the strategies put in place in the educational program for cost-effectiveness. The processes are the documentations and program activities. The product would be the impact of the educational program which could be the intended and unintended outcomes (Owston, 2008; Ruhe & Zumbo, 2009). The evaluation methods proposed by Scrivens (1974) and Stufflebeam (1974) are still in use today but cannot address all the needs of e-learning.

Another commonly used model is the Kirkpatrick model which was developed in 1959 (Kirkpatrick, 2006a). Some researchers feel that these models are antiquated and cannot be used for the evaluation of e-learning (Galloway, 2005; Hamtini, 2008; Peak & Berge, 2006) while some feel it can still be used (Horton, 2006).

Gaps and Highlights in the Literature

The highlights in the literature show that e-learning has come to stay. The gaps reveal that literature that claim to conduct evaluation of e-learning, evaluate the technology attached to the e-learning and not the pedagogy. A lot of research has focused on software used for e-learning or on the learning platforms. While they are important, the focus should not shift entirely to the technologies and ignore the pedagogy. Some evaluations focus on the performance scores of students that use the software and not on the pedagogy that was used in the e-learning software (Davies & Graff, 2005; Hannafin & Foshay, 2008).

Further, when the company manufacturing or marketing the software sponsors the research the results seem to extol the software or the company (Young, 2002). Another gap is that there are several models of evaluation and they do not always measure the same things. In the same evaluation model, methodologies are not consistent. Some evaluations were done without any stated theory. Also, it appears that the discipline of the evaluators imparts the evaluation. Instructional designers tend to state the theory when they evaluate e-learning.

However, evaluation done by some other disciplines just delve into the software and the theory is missing. Further, some definitions like E-learning Platforms, Learning Systems and Learning Management Systems used in the papers were not consistent (Attwell, 2006; Ćukušić, Alfirević, Granić & Garača, 2010; Garcia & Jorge, 2006) but had similar meanings.

Categorizations of Evaluations used for E-Learning

There are many categories of evaluation models (Kifer, 1995; Ruhe & Zumbo, 2009). However, there is scant literature on the categorization of evaluations used for e-learning. The evaluation of e-learning project (Attwell, 2006) categorized the evaluation of e-learning into nine. Some of the nine categories used by Attwell (2006) overlap and this chapter used only five categories for brevity. The five categories examined in this chapter are the benchmarking model, the return on investment report, product evaluation, performance evaluation and the hand book of evaluation.

OUTLINES FOR REMAINING CHAPTER

1. Benchmarking model
2. Return on Investment (ROI)
3. Product evaluation
4. Performance evaluation

5. Handbook for evaluation of e-learning
6. Summary table from chapter findings
7. Overall summary of the categories of evaluation of e-learning
8. Steps taken in this chapter to develop a framework
9. Framework for evaluating e-learning model
10. Conclusion

BENCHMARKING MODELS

"The process of comparing one's business processes and performance metrics to industry bests and/or best practices from other industries. Dimensions typically measured are quality, time, and cost. Improvements from learning mean doing things better, faster, and cheaper" (Scepanovic, Devedžić & Kraljevski, 2011). Benchmarking became a popular evaluation tool of e-learning in 2005 (Scepanovic, Devedžić & Kraljevski, 2011).

There are usually a set of criteria against which e-learning is evaluated. Benchmarking models are not consistent in their choice of criteria and lack theoretical foundations. Even within the same country the criteria for the benchmarking models are not the same and so it is difficult to compare results. Some of the benchmarking models were started as projects and lacked continuity because the projects were no longer funded (Scepanovic, Devedžić & Kraljevski, 2011). When most of these models were evaluated, persons vested in the program evaluated them and the results usually extolled the values of the model (Legon & Runyon 2007; Shattuck, 2007).

In this chapter, Quality Matters (Quality Matters, 2013) and the E-learning Maturity Model (Marshall, 2005a) were selected as two examples of benchmarking models because both models were used in tertiary institutions in two separate continents. Quality Matters was developed in the

United States and it has been used in the United States. The E-learning Maturity Model was developed in New Zealand and has been used in New Zealand (Marshall, 2005a, 2005b).

Quality Matters is a popular benchmarking model tool in the United States and is used by most universities and technical colleges, (Shattuck, 2007). The Quality Matters benchmark tool includes verbs in the criteria that make the objectives ambiguous. Some objectives like "encourage student cooperation", "let students know what to expect", "encourage faculty-student contact" and "interaction" are ambiguous and give room to multiple interpretations. The Quality Matters benchmark tool focuses on the online course.

The emphasis is on the course subject being taught. As part of the benchmark, there must be an expert in the subject being taught online. It does not emphasize the pedagogy. It does not identify technological variables, or learner variables that would affect the online course. It does not emphasize the environmental variables. The model was developed based on criteria from eleven national standards across the country. Quality Matters is not based on a theoretical model. Quality Matters model proponents admit that the tool is based on rubrics, which can change when literature reviews reflect new evidence.

The E-learning Maturity Model Evaluation was developed by Marshall and Mitchell (Marshall, 2005a) and has been used to assess the e-learning programs in the tertiary institutions in New Zealand. The model only looks at the process in training of instructors that teach online and the readiness of institutions to maintain the e-learning programs. The developers admit that the model is not interested in pedagogy and it is not interested in evaluating the technology (Marshall & Mitchell, 2002). Its emphasis was to determine whether the various tertiary institutions were able to provide high quality e-learning that was sustainable. It emphasizes the process of the design of the e-learning and determines if it meets the needs of students, instructors and staff of the

institutions. Marshall and Mitchell (2002) developed the e-learning maturity model from the Seven Principles of Chickering and Gamson and the benchmarks developed by the Institute of Higher Education (Marshall, 2005a). They also adapted the capability maturity model (Marshall & Mitchell, 2002).

Table 1 Highlights From Benchmarking Model

- Uses selected criteria
- Can be based on rubrics
- Objectives may not be stated clearly
- Not based on any theory
- Learning outcomes not stated clearly
- Usually measures quality, time and cost
- Measures processes

Summary on Benchmarking Models

A review of benchmarking models has shown that studies done using the benchmarking model did not examine the same criteria. The two benchmarking models examined did not include pedagogy. The e-learning maturity model focuses on the training of the online instructors and on the maturity of the institutions to maintain e-learning. They were more concerned about the ability of the institution to offer e-learning programs.

The criteria used by Quality Matters included examination of the course content by a committee that included an expert in the field and if the committee did not approve, the course content was taken back and reviewed a second time. It did not include clear objectives and it did not include clear learning outcomes. In addition, the developers admit that the criteria can change when they see a need to change that may arise from a literature review. Although both models are not based on any theory, many schools of higher learning appear to have been using the models successfully. Further, the seven principles that were used in the development of the e-learning maturity model made use of theory.

RETURN ON INVESTMENT REPORT (ROI)

Return on Investment (ROI), strictly speaking, is an accounting-based method of comparing the costs and benefits of a product, program or service by converting all tangible costs and benefits to financial measures. It can be used, however, to include intangible costs and benefits, particularly as the concept is applied to public expenditures for education and training (Barker, 2005, p. 3).

Most business companies use ROI reports to check if the money spent on the e-training programs of their employees is profitable. Measuring ROI can be difficult because there are soft and hard costs involved (Gale, 2002). The hard costs are the documentation of the e-learning. If the training could have taken the employees a day out of work if they did a face-to-face training as opposed to an e-learning training that they would complete in a few hours, the company would find it cost effective to do the e-training (Gale, 2002). In ROI analysis, attempts must be made to convert all the documentation into monetary values.

Return on investment models vary depending on who is carrying out the research. The objective of a vendor-based model is different from the objective of an academic based model because they both have different goals. The vendor that would use the vendor-based model wants to increase sales and the academician would use the model for publication. There are different formulae for calculating ROI depending on the type of program

"For one-time programs

Program Benefits / Costs X 100 = ROI (expressed as a percentage)

For prepared programs

Total cost of design, development, duplication, delivery and support

(divided by) the number of students over the life of the course

For a range of results

ROI = (value of benefits - cost of training) / cost of training" (Barker, 2005, p. 13).

In conducting an ROI on e-learning, many models can be used including the Kirkpatrick model. This may be because the model was developed as far back as 1959 (Kirkpatrick, 2006a) and major companies have been training their employees using this model even before e-learning began. Donald Kirkpatrick's model was developed from his work on his dissertation.

The following description of the Kirkpatrick model is from Kirkpatrick's book on evaluating training programs. The Kirkpatrick model is a four level approach to evaluation of training programs. It has been used in technical and managerial sectors (Kirkpatrick, 2006 b).

The first level or level one is also called reaction. This is usually a survey of the participants of the training program to the training. Questions are asked about the content, the instruction and the overall. A question on content could be: The skills taught in this class are relevant to my personal development with options varying from disagree strongly to agree strongly. Kirkpatrick also calls the first level a customer satisfaction survey (Kirkpatrick, 2006b). He points out that even though the trainees are not paying for the training, they are nonetheless customers and their satisfaction or dissatisfaction can make or break the training program.

The second level is learning. According to Kirkpatrick, learning has occurred if there has been a change in attitude, if there has been an increase in knowledge or if there has been an improvement of skills.

The third level is behavior. In Kirkpatrick's model, behavior is the change that occurs as a result of attending the training program. Kirkpatrick's identifies four conditions that must be present for a desired behavior; 1.) The person must have a desire to change 2.) The person must know what to do and how to do it. 3.) The person must work in the right climate and 4.) The person must be rewarded for changing.

Kirkpatrick identifies five types of climate that may enable or disable the behavior that was achieved at the training. In a preventing climate, the trainee is prevented from performing the new behavior learnt at the training. In a discouraging climate, the trainee is discouraged from performing the new behavior that was learnt at the training. In a neutral climate, the training is not prevented or discouraged from performing the new behavior. The reception of the boss to the new skills is one of indifference but may slide into a discouraging climate or even a preventing climate if the behavior negatively interferes with the job.

An encouraging climate encourages the trainee's new behavior and a requiring climate requires the trainee to inform the supervisor of the new skills and in some instances, a contract may be signed between the trainee and the boss for the boss to see that the new behavior learnt are transferred to the job.

The fourth level is also called the results. This is the outcome of the training. It could be measurable in monetary values and it may not be measured in monetary values. A training to effect a change in attitude to minorities may be measured in non-monetary values as increased motivation.

Two case studies were selected as examples for ROI. Young's (2002) article was selected even though it was as far back as 2002 because it pointed out biases in reporting and e-learning was just beginning to take off in 2002. In this chapter, Young's article was compared with Nathan's (2009). Young (2002) conducted an ROI on top-level management executives on their attitudes to e-training and on the justification of e-learning to the employees. In 2000, Young's (2002) company had also conducted a similar study on top level managers but the literature did not indicate if it was the same set of participants. Computer aided telephone interviewing tool was used.

Young's (2002) article did not discuss the use of theory but mentioned the name of the company as the first to conduct such a study in that area. The interviews were all conducted over the telephone. Only the top management personnel were interviewed. The learners or trainees were not interviewed. The results were based on perception and attitudinal questions to determine if e-learning had an impact on their organization and if they would continue to use e-learning. There were no questions on learner variables, technology variables or pedagogy variables. There

was no use of theory. Young (2002) presented the results using bar charts and it was easy to see the responses of the respondents.

Although the title of Young's (2002) article was, "Is e-learning making ROI?" the study was based on perceptions and attitudes of top-level managers to e-learning and not entirely on ROI. Also, Young (2002) was the vice president of the software company that was instituting e-learning programs in the companies tested thereby creating a source of bias in reporting.

The second case study is an ROI on an online course (Nathan, 2009). In this study, Nathan (2009) discussed the theory he was going to use. A modified Kirkpatrick model was used. The modified Kirkpatrick model had additional levels instead of the four levels that the Kirkpatrick model has. The fourth and fifth levels were combined to determine the business impact of the online lesson. The design objectives were matched to every level of the model. The data collected from the evaluation of levels one and levels two were converted to monetary values. The benefits were calculated in dollar amounts and tables were used to illustrate the conversion. Nathan (2009) described the processes.

Table 2 Highlights From ROI

- Accounting based method of comparing cost and benefits
- Theory used
- Can also be used to compare intangible cost
- Attempts to convert documentation into monetary value
- Goals of ROI vary depending on the purpose of the evaluator
- Can measure attitudinal change
- Can measure the input, process or output

Summary on ROI

Most training organizations usually evaluate using ROI. Return on investments is an evaluation tool that usually surmises the results in monetary value. Mathematical calculation exists for calculating ROI. However, it does not have to be in monetary value alone. It can be examined in terms of the attitudinal views as was done by Young (Young, 2002). He looked at the ROI from the attitudinal responses of the top management personnel. Young's (2002) reporting could be seen as biased because he was the vice president of the company that was supplying the software for e-learning.

Kirkpatrick's model is still being used by organizations to evaluate e-learning even though the model existed before e-training began. Nathan's (2009) ROI study was based on the Kirkpatrick model and he matched the theory to the objectives of his evaluation. It was not all aspects of his evaluation that was converted to monetary values but he was able to match most of the aspects of evaluation to monetary value.

PRODUCT EVALUATION

Patton (1997) p. 23 suggests that before an evaluation must be conducted, evaluation must be defined because it is on the functionality of that definition that the evaluator would be conducting the evaluation. In product evaluation the evaluator should be able to answer the question, "what are the cost, benefits, and market for a specific product?" (Patton, 1997) p. 194

The first product evaluation that would be discussed is the evaluation of nine open source-learning platforms that were evaluated to determine the most adaptable learning platform to the user (Graf & List, 2005). The second product that would be examined would be the evaluation of computer-based instruction (CBI) software on a high school's high stake's test (Hannafin & Foshay, 2008).

Graf and List (2005) used a qualitative weight and sum approach (QWS) to evaluate the nine open learning platforms. Graf and List (2005) explained how the QWS approach was used to evaluate software. The QWS uses weights that are measured according to a range of criteria from not valuable to essential. In between, the values are marginally valuable, valuable, very valuable, extremely valuable and essential is the highest value.

Each of these values is represented by a symbol. The software product is now weighted according to the symbols. The software product that has the highest number of weights would be the most adaptable. If Moodle has nine values for extremely valuable while the other platforms have three values for valuable, then Moodle would be judged the most adaptable. Graf and List (2005) initially started with 36 open source-learning platforms and eventually streamlined to nine open source-learning platforms.

They tested the nine learning platforms using a questionnaire and the questions covered eight categories, which were divided into sub categories. These categories covered areas of usability, adaptability, communication tools, learning objects, management of user data, administration, course management and technical aspects.

After the platforms were ranked according to the highest number of weights, Moodle scored the highest and Sakai scored the lowest. The research was funded by the Austrian Ministry of Education and not by any of the open source-learning platforms so the results would not have been influenced by any of the software companies.

Graf and List (2005) did not define terms like open source-learning and they did not define-learning platforms. They defined adaptability and explained the criteria used to rank the-learning platforms. However, Graf and List (2005) did not describe the users that filled the questionnaires

in order to rate them. They also used variables in the sub categories but these variables were not identified.

Hannafin and Foshay (2008) compared the performance scores from using a CBI product that helped high school students to master competency in Mathematics to the performance scores obtained from using a traditional method of teaching Mathematics. The results showed that the students that used the CBI product outperformed the students that studied using traditional methods. The evaluation was conducted in a high school where the 10th grade students had failed the competency exam for Mathematics.

The CBI product used was Plato Learning Systems. In addition to using Plato, the school also employed other methods to help the failing students including one on one tutoring, community volunteers and parental assistance. The evaluation focused only on the effectiveness of the Plato Learning System. The evaluation did not account for the contribution of the one on one help or on the impact of the help by volunteers and parents to the students' success. Students that failed or marginally passed the 8th grade Massachusetts Comprehensive Assessment System (MCAS) were enrolled in the Plato Learning System in preparation for their 10th grade MCAS. The MCAS was taken in 8th and 10th grades.

The study evaluated the scores of students who had gone through the Plato Learning System for Mathematics in 10th grade and compared it with their scores when they were in 8th grade and had only traditional methods of learning Mathematics. The variables tested were the data from the Plato Learning Systems and the MCAS scores. Hannafin and Foshay (2008) did correlation analysis on the MCAS scores of the students while they were in 8th grade and when they were in the 10th grade and had taken the Plato Learning System modules for Mathematics. The correlations showed that the MCAS scores improved after taking the Plato Learning System.

In addition, the Mathematics instructor in charge of the Plato Learning System in the school was interviewed and the interview was reported qualitatively. Hannafin and Foshay (2008) also pointed the limitations in their studies that the students were not only helped by the CBI program but that they were helped by volunteers, students helping fellow students and the instructor helping students. Further, the teachers had to take staff development courses. In the study, Hannafin and Foshay (2008) explained that the Plato Learning System was based on cognitive theories of learning where the student masters a module before moving on to the next module.

Table 3 Highlights From Product Evaluation

- Evaluation must be defined before evaluating the product
- Can be used to evaluate software used in learning
- Criteria can be developed to rank the product being evaluated
- Processes of the product that include usability and adaptability can be evaluated
- Output of the product like scores can be evaluated
- Can make use of theories of learning
- Interactions included use of volunteers

Summary on Product Evaluation

While both articles examined did a product evaluation, they evaluated different aspect of the product. Graf and List (2005) used a software product to evaluate nine open source learning

systems. The criteria chosen were subjective. Values used in the criteria were marginally, valuable, valuable, very valuable, extremely valuable and essential. A qualitative weight and sum approach was the software being used as an evaluation tool. Graf and List (2005) did not identify the variables that were used. They pointed out that there was no bias in their reporting because none of the open source learning systems sponsored the evaluations.

Hannafin and Foshay (2008) looked at only the output from the product, i.e the performance scores. Admittedly, they did not look at other variables that could have contributed to the improved performance of the students. The teachers took staff development courses. The students had help from volunteers, fellow students and other support network before their grades improved but these variables were not factored into the evaluation.

PERFORMANCE EVALUATION

Scriven (1991) differentiated between performance evaluation and product evaluation because performance evaluation is usually absorbed under product evaluation. Performance evaluation is the measurement of a particular achievement through its output or through its processes (Scriven, 1991). Patton (1997) also agreed that before an evaluation begins, the evaluator must define evaluation because it would be this definition that would drive the approach of the evaluation.

Davies and Graff (2005) evaluated the performances of undergraduate students who participated in on line discussions and compared it with the performances of undergraduate students who participated less frequently in online discussions by following the students' grades for up to a year. The second study that would be examined was by Ćukušić et al. (2010). This was

an empirical study that looked at the performances of the e-learning process across 14 schools in Europe.

Davies and Graff (2005) did not give a theory of their research. Although their results showed that the students who participated more in online discussions performed better than students who participated less frequently, they concluded that the evaluations did not prove that the online discussions improved the grade performances of the students because it was not statistically significant. Davies and Graff (2005) asserted that the quality of the on line interaction was not measured but it was the number of times the students accessed Blackboard that was counted. However, they presented both sides of the literature that supported on line-learning discussions and improved student performance and online-learning discussions without a change in grade performances of students. They followed part time and full time students for a year and followed their grade results.

The students were all enrolled in the same school and used the Blackboard. The Blackboard had four sections; communication, main content, group areas and student. The students were able to communicate through the Blackboard using the group areas and the student areas. Davies and Graff (2005) combined the number of times that students communicated through the group area and through the students areas and plotted these variables against their grade performances.

Their analysis showed that the students who scored the highest grades were the ones who interacted most on the Blackboard. The students who scored the lowest grades were the ones who interacted least on the Blackboard. Their results were not statistically significant. It is only after reading the introduction and the discussion section that their hypothesis becomes clear. They also stated their variables.

The purpose of the study by Ćukušić et al. (2010) was to evaluate the e-learning platform process from planning, implementing to learning outcomes using the Unified E-Learning Environment for School Project (UNITE) as a model. Further, the study was to determine if there were any relationships between the implementation of the model and the subject of learning.

According to Ćukušić et al. (2010), previous studies looked at a part of the e-learning model. They declared that previous studies had looked at processes, implementation, learning outcomes and inputs as separate entities but their own study was the first to look at the entire e-learning process from planning to learning outcomes and to establish a link between the planning and the-learning outcomes.

Ćukušić et al. (2010) described many variables like the educational context of the learners, identification of learners' needs, learners' technological skills and learning styles. The educational context of the learners was where the e-learning would take place. Most of the literature on evaluation of e-learning models examined for this chapter did not describe the variables that were important to the learners.

Ćukušić et al. (2010) mentioned models that would be familiar to European researchers and may not be familiar to American researchers. They used terms that were probably commonly used in the European context. They used terms like e-learning scenario to describe the planning stage of the e-learning platform. They also used the word assessment to mean evaluation. They discussed the theory of the input, process and outcomes in e-learning.

Ćukušić et al. (2010) stated their research hypotheses. They also evaluated the e-learning model using two questionnaires that were sent out to 15 teachers across 14 schools in the European block. There were 56 close-ended questions that were sent by email. The questions were divided into sections that covered planning, controlling, implementing and evaluation. Controlling the e-

learning process included analyzing the data and identifying methods of evaluation. Ćukušić et al. (2010) concluded that there was a positive relationship between the systematic planning of the different aspects of the e-learning process and the e-learning performance.

Table 4 Highlights From Performance Evaluation

- Outputs like achievement scores are measured
- Inputs like attendance can be measured
- Inputs like learning style can affect performance
- Processes like the interactions learners make with the e-learning platform can be measured

Summary on Performance Evaluation

Davies and Graff (2005) conducted their evaluation by comparing the performances of students who engaged frequently in online discussion with those that engaged less frequently in online discussions. They only looked at the performance scores of the students. Although, students who spent the longest time in online discussions scored higher than those who spent the least amount of time in online discussions, their results were not statistically significant. They admitted that their study did not examine the quality of the online discussions.

Ćukušić et al. (2010) evaluated the entire e-learning platform from planning, to implementation to outcomes and concluded that the e-learning platforms gave a better outcome when it was planned. However, they concluded that there was no link between the planning of the

different aspects of the e-learning process and the subject content. They identified many variables in their evaluation. They identified learners' needs, learners' technological needs and learners' learning systems. They did not follow their respondents for a year like Davies and Graff (2005).

HANDBOOKS FOR THE EVALUATION OF E-LEARNING

The handbooks that would be mentioned in this chapter are the evaluation cookbook (Harvey, 1998) and the Kellogg evaluation handbook (Kellogg, 2010). These two books were written with the inputs of several technocrats in evaluation. The Kellogg evaluation handbook was specifically written for the evaluation of Kellogg programs.

The evaluation cookbook was developed by the Learning Technology Dissemination Initiative (Harvey, 1998). It has been used as a reference material by many authors in Europe (Attwell, 2006; Michaelson, Helliar, Power & Sinclair, 2001). It gives practical guidelines on evaluation.

The Kellogg's evaluation handbook is used to evaluate programs sponsored by the Organization ("Evaluating The Kellogg Project," n.d.; Kellogg, 2004). In one of their programs, the W.K. Kellogg Foundation provided Internet access, email account, web page, networking and training to neighborhoods around Trinity College. Computer classes and use of on-site computers were also provided (Sirbirsky, 2002).

The project participants were surveyed as part of the evaluation of the effectiveness of the technology in improving communication. One hundred and seventeen participants were contacted but only 71 responded. The participants included administrators, a church treasurer, volunteers and the director of a youth organization. The evaluation report did not indicate how long the

organization had provided the technology service but from the questionnaire, it could be inferred that the service had been provided within one year (Sirbirsky, 2002).

The participants were contacted by email. The participants were asked to respond to open-ended questions on whether or not the provision of the technology had met the needs of their organization. Close-ended questions on their knowledge and attitude to the technology provided were also asked. The results showed that the Kellogg's sponsored program had met the participants' expectations and also indicated that it needed improvement in the area of technical assistance (Sirbirsky, 2002).

Another evaluation conducted on a program sponsored by Kellogg's was the Community Learning Initiative courses (Sirbirsky, 2001). The Community Learning Initiative courses were incorporated into student classes and primarily focused on engaging students in service learning and research. A total of 305 students and 13 faculties were evaluated. The faculties were those that incorporated Community Learning Initiative courses into their own courses. The Community Learning Initiative courses also included fieldwork. The courses were offered in spring 1999 and in fall 2000. Sixteen Community Learning Initiative courses were offered in spring 1999 and in fall 2000. The evaluation report (Sirbirsky, 2001) did not state if any of the courses were online and if the questionnaires were online.

Importantly, the evaluation measured the academic impact of the Community Learning Initiative courses on students and examined faculties' attitudes in incorporating Community Learning Initiative courses in their own courses. Some of the questions were open-ended. The results from the students' responses showed that they felt the Community Learning Initiative was a positive experience. The faculties agreed that the Community Learning Initiative courses contributed to the students' learning.

As a basis for comparing, attempts were made to get information from websites of other food companies to determine if they had handbooks on evaluation and how evaluations of their sponsored programs on technology were conducted. The search did not yield enough detailed information to be included in this chapter.

Table 5 Highlights From Handbooks For The Evaluation of E-Learning

- Inputs come from evaluation technocrats
- The Evaluation Cookbook was a sponsored project of the Learning Technology Dissemination Initiative and is used as a reference book. It contains different evaluation methods and guidelines.
- Some handbooks of evaluation were developed specifically for a company's product.
- W.K. Kellogg Foundation has an Evaluation Handbook devoted to evaluating projects sponsored by the organization
- One of the evaluations (Sirbirsky, 2002) conducted on a program by Kellogg's had diverse group of participants unlike other evaluation methods previously discussed in this chapter.
- The two evaluations conducted on the projects sponsored by the Kellogg Foundation evaluated the outputs from the program by surveying the attitude of the participants.
- While it would have been good to compare how another food company evaluated their technology sponsored programs, the available information from websites of other food companies was not sufficient to be included in this chapter.

Summary on the Handbooks for the Evaluation of E-Learning

The two handbooks for the evaluation of e-learning mentioned in this chapter were the evaluation cook book and the Kellogg evaluation handbook. Several experts in evaluation contributed to the writing of both handbooks. This section examined the evaluation of two projects sponsored by the W.K. Kellogg Foundation. One project was the provision of technology to the community. The participants were surveyed using email and the responses showed that the provision had improved communication.

The second project was the inclusion of a course on services and student engagement in their regular courses. The report on the second project did not indicate if any of the courses were online or if the questionnaires were delivered online. The results showed that the participants had a positive attitude to the project.

SUMMARY TABLE FROM CHAPTER FINDINGS

The table below shows a quick summary of the findings from the five categories of evaluations examined in this chapter. The ✓ means that the element identified was used in the evaluation e.g use of theory was used in at least one of the evaluations under benchmarking. X means that the element was not used for the evaluation e.g monetary value was not measured in the evaluations that used benchmarking. The elements are use of theory, criteria, rubrics, monetary value, achievement/performance scores, usability, attitude change, interaction with learners/with e-learning platform and attendance.

Table 6 Summary Table from Chapter Findings

Elements	Benchmarking	ROI	Product Evaluation	Performance Evaluation	Handbook
Use of Theory	x	✓	✓	✓	x
Criteria	✓	x	✓	x	x
Rubrics	✓	x	x	x	x
Monetary Value	x	✓	x	x	x
Achievement /Performance Scores	x	✓	✓	✓	x
Usability	x	x	✓	✓	✓
Attitude Change	x	✓	x	x	✓
Interaction with learners/ with e-learning platform	x	x	✓	✓	✓
Attendance	x	x	✓	✓	x

Overall Summary of the Categories of Evaluations of E-Learning

This chapter was on the evaluation of e-learning. Although there are many definitions of evaluation, the meaning has not changed over the years. It is only that more definitions have been added. Many of the definitions of evaluation were as far back as the 1950's (Kirkpatrick, 2006a) and 1970's (Scriven, 1974; Stufflebeam, 1974) but the definitions are still as valid today as they were then. Similarly, there are many definitions of e-learning. The commonality in the definitions of e- learning is that it is an electronic means of learning.

Within the same categories of evaluations of e-learning, the evaluations done were not done the same way. This was the pattern for all the articles on evaluation that was reviewed. Some evaluations examined the output (Davies & Graff, 2005; Hannafin & Foshay, 2008) while some evaluated the processes alone (Graf & List, 2005) and some evaluated the inputs, the implementation and the learning outcomes altogether (Ćukušić et al., 2010). Some evaluations looked at learner variables (Ćukušić et al., 2010) and some looked at attitudinal variables (Young, 2002).

The criteria used in some evaluations were given a monetary value because the e-learning was seen as an investment by the company (Nathan, 2009). This was usually the case in ROI evaluations although Young (2002) conducted an ROI based on an attitudinal survey. The criteria in some evaluations were given a weighted value (Graf & List, 2005; Marshall, 2005a; Shattuck, 2007). Some of the criteria had ambiguous statements compounded by the use of non-specific verbs (Shattuck, 2007).

Few of the articles brought congruence between the domain of theory and the e-learning outcomes (Ćukušić et al. 2010; Nathan, 2009; Marshall, 2005). Several of the articles examined did not explain their use of theory. Proponents of some models admitted that they did not base their models on theory (Marshall, 2005a; Shattuck, 2007). However, a closer look at their models showed that they had adapted models from other domains that were based on theory.

An evaluation that was sponsored by the software company that owned the software that was being evaluated reported with a bias (Young, 2002). Young (2002) interviewed the top management personnel and did not interview the employees that actually took part in the e-training.

The Kirkpatrick model was commonly used by companies that wanted to evaluate their training programs (Nathan, 2009). This could be because the Kirkpatrick model has been around since 1959 (Kirkpatrick, 2006a) and many of the companies that were using the model had been using it as far back as 1959 before e-learning was birthed. Some companies modified the model before using it but it was still basically a Kirkpatrick model (Nathan, 2009).

This chapter reviewed several articles published in European countries and in the United States of America and did not see any that described the systems theory even though, in their evaluation, they were using the systems theory. A British article described the activity theory and it had similarities to the systems theory, only the name appeared to be different (Mayes & de Freitas, 2004). Articles from Europe also used assessment to mean evaluation (Attwell, 2006).

This chapter has been able to point out the differences and similarities in the patterns of evaluations of e-learning. These differences make it difficult to compare evaluations across and within categories. Perhaps, over the next few years, a consistency can be achieved.

STEPS TAKEN IN THIS CHAPTER TO DEVELOP A FRAMEWORK

Step 1

Identify the categories of methods used to evaluate e-learning;

- ✓ Benchmarking
- ✓ ROI
- ✓ Product Evaluation
- ✓ Performance Evaluation
- ✓ Handbook on Evaluation

Step 2

Examine two e-learning models/modules under each category and compare along lines of similarities if they have any. Itemize all the similarities and use them as elements in the summary table.

Step 3

Match the elements to input, processes and output

Elements	Input/Processes/Output
Use of Theory	Input
Criteria	Input, Processes, Output
Rubrics	Input, Processes, Output
Monetary Value	Output
Achievement/Performance Scores	Output
Attitude Change	Output
Interaction with learners, e-learning platform	Process
Attendance	Process, Output
Usability	Input/Process

Framework for Evaluating E-learning Models

After examining two evaluations that were done in each of the five categories, this chapter pulled out the common threads from the highlights. These common threads were then aligned into tables (see Tables 7 & 8) to develop a framework for evaluating E-learning models.

Table 7 Steps for Evaluating E-Learning Model

Step 1 Select any e-learning module/platform e.g Learning Management System **Step 2** Determine the tasks that can be done by the e-learning module. For example; if the e-learning module was not developed from any theory then you cannot examine along the line of a theory. Similarly, if the e-learning module was not developed from a criterion, you cannot examine along the lines of criteria. **Step 3** Determine if you want to evaluate the input, processes or output from the e-learning module. **Step 4** Go to the task table in Table 8 and select the tasks that can be evaluated for the e-learning module.

Table 8 Framework/Task Table for Evaluating E-learning Models. Model and Module are used interchangeably.

Select one e-learning module. Examine the tasks and parts of the system in the modules.	
Tasks	**Part of the System**
Examine Objectives in the Evaluation of E-Learning	Input/Output
Examine how the E-Learning Model was Developed	Input
Examine Criteria if Used	Input/Process/Output
Examine Variations if any in the Models Examined	Input/Process/Output
Examine Similarities if any in the Models Examined	Input/Process/Output
Examine Theory used if any	Input
Examine Attitudes of Participants	Output
Examine Behavior Change	Output
Usability of the Technology	Input/Process

Table 9 Examples of Inputs, Processes and Outputs. The lists in the table are not exhaustive.

Inputs can be educational level of learners, usability of the e-learning module or the technology used. **Processes** can be attendance of learners over the e-learning module, interaction with other learners and instructors over the e-learning module, training of instructors on the e-learning module. **Outputs** can be performance scores, documentation converted to monetary value, benefits or attitude change.

Conclusion

This chapter started with a discussion of the input, process and output in a HCI system. Next, it addressed the different assumptions about how people learn; behaviorism, cognitivism and constructivism. Further, it examined the literature on evaluation of e-learning models, the common threads in the definitions of e-learning, the definitions of evaluation and the historical background of evaluation.

In addition, it discussed the gaps and highlights in the literature. It described the evaluations of e-learning under five categories. Two evaluations were reviewed under each category meaning a total of ten evaluations were examined altogether. Subsequently, a framework for evaluating e-learning was developed using the highlights from the review and matching them

with inputs, processes and outputs. The developed framework can be used to evaluate different e-learning modules along common lines making it easy to compare evaluations. It is hoped that over the next few years, a consistency in evaluations would be achieved for use in HCI.

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