DOCUMENT RESUME

ED 456 159 TM 033 222

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TITLE Critical Analysis of Models and Methods Used To Evaluate Online Learning Networks.
PUB DATE 2001-04-11
NOTE 17p.; Paper presented at the Annual Meeting of the American Educational Research Association (Seattle, WA, April 10-14, 2001).
PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Evaluation Methods; *Models; *Networks; *Online Systems; *Systems Approach

ABSTRACT

This paper describes and analyzes the models and methods used to evaluate asynchronous online learning networks and presents a "Systems Component Contexture Model" for conceptualizing the evaluation of online learning networks. The evaluation team finds it useful to divide the variables they examine into descriptive, process, and outcome variables. The complexity of the relationships of these variables has resulted in the development of a model based on systems theory and research that can be used as a unifying conceptual tool for component analysis and further research. The model consists of examining the influence of four components (Content, Context, Collaboration, and Control) of the online learning network at three levels: institutional experience, all aspects of the mediated curriculum, and the learner level. The use of this holistic model provides a framework from which to evaluate and to examine the questions left unasked, even as it provides the opportunity to draft new questions for the future. (Contains 1 figure and 15 references.) (SLD)

Critical Analysis of Models and Methods Used to Evaluate Online Learning Networks

American Educational Research Association

Annual Meeting

April 11, 2001

Seattle, WA

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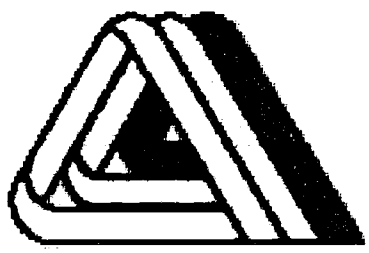

Critical Analysis of Models and Methods Used to Evaluate Online Learning Networks

Purpose

The development of appropriate methodologies for evaluating the myriad, ever-changing forms of online learning presents a critical challenge to distance educators. The open-ended nature of online learning projects, the multiple threads of conversation, and fluid participation patterns call for new ways of looking at evaluation. The purpose of this paper is to critically analyze the models and methods we have used to evaluate asynchronous online learning networks, and to present a "Systems Component Contexture Model" that we have developed for conceptualizing the evaluation of online learning networks. We have selected three questions for discussion. For each question, we will discuss the models and methods used to examine the question, the theoretical framework or perspective underlying each model, mode of inquiry, data sources, and a critical analysis of the application of the model.

Introduction

We have previously defined evaluation as a

> *"... systematic and purposive inquiry that includes the collection, analysis, and reporting of data relating to the efficiency, appropriateness, effectiveness, and value of operational characteristics and outcomes of a procedure, program, process, or product."*

Traditional evaluation methods used to evaluate the effectiveness of learning within the four walls of a classroom do not transfer well to the varied contexts included within the umbrella designation of online learning networks. Because a "network" may be used in distinguishing any set of people, organizations, or other social entities connected by socially meaningful relationships the term can be broadly applied to many learning projects from course-based instruction to professional development conferences. In addition, online learning designs are often based on constructivist, learner-centered principles which provide more learner control, facilitate the sharing of multiple perspectives, and place emphasis on the collaborative construction of knowledge occurring within a group of learners. Objectives, either behavioral or cognitive, with a stated outcome for all learners within a fixed period of study are not the goal of many online learning projects. We, as evaluators are challenged to understand the unique characteristics of the sociotechnical network created in the online medium and its social, organizational, and ecological structure in order to develop new principles for examining and evaluating learning.

Our evaluation team finds it useful to divide the variables we examine into three categories: descriptive, process, and outcome variables. Descriptive variables address the context, setting, and characteristics of the participants before the course, program or learning event. Included among descriptive variables we have studied are the organizational setting, demographic characteristics of faculty, staff and learners, and the participants' attitudes and levels of experience. Process variables describe the process or program implementation including needs assessment, design, technology, and the types and levels of interaction and learner support provided. Program outcome variables include participant satisfaction,

performance, learning, and impact. This framework encompasses a broad listing of evaluation questions. More complex questions typically involve examining the interrelationships between variables from two or more of these categories.

Online Participation, Interaction Patterns, and Group Dynamics

A question frequently asked when evaluating online networks is: How can we describe online participation, interaction patterns, and group dynamics? In relation to this question, we will critically analyze the model developed by Levin, Kim and Riel (1990) for analyzing instructional interactions on electronic message networks and the content analysis model developed by Henri (1992).

Levin, Kim and Riel's (1990) model has four dimensions of analysis: (a) Participant Structures Analysis, (b) Intermessage Reference Analysis, (c) Message Act Analysis, and (d) Message Flow analysis. This model was used by Gunawardena, Gittinger, and Dvorak, (1991) to evaluate a computer conference for medical students. This team found Intermessage Reference Analysis difficult to apply in the specific context; use of the technique generated a large message map that was difficult to decipher. In the experience of the present authors, even when the interrelationships among messages can be mapped out clearly little is revealed about the learning processes of participants. Levin, Kim and Riel (1990) acknowledged that patterns of message interrelationship sometimes had more to do with the dynamics and/or power structure of the group than with the cognitive freight of messages. For example, messages posted by the teacher generated a disproportionate number of responses. Likewise, a second technique presented by Levin, Kim and Riel, Message Act Analysis, dealt more with interrelationships among the participants than with development of course topics.

Message Flow Analysis is Levin, Kim and Riel's (1990) third technique for analyzing online interaction among course participants. This technique is based on tallying the number of messages exchanged by group members within specific time periods during the conference. This technique can be used to produce a graphic representation of the flow of participants' interest in a conference. Typically conferences start slowly, then experience a period of intense activity, and then gradually taper off to a desultory trickle. Levin, Kim and Riel thus provide quantitative verification of the participation patterns familiar by experience to most people who regularly participate in computer conferences. This technique seems most promising when we are looking for unusual patterns, as for example when we are attempting to determine whether a redirection of topic reverses the downward slide of interest. When used in this way, Message Flow Analysis may show the effects of message content, but the technique does not deal directly with content, per se. We feel it is difficult to prove that learning is taking place without looking at the evolution of message content (if any) during the progress of a conference.

Sudweeks and Simoff (1999) discuss an approach similar to Levin, Kim and Riel's (1990) in that they advocate use of multiple techniques and perspectives. Within this approach, the techniques they present for dealing specifically with CC include "Neural Network Analysis." This appears to be an extension of the Intermessage Reference Analysis procedure described above, originated by Levin, Kim and Riel (1990) , with the added feature that Sudweeks and Simoff apply numerical valuations to the strength of interrelationships between messages to produce a dynamic model rather than a map. The position of each message in time also forms part of its description in this system, although in

our experience the timing of messages in any asynchronous forum tends to reflect the demands on participants' time of their lives and work rather than the degree of participants' interest in the conference. Levin, Kim and Riel's (1990) Message Flow Analysis appears to provide a somewhat more realistic view of the growth and decline of interest in a conference.

While by adding numerical valuations to intermessage analysis Sudweeks and Simoff present a quantitative method of content analysis, they also present a qualitative method of analyzing the "dimensions" of a conference. The dimensions they identify overlap to some degree the message functions identified by Henri (1992) discussed later. It would be interesting to compare the use of the two systems on a single data set.

Informed by cognitive-information-processing theory, Henri (1992) has developed a content analysis model that provides a sophisticated, multi-dimensional analytical framework for evaluating online participation, interaction, and the learning process. Citing the "richness and efficiency" (Henri, 1992, p. 120) of computer conference transcripts in understanding the exteriorized internal cognitive learning process, she proposes examining the content of messages as an appropriate analytical method to identify the learning processes and strategies selected or developed by learners. Rather than mapping the messages, Henri suggests dividing messages into "units of meaning" and classifying these units according to their content or function within five dimensions: (a) participation and social interchange, (b) interactive content, (c) organizational intent, and application of (d) cognitive or (e) metacognitive skills.

The participative dimension is evaluated quantitatively and qualitatively by numbering messages and determining those statements related to the formal content of the lesson. Messages not related to formal content of the subject matter are coded as social. These statements are critical to the building of community, establishing social presence, and group cohesion. Henri's model then distinguishes between interactive versus non-interactive and explicit versus implicit interaction. This chain of interaction is represented as a three step process whereby 1) interlocutor A speaks to B; 2) B responds to A; followed by 3) A's answer to B. Organizational functions are statements that organize the learners in the accomplishment of educational tasks. Cognitive message units exhibit knowledge and skills related to the learning process in contrast to metacognitive statements showing self control or awareness and that demonstrate strategies relative to the self-regulation of learning.

In applying this model to the evaluation of an online debate discussed later, a number of shortcomings were found (Gunawardena et al, 1995). First, the model appears to be based on a teacher-centered instructional paradigm. For example, Henri states (p. 123) that "the educator can offer input at three levels: what is said on the subject or theme under discussion, how it is said; and the processes and strategies adopted in dealing with it... The educator may favor one or another level, according to his or her pedagogical aims and intentions." The paradigm described by Henri is clearly one that is widely applied, as many educators drawn to distance learning continue to recreate the traditional patterns of instruction in the new medium.

The second difficulty encountered by the authors in applying the model arose from the limited definition and treatment of the concept of interaction. Henri states that messages are either "monologic" or "interactive" and suggests further analysis based upon observing whose messages garner the most response. This is somewhat similar to Levin, Kim and

Riel's (1990) "message maps." However, this type of analysis is merely descriptive of individual student performance and the pattern of messages. It offers little insight into the contribution individual messages make to the emerging totality of constructed knowledge (Gunawardena et al, 1995). The analysis indicated the presence and frequency of participants employing cognitive skills, but was unable to explain the learning process taking place within the group through the process of interaction between participants.

In addition, the "unit of meaning" in the model is undefined. It is not based on a syntactical unit such as a phrase, sentence or paragraph, rather it is subject to an interpretative judgement on the part of the researcher. This was especially problematic when distinguishing cognitive from metacognitve units. The purpose of an easily identifiable unit is that multiple coders can reliably and objectively recognize the unit for recording, leading to an evaluation model that produces an interrater reliability that increases confidence in the validity of the data description.

The model is perhaps best suited for evaluation within an objective-based learning environment of defined membership However, is it also quite clear that such a paradigm is inappropriate for evaluating the quality of a learning event designed within a collaborative, social constructivist learning environment.

In concluding this section it is of interest to note a study in which McDonald and Gibson (1998) used transcript analysis to examine interpersonal dynamics and group development in computer conferences (CC). Research suggests that the nature of communication and group process is changed when interaction is computer-mediated, yet there is little evidence in the literature, other than anecdotal, that demonstrates groups can and do develop online. Using an adaptation of Henri's model, this study suggested that it was possible to identify specific criteria for use in content analysis with which to study group dynamics and development within an online environment. As Brookfield (1990) observes group dynamics are an important factor to be considered when planning for discussions and group work. This would include such considerations as the degree of cooperation, how the group organizes itself and how the dynamics of group cooperation are achieved. Evaluation questions for the future will likely include how do online learning networks promote collaborative learning? How does group development impact peer exchange and the social construction of knowledge?

Learner Satisfaction with the Online Learning Experience

Evaluators are often interested in determining whether learners were satisfied with their online learning experience. Did they feel that it had been a worthwhile use of their time, and one that they would be willing to repeat? We will discuss two studies (Gunawardena and Zittle, 1997; Gunawardena and Duphorne, 2000), that used survey data and regression models to answer the question: What are the variables that can predict learner satisfaction in online learning networks? Both studies are based on survey data from an inter-university CC that provided a forum for graduate students in distance education to share and discuss research, and experience distance education by using computer mediated communication (CMC). Gunawardena and Zittle (1997) used eight process variables to predict overall student satisfaction with the CC. Gunawardena and Duphorne (2000) explored predictors of learner satisfaction in a CC basing their analysis on the Adult Distance Study Through Computer Conferencing (ADSCC) model developed by Eastmond (1994). In this model, Eastmond identified three major aspects which sequentially influence the student's study

experience: (a) readiness -- the personal and environmental factors that prepare the student for study in this instructional situation; (b) online features -- the unique elements that make up the computer conferencing environment; and (c) learning approaches -- the general and specific learning strategies a student uses to make the conference an effective learning experience. Gunawardena and Duphorne tested the predictive power of the Eastmond ADSCC model by examining which of the three independent variables: learner readiness; online features; and CMC-related learning approaches, could best predict the dependent variable, learner satisfaction with an academic CC.

As with any survey-based research, both studies relied on learner self-reports in evaluating learner satisfaction. This always carries some potential for error; either learners may be tempted to answer in the way they feel is somehow more creditable or they may find that the way in which survey questions are asked does not fit their experience well. The use of qualitative data – in this case, allowing the participant to describe the conferencing experience in his or her own words – is a good counterbalance.

Knowledge Construction

Perhaps the most challenging question one can ask in evaluating online learning is: Was knowledge constructed within the group by means of the exchanges among participants? We will discuss two interaction analysis models we have used to answer this question. Initially, we began to use Henri's (1992) model to analyze the transcripts of a global online debate we had conducted as an adult professional development experience. However, it became clear that three aspects of Henri's model; its basis in a teacher-centered instructional paradigm, its distinction between the cognitive and the metacognitive dimensions, and its treatment of the concept of interaction, were unsuited for application to the debate.

In response to the perceived limitations of the Henri model, Gunawardena, Lowe, and Anderson proposed a new model (1997) for use in evaluating the construction of knowledge through social negotiation in online learning networks. This model developed a new definition of interaction for the online learning environment and used the metaphor of a patchwork quilt to better describe the process of shared construction of knowledge that occurs in a constructivist learning environment. Based on this new definition of interaction, and grounded theory principles, an interaction analysis model was developed that included five phases, reflecting the process of negotiation which must occur in a social constructivist learning environment. The phases of learning outlined in this model occur at both the individual and social level and can be described as: Phase I: Sharing/Comparing, Phase II: Dissonance, Phase III: Negotiation/Co-construction, Phase IV: Testing Tentative Constructions, and Phase V: Statement/Application of Newly-Constructed Knowledge.

Two major themes were observed related to knowledge construction when applying the model to the analysis of a debate. One was the progress of certain strands of argument from Phase I to Phase V, which can be described as an exercise in the co-construction of knowledge, moving from lower to higher mental functions. The other was the evidence of more than one and sometimes three phases within a single message posted by one participant, which usually progressed in sequence through the phases, showing progress from lower to higher mental functions, showing how individuals contributed toward the co-construction.

As the model has been applied to a succession of conferences, however, it has brought to light indications that many, perhaps most, conferences do not proceed beyond Phase II. Very often, participants share and compare their experiences and viewpoints on the course topic, and then when they find areas of disagreement they appear to "agree to disagree," rather than proceeding to negotiate new meaning as the social constructivist theory would suggest. It is still unclear how this discovery may be used to improve techniques for moderating conferences, or making whatever other changes are needed to increase the likelihood of new knowledge construction. Other drawbacks which may be encountered in using this method include the fact that it is time consuming and the fact that some message elements may be difficult to assign with certainty to a specific phase thus lowering interrater reliability.

Issues in Content Analysis

Analysis of the actual content of messages submitted and archived within an online learning network experience is a logical, appropriate and recommended means of evaluating the quality of the learning experience (Mason, 1991). Content analysis is undoubtedly one of the most powerful and important research techniques in the social sciences (Krippendorf, 1980) and holds high promise as an analytic method for the evaluation of the quality of learning in an online learning network. It is also a method found to be methodologically challenging to evaluators.

Content analyses are comprised of four basic steps. The first is a compilation or selection of the transcript(s) for analysis. Unique to the online learning network is the automatic creation of text-based archives of communication interactions that constitute the online forum. Downloading or accessing these files provides a ready data source for the evaluation. Second, the researcher develops a coding scheme for empirically identifying instantiations of the variable of interest and trains coders to implement the protocol. Following the transcript coding, coding decisions are compared for interrater reliability, that is, the extent to which different coders, coding the same transcript, reach the same coding decision. The final step is an analysis and reporting of the coded data either in describing the variable(s) or identifying relationships between variables. The extent to which the analysis and findings are credible and accessible to the evaluation audience is directly related to issues of reliability and validity. According to Potter-Levine Donnerstein (1999), "If content analysts cannot demonstrate strong validity and reliability for their findings, then people who want to apply these findings should be wary of developing implementations, especially when resource costs and client expectations are high."(p.258).

Reliability

Establishing reliability begins with the development of a coding scheme likely to activate similar psychological schema within different coders and result in a high degree of similar decisions among these coders as they assign message units to categories determined by the researcher as an instantiation of the construct of interest. Following coding, calculations are made to determine the level of agreement in coding decisions across coders, i.e. interrater reliability. Three difficulties are apparent. First, many studies simply do not report interrater reliability statistics leaving reliability in question. Second, while higher levels of agreement are obviously desirable, the exact level of interrater reliability that must be achieved has not been clearly established, forcing researchers to decide acceptable levels for themselves and reporting results largely uninterpretable for evaluation stakeholders.

Further, choosing a method of calculation is problematic. The most common method of reporting interrater reliability is the calculation of a simple percent agreement statistic (Holsti, 1969), yet a number of methodologists declare this practice inadequate by failing to account for chance agreement (Krippendorf, 1980) recommending far more conservative statistics; i.e.Cohen's kappa (k) or Krippendorf's alpha. Still others debate these statistics as too conservative and constraining to the researcher. See Potter and Levine-Donnerstein (1999) for a detailed explanation.

Validity

Further exacerbating this dilemma is the issue of the trade-off between reliability and validity. As Krippendorf notes, reliability often gets in the way of validity (1980). The design of a coding scheme sufficiently detailed as to provoke few disagreements across coders in assigning coding decisions often lowers ecological validity. Establishing validity in content analysis is a two-step process: first, developing a coding scheme that is faithful to the focal concepts of the theory and second, assessing the decisions made by coders against some standard. According to Potter & Levine-Donnerstein (1999), if codes match the standard for correct decision-making, then the coding is regarded as producing valid data. Yet, surprisingly little attention has been given to the validation issues surrounding the development of coding schemes. Determining validity implies the existence of some sort of standard or sound theoretical basis for the evaluation of social learning that occurs within an online learning network. Without a descriptive model of the ideal collaborative learning process we cannot even begin to identify empirical indicators or instances that will form the basis of a coding scheme as a standard against which to evaluate whether or not effective learning is occurring within the network.

Potter and Levine-Donnerstein propose the resolution of these issues based upon carefully developed coding schemes that sufficiently activate focal concepts of theory and provoke a high degree of congruent judgements (i.e. intersubjective congruence) thus maintaining both ecological validity and high reliability. In surveying the methods and models employed in the evaluation of online learning networks, the exploitation of content analysis techniques in evaluation studies is particularly inviting. In our current studies we are attempting to develop coding tools that are reliable, efficient, effective, and valid in the empirical investigation of online learning.

The Systems Component Contexture Model

Thus far this paper has presented an overview of the approaches used and challenges faced by the authors in the evaluation of online learning networks and focused on answering three frequently asked evaluation questions. Each of these questions provide the evaluator an opportunity to address a number of variables: descriptive, process, and outcome albeit in a decontextualized manner. Indeed, much of the evaluation and research in online learning is based upon focused inquiry directed at one or another variable comprising only one or two components of the network often disregarding the organizational context in which it is embedded. This has led to a somewhat fragmented understanding of the functioning of the socio-technical system as a whole.

The very complexity of the interrelationships of these variables has led us to develop a model based upon systems theory and extant research that can be used as a unifying conceptual tool for component analysis and further research. As Coldeway (1988) has

suggested, component analysis is an especially effective way to combine the benefits of evaluation with a potential of more generalizable research. Component research formatively analyzes each component in a course or a system to determine the overall impact or level of contribution each makes to the larger picture of the learning network. Evaluation questions are formulated to answer questions within or across components. Adding the multi-level analysis to the component evaluation model, represents an attempt to make explicit the cultural and organizational setting in which the technology of the online learning network is employed. This provides the foundation for consideration of the effectiveness of the online learning events at a number of levels simultaneously, and the identification of the trade-offs between them. To what degree, for example, does the online learning network support the social learning desired and to what extent does this paradigm complement existing institutionally supported pedagogical practice? To what extent is it economically feasible to train instructors and design teams to adapt to new collaborative learning philosophies in order to utilize this virtual medium to its fullest potential?

The System Component Contexture Model provides the opportunity to integrate various knowledge bases in addressing not only these questions but also other equally important variables, by incorporating theoretical notions such as interaction, social presence, transactional distance and learner control. It consists of examining the level of influence of four components of the online learning network at three levels. By explicitly distinguishing the components at different levels, the interests and impact of all participants and variables within the context are brought sharply into focus. In our current work, we distinguish between and highlight the importance of researching all component processes that contribute to and impact an online learning environment - including teaching, learning, communication, design, management, institutional mission, and socio-cultural context. Few studies document these components in relationship to the effectiveness of the overall program of which they are a part. Our model incorporates the components of the system; the institutional context, and the instructional experience, connected by extensible bands within a resiliency framework.

The function of the evaluation then may be extended to include a systematic monitoring of the pressure pulls of each component and the ultimate effect on the learner. The model accounts for the dynamic connection of each component at multiple points; represented by ovals in the diagram (see page 12.) These connections exist in a state of pressure. In a robust system, a state of equilibrium (symmetry) exists. At any given pressure point, however, an ineffective, inefficient, or inappropriate practice, method, or preparation elicits a pressure pull on the extensible band (connection) connecting one component to the system. While these pressure pulls may originate from any level of any component, their interconnectivity results in an effect that is ultimately felt throughout the system and is therefore, detectable at several levels. Measurement is not always systematic, hence the need for frequent, formative, and multiple methods of measurement. An example may serve to enlighten these dynamics; the voice of student dissatisfaction with delivery technology, i.e. synchronous versus asynchronous software (Level 3/ Context Component decision) may be clearly heard in a survey-based evaluation of an online course (Level 1/ Control Component impact).

Each component possesses a certain inherent ability to adjust to ineffective elements within it. This ability is component resiliency. Just as an extensible band can accommodate and adjust to changing pressures, so too can a component adjust and maintain the integrity of the system. Ultimately, if the pressure exceeds the ability of the band to accommodate the

pressure (resiliency), one or more of the bands will disconnect at the defining point. In an online learning network as the upper level of the resiliency factor is approached, the component is rendered increasingly ineffective. Due to the interweaving of the conjoined bands an negative impact will be exerted on the entire system equilibrium.

Levels

The first level of influence is institutional experience, which encompasses the educational philosophy, mission, resources, and management of the institution within which the online learning network program is housed. The next level incorporates all aspects of the mediated curriculum including the epistemology of the instructors, the course design team, the knowledge resources, the choice of media, and the activities designed in support of the learning events. The final level is the learner level that includes, learner characteristics, life situation, prerequisite skills, attitudes, and goal orientation.

Components

The four components of the model are: Content, Context, Collaboration, and Control. The content component is concerned with the topic area of the course or program being evaluated. Evaluation at this level concerns: the place of this course or program within the institutional mission (mission-specified program, core program, elective course, pilot project, course component, conference etc.) and the relationship of the program to the achievement of the institutional goals. From the instructional level, the questions center on course structure, instructional design, instructional goals, objectives, and anticipated outcomes relative to the specific subject matter, as well as sources of knowledge and available resources. On the learner level, evaluators address prerequisite skills, attitudinal factors specific to content, and goal orientation.

The context component examines situational, environmental factors. At the institutional level, evaluation questions address the management of the institution, cost-benefit analysis, support of the delivery technology, support for student, staff, and faculty needs, faculty-student ratios, and the ability for increased capacity (i.e. the degree of flexibility for program expansion). Second level questions look at professional development for staff and faculty, faculty experience with technology, and the choices of technology available. From the learner level, such things as learner support, and technology training are considered.

The collaboration component includes intra-institutional collaboration as well as inter-institutional collaboration, including external alliances with like institutions and support for cross-departmental course design teams. These factors largely impact instructor-student interaction and student-student interaction at the learning event level. The pressure pulls in this component are straightforward as evaluators address situational opportunities provided for group processes resulting in the social negotiation of meaning.

The final component deals with issues surrounding learner control. The focus of the evaluation of this component is on learning and the assessment of learning. At an institutional level, factors will include the assessment philosophy, indicators for student achievement and success, entry and exit and external accreditation requirements. At the instructor level, evaluation questions will be asked based upon instructor epistemology,

learning theory perspective, and choice of instructional design and media. At the level of the learning event, learner control, and level of learning will be addressed.

The model forms the basis for an evaluation plan that provides a contextual framework firmly grounded in past distance education research from which to conceptualize, analyze, and make decisions related to the teaching/learning situation within which an online learning network is embedded. Descriptive, process, and outcome variables can be examined within a social context. This conceptualization can encourage theoretical speculation and formulation by reducing complexity as well as providing a means to operationalize relatively abstract variables.

To summarize, the function of a systems-component contexture evaluation is to systematically monitor the pressure pulls of each component and the relationship each level of each component ultimately has upon the learner. The questions that we ask as we evaluate, and the instruments we choose to employ, enlighten and inform us about some aspects of each component while leaving us ignorant of other components. The use of this holistic model provides a framework from which to determine those questions left unasked as well as the opportunity to draft new questions for the future.

Conclusion

In order to improve our understanding of how to use online environments to foster learning, it is important to examine the online learning experience from multiple points of view. This paper has touched on a number of models which have been suggested by those interested in evaluating and researching online learning environments. We believe that no single technique for analyzing the quality of online learning experiences can yield complete answers. The complex nature of online learning calls for the use of multiple methods and multiple sources of data to understand group as well as individual learning. The Internet is an ever-changing phenomenon. We advocate the use of multiple approaches in studying online learning networks in order to obtain a wider picture of this dynamic learning environment.

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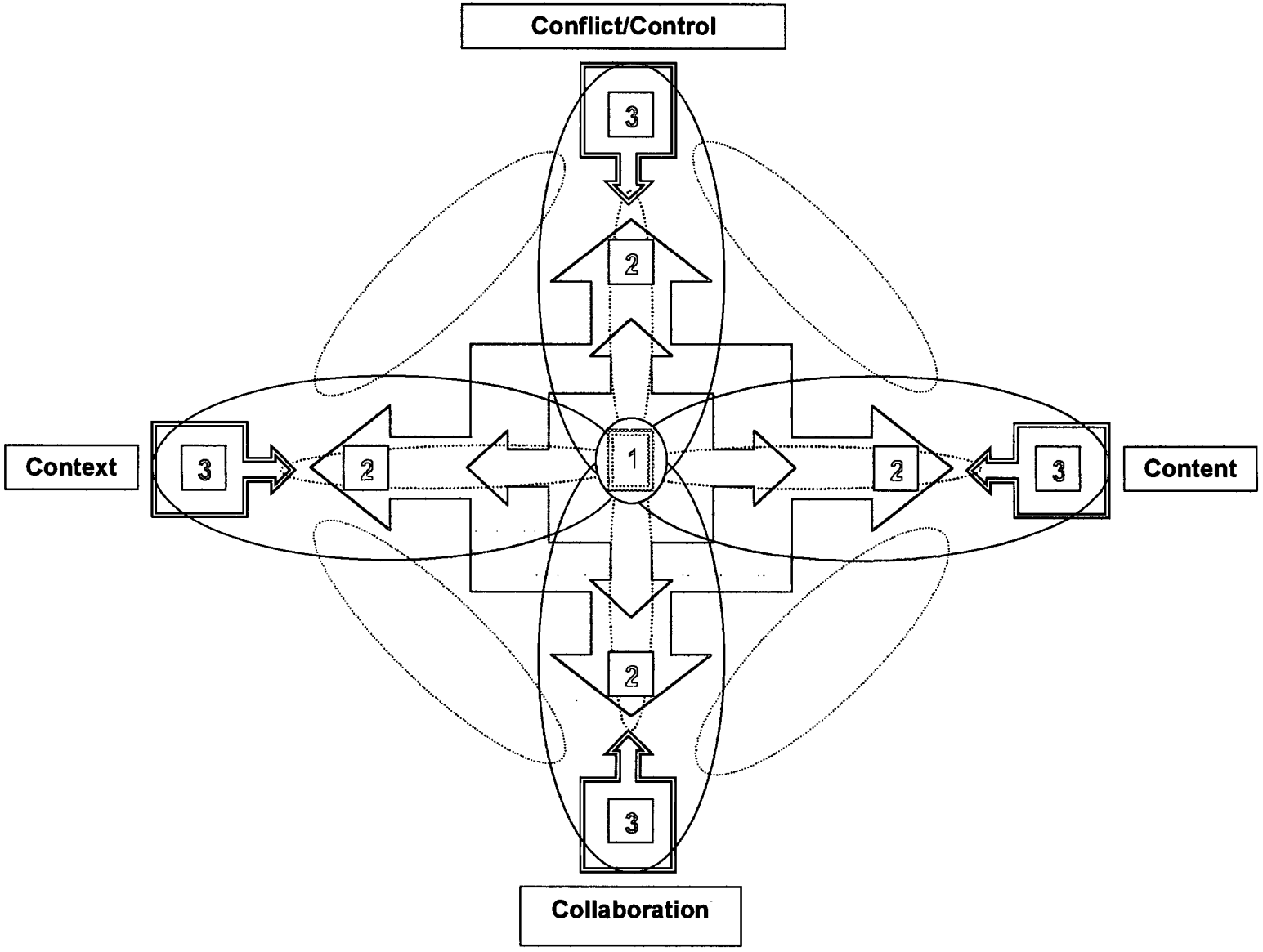
The Systems Component Contexture Model (in Equilibrium).



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I. DOCUMENT IDENTIFICATION:

Title: Critical Analysis of Models and Methods Used to Evaluate Online Learning Networks

Author(s): Charlotte N. Gunawardena, Kayleigh Carabajal, Constance A. Lowe

Corporate Source: Paper Presented at the Annual Meeting of the American Educational Research Association, April 10-14, 2001, Seattle, Washington

Publication Date: 2001

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