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ABSTRACT

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A SYSTEM-SCIENCE APPROACH TOWARDS MODEL CONSTRUCTION FOR CURRICULUM DEVELOPMENT

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Abstract

A new morphological model based on modern system science and engineering is constructed and proposed for curriculum research and development. A curriculum system is recognized as an engineering system that constitutes three components of clients, resources, and knowledge. Unlike the objective models that are purely rational and neatly sequential in curriculum development, this new model captures the complex interactions between a curriculum system and its social context. In the morphological model, decision-making is a core action to direct system evolution in research and development. With the engineering concept of life cycle in curriculum research and development, processes of cyclic evolution of curriculum system from problem domain to solution domain can be identified and supervised.

Introduction

To face the coming of the twenty first century, a scientifically objective-oriented methodology for curriculum development, which has been employed and dominated in this century, now encounters the challenges overwhelmingly coming from all around the educational society (Jackson, 1992). In the future, the trend of curriculum development is still unpredictable. However, whether the curriculum itself will evolve from the stage of prosperity back to its initial infancy or it can overcome the crisis of curriculum theorizing to become mature and robust, the fate all depends on the related participants in the curriculum development. Optimistically, as scientific evolution stated by Kuhn (1962), the current crisis of curriculum theorizing may imply that a new era of changing tool and methodology for curriculum research and development is coming.

The phenomenon of curriculum development is a rather complex, diverse, and dynamic behavior. However, if the curriculum itself can be recognized as a system, the curriculum development should follow a general procedure and evolve under generic governing rules (Checkland, 1981). Generally speaking, the curriculum design and development according to the curriculum researchers should include six stages: needs assessment, planning, design, realization, implementation, and evaluation (Beauchamp, 1975; McNeil, 1996; Pratt, 1980; Zais, 1976). By considering a curriculum system as a subsystem of education system, then the processes of curriculum changes will be consistent with those of education changes with four stages: research, development, dissemination, and adoption (Clark & Guba, 1967). If the curriculum field is regarded as a scientific discipline, the curriculum development should follow the pattern of scientific development. The curriculum development, as scientific development modeled by Popper (1965), can be recognized as initiated from the existence of curriculum problem and ended before the appearance of a new problem. Thus, with the system view and appropriate model on curriculum development, the complex dynamic behavior can be predicted, supervised, and even managed.

In this paper, the curriculum development is studied and treated from the viewpoint of modern system science and engineering (Blanchard, 1991; Checkland, 1981). The first part will be devoted to identify the importance of proposing real questions in curriculum research. Then, a general review of contemporary viewpoint and issues on curriculum design and development is given. Next section is devoted to the construction of research and development model. By recognizing the contemporary curriculum system as a class of modern engineering system, a morphological model of research and development is proposed. Finally, the essence, role, and use of the present model in curriculum research and development are concluded.

Problem and Research

Problem is the core for stimulating and activating the intellectual behavior of researches. With the existence of problems and the difficulties to solve problems, a series of knowledge-based activities including inquiry, exploration, discovery, and applications can be evolved (Ziman, 1984). For the initiation and existence of problems, the propositions and reasoning by different researchers are diversified (Runco, 1994). However, recognizing the existence of problem depends on the subjective perception and desire of observer, objective phenomenon and situation of the problem, and the interactions between the subject and object.

Problem recognition and solving, essentially, is an intelligent psychological and physical behavior of learning and practicing (Leahey & Harris, 1996). For the research of such a complex intellectual activity, Thorndike first conducted an experimental study to obtain his learning theory as a trial-and-error process. Relative to the proposition of trial and error, Kohler conducted his experiments and realized that a problem was solved whenever an insight occurred after seeing all relevant parts and situation of the problem. The arguments of propositions on learning and problem solving between behavioristic psychologists and Gestalt psychologists have stimulated the revolution of modern cognitive psychology. Cognitive psychology, as stated by Neisser (1967), refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. The fact that cognitive psychology is often called human information processing reflects the predominant approach to the learning and problem solving used by cognitive psychologists. From the cognitive psychology, the solution of problem is viewed as an activity of searching through the problem domain for a solution path, a path connecting the start state and the goal state. Either algorithms or heuristics can be used as solution procedures. Recently, the behavior of cognition and problem solving is viewed from the theory of multiple intelligences. Gardner (1983) defined intelligence as the ability to solve problems or make products. From Gardner's investigation, seven categories of intelligences are identified and proposed for problem solving.

To recognize and solve curriculum problems, a scientific and systematic approach is required in the curriculum research. With the recognition of curriculum problem, knowledge-based activities of learning and practicing can be evolved for problem solving. Often, the most difficult aspect of problem solving is understanding and defining the real or underlying problem. The importance of defining problem is just as asserted by Einstein "The mere formulation of a problem is far more often essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle requires creative imagination and masks real advances in science." By employing the statement of Einstein on interpreting the scientific research in curriculum, proposition of real questions to guide curriculum research can be recognized as true advances in the curriculum field. In 1949, Tyler published his book "Basic Principles of Curriculum and Instruction" which marked the advances of scientific research of curriculum with four core questions: 1. What educational purposes should the school seek to obtain? 2. What educational experiences can be provided that are likely to attain these purpose? 3. How can these educational experiences be effectively organized? 4. How can we determine whether these purposes are being attained? With the scientific rationalization of curriculum by Tyler, elementary components and procedures for curriculum design and development are illuminated.

Curriculum Design and Development

Curriculum design is concerned with the nature and arrangement of four basic curricular parts. The parts, sometimes called components or elements, that are arranged in a curriculum design are (1) aims, goals, and objectives; (2) content or subject matter; (3) learning experiences/method and organization; and (4) evaluation approaches (Ornstein & Hunkins, 1998). The four components in design suggest to the curriculum maker four questions: What is to be done? What subject matter is to be included? What instructional strategies, resources, and activities will be employed? And what methods and instruments will be used to appraise the results of the curriculum? The Tyler model mentioned four components of curriculum design including purposes, educational experiences, organization of these experiences, and evaluation. Tyler's model is very similar to a model that Harry Giles developed several years earlier (Giles, McCutchen, & Zechiel, 1942). However, Gile's model denotes ongoing interaction among the components, while Tyler's model shows linear relationships among the key elements.

Curriculum design involves various philosophical or theoretical issues, as well as practical issues. A person's philosophical stance will affect his or her interpretation and selection of objectives, influence the content selected and how it will be organized, affect decisions about how to teach or deliver the curriculum content, and guide judgements about how to evaluate the success of the curriculum developed.

Curriculum development is not static. The components to consider in developing a curriculum consist of not only curriculum content and curriculum experiences but also educational environments and participants in developing the curriculum (Ornstein & Hunkins, 1998). As we cannot separate content from experiences in the actual delivery of a curriculum, neither can we divorce the experiencing of content from the environment within which experience occurs. Educational environment is crucial to meaningful educational experiences. The environments should facilitate students' attending to the experiences and content that they have selected and organized. Educational environments should engage, challenge, and arouse students regarding their learning. Educational environments should address social needs, security needs, and belongingness needs, as well as the development of inner awareness, appreciation, and empathy for others.

Developing a curriculum involves a large number of persons, both school based and community based. It also involves different levels of planning: the classroom level, the school level, the national level, and even the international level. In fact, concern among people or groups for certain types of curricula makes curriculum development largely a political activity in which there is competition for authority and control, for scarce resources, and for primary of certain values (McNeil, 1996).

Research and Development Model

The curriculum research and development ever since 60s, has been gradually deviated from the paradigm of classical scientific and psychological approaches. Actually, ever since Bobbitt (1924) proposed and coined the subject of curriculum, the framework of Bobbitt's activity analysis and Tyler's objective-based design now faces the crises in curriculum field (Tanner & Tanner, 1995). The curriculum research turns to humanistic tradition of philosophy, sociology, history, etc. to grasp new concepts and methods. For instance, the development of reconceptualization theory (Pinar, 1975) is an attempt and inquiry for developing new approach in curriculum studies. However, philosopher Phillips defended that natural science was still an appropriate model for educational research (Phillips, 1987). The current crisis in using scientific or humanistic method may just mean an epoch for the paradigm shift (Kuhn, 1962) in curriculum design and synthesis in the next century.

Curriculum design and development is a core activity in curriculum research. For the related activities and literatures in curriculum design and development, the early work was mainly concentrated on the practical activities in design and development (Jackson, 1992). These practical activities in general were called curriculum making and/or construction by curriculum researchers. Recently, Beauchamp (1975) proposed the concept and terminology of curriculum engineering for curriculum development. Curriculum engineering is used to denote all the processes and activities in curriculum development including analysis, planning, design, realization, adoption, reform, etc. By recognizing the curriculum system as an engineering system, the concepts, techniques, and approaches in analyzing and synthesizing an engineering system can be readily applied to solve curriculum problems. Actually, a modern curriculum system, just likes an engineering system, that constitutes a combination of different components integrated in a manner to fulfill a designated need. In addition, a modern curriculum system as an engineering system encounters the same environment with greater influences from society, economics, politics, and new technologies (Blanchard, 1991; Cornbleth, 1990). As a result, for a curriculum system in such a modern environment, the curriculum system can be characterized as an open dynamic system with complex interactions between the system and its social environment.

Traditionally, method in curriculum design and development mainly realizes the Tyler's rationale with four elements: objectives, activities, organization of the activities, and evaluation. The Tyler's rationale was technically realized as a linear objective model and the curriculum development is undertaken to meet design objectives. Recently, the necessity of "re-activity" in modern curriculum development is realized and proposed by curriculum specialists. Walker (1976) proposed changing the image and idea about the behavior and process of curriculum development. The essential elements which influence the development process including issues of power, people, procedures, and participation were identified (Gay, 1985). Modern concept of design in curriculum as an engineering approach for problem solving was proposed (Feyereisen, Fiorino, & Nowak, 1970). Decision-making was emphasized as a core action to direct the processes of curriculum development including planning, design, implementation, evaluation, improvement, reform, change, etc (Doll, 1996; Wulf & Schave, 1984). With above propositions on a contemporary curriculum system, a model to express the evolution of system integrated with technologies and life cycle is essential in managing system performance and development.

Construction of a curriculum research and development model is of great importance to guide, predict, and manage modern curriculum activities in life cycle. Actually, model construction is an essential and unique approach in science and engineering to handle complex problems. The same role and use of model in the curriculum field are also identified and emphasized by curriculum specialist (Pratt, 1980). In the construction of a curriculum model, a system boundary needs to be first identified for distinguishing the internal system from its external environment. By noting the knowledge based in curriculum research and the participants and resources involved in curriculum development (Checkland, 1981; Gay, 1985; Ziman, 1984), a macro system-context model with system boundary will be depicted as shown in Figure 1. In Figure 1, three components including clients, resources, and knowledge are identified and enclosed by system boundary. The system boundary is represented by a dash line to indicate the characteristics of an open system that allows the complex interactions between the internal system and its external social environment. With this macro system-context model, the development of curriculum can be viewed as an evolutionary process rather than a design process through its life cycle.

The development of curriculum in life cycle is affected by various interactions of forces (Nicholas, 1980). However, the life of research and development process, as a scientific process of problem solving indicated in the Problem and Research, is recognized to initiate from problem domain and to end with results in solution domain. Further development to continue the life cycle of curriculum system depends on the decision-making by the subject of clients, resources, and knowledge in curriculum system, the object of society, and the interactions between the subject and object. Although the application of four elements of Tyler's rationale in technical design process is critiqued for developing a curriculum, fundamental procedures in system development such as analysis, planning, design, realization, and operation are usually required (Blanchard, 1991). As a result, a morphological model of curriculum research and development to integrate system technologies and life cycle is proposed and depicted in Figure 2. In Figure 2, the activities of system engineering and logical sequences in system development from problem domain to solution domain in the life cycle of curriculum system are expressed. The curriculum problem is first perceived, recognized, and identified in the social context. The engineering technique employed in this stage is the 5W1H method, which is usually used in system management (Davis, 1994). The 5W1H method consists of raising six questions with what, why, who, where, when, and how for problem inquiries. Through using the 5W1H method in problem inquiries, the statement of problem can be defined and the boundary of curriculum system including clients, resources, and knowledge as shown in Figure 1 can be identified. With the problem statement and boundary of system, the development process then moves to the second stage. In this stage, the activities of curriculum engineering consist of a series of iterated processes from analysis, design, to implementation. Since the problem statements and boundaries of curriculum systems are varied according to different curriculum problems and social contexts, the reflections in the problem statements, designs, and implementations are different. If the curriculum problem is identified as a specific knowledge-center problem, then the traditionally technical design process for curriculum development can be employed and realized. The iterated results obtained in this stage from curriculum analysis, curriculum design, and curriculum implementation will be inputs to the next engineering decision stage. In this stage, the decision to select a continuation or "disjointed incremental" (Kirst & Walker, 1971) process of development will be determined by the subject of curriculum system, the social context, and the iterated output results from the previous stage. The final subjective and/or objective decision with previous results will move to the solution domain for curriculum adoption and dissemination or return back to the previous stage for improvement, revision, or change. Here, it is noted that the output solution from the stage of decision-making is actually an acceptable solution under system constraints. This means that the solution is nothing but a relatively optimal solution by trade off in engineering sense. Whenever the optimal condition is changed, new problem will be initiated and thus the development process moves back to the initial problem domain. As a result, a cycle of life of curriculum system is complete and a new cycle of curriculum evolution begins and continues.

Conclusions

An approach by modern system science and engineering is employed for handling the contemporary issues of curriculum development. The contemporary curriculum system is recognized as a class of modern engineering system that constitutes three components of clients, resources, and knowledge. With features of complexity, diversity, and evolution in the curriculum development, a new morphological model of curriculum research and development is proposed. In the present morphological model, an objective-based technical model is included as a method of curriculum development for a specific knowledge-center problem. Traditional activity of design in curriculum development is regarded as a process embedded in the present model for solving curriculum problem. Engineering decision-making is a core action to direct the trend of curriculum development. With the constructed morphological model of curriculum research and development, the evolutionary trend of curriculum system can be predicted and guided and the activities of curriculum development can be supervised and managed.

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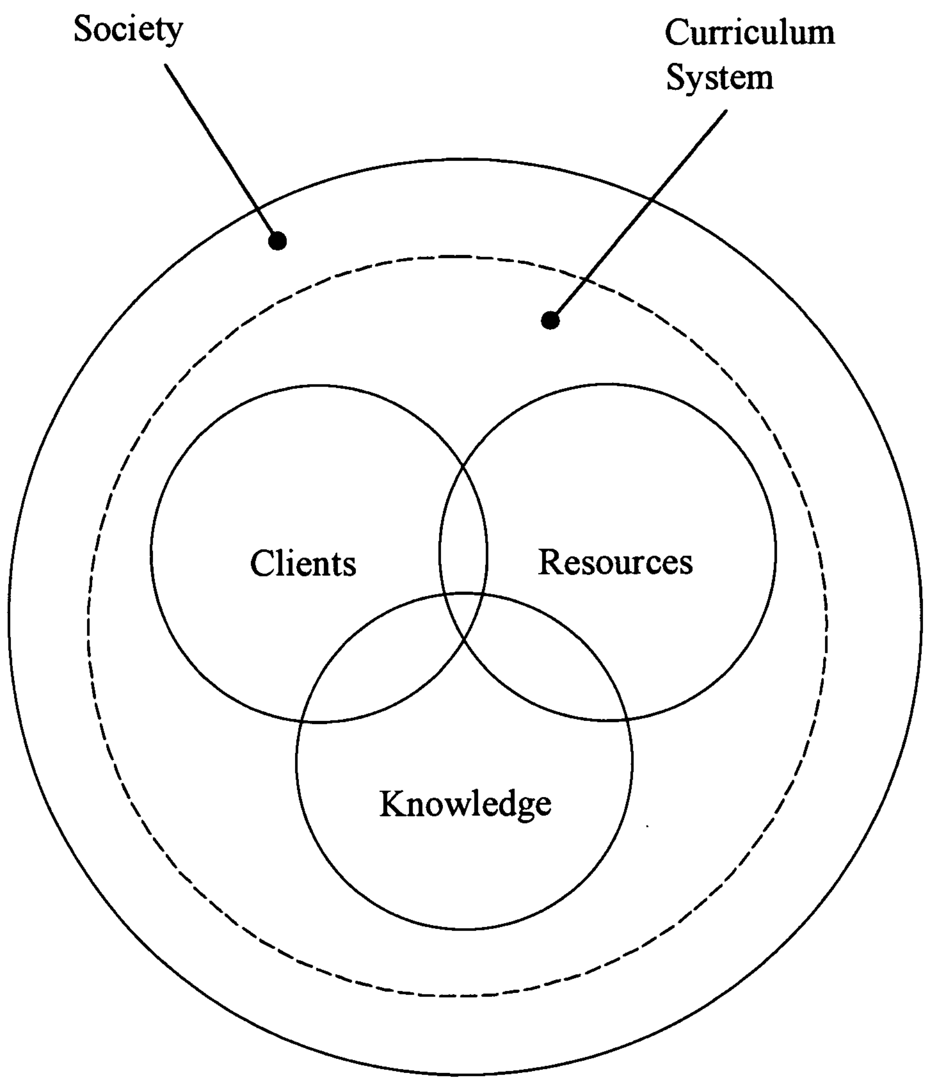

Fig.1 System-Context Model

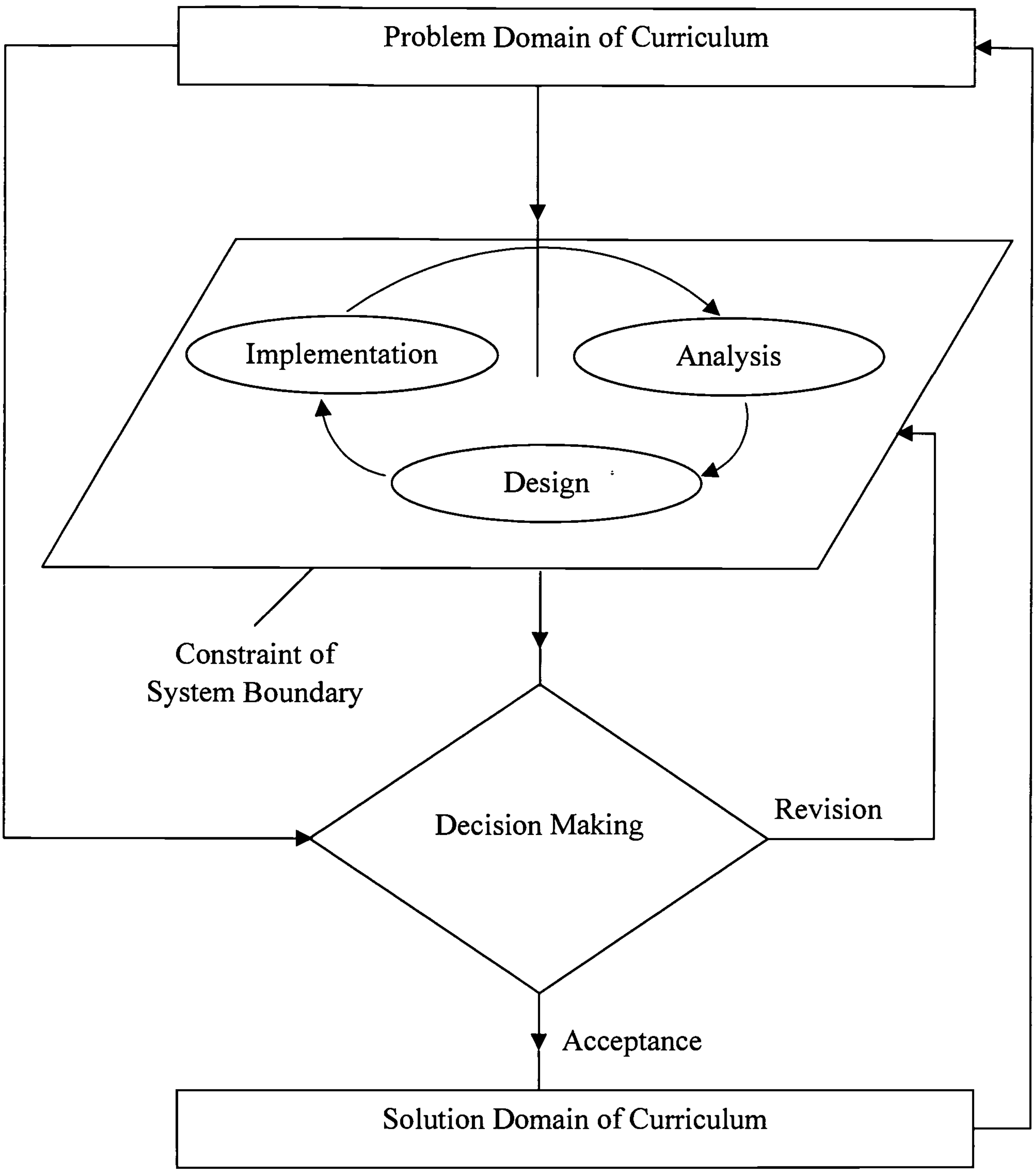

Fig.2 Morphological Model of
Curriculum Research and Development

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