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A Group Problem-Solving Model for the CIS Curriculum

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Abstract

The development of problem solving, abstraction, and design skills through group activities and projects was prescribed in the revised curricula for Computer Science and Information Systems. Myers' Zig Zag problem-solving model is adapted into a group problem-solving model, Group Zig Zag, for use throughout a curriculum. In this paper, we describe our initial efforts at introducing this model into three CIS course sequences.

Introduction

The Association for Computing Machinery (ACM) and the Data Processing Management Association (DPMA) have continuously undertake curricula development and standardization to address the education needs of future professionals. The latest curriculum guidelines (ACM, 1991; Fournier, Longenecker, Feinstein, & Reaugh, 1993; Longenecker & Feinstein, 1991) emphasize the development of problem-solving skills in concert with project and team activities.

The purpose of this paper is to describe a group problem-solving model and our initial efforts at introducing the model into selected courses at our institution. The remainder of this paper is divided into four parts. The first section provides an overview of problem solving in the CIS curriculum and its relation to psychological types. The second section describes the Group Zig Zag model. This is followed by a section describing the prototype usage in three CIS courses. The final section gives benefits and future directions for the use of the model.

Problem-Solving

For CIS problems, a "reflective" problem-solving approach is fundamentally important for communicating a clear explanation of a solution (Aiken, 1991; Soloway, 1986). A "reflective" approach in CIS problem situations translates into the consistent adoption and usage of design methodologies. Studies by Messer (1976) and Merrienboer (1988) suggest that impulsive problem-solving behaviors typically lead to incorrect, suboptimal,

and incomplete CIS problem solutions and that performance is improved when reflective behavior using established design methodologies is adopted.

Psychological Types. One well-known problem-solving model based on the Myers-Briggs Type Indicator (MBTI) that cultivates a reflective approach to problem-solving is the Zig Zag model (Myers & Myers, 1980; Lawrence, 1982; McCaulley, 1987).

The MBTI is a standardized instrument developed by Katharine Briggs and Isabel Myers (Myers & McCaulley, 1985) to test Jung's theory of Psychological Types (Jung, 1971) and to make the theory understandable and useful in people's lives. In Jung's theory, the two ways of perceiving information (Sensing and iNtuition) and the two ways of making decisions (Thinking and Feeling) are influenced by psychological preferences. In addition to the mental processes for perception and judgment, the MBTI gathers preferences for their application to life and the outer world. Results are reported as a four letter code, with each letter indicating the direction of preference in each of four bipolar dimensions. The Extraversion--Introversion dimension deals with preferences for focusing attention; the Sensing--iNtuition dimension, for perception; the Thinking--Feeling dimension, for decision making; and the Judgment--Perception dimension, for preference between perception and judgment when dealing with the outer world. Broad applications of the MBTI focus on individuals, interpersonal relationships, and group interactions.

The Zig Zag's sequencing of mental processes is Sensing Þ iNtuition Þ Thinking Þ Feeling. This sequencing mandates a transition from the mental processes for perception (Sensing, iNtuition) to those for decision (Thinking, Feeling). During perception, facts gathered by Sensing are then analyzed by iNtuition for possibilities. During decision, facts organized by Thinking are then evaluated by Feeling in accordance with the problem requirements. An individual applying Myers' Zig Zag model is placed in a reflective mode of focus--in MBTI terminology, an attitude of INTROVERSION. The Zig Zag model therefore associates previous CIS research on problem-solving with the rich vocabulary of the domain of psychological type theory. In the next section, an extension of the Zig Zag model for use by groups is described.

Group Problem-Solving

Students benefit from a collaborative learning experience (Webb, 1982; Slavin, 1980; Pardue, Doran, & Longenecker, 1991). The influence of individual psychological types in group situations has been found to be a potential source of communication dysfunction if not properly managed (Myers, 1979). Thus individual psychological types of team members influence the effectiveness of formal problem-solving methodologies.

The Group Zig Zag. The model obtained by adding a new dimension, FOCUS, to the Zig Zag model is called Group Zig Zag. A generic diagram of this Group Zig Zag model is shown in Figure 1. The model consists of the four mental processes (Sensing, iNtuition, Thinking, and Feeling), two attitudes (Extraversion and Introversion), and two types of generalized transition states (directed lines between mental processes or attitudes). One kind of transition occurs between mental processes in the same attitude (Introversion or

Extraversion). The second kind of transition occurs between two attitudes within the same mental process. The model is a representation of an individual's mental processes and attitudes in a group problem-solving environment. There is a representation for each group member. The Zig Zag model occurs when the only attitude is Introversion.

Adding a new dimension is an explicit way of emphasizing the responsibility of each member to communicate during the group problem-solving effort. To communicate with group members, an individual must consciously shift between a reflective attitude (focus within--Introversion) to process ideas of group members and a sharing attitude (focus on the external world of the group and the shared problem--Extraversion) to effectively interact with group members. Figure 1 represents a very abstract, stylized model of what actually transpires in a group problem-solving session. Although the process is depicted as strictly linear and non-iterative, in practice there can be considerable variation in the number of iterations of mental processes and frequency of attitude transitions. The attitude state (Extraversion or Introversion) might not be simultaneously used by all members--some may be focusing on the outer world while others are focusing on their inner world.

Initial Usage

Three modes of usage in a curriculum are defined as a means of managing, in a step-wise manner, the development of group problem-solving competence in majors. The three modes of usage are summarized in Table 1. The remainder of this section is used to describe our initial efforts at implementing the model in our curriculum.

Computing I and II. The objective of our Computing I and II is to develop individual CIS problem-solving skills and a basic understanding and awareness of the concepts, theories, and paradigms of the computing sciences (Doran, Longenecker, Pardue, 1993). A primary goal is to establish the application of a reflective problem-solving methodology as a standard practice by a student. The Zig Zag model was taught as an individual problem-solving model.

Mode 1 usage is used in both in-class exercises and lab assignments. During in-class exercises, the instructor directs attention to mental processes and regulates transitions. During bi-weekly 1-hour lab sessions, the instructor allocates a specific amount of time for the production of a clearly defined set of deliverables for each lab assignment, viz., a clear statement of the problem, an outline of the problem specifications, a set of data flow diagrams with data dictionary, and a control flow diagram. Mental process transitions are self-regulated by student teams of three to five members.

IS Applications Development Sequence. The IS applications development sequence is a series of three junior-level courses formulated according to the DPMA IS'90 model curriculum (Daigle & Kemp, 1993, 1994, 1995).

In this sequence, problems more closely approximate those encountered by CIS professionals. Projects are more complex, are not merely subproblems of a larger whole,

require substantially more time to accomplish, and are completed both individually and in teams. The software engineering and formal problem-solving principles learned in the Computing I and II sequence is extended by introducing a relational database emphasis.

The Group Zig Zag is used in Mode 1 for the first two courses and Mode 2 for the third course. In the first course, the entire class functions as a single, instructor-managed team in a classroom setting, but individual solutions to the large-scale course project are accomplished independently as out-of-class assignments. In the second course, the class is divided into instructor-managed teams in order that students complete part of the large-scale course project in teams and part of it individually. In the third course, students form self-managed teams to conceive, design, and implement a project of their own choosing. Because self-managed team work is required, students were provided with a brief introduction to Jung's theory of psychological types and MBTI terminology, a discussion of attitude and functional transitions in the Group Zig Zag model, and the use of the Group Zig Zag as a means of managing communications during group problem-solving sessions.

Senior Projects Course. In response to the recommendation in IS '90 (Longenecker & Feinstein, 1991) a capstone project-oriented sequence is required of our majors. Since the groups are reaching discipline maturity according to our curriculum, Mode 3 usage is appropriate. Groups are self-directed and self-managed with the instructor serving as advisor and counselor. Projects are viewed as a vehicle for transition from pedagogical applications to practical, real-world applications. By acquainting group members with their individual preferences and how those preferences relate to problem-solving and communication, a deeper, richer application of the Group Zig Zag can be gained.

Benefits and Future Directions

Benefits. We believe that use of this group problem-solving approach in the curriculum is beneficial because it provides students with a single model. The three modes of usage provide a step-wise approach to integration of the model throughout the curriculum, according to discipline maturity. Early in the curriculum, the Zig Zag meets the pedagogical need to establish the application of a reflective problem-solving methodology as a standard practice by the student. Later in the curriculum, extending the individual model as described assists in managing and facilitating communications in instructor-directed group-oriented projects. Much later, when group projects are more intensive and time demanding, the introduction of the perspective of psychological types enables project groups tobe self-directed and overcome communication dysfunctions resulting from type differences. The step-wise approach permits integrating discipline knowledge, problem-solving techniques, and group communications methods in a complementary way.

Future Usage. The perceived benefits of our initial attempts at integrating the Group Zig Zag model in the curriculum has been based upon observations and anecdotal feedback. We are currently developing an experimental approach that will assess these benefits in a

scientific manner. Our initial efforts will be in CS I, II and in the Senior Projects Sequence.

References

Available upon request.

Mode 1 **"Instructor-Managed"**	**Mode 2** **"Self-Managed"**	**Mode 3** **"Self-Directed"**
Instructor is manager (interventionist role)	Instructor provides direction and is advisor	Instructor is advisor and counselor
Facilitator is instructor or lab assistant(s)	Facilitator is member of team	Facilitator is member of team or outside advisor
Students told what to do and when to do it; awareness of individual problem-solving purpose of process	Awareness of purpose of each event in process, i.e., shifts in mental processes and attitudes	Awareness of purpose, role of types, their own psychological types, and their consequences
Closed, supervised lab	Open, unsupervised lab	Open, unsupervised lab
Used as an external means of producing deliverables and gaining domain knowledge	Used as an internal means of managing the production of deliverables	Used as self-diagnostic tool to understand dynamics and communication dysfunctions caused by type

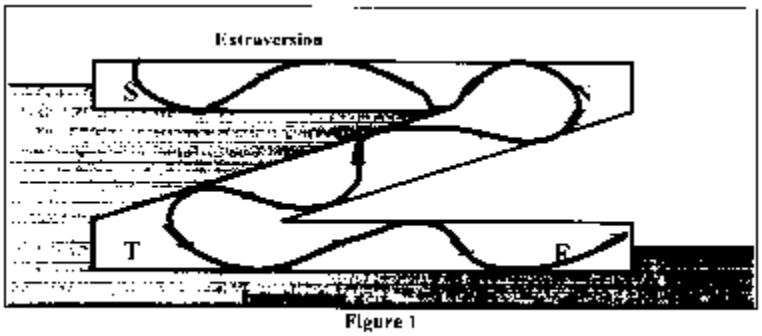

Figure 1
Generic Group Zig Zag