

COMPARISON OF COURSE TYPES BY DESCRIPTIVE AND PRESCRIPTIVE EDUCATIONAL FACTORS

The following two papers concern subjects presented at the Pentennial Summer School for ChE Faculty in Snowmass, Colorado, July 31 - August 5, 1977. Other Summer School papers will appear in subsequent issues.

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IN PREPARING TO teach a course, there are several major decisions which must be made. What should be the general goals? What content needs are to be included? What type of learning environment should be fostered? How can the selected goals best be achieved? The decisions must rest with the faculty involved.

However, this paper is intended to aid the decision-making process by providing informa-

TABLE I
Prescriptive Factors in Educational Design*

These are factors needed to best enhance student learning, irrespective of format.

- Statement of Intended Outcome (Precise statement of instructional objectives and goals for student to perform)
- Pleasant Conditions
- Informative Feedback (to students)
- Meaningfulness, Relevancy (as perceived by students)
- Reinforcement (of student performance, including valid measurement of learning, and rewards)
- Hierarchy of Content Organization (Materials)
- Active, Appropriate Practice (by students in homework, design, projects)

*These factors are based on a consensus input from groups at the Engineering Education Conference, New Hampshire 1976; West Virginia University Engineering Education Seminar, 1976; and the A.S.E.E. Summer School, 1977.



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tion about course formats and the framework they provide to meet selected objectives. This paper will classify the important possible course structures into five formats and discuss these structures with respect to educational prescriptive and descriptive factors.

Any course needs to include certain features in order to be successful, and these, as listed in Table I, are based on responses of concerned educators from several workshops. Although arguments might be made to include other factors, for brevity, only these composite factors will be discussed.

In addition, a course can be described according to class size, pacing, resource consumption and other factors given in Table II. Most of these factors are self-explanatory, but a few words should be said with respect to group size and problem solving.

For one or two students, a Socrates individualization with the instructor is possible, but this group size is generally unrealistic. For a group size of three to seven, all students have an opportunity, and can be expected, to participate in class questioning and discussions. For group sizes of seven to twelve, all students have an opportunity to participate without feeling inhibited, but normal interactions will not necessarily result in full participation of everyone. With group sizes of 13 to 35, only those students that are aggressive will normally participate, and many (most) students cannot be expected to participate. With more than about 35 students, hardly any students can be expected to speak up, as the size and environment is very inhibiting.

Problem-solving can be described as either closed-ended or open-ended. If closed-ended, the problem can be simple (one-step solution) or complex (a chained series of steps which need to be known or discovered as the student proceeds). Problem-solving strategies found in the literature usually work towards expanding the students' abilities in solving complex, closed-ended problems or open-ended problems. Simple, closed-ended problems primarily require the thinking abilities [1] described as knowledge, comprehension, and application. Complex, closed-ended problems require, in addition, analysis and evaluation. Open-ended problems also require the use of synthesis (idea generation) thinking skills.

CLASSIFYING COURSE STRUCTURES

THE FIVE COURSE formats discussed are listed in Table III and include lecture, discussion, PSI and group-paced individualization

TABLE II

Descriptive Factors of Course Structures

- Pacing (Student learning in lock-step to complete student freedom)
- Specificity of Coverage (Branched, fixed, or flexible in content)
- Feedback Rate (Immediate to slow)
- Type of Interaction (Student to student, instructor, tutor, or material)
- Group Size (One to large lecture)
- Instructor Role (Provider, guide, oracle)
- Student Role (Active to passive)
- Type of Problem-Solving (Closed or open-ended)
- Resource Consumption (Paper, audio-TV, computer)
- Costs

TABLE III
Classification of Course Structures

- A. Formal Lecture
- B. Discussion
- C. Personalized System of Instruction (PSI)
- D. Group-Paced Individualization—Class Centered (GPI—Class)
- E. Group-Paced Individualization—Project Centered (GPI—Project)

See Grayson, L. and Biedenback, J., Editors, *Individualized Instruction*, A.S.E.E. Press, Washington, D.C. (1975), for further discussion of some of the structures in C, D and E.

Specific examples include the work of Professor Caenpeel at California-Pomona in operating an engineering discussion course. Professor J. Stice at the University of Texas-Austin has directed a program of 17 PSI courses, and informative reports are available. Professor H. Plants and W. Venable at West Virginia University have operated strict GPI—Class Centered courses in statics and dynamics. The PRIDE program in chemical engineering at West Virginia University has developed GPI—Project Centered courses. Many others throughout the country have operated courses of the various structures.

methods. This classification is really a spectrum and should encompass almost all structures normally utilized, except for research and individualized contract. In Table IV are listed major distinguishing features of each of the five structures. It is assumed for the purposes of this paper that each structure is administered to try to meet the prescriptive factors in Table I.

This comparison is intended to provide a compendium of the merits and possible deficiencies of course structures presently being used in engineering education.

COURSE STRUCTURE COMPARISON

IN TABLE V ARE listed the author's opinions as to how each structure meets the prescriptive factors. These ideas are based on many reported studies of course formats, and include the consensus of opinions expressed by participants at the workshops where the factors were developed.

In Table VI are listed the comparison of the descriptive factors. Cost information statements are admittedly scanty, but are based on the available facts from studies at the University of

TABLE IV
Elements of Five Course Structures

Element/Course	(A) Lecture	(B) Discussion	(C) PSI	(D) GPI—Class Centered	(E) GPI—Project Centered
Special Provisions and Materials	Text	Discussion Groups Students are Required to do Preparative Work Texts, Articles	Required Program Guides with Text	Instruction or Study	Study Guides with Text Project Work in Small Student Groups
Pacing	Instructor	Group—Discussion Sessions Instructor—Discussion Program	Student	Instructor as Modified by Class Needs, with Flexibility on Instructional Units	Project Needs After Instructor Sets Content/Project
Instruction Help	Teaching Assistant for Grading Student Work Helpful	Assistants for Discussion Leaders Helpful	Proctors (Graders) for Instructional Unit Quizzes and Student Tutoring	Proctors for Instructional Unit Quizzes and Student Tutoring	Tutor, Homework Grading
Testing	Tests a Few Times per Semester	Tests on Content for each Major Discussion Topic	Quizzes on Instructional Units (1 hr—1 week length)	Quizzes on Instructional Units (1 hr—1 week length) Tests on Major Topics	Tests on Major Topics (Modules of 2-4 weeks) Design Reports
Grading	Spectrum of Grades Based on Homework and Student Mastery of Instructional Objectives on Tests	Spectrum Based on Student Mastery of Instructional Objectives on Tests Contribution to Discussions and Reports	Work to A, Based on Mastery of all Instructional Units	Spectrum, Based on Student Mastery of Instructional Objectives on Quizzes and Tests, about Equally Weighted	Spectrum, Based on Mastery of Instructional Objectives on Tests, and Design Work and Design Reports

Texas [2], West Virginia University [3, 4], and Oklahoma City Christian College [5].

The range of performance of a course structure in meeting an educational factor in Tables V and VI indicates the results normally to be expected—depending on the quality of instruction, facilities, and program developed to emphasize a particular factor.

This comparison is intended to provide a compendium of the merits and possible deficiencies of course structures presently being used in engineering education. Faculty members can pick a course structure because of its merits, and improve or modify an area where the structure has a tendency to be weak. No one course is seen as preferable for all courses and situations; rather the structure should be chosen to effectively meet the desired goals. □

TABLE V
Comparison of Course Structures for Prescriptive

Factor	Rating: How Does Course Achieve Factors?				
	Poorly 0	1	2	3	Well 4
Statement of Intended Outcome		A	B	E D C	
Pleasant Conditions	A		E	C D B	
Informative Feedback		A		*	
Meaningfulness			*	E	
Rewarding			(*=A, B, C, D)		
Consequences			A B	E C D	
Hierarchy of Organization		A B		E C D	
Active, Appropriate			A B	C D E	

A = Lecture
B = Discussion
C = PSI
D = GPI-Class Centered
E = GPI-Project Centered

TABLE VI
Descriptive Comparison of Course Structures

Factor	Comparison						
Pacing	Lock						Student
	Step	A	D	E	B	C	Freedom
Specificity of Coverage:	Branched			B	C		
	Fixed						
	Flexible	A	B	C	D	E	
Feedback Rate	Immediate						Never or Very Long
		C	D	E	B	A	
Type of Interaction†	Student-Student				B		E
	Student-Tutor					C	D
	Student-Instructor				A	B	D
	Student-Materials				B	C	D
Group Size	1			10		20	E
		C	(E Project)	D	B		>>35
						A	E
Instructor Role	Provider				A	B	E
	Guide				B	C	D
	Oracle				B		E
Student Role	Passive			A			B
							Active*
							(* = C, D, E)
Type of Problem-Solving†	Simple, Closed-Ended				A	C	D
	Complex, Closed-Ended				A	B	C
	Open-Ended				B		D
Resource Consumption	Low						E
		A	B		E		D
							C
Operating Costs:**	Low				Median		High
Lecture					A		
Discussion, Small Groups					B		
PSI [2], [5], [6]	Large Enrollment ←				C		→ Small Enrollment
GPI—Class Centered [3]					D		
GPI—Project Centered [4]					E		

** (Note: Developments of a new course and materials for structures C, D, and E may be quite high.)

† If these factors can normally be present, they are listed only and not compared.

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