Chapter 4
Instructional Methods and Learning Styles

How do we factor the variability of students into our instructional methods? All students are different, and yet there are many commonalties from student to student. Should students simply design their own education, an education that theoretically would be tailored to their needs? Should students be left to their own desires and needs, as Rousseau advocated in *Emile* in the late 1700s and as A. S. Neill advocated in *Summerhill* in the 1960s? Or are there ideas and methods that all students should simply endure, for the good of the social system? We have learned quite a bit about accommodating the variability of students through research into instructional methods and learning styles. If we vary our methods, we have learned, we accommodate a wider range of learning styles than if we used one method consistently. Teaching methods are the complement of content, just as instruction is the complement of curriculum. Technology teachers tend to over-use projects and problems, ignoring the options and opportunities that the balance of teaching methods offers. In this time of global hazards and changes in our lives wrought by technology, it is essential that technology teachers maintain a refined sense of how to teach about controversial and sensitive technological issues. It is essential that technology teachers have a command over values clarification methods as well as demonstration and project methods. Given that technology teaching methods are often research-driven, twenty-two research methods are outlined in this chapter. Forty-one teaching methods are defined and five that are central to technology studies are explained in detail. The chapter concludes with detailed sections on the relationships among instructional methods, personalities and learning styles.

Instructional Systems

Think *systemically* about instruction. Systems involve relationships, conditions, processes, causes, effects and feedback. To identify a system, we must demarcate where one system ends and another begins. In education, as in ecosystems, this is done somewhat arbitrarily. For example, if we identify and focus on an instructional system, we necessarily bracket out the learning system. We make some system components visible and leave others invisible. We identify an instructional system at the peril of ignoring other systems or bracketing too narrowly. What is involved in the process of instruction? What are the essential components of instruction? Instructional systems involve decisions related to what will be taught, how it will be organized for learning and how learning will be assessed. For analytical purposes it is necessary to identify what students and teachers do within the system. It is important to address individual components of the system. While there are components that are overlooked, the diagram below generally represents an instructional system. Events of instruction, such as an activity, demonstration or presentation

require that teachers attend to all of the components within the system. Instructional planning unfolds quite procedurally, but not necessarily in the linear fashion below (Fig. 4.1).

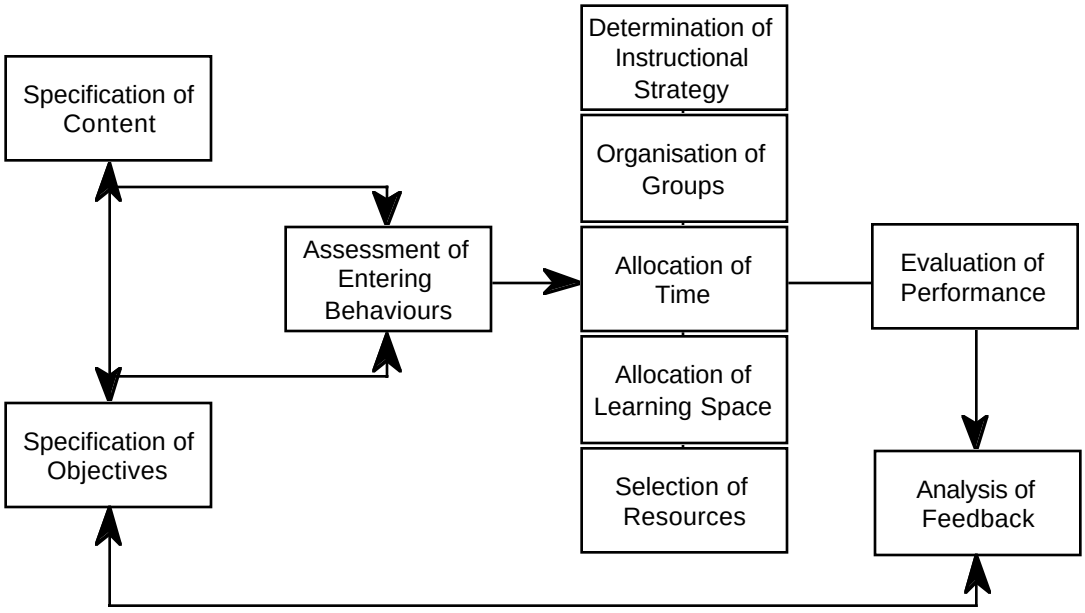

Figure 4.1. Instructional System

The intention of this diagram is not to suggest that you ought to identify and memorize the components of an instructional system. Rather, one intention is to help you grasp the scope of an instructional system and its complexities. A second is to demonstrate the interrelations among components of an instructional system. When we alter a component within the system, we change the conditions for all the components. We alter the process of instruction. A third is that while we may isolate an instructional system, we do not eliminate the interrelations among this system and others. When we alter instructional systems, we alter learning systems as well. Instructional systems are not built in stone. They are malleable. Hence, if there are problems and issues that are systemic rather than consequential to the system, the system can be altered. These are the most important lessons to take from our recommendation to think systematically about instruction.

In the first chapter, we approached the subject of communication and instructional planning holistically. Invoking our cycle of experience, we suggested that the best way to learn how to teach is to teach. The best way to learn how to teach technology studies is to learn how to demonstrate. Demonstrations involve all of the components of an instructional system. Instead of breaking down a demonstration into separate components, we approached it as a whole entity. However, we also dealt with instructional objectives in an isolated, albeit focused, way. In the remainder of this chapter, we address instructional methods, teaching styles and learning styles.

Teaching Methods

General models and families of teaching methods are guides for designing educational activities, environments and experiences. They help to specify methods of teaching and patterns for these methods. Instructional strategies, or teaching methods, depend on a number of factors such as the developmental level of students, goals, intent and objectives of the teacher, content, and environment including time, physical setting and resources. Imagine a course that challenges teachers to meet a number of objectives. A single method cannot meet all of our goals nor can a single method accommodate all learning styles at once. For example, demonstrations or projects are effective for meeting some goals but ineffective for meeting others. So we need a toolbox of methods, not merely a single tool.

In the most general terms, there are four or five different models of instructional strategies or teaching methods. Having spent years in schools, you will recognize each and probably have strong preferences for one or two models.

- Didactic- Direct teaching; Verbal and typically in the form of a lecture or presentation.
- Modeling- Direct teaching; Visual and typically in the form of demonstration and practice.
- Managerial- Indirect or Interactive teaching; Facilitation, individualization and group management.
- Dialogic- Indirect Interactive teaching; Socratic Technique of dialogue, questions and thought provocations.

In the **Direct Instruction** models, the teacher imparts knowledge or demonstrates a skill. In the **Indirect Instruction** models, the teacher sets up strategies, but does not teach directly; the students make meaning for themselves. In the **Interactive Instruction** models, the students interact with each other and with the information and materials; the teacher is organizer and facilitator. **Experiential Learning** models mean that the students experience and feel; they are actively involved. In **Independent Study** models, the students interact with the content more or less exclusive of external control of the teacher. Some theorists prefer to reduce these to three general methods: Transmissive, transactive and transformative teaching. **Transmissive teaching**, or direct instruction, means that the teacher delivers *status quo* content *via* some method such as lecturing or demonstrating. **Transactive teaching**, or indirect instruction, means that the teacher and students arrive at *status quo* content to be learned though transactions and dialogue. **Transformative teaching**, or a combination of direct and indirect instruction, means that the teacher and students reject status *quo content* and focus on a transformation of themselves or their world.

These general models help us to classify teaching methods and simplify our discourse for conversing about them. We also group methods by their "family" affiliations. Some methods lend themselves to encouragement of social interaction in students. Other methods encourage information processing and some facilitate behavioral modification. Still others support intrapersonal and interpersonal development. Each of these families offers different approaches to teaching, respond to different objectives and goals, and yield different results in students.

Four Families of Teaching Methods (Joyce & Weil)

- **Social Interaction Family**- Emphasizes the relationship of the individual to society or to other persons. Gives priority to the individual's ability to relate to others.
  - Partner and Group Collaboration
  - Role Playing
  - Jurisprudential Inquiry
- **Information Processing Family**- Emphasizes the information processing capability of students. Gives priority to the ways students handle stimuli from their environment, organize data, generate concepts and solve problems.
  - Inductive Investigation & Inquiry
  - Deductive Investigation & Inquiry
  - Memorization
  - Synectics (Techniques for Creativity)
  - Design and Problem Solving
  - Projects & Reports
- **Personal Family**- Emphasizes the development of individuals, their emotional life and selfhood. Gives priority to self-awareness.
  - Indirect Teaching
  - Awareness Training & Values Clarification
  - Role Modeling
  - Self-Reflection
- **Behavioral Modification Family**- Emphasizes the development of efficient systems for sequencing learning tasks and shaping behavior. Gives priority to the observable behavior of students.
  - Direct Instruction (Demonstrations & Presentations)
  - Anxiety Reduction
  - Programmed Instruction
  - Simulations

The following list provides definitions for a variety of different methods, including most of those listed above (Cruikshank, Bainer & Metcalf, 1999). Every method has advantages and disadvantages. For example, cooperative learning allows for the participation of everyone, but the groups often get side tracked. Role playing introduces a dramatic problem situation, but some students are too self-conscious to project themselves into the situation. Large group discussions

pool ideas and experiences from the group, but a few students may dominate. Values clarification allows students to clarify their values in a safe environment, but some students may not be honest in this environment. Projects allow for self-directed problem solving and creativity and take advantage of intrinsic purposes, but too much focus is placed on the product and too little on the process. There is a pedagogy (art and science of teaching) to each method that is beyond the scope of this book. In the first chapter, we explained the pedagogy of demonstrations and presentations. In the next chapter, we will address problem solving and design briefs. Chapters six and nine will deal with activities, projects and units. Think about your teaching methods and the range that you use. Practice a variety, if only to make your practice interesting.

Teaching Methods

(Cruikshank, Bainer & Metcalf, 1999)

1. **Academic games or competition**- Learners compete with each other one to-one or team-to-team to determine which individual or group is superior at a given task such as "spelldowns," anagrams, technology trivia, Odyssey of the Mind, or project competition. Commercially available, academic computer games are also very popular.

2. **Activity**- a general teaching method (e.g., problem solving, design challenge, field trips, role playing) based on planned, purposeful involvement of students.

3. **Brainstorming**- order to generate creative ideas, learners are asked to withhold judgment or criticism and produce a very large number of ways to do something, such as resolve a problem. For example, learners may be asked to think of as many they can for eliminating world hunger. Once a large number of ideas have been generated, they are subjected to inspection regarding their feasibility.

4. **Case study**- A detailed analysis is made of some specific, usually compelling event or series of related events so that learners will better understand its nature and what might be done about it. For example, learners in a technology lab might investigate the wear and tear of skate boarding on public works. Another class might look at cases of digital technologies and privacy.

5. **Centers of interest and displays**- Collections and displays of materials are used to interest learners in themes or topics. For example, children may bring to school and display family belongings that reflect their ethnic heritage. The intention may be to interest the class in the notion of culture. Or, the teacher might arrange a display of different devices used in measurement to prompt interest in that topic.

6. **Colloquia**- A guest or guests are invited to class for the purpose of being interviewed in order to find out about the persons or activities in which they are involved. Thus, a guest musician might serve as a stimulus for arousing interest in music and musical performance.

7. **Contract**- Written agreements entered into by students and teachers which describe academic work to be accomplished at a particular level ill a particular period of time such as a week or month.

8. **Controversial Issues**- An issues-based, teacher-directed method that focuses on controversies. Students are directed through a process that assists them in understanding how

to deal with controversial and sensitive issues and clarifies these issues in a group context. Involves critical thinking and discourse analysis (Chapter 4).

9. **Cooperative learning**- Learners are placed in groups of four to six. Sometimes the groups are as diverse or heterogeneous as possible. In such cases, group members are often rewarded for the group's overall success. Student groups might be given a teacher presentation on division of fractions. They would then be given worksheets to complete. Team members would first help and then quiz one another (Chapter 4). See also student team learning.

10. **Culture jamming**- A methods used to empower students to "speak back" to mass advertisements and media images that enforce stereotypes and select representations of individuals or groups. Empowers students to mock or "jam" images of popular culture.

11. **Debate**- A form of discussion whereby a few students present and contest varying points of view with regard to an issue. For example, students could take different positions and debate an issue: "Should rights to free speech on the internet be extended to students in schools?"

12. **Debriefing**- A method used to provide an environment or platform for the expression of feelings and transfer of knowledge following an experience. Debriefing may come at the hands of a tragic event or may be used more generally following an intentionally educational experience. Debriefing relies on the skills of the facilitator to reframe an experience or event to appropriately channel emotions and knowledge toward understanding and transformation.

13. **Demonstration**- A teaching method based predominantly on the modeling of knowledge and skills. A form of presentation whereby the teacher or learners show how something works or operates, or how something is done. For example, a teacher could demonstrate how to use a thesaurus, how to operate a power drill, how to scan an image, or what happens when oil is spilled on water as when an oil tanker leaks. Following that, students practice under teacher supervision. Finally, independent practice is done to the point of proficiency (Chapter 1).

14. **Direct instruction**- A term used to describe explicit, step-by-step instruction directed by the teacher. The format or regimen advocated is demonstration, guided practice, and independent practice. Thus the teacher might teach a reading, mathematics, geography or technology concept or skill. Following that, students practice under teacher supervision. Finally, independent practice is done to the point of mastery.

15. **Discovery or inquiry**- Discovery learning is used when students are encouraged to derive their own understanding or meaning for something. For example, Students are asked to find out what insulation acts as the best barrier for cold or hot environments. Experiments that are not teacher demonstrations are part of discovery learning (Chapters 2, 5).

16. **Discussion**- Discussions occur when a group assembles to communicate with one another through speaking and listening about a topic or event of mutual interest. To illustrate, a group of learners convenes to discuss what it has learned about global warming (Chapter 4).

17. **Drill and practice**- A form of independent study whereby, after the teacher explains a task, learners practice it. After Students are shown how to use Ohm's Law, they are asked to make calculations of current, resistance and voltage.

18. **Feedback**- A semi-formal mode of communicating to students constructive criticism regarding their performance during an activity (Chapter 1).

19. **Field observation, fieldwork, field trip**- Observations made or work carried on in a natural setting. Students visit the local museum of natural history to see displays about dinosaurs, or they begin and operate a small business to learn about production and marketing.

20. **Independent study or supervised study**- Described in this chapter, independent study occurs when learners are assigned a common task to be completed at their desk or as a home study assignment.

21. **Individualized instruction**- Any of a number of teaching maneuvers whereby teaching and learning are tailored to meet a learner's unique characteristics.

22. **Installation**- Students present material within a formal structure for displaying audio, multimedia or visual artifacts.

23. **Module**- A module is a self-contained and comprehensive instructional package, meaning that basically everything that the student needs is in the module. A form of individualized instruction whereby students use a self-contained package of learning activities that guides them to know or to be able to do something. Students might be given a module containing activities intended to help them understand good nutrition (Chapter 9).

24. **Mastery learning**- As a class, students are presented with information to be learned at a predetermined level of mastery. The class is tested and individuals who do not obtain high enough scores are retaught and retested. Those who passed undertake enrichment study while classmates catch up.

25. **Mixed-mode instruction**- A combination of "face-to-face" and on-line methods.

26. **On-line instruction and learning**- A self-directed and automated approach that utilizes hypermedia (internet browsers, etc.) for communication that generally provides independence from the architectural constraints of classrooms.

27. **Performance**- Students act out through dance, drama, music or other expressive forms.

28. **Presentation and lecture**- Students listen to a person who talks about a topic. To illustrate, the teacher, or a guest speaker, tells the class all about the invention of the transistor.

29. **Problem**- A general teaching method and organization of curriculum and knowledge where students work purposefully toward a solution, synthesis or cause. Often called problem-based learning (Chapter 5).

30. **Programmed and automated instruction**- A form of individualized instruction whereby information is learned in small, separate units either by way of reading programmed texts or using computer-based programs (See On-line instruction).

31. **Project**- Students work through a series of activities and problems culminating in the completion of something tangible (e.g., artifact, media, performance). A form of individualization whereby learners choose and work on projects and activities that facilitate and support the development of skills and knowledge. Often, learners not only choose topics but also the means of their conduct and production. (Chapters 6, 9).

32. **Protocols**- Learners study an original record or records of some important event and then try to understand the event or its consequences. They might watch a film depicting actual instances of discrimination and then consider its causes and effects.

33. **Recitation**- Students are given information to study independently. They then recite what they have learned when questioned by the teacher. For example, students read about what causes pollution, and the teacher, through, questioning, determines the extent and nature of their knowledge and understanding.

34. **Reports, written and oral**- Individuals or groups of learners are given or choose topics. For example, each may be asked to find out about one planet in our solar system, or about solar powered vehicles. What they learn is shared with other class members by way of oral or written presentations.

35. **Role playing**- Learners take on the role of another person or character to see what it would be like to be that person or character. Thus, a student could play the role of an imaginary student no one likes or a news reporter.

36. **Simulation game**- Students play a specially designed, competitive game that mirrors some aspect of life. For example, they might play the Ghetto Game to find out about the problems and pressures that ghetto dwellers face and to sense how difficult it is to improve one's lot in life. Another commercially available simulation game is Gold Rush (life and adventure in a frontier mining camp). Many simulation games, such as Sim City, are automated.

37. **Simulation**- Learners engage with something intended to give the appearance or have the effect of something else. Thus students may engage in a simulation of the United Nations General Assembly in order to have "first hand experience" with how it works and what its delegates do.

38. **Synectics**- The use of specific techniques to foster creativity in students. For example, the students may be asked to develop metaphors to describe mobility across different terrains (Chapter 5).

39. **Tutoring**- A form of individualization whereby either a teacher, or perhaps a fellow student, provides a learner or small group of learners with special help, usually because they are not learning well enough with only conventional instruction.

40. **Unit**- An intentionally designed, integrated, thematic organization of curriculum and knowledge through combinations of demonstrations, discussions, activities, problems, and projects (Chapter 9).

41. **Values clarification**- Teachers lead students through a series of moral and ethical dilemmas, such as birth control or clear-cutting forestry practices, to assist them in clarifying their values and moral choices (Chapter 4).

In the next few sections, a summary of some of the most commonly used methods in technology studies is provided. Other common methods are described in other chapters as indicated in the definitions above.

Controversial Issues

The controversial issues method deals with the processes of critical thinking and working through controversies. As the world gets smaller through the globalization of culture, economics and media, controversial issues proliferate. As we grow more sensitive to the interdependence of cultures, individuals, races, religions and species, we assume more responsibility for sensitivity

when dealing with issues. As technology is made more invasive and pervasive in our lives, it becomes more critical to make wise choices for what we create, buy or sell. Students at younger and younger ages are finding themselves entangled in webs of economics, politics, sex, technology and violence. The controversial issues method will not help us reduce the number of controversies in our lives but it does help us to deal with controversies critically and sensitively.

Controversial issues are quite topical and can typically be directly related to students' lives. Controversial issues are an essential part of the curriculum if the schools are to fulfill their mandate to prepare citizens for democratic participation. Controversies provide students and teachers with opportunities to comprehend, reflect, practice, and make commitments and act. They are crucial for helping students to develop their ethical and moral reasoning and to become critical thinkers. Controversial issues are likely to challenge students' beliefs, values and worldviews. This can be threatening and confusing, and can cause some students considerable emotional distress. Hence, if controversies are not properly addressed in the classroom, students often resist engaging with the issues because they are angry or feel threatened. What is a controversial issue?

Criteria that characterize a controversy:

- There are competing views and interests
- People disagree strongly about statements, assertions or actions
- There is sensitivity
- Emotions become strongly aroused

Controversial issues form around:

- What has happened
- The cause of the present situation
- The desirable ends to work towards
- The appropriate course of action to be taken
- The likely effect of action

Controversies are complex. Working through controversies requires knowledge of what the controversy is about, an awareness of one's own values and a sense of identification with the controversy. Teaching with the controversial method requires balance, disclosure of commitment, and taking a stance without coercion or indoctrination of others. Teachers are responsible for establishing ground rules, moderating any classroom incivilities, moderating one's own and the students' over-attachment to content or an overreaction to criticism. Teachers are responsible for moderating negative thinking and strong emotional reactions in their students. **Ground rules** are necessary to govern classroom procedures and to moderate the nature of the contributions to understanding the controversial issue. Ground rules should enable the free flow of information in a safe, non-threatening environment. **Classroom incivilities** include teacher and student behaviors that distort the classroom atmosphere and negatively affect learning. Teacher incivility can include rudeness, prejudice and the neglect of the needs or emotions of individual students or groups of students. Teachers can actually stimulate student incivilities by appearing neglectful of students' welfare. Student incivility can include disruption, rudeness and distractions during an activity. When using the controversial issues method, teachers must be vigilant about behaviors

that stimulate incivilities. **Moderating an over-attachment** to ideas and an overreaction to criticism will help students move from black-white thinking to complex understandings. Students use a range of strategies to deliberately cling to a certain view. Students will discount information that is not congruent with their opinion or distort and revise this information to become congruent. Teachers must help students keep these practices in check by encouraging a fair analysis of multiple aspects of a controversial issue. **Moderating negative thinking** and strong emotions involves the reframing of negative thoughts and irrational feelings. Teachers must reframe into positive terms what students say in negative terms. They have to help clarify issues that might underlie irrational feelings (Flinders University, 2001).

Tips for Teaching Controversial Issues
(Street Law, 2003)

1. Recognize the general legitimacy of controversy. Controversy is part of society and students must learn to discuss the issues and problems presented.
2. Establish ground rules for proceeding. Create and agree on effective rules.
3. Use the framework provided for dealing with controversial issues.
4. Concentrate on evidence and information.
5. Represent opposing positions accurately and fairly (balance).
6. Clarify the issue so that students understand where there is agreement and disagreement.
7. Identify core issues.
8. Make the issues concrete before launching into levels of abstraction.
9. Allow students to question authority (i.e., question the teacher's position)
10. Admit doubts, weaknesses and difficulties in your position.
11. Teach understanding and active listening by re-stating the perspective of others. Have students paraphrase what others said to gain this skill.
12. Demonstrate respect for all opinions.
13. Establish a means for closure. Examine consequences and consider alternatives. Do not leave the class suspended in neutrality or inaction.

The key to the controversial issues method is a framework for handling the controversy (Clarke, 1993). Success depends on whether participants communicate and methodically work through the issue. Werner and Nixon (1990) developed a comprehensive framework for teaching controversial issues that orients the method towards clear communication and critical thought (Table 4.1). As well as setting the tone as we described, teachers have to assume responsibility for clarifying the issues, arguments, assumptions and manipulations contained in the controversy itself. They have to assist their students clarify the values contained in the issue and their own

values effected in response to the issue. The values clarification method is provided in the next section. Werner and Nixon's framework is provided in Table 4.1:

Table 4.1. Controversial Issues Framework

What is at Issue?		
Identify and Clarify Central Value Questions	Identify and Clarify Central Empirical Questions	Identify and Clarify Central Conceptual Questions
What should be done? What is the alternative? Is X better than Y?	What is the case? What was the case? What will be the case?	What is X? How is X to be defined? What is the meaning of Y?
What are the Arguments?		
Clarify the Value Claims	Clarify the Empirical Claims	Clarify Conceptual Claims
What is the argument for X? What is the argument against X?	What evidence is there for X? What evidence is there against X?	Does the evidence for X match the argument for X? Does the evidence against X match the argument against?
What is Assumed?		
What Attitudes are Assumed?	Whose Voice is Heard?	What Points of View are Assumed?
Are prejudice attitudes present? Ethnocentrism? Racism? Parochialism?	Insiders? Outsiders? Experts? Lay public?	Personal? Institution? Region? Academic subject area?
How are the Arguments Manipulated?		
What groups are Involved?	How are the Media Involved?	What Strategies are Used?
What are their interests? What are their rationalizations?	News? Documentary? Internet? Alternative media?	Unfairly attacking opponents? Reducing complex issues? Using loaded language or exaggeration?

Controversial issues can be combined with the values clarification method or with sociologics (Chapter 5). This method can also be designed into a module (Chapter 9), which is student directed, or a unit (Chapter 9), which combines activities and projects with discussion. Controversial topics in technology studies include: Acid Rain, Alternative Medicine, Cancer & Risk, CFCs & the Ozone, Crime & DNA, Deforestation & Jobs, Disease & Treatment, GMOs,

Habitat Preservation, Organic Farming, Privacy & the Internet, Racing, Recycling, Rights and New Technologies, SUVs, Wildlife Management and War.

Values Clarification

Values clarification (VC) is a method that deals with the *process* of valuing and challenges students to formulate and test their values against a range of issues. VC is intended to help students communicate their beliefs, feelings, ideas and values, as well as empathize with others. It is a method that assists students in holding and using consistent beliefs and values. There are four general phases in the VC method: 1) the comprehension phase, 2) the relational phase, 3) the valuational phase and 4) the reflective phase. Similar to the first stage of the controversial issues method, the comprehension phase involves clarifying and interpreting the issue. The second phase challenges students to define how, if at all, they relate to the issues. In the valuing stage, students are challenged to make ethical judgments (good or bad, right or wrong, fair or unfair, etc.) on the issue. They are challenged to choose and elaborate preferences. In the reflective stage, students assess potential consequences to and conflicts with their choices. They face the imperatives of their choices. The VC method aims to move students from a process of identifying and prizing to choosing and acting on beliefs and values (Raths, Merrill and Simon, 1966):

Prizing one's beliefs and behaviors	**Choosing one's beliefs and behaviors**	**Acting on one's beliefs**
1. Prizing and cherishing 2. Publicly affirming, when appropriate	3. Choosing from alternatives 4. Choosing after consideration of consequences 5. Choosing freely	6. Acting 7. Acting with a pattern, consistency and characterization

Values clarification in technology studies involves helping students become aware of their beliefs about technology and technological practices they prize and would stand up for (**Prizing and Affirming**). VC allows students to consider alternative ways of thinking about technology and acting in accordance with values. VC encourages students to weigh the pros and cons and consequences of various technological alternatives and to choose among alternatives (**Choosing**). Students are encouraged to determine whether their beliefs and positions on various alternatives match their actions, and are helped to bring beliefs and actions in harmony. Finally, students are given real world options to make choices and test their beliefs and assess the consequences of their actions (**Acting**). Basically, CV helps students deal with moral dilemmas in their lives and works in tandem with the controversial issues method.

A small design project can serve as an example of how the VC method can be used in technology studies. The project provides for a fair amount of choice among materials and one of the choices is the use of southern rain forest wood, such as mahogany or teak. The responsibility

is in the teacher's hands to provide a detailed description of rain forest tree harvesting practices and the arguments for and against (see controversial issues method). A brief description of the interdependencies between southern jungles and northern home furnishings would be necessary. At this point, the stage is set for VC. The first step is to prompt the students to name the values they prize and cherish regarding their surroundings, their fashions and their products. Ask them to write down answers to the following yes-no questions. Do you want to feel exotic? Do exotic clothes or products make you feel exotic? Do you care if your exoticism comes at the expense of the health of your environment? Do you care if your exoticism comes at the expense of the health of an environment in another part of the world? These types of questions help the students to clarify the values they prize and cherish. The second step is to provide alternatives for them to choose among values and the consequences for their choices. Provide a list and description of alternatives to choose from, including rain forest mahogany. For example, a teacher may say the following: If you choose a local wood (e.g., fir) and stain it red, it may look obvious that it is stained. If you choose just one kind of wood your box may be just like many of your peers. If you choose mahogany you may be partially responsible for a homeless parrot family or the destruction of the jungle. The third step is to let the students choose and act on their choice. Ideally, their values will be tested again in a similar situation.

This is a simplified test that pits ecological diversity against fashionable exoticism. You may feel this is a false dichotomy. Or you may go ballistic if they choose to use mahogany, in which case, you probably should not have exotic woods in your workshop. VC means that students are taught a process. There are issues where it may be important for the teacher to take a stance and make choices for the students, or weigh in on influencing their decision one way or the other. Teachers have to make a choice on issues when to enact VC and when to take a stand. If teachers feel that the rain forest can take no more development that is driven by northern demands, they will do well to insist that students rethink their values on exoticism. The harvesting of elephant tusks is another example where demands are inharmoniously interdependent with supplies. In a digital design course, the question of sexism in advertisements may serve as another case for VC. Should students use scantily clad females or males in the ads they are creating? VC invariably brings students to the brink of choice, and asks them to make a choice among values. The premise here is that it is all too easy to be suspended in information and neutrality. "Someone else will make the decision for me" is an expression of an apathetic attitude. When ought the teacher declare her or his values? A delicate balance is recommended. Teachers who moralize too much forfeit influence at times or even create intentional dissent. Teachers who don't care, waffle or fence-sit appear to be apathetic or flighty. Technology studies provide a wealth of issues and opportunities for students to develop the process of VC for future decisions.

Class Discussion

Class discussion is one of the most common teaching methods and one of the most misunderstood. Systematically facilitated, it is also one of the most democratic of methods. Discussions can be facilitated by the teacher or by one of the students. It is an effective democratic method for dealing with a wide range of issues, be they classroom management or controversial issues. Students can prepare for components of the discussion by researching outside class, or arrive fresh to the discussion drawing upon their experiences. Discussions can take the form of responding to an issue, asking students what they think the most important issues to address might be; it could be in response to a demonstration or presentation, an assigned reading or field trip. Braundy (1997, pp. 45-50) proposed the following guidelines for discussions and responding to students in general:

General Guidelines for Discussions

Clarify the objective of the discussion: what the topic is and the ground rules (e.g., everyone's contributions will be valued; a wide range of points of view will be expressed, try to understand points of view different from your own). **Frame** several thought-provoking starter questions to begin the discussion. **Do not be caught with nothing to say**. The teacher's role is to **facilitate** the discussion. Try to bring reluctant members into the discussion with **encouraging questions**. This means carefully **monitoring** the discussion and the amount of speaking time each individual is using. Take steps to **ensure** that one or two people do not dominate the discussion. This combination of encouragement and knowing how and when to limit discussion takes skill and practice. **Be prepared** to clarify remarks, but refrain from injecting your own point of view. Commit to **hearing** and **paraphrasing** the students' contributions. **Summarize** the discussion at the end, but be sure that the summary reflects the diverse viewpoints presented.

Guidelines for Stimulating Discussion:

- Ask for more information to help clarify or make the response more specific: "Can you give me an example?" or "What exactly do you mean?"
- Restate what you have heard. Also called paraphrasing, this technique lets the participant know that her or his ideas have been heard correctly or gives her or him the opportunity to correct misunderstandings. It also serves to encourage the speaker to expand on any point made.
- Use questions to introduce larger issues and develop critical thinking: "Can we take this one step further?;" "What solutions do you think might solve this problem?;" "How does this relate to what we have learned about..?;" "What are the differences between ... ?;" "How does this relate to your own experience?;" "What do you think causes .... ?;" "What are the implications of .... ?"

- Accept controversial answers to create an atmosphere of open inquiry and debate. Encourage learners to assess and evaluate each other's solutions. Ask the same question of several participants to elicit a range of responses.

- Use open-ended questions (those that can't be easily answered with a simple yes or no) to encourage participants to provide longer, more thoughtful answers. Try not to answer your own questions. Avoid rhetorical questions or those that have an obvious answer: "Don't you think that ... ?" Try instead to make a statement and invite a reaction: "[Someone] thinks that.... What do you think?" Encourage learners to share knowledge and experience based in their cultures, without asking them to be spokespersons for that culture. Ask learners to share a "critical incident" from their own lives that relates to the topic. Look for non-verbal cues. If someone seems perplexed, try: "You seem puzzled, "You seem to feel differently, what is your point of view?" If she or he seems angry, try: "Could you give us an idea of what you are disagreeing with?"

- To help your participants look at their ability to participate in group discussions, you might ask one of the students to keep track and provide feedback on the process. Have them look at these factors: Who talks? For how long? How often? Whom do people look at when they talk: individuals, the group, nobody? Who talks after whom, or who interrupts whom?

Guidelines for Assessing Participation:

The following list provides a useful framework for teachers to use in assessing participation in class discussions:

- **Initiating**: proposing tasks or procedures, defining problems, identifying action steps
- **Eliciting**: requesting information, inviting reactions, and soliciting ideas.
- **Informing**: offering information, expressing reactions, and stating facts.
- **Blocking**: introducing irrelevancies, changing the subject, questioning others' competence.
- **Entrenching**: expressing cynicism, posing distractions, digging in.
- **Clarifying**: clearing up confusions, restating others' contributions, and suggesting alternative ways of seeing problems or issues.
- **Clouding**: creating confusion, claiming that words can't "really" be defined, remaining willfully puzzled, quibbling over semantic distinctions, obscuring issues.
- **Summarizing**: pulling together related ideas, offering conclusions, stating implications of others' contributions.
- **Interpreting**: calling attention to individual actions and what they mean.
- **Consensus proposing**: asking whether the group is nearing a decision, suggesting a conclusion for group agreement.
- **Consensus resisting**: persisting in a topic or argument after others have decided or lost interest, going back over old ground, finding endless details that need attention.
- **Harmonizing**: trying to reconcile disagreements, joking at the right time to reduce tensions, encouraging inactive members.
- **Disrupting**: interfering with the work of the group, trying to increase tensions, making jokes as veiled insults or threats.
- **Evaluating**: asking whether the group is satisfied with the proceedings or topic, pointing out implicit or explicit standards the group is using, suggesting alternative tasks and practices.

Cooperative Learning or Dyads

Cooperative learning refers to any pairing of between two and six students for learning (Braundy 1997). Cooperative environments generally foster greater learning and retention than larger modes of instruction (e.g., lectures). Cooperative groups can be formal study groups, informal discussion groups or task-oriented groups. Cooperation, creativity, responsibility, constructive feedback, conflict resolution skills and problem-solving skills are typically developed and necessary in small group environments. Students get to informally address their assignments. The teacher's task is to foster a positive emotional environment where group members experience a sense of responsibility and interdependence.

Cooperative learning provides an environment where those who may be reluctant to present their ideas in a large group may find some comfort and confidence. Dyads (two), triads (three) or small group discussions enable students to cooperate in activities and projects. In the world of business, design and production, small teams are formed and reassembled to form a larger, cohesive whole in the design and production of products. Hence, cooperative learning has very important implications for technology studies. Braundy (1997, pp. 49-50) offers the following guidelines:

Guidelines for Cooperative Learning

- Divide the students into subgroups of four to six. Make sure the students are seated next to each other to facilitate interaction.
- Clearly state the problem or issue that they are supposed to address. Write it on the board, provide handouts, refer to your website or use an overhead projector to ensure that the students understand what is to be addressed.
- Have the group members select a recorder and spokesperson to keep track of the progress of the group.
- Briefly discuss approaches to the issue and deal with any questions.
- Have participants deal with the issue for the designated period of time while you circulate from group to group assisting as necessary.
- For assessment, it is useful for the groups set to work on a particular project, design, or research project, to have an opportunity to evaluate the group effectiveness.
- For an icebreaker, students give the students a question to resolve, such as this: "Who are the key professionals, besides the architect, involved in designing, financing and constructing a building?" Tell each group to generate as many responses as possible in three to four minutes. Ask a designate spokesperson from each group to provide items from their list. The contributions from the small groups will form as a bigger, comprehensive picture for the larger group.

Debriefing

Debriefing and feedback facilitate reflection and make experiences worthwhile. Debriefing is a method used to provide an environment or platform for the expression of feelings and transfer of knowledge following an experience. Debriefing may come at the hands of a traumatic event or may be used more generally following an intentionally educational experience. Debriefing relies on the skills of the facilitator to reframe an experience or event in order to appropriately channel emotions and knowledge toward understanding and transformation. For some experiences, this could be as simple as bringing the group of students together and asking: "How did it go?" or "What are the important things we can draw from this experience?" Other experiences will require a more formal approach that is structured within a framework somewhat similar to the controversial issues framework. If an experience is important enough to undergo in technology studies, it ought to involve a degree of debriefing.

Debriefing may involve feedback to the students or among the students, but this is not the intent. The intent is to allow the students to "thaw" and to judge their experience and progress toward change or transformation. The intent is to help them come to terms with their experience. This process involves a cognizance of cycle that students may have to be guided to completely debrief (Table 4.2). Some students will have no intention of debriefing and will have to be coaxed, but not coerced, into the process. Once inspired to debrief, teachers can begin to help their students contemplate what happened— what went right or wrong. Through this early stage of debriefing, students may show a determination to change, improve their strategies and make plans. Over time, many will maintain their behavioral commitments. Others will relapse and this is perfectly normal. Teachers should not be overly critical of relapses in behavior. Once the experience is completely integrated, the students will exit this cycle and get on with the next. The debriefing cycle is a mini-cycle in the larger cycle of experience explained in Chapter 6 and in the learning style section at the end of this chapter. A range of other teaching methods, such as creative problem solving, projects, modules and units will be explained in Chapters 5 and 9.

Table 4.2. Debriefing Cycle

Precontemplation	No intention of debriefing
Contemplation	Considering the experience
Determination	Decision to change and strategizing
Action	Commitments and plans made
Maintenance	Maintaining commitments
Relapse	Normal process of backsliding and recycling
Exit	Experience fully integrated

Research Methods

Models of active learning require that students spend a fair amount of time constructing knowledge. Most often, teachers provide pre-established knowledge for their students to analyze and contemplate. At times, teachers design the route and passageways for students to construct and discover new knowledge *via* a discovery method. Here, the teacher is well aware of the type of knowledge to be constructed. At other times, teachers equip their students with a research method to challenge them to construct new meanings and knowledge. In schools, the research methods are simplified, allowing the students to access the methods at their own levels.

Research Methods

1. **Content Analysis**— A systematic method in the social sciences by which contents of spoken or written text are counted. This involves counting the number of times particular words, or phrases, are used, within selected passages (speeches, news stories, etc.). Conceptual and operational codes, like conservative or radical, and economic or cultural help to give latent meaning to the analysis of content.

2. **Critical incident**- A method where students are challenged to identify critical incidents in their lives to examine and elaborate on (Chapter 11).

3. **Design**- Students are challenged to generate tangible solutions to problems, through fairly strict rules guiding aesthetics, function and form (Chapter 5).

4. **Disclosive analysis**- Disclosive analysis refers to a group of methods that are used to derive meaning from the artificial and natural worlds. Common disclosive methods include basic causes, ecological footprints, laws of media, life cycle assessment, quotidian deconstruction, resource streams, reverse engineering, sociologics, systems analysis, technology assessment and forecasting (Chapter 5).

5. **Discourse analysis**- A social science and literary method for analyzing meaning in the images and text of communication. In most cases, this method is used to link everyday discourse with power structures or propaganda.

6. **Discursive analysis**- A philosophical method that draws on techniques such as logic and dialectics to help students analyze claims, grounds, warrants and conclusions in arguments and discourse. Students are given problems and proposed solutions to analyze and determine whether means are commensurate with ends, or whether ends justify the means.

7. **Ethnography-** An anthropological method of observation. Students are challenged to observe and record the actions and culture of subgroups within their own communities.

8. **Forecasting**- Students use methods of Delphi survey, extrapolation, trend analysis or scenario to project into the future and study the future as a continuum of the past and present (Chapter 5).

9. **Genetic method**- A method that focuses on the manner or process by which anything comes into experienced existence. As a teaching method, it is also anthropological in the sense that students trace the "development" of cultures, including their own, through evolutionary stages

of growth. Often called the cultural epoch approach associated with recapitulation theory (Related to genetic epistemology of Piaget and Vygotsky).

10. **Hermeneutics**— The theory and practice of interpretation. This method is common to theological scholars who interpret religious texts. The text must be given space to speak for itself, literally, without editorial license.

11. **Historical method**- Students document (serialize events, organize thematically) continuity and changes over time and analyze and judge the nature of these continuities and changes.

12. **Jurisprudence**- A general method where students follow the legal arguments of a case or establish a court to hear trials and cases. The use of legal techniques to make or break cases that involve issues close to the students such as graffiti laws, minimum wage or war.

13. **Narrative**- A method for making sense of experiences by placing feelings, observations and thoughts into a story form. Narrative helps students connects a wide range of knowledge by challenging them to construct a coherent story. Narrative typically accompanies other methods, such as the historical methods.

14. **Phenomenology**- A method for getting to essences of feelings and experiences. The key is to analyze the lifeworld and nature of experience in pre-reflective ways, or without guiding concepts and theories.

15. **Problem finding and solving**- Students are challenged to identify problems or are presented with perplexing, difficult problem, to think about, troubleshoot and try to resolve. Typically, problem solving is done with an empirical procedure (**technological method**) or scientific method (Chapter 5).

16. **Quotidian deconstruction**- A form of disclosive analysis that focuses on the feelings that people derive from their existence of "being human in a more than human world" (Feng, 2003). Students focus on their everyday life and use phenomenology to help them disclose their desires and feelings about the nature of nature and technology (Chapter 5).

17. **Scientific method**- A general method for logically testing hypotheses, proving theories or constructing generalizations and models. Deductive method begins with a hypothesis to be proved or tested (physical sciences) and proceeds within the constraints of an experiment Inductive method begins with observations and proceeds through methodical examinations of evidence and subsequent observations (biological and earth sciences) (Chapter 2, 5).

18. **Survey**- Students prepare a questionnaire to collect information on some topic of interest and eventually analyze the information.

19. **Systems analysis**- A method of for analyzing human-machine and machine-machine interactions by determining the inputs and outputs of a given system. This is an effective method of disclosive analysis for demystifying the operations and inner workings of natural, social or technological systems (Chapter 5).

20. **Task analysis**- Techniques used to identify the details of specified tasks, including the required dispositions, knowledge and skills required for successful task performance. Worker-oriented, job-oriented, cognitive and emotional task analysis help students engage with career-related knowledge (Chapter 8).

21. **Technological method**- See design, problem solving and scientific methods (Chapter 2, 5).

22. **Technology assessment**- A specific form of disclosive analysis used or assessing the cultural, ecological and social consequences (collateral or deferred) of technological events, practices, trends and values (Chapter 5).

Each teaching and research method, model and family is essential to the practice of technology studies. Teachers have their strengths and weaknesses, and adopt particular models to complement strengths and contradict weaknesses. You will feel more comfortable working within a particular family of methods. For example, you may feel secure with the control that the behavioral modification family offers. You may feel uncomfortable with the messiness and lack of control of the information processing family. You may feel at home with the personal family and its methods and alienated by behavioral modification. Nevertheless, you will have to come to terms with why you prefer some to others and develop proficiencies and facilities for teaching within each of the families. You will have to come to terms with your own style.

Teaching Styles

Teaching style refers to the manner in which a teacher manages instruction and the classroom environment. There are three major teaching styles (permissive, authoritarian and democratic) that are prevalent in classrooms. Most of us have a teaching style that is dominant but display characteristics that include some aspects of each of the other styles. The teaching style that identifies your personality in the classroom controls most aspects of your instruction, classroom management strategies and techniques. Your teaching style determines how you implement classroom management tasks. **Permissive** teachers establish few rules and tend to be inconsistent in enforcing rules or applying consequences for misbehavior. **Authoritarian** teachers establish the classroom rules, learning is teacher centered, the student's role is to comply with the rules and complete all work satisfactorily. **Democratic** teachers establish a classroom environment that includes input on nearly all issues of management, voting privileges for students, and generally positive reactions to student desires and needs. Authoritarian and democratic teaching styles tend to be most effective because disruptions in the classroom are kept to a minimum. Teachers who exhibit a permissive teaching style sacrifice an orderly classroom by trying to allow the students to police themselves. Permissive teachers are generally hands-off, encouraging their students to develop independence and individual responsibility. Many new teachers enter the teaching profession because they like children and teens and enjoy being around them. Beginning teachers tend to be permissive in their dealings with students. Students quickly pick up on these tendencies to overlook minor infractions. Classroom control typically suffers as a result. It is recommended that new teachers develop a teaching style that leans toward authoritarian or democratic style personality types. In Chapter 11 we will address classroom management as it relates directly to teaching styles.

Teaching styles do not develop naturally and without practice or experimentation. It takes time before a teacher establishes a style that accommodates particular teaching methods and families. Permissive teachers tend toward the personal and social families of instruction and emphasize discussion and Socratic methods. Authoritarian teachers prefer direct instruction and information processing and behavioral modification families. Democratic teachers typically adopt managerial methods and find the social interaction family of methods to be most conducive to their style. It is extremely important that teachers clearly understand their style and consistently use one or two styles. Each teaching style and the degree to which the teachers express it has implications for the styles that the students bring to the classroom.

Personality Types

Your preference for certain methods, families or teaching styles will be directly related to your personality type. We develop a fairly distinct, recognizable personality type through the conditions under which we were raised and the events that we have endured. Our personality type acts as a filter that sets the tenor of our lives. Rather than a projection of our true selves, personality types serve to protect a specific aspect of our inner selves. Personality types help us cope with the world, and color the way we see people and make decisions. There are literally dozens of tests and inventories for determining personality types in individuals. Psychological therapists, beginning with the work of Carl Jung, use personality types to help people adjust to social conditions or overcome their personal issues. Career counselors and educators use personality type inventories to guide students toward careers and interests that are congruent with their personalities. Teacher educators use these inventories to help teachers realize how their personality types shape their classroom practices. For example, teachers with a perfectionist personality type will tend to prefer methods that allow for detailed mastery and will organize their labs and workshops in very orderly ways.

Jung introduced the notion of introverted and extraverted personalities. Introverts find energy and solace in the inner world of abstractions, concepts and ideas. They can be sociable but need quiet time to recharge their energy. Introverts want to understand the big picture and how the world works. Introverts learn most through concentration and reflection. Extraverts find energy in doing things and interacting with people. They are comfortable with addressing facets of a problem rather then the whole problem. Extraverts learn most through interaction and in-the-moment discussion. Most expanded systems of personality types are based on variations of these two basic types.

The Enneagram is one system of personality types that was popularized by Helen Palmer in the 1970s (Webb, 1996). The Enneagram has nine personality types and depicts their relationships as well as the direction that particular personality types will tend in times of security and stress

(Fig. 4.2). Type ones (perfectionist) are independent, responsible, hard-working people with high standards. They can also appear to be irritable, intense, judgmental, self-righteous and compulsive. Type twos (giver) are independent and capable, and prefer giving to receiving. They can appear naïve, proud and manipulative. Type threes (performer) are ambitious, high-achievers, good motivators and work hard in pursuit of their goals. The can appear cold and manipulative and can disregard people in pursuit of their goals. Type fours (romantic) are dramatic, intense and attracted to extremes. They can appear flamboyant, elitist and superior. Type fives (observer) are analytic, reflective and observant. The can appear withdrawn, distant, intellectual, objective, quiet and unemotional. Type sixes (questioner) are loyal, dependent, cautious and imaginative. They distrust authority and can appear calm, cautious and guarded. Type sevens (epicure) are cheerful, energetic, charming and elusive. They can appear busy, superficial and self-centered. Type eights (boss) are assertive, energetic, intense, rebellious and direct. They can appear bossy and dogmatic, and see the world in black and white. Type nines (mediator) are accommodating, talkative, uncompetitive, tolerant, warm and good listeners. They can appear laid back, mellow and predictable. There is not a "best" type. All personality types have their advantages and disadvantages, light sides and dark sides. One of these personality types may have immediately resonated with you as they were described.

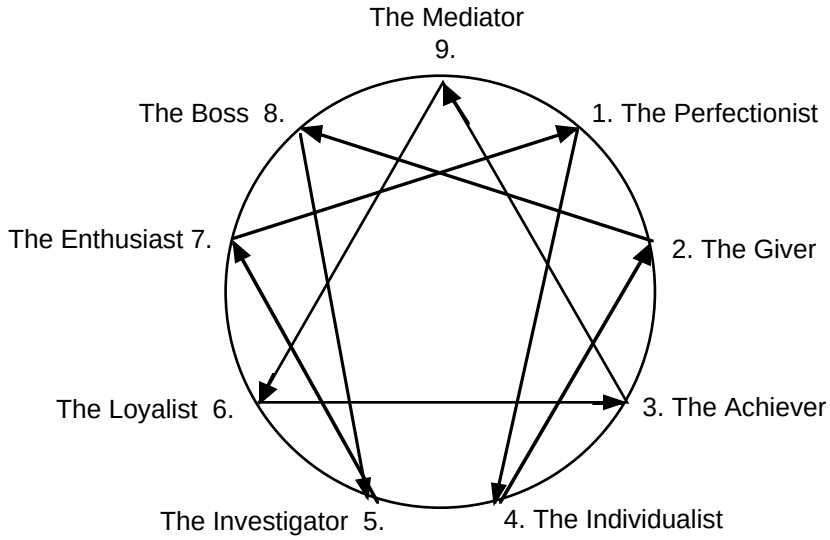

Figure 4.2. Enneagram of Personality Types

The Enneagram divides personality types into three sections of the circle. Each section corresponds with ways in which we experience the world: sensing, feeling and thinking. The three personality types at the top of the circle, boss, mediator and perfectionist, favor instinctual intelligence and speak of making decisions based on gut feelings. These types tend to be in the

world through action. They primarily perceive the world through doing. The three types in the lower left section of the circle, epicure, questioner and observer, favor thought, imagination, and analysis. They tend to respond to the world through their thoughts. The types in the lower right section, giver, performer and romantic, operate in the world through relationships and are concerned with how they are seen by and relate to others. They tend to respond to the world through their feelings.

This section was not to fully explain the Enneagram or personality types. The objective was to provide an idea of how your personality type will influence your choices of teaching methods and development of a teaching style. "Know thyself" is the best advice here. But as teachers, we cannot justify our selections of teaching methods and styles by our personality types. Would we allow our students to justify their behavior by their personality types? We all have a comfort zone and our challenge is to encourage our students to move from their comfort zones. We cannot address all students, their personalities, or their learning styles by a single teaching model, family method or style.

Learning Styles

> If we get too comfortable, we stop growing. Students can put pressure on us to work within their comfort zone. Let's be kind about that. Kind enough to let them learn to be uncomfortable. (Thelan, 1963)

Just as teachers will develop preferences for particular methods, students develop preferences for particular way of learning. We teachers, and our students, probably have preferred ways of perceiving and processing new information. These preferred ways are called learning styles. Typically, our students and we like to know why we are learning something, like to have time to practice, and time to integrate what we have learned into our lives. While schools may excel in delivering facts and overlook the importance of the three stages above, we cannot dismiss the fact that individuals have preferred ways of learning. Individuals have preferred ways of learning throughout the different stages of learning.

Learning styles address the ways we perceive and process. Perceiving relates to the way we notice the world and the way we see reality. Processing relates to the way we internalize an experience and make it our own. Some people prefer to perceive the world through **concrete experience**. These people perceive by sensing and feeling, and prefer to use intuition to solve the problems of a given task. They function well in unstructured situations. Other people prefer **abstract conceptualization**. They like to think things through, analyze and intellectualize. They function well in structured situations. Some people prefer to process new information by **active experimentation**. They like to roll up their sleeve and immerse themselves in the task. They look for practical ways of applying what they learn. They embrace risk-taking and are results

oriented. Other people process through **reflective observation**. They like to watch and ponder the situation. They likely see tasks from several points of view. They value patience and judgment. **Concrete experience, abstract conceptualization, active experimentation and reflective observation** are four general learning styles (Fig. 4.3).

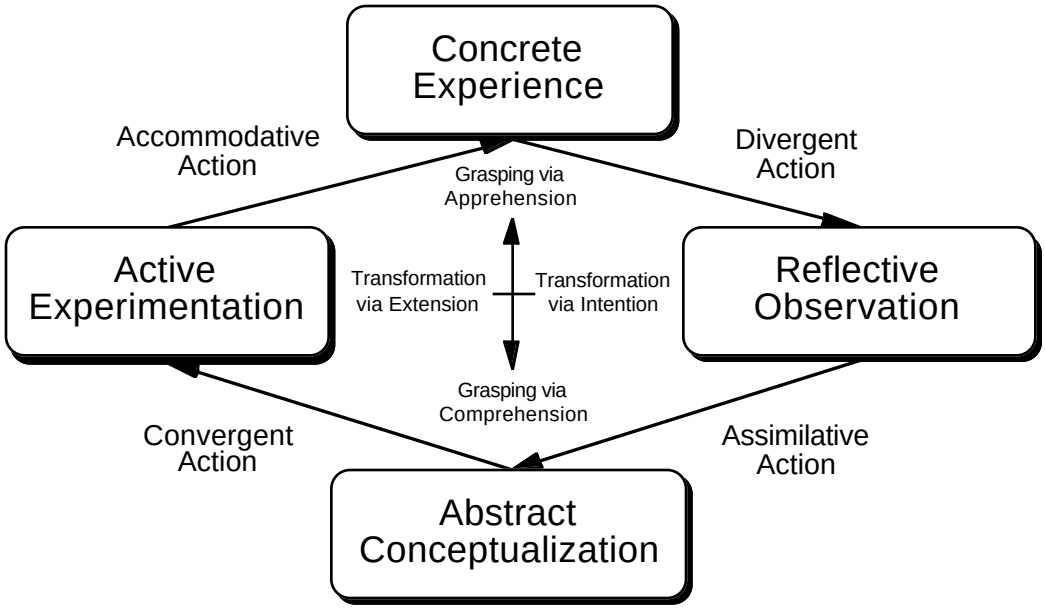

Figure 4.3. General Learning Styles

There are numerous theories of learning styles and categories of learning styles associated with the theories. For example, some educators use Howard Gardner's theory of Multiple Intelligences and derive nine learning styles from his nine intelligences. Others use Rita Dunn and Kenneth Dunn's learning styles inventory, which focuses on the environmental, emotional, sociological, physiological and psychological aspects of learning. Their learning styles are derived from combinations of these aspects. Bernice McCarthy's learning style theory is based on right-brain, left-brain neurological science and David Kolb's learning cycle work. Generally, the following nine learning styles, in pairs, are considered to be the most common. Of course, most of us function by accommodating combinations of a range of learning styles.

The most common test of learning style is the 126 item Myers-Briggs Type Indicator (MBTI), Form G. The MBTI provides data on four sets of preferences. These preferences result in 16 learning styles, resulting from combinations of Introversion versus Extraversion, Thinking versus Feeling, Sensing versus Intuition and Judging versus Perceptive.

Thinking students choose to decide things impersonally on analysis, logic and principle. **Thinking** students value fairness. They place great weight on objective criteria in decision making and judge situations on logic and reason. Data, on *Star Trek*, had an extreme preference for thinking. **Feeling** students value harmony. They focus on emotions and needs as they make

decisions or arrive at judgments. They tend to be good at conversation, persuasion and facilitating differences among group members. The character played by Whoopi Goldberg on *Star Trek* demonstrated an extreme preference for feeling. Some students choose to rely on their five senses and prefer taking in information through a "sixth" sense. **Sensing** students are detail oriented and want facts and explanations. **Intuitive** students, on the other hand, seek out patterns and relationships among pieces of information. They trust hunches and their intuition and look for the "big picture." Some of students prefer to postpone action and seek more information. Others like to make quick decisions, to "get on with the show." **Judging** students are decisive, plan out their decision and are self-regimented. They focus on completing the task, only want to know the essentials, and speak or act quickly, often too quickly. Deadlines and clearly defined roles are extremely important. They prefer to "just do it!" **Perceptive** students are curious, flexible and relatively spontaneous. They start many tasks, have to know the details about each task and often find it hard to complete a task. Deadlines are meant to be moved. Their motto is "but wait a minute!"

Learning Styles

Global or Feeling- prefer to have big pictures of tasks presented first. Learn most effectively when a meaningful context is provided.

Analytic or Thinking- prefer to have small steps build to whole. Learn most effectively when pieces are provided first.

Verbal- rely on words and labels. Prefer to have definitions over images.

Imaginal or Intuitive- prefer to have images (concrete or abstract), metaphors, symbols and diagrams. Difficult concepts are best explained through images.

Concrete or Sensing- prefer concrete examples, followed by concepts or principles.

Abstract or Intuitive- prefer concepts of principles prior to concrete examples.

Haptic, Trial and Feedback or Judging- prefer doing tasks and hands-on applications followed by feedback. Prefer to make errors and build on trials and errors.

Reflective or Perceptive- prefer to think through and reflect on tasks prior to trials. More dependent on time to respond than on external feedback.

Relational- prefer to link new material to what is already known, or unfamiliar tasks to familiar tasks. These students need time to discuss what is being learned prior to executing the tasks.

Research suggests that 90% of girls and women in technology and 60% of boys and men are **relational** learners. They learn best when relations are drawn between different technologies (e.g., fastening seams on cloth when sewing compared to fastening seams on metal when

soldering; fish scales compared to files), and when tasks are related to their lives. For this second point, instructors have to reiterate the relevance of what is being learned by relating it to the students' school life, potential work life, or everyday home life. Personal stories from the instructor's life work well here. These learners prefer to link new material to what is already known, or unfamiliar tasks to familiar tasks. These students need time to discuss what is being learned prior to executing the tasks.

Most, if not all, of the activities and projects we use in technology studies ought to complete a cycle of learning styles. We ought to provide time for and concrete experience (activities, projects) and reflective observation (demonstrations, examples). Students need time for abstract conceptualization (discussions, questions concerning why and what) and time for active experimentation.

Bernice McCarthy expanded on Kolb's learning cycle, and defined her four general learning styles as Imaginative, Analytic, Commons Sense and Dynamic (Fig. 4.4). Imaginative learners prefer to experience and reflect. Analytic learners prefer to conceptualize and reflect. Commons Sense learners prefer to experiment and conceptualize. And dynamic learners prefer to experiment and experience. McCarthy stresses that we should accommodate all four of these learners in our activities or lessons.

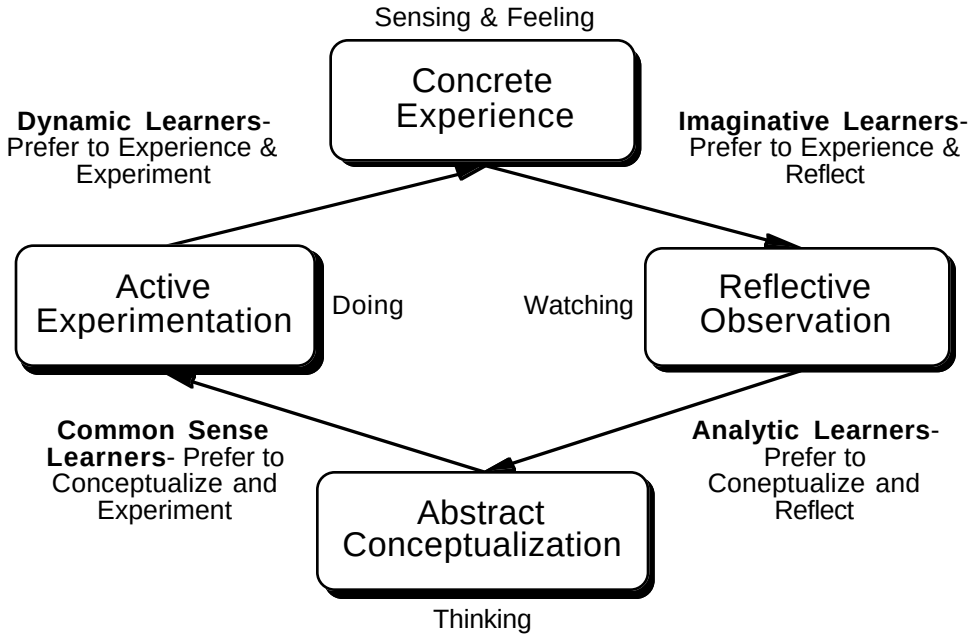

Figure 4.4. McCarthy's 4Mat Learning Cycle

Most learning styles, including McCarthy's, are based of perceptual modality preferences. Perceptual modality refers to the way we perceive or take in the world. The notion of sense

modalities is based on the Perceptual Learning Styles theory of French, Gilley and Cherry. Perceptual learning styles refer to the means by which learners extract information from their surroundings through the senses. Each individual has a preferred sense for accessing knowledge— they use different "pathways" specific to them. Initially, knowledge is stored in short-term memory. Repeated exposure, experience and application promote retention in long-term memory. Perceptual Learning Styles refer to the pathways we use to access and reinforce knowledge. According to this theory, there are seven pathways or learning styles at work in the average classroom:

1. **Print**- refers to seeing printed or written words.
2. **Aural**- refers to listening.
3. **Interactive**- refers to verbalization.
4. **Visual**- refers to seeing visual depictions such as pictures, graphs.
5. **Haptic**- refers to the sense of touch or grasp.
6. **Kinesthetic**- refers to whole body movement.
7. **Olfactory**- refers to sense of smell and taste.

For example, dynamic and common sense learners tend to be haptic, kinesthetic or enactive. They prefer to learn by physical contact and the "mind's hand." Imaginative learners tend to be visual or iconic. They prefer to learn by figural and spatial thinking or the "mind's eye." Analytic learners tend to be auditory or symbolic. They learn through verbal thinking or the "mind's ear." In chapter six, we will explain the role of perceptual modalities in various learning theories.

The fact that people learn and process information differently is *not* under contention. Nonetheless, the degree of differences between people and questions of how and why people differ are under contention. Research into the sources of learning styles often reflects the tired arguments between nature and nurture in explanations of intelligence. Neuroscientists attempt to explain the differences through biological and physiological descriptions. Social scientists attempt to explain learning styles by referring to socioeconomic conditions, familial tutelage or class, gender, race and sexuality.

Brain lateralization, or the notion that the left side and right side of the brain are differentiated by function, has had the greatest influence on learning style theorists. This notion originated in the "split-brain" research on patients with epilepsy during the 1960s. The neurophysiologists who did the research concluded that the brain was divided into two "spheres of consciousness." They theorized that the left side was the site of speech and rational thought while the right side was the site of intuition and spatial abilities. From this, an entire discourse on brain lateralization was founded. According to the myth, left hemisphere is logical, verbal and dominant. The right hemisphere is imaginative, emotional, spatially aware and suppressed. Hundreds of articles, books and web sites promise techniques to liberate the right side of the brain (e.g., *Drawing on the Right Side of the Brain*). In the urban legend of cerebral lateralization, the brain neatly divides its labor between left and right functions such as linear and holistic processing,

sequential and random processing, symbolic and concrete processing, logical and intuitive processing, verbal and nonverbal processing, and reality-based and fantasy-oriented processing. Such simplicity is not the case.

Most neuroscientsts claim that the discourse is mythical, noting that research on brain lateralization is complex, contradictory and inconclusive. First, any lateralization that may exist in the brain is based on a difference of processing style, not function. In other words, intellectual tasks are shared across hemispheres, and each side contributes in a complementary, not exclusive, way. Experiments involving navons, or images that have a larger coherence but are made of smaller parts, are at the base of the controversies. Subjects with their brains wired to scanners are given a series of navons, such as a large letter S, which is made up of small letter Fs. Their reactions in the left and right hemispheres depended on whether the subjects concentrated on the whole (the S) or the parts (the Fs). However, activity on each side on the brain was reversed when the subjects were given 3D object navons, such as an anchor made up of little boats. These types of contradictory findings have left most neuroscientists to stick to their original conclusions: Brains have evolved to be balanced across hemispheres, drawing on the left and rights sides to process the same tasks.

Projection and Reflective Practice

In chapter one, we acknowledged that a basic cycle of communication was at the base of instruction and instructional planning. We also asserted that the most common instructional strategy for technology teachers was demonstrations. In this chapter, we argued that teachers ought to think systemically about instruction. Instructional strategies are a component of a larger instructional system. We noted that our instructional strategies, or teaching methods, must be sensitive to other components in the system and respond to other systems, such as the learning system. Our personality type inherently influences our preferences for particular teaching models, families, methods and styles. However, this does not excuse us from attending to our students' preferences. We must develop a toolbox with a range of teaching methods so that we can anticipate and respond to our students' learning styles and perceptual modalities. The learning style cycle, developed by McCarthy, helps us to think systemically about instruction and learning.

Of course, learning styles are only one characteristic of students. Students arrive with basic needs (food, shelter, clothing, emotional love) that differ. They have different capabilities, interests, personalities and racial or gender characteristics. Students mature at different rates. Students without much discipline or stability in their home life need discipline and stability in their school life and teaching methods. Look at the grid or table of specifications below. Across the top are teaching methods and on the left are various ways by which students are differentiated. The purpose of this grid is to demonstrate the challenge of finding one method that is adequate for all

students. Picture the addition methods to meet content objectives and various societal expectations! Obviously, there is no "one size fits all," generic method. Nor is there a scientific way of merely correlating student characteristics with methods, as the grid may suggest (Table 4.3).

In the next chapter, we address the issues and challenges of teaching creativity, ingenuity, design and problem solving. Specific teaching methods, such as design briefs, respond quite effectively to teaching creativity and ingenuity. We will provide details for developing design briefs and other methods specific to design and problem solving.

Table 4.3. Student Characteristics by Method

	Teaching Method or Instructional Strategy										
Nature of the Students:	Lecture	Discussion	Demonstration	Hand-outs	Controversial Issues	Values Clarification	Role Playing	Problem Solving	Design Brief	Module	Project/ Report
Developmental tasks and Maturity											
Learning Styles											
Diversity of Interests											
Diversity of Capabilities											
Experiential Background/ Entry Characteristics											
Special Needs and Abilities											
Class, Gender & Racial Differences											

1. **Teaching Methods:** List the five teaching methods that are most attractive to you, exclusive of demonstrations, design briefs, problems and projects (these are the core methods of technology studies). What teaching method family are they from? Is this by coincidence or congruent with your personality? Choose a content topic that you anticipate teaching (e.g., alternative energy, digital technologies and rights, forestry practices, pre-fab housing, desk-top publishing). Write a brief scenario describing how you will use each of the methods to teach the same topic. Will you actually use all of these methods, or will you pick and choose two out of the five? Why?