Do Engineers fit the mold, or are they made to fit it?

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Abstract

Do all engineers really think the same way, or do we eliminate some people from being engineers just because they think differently or learn differently than the "normal" engineer?

In an effort to help students learn better, two learning style surveys were administered to the freshmen students in the introductory electrical engineering class (EE111) at New Mexico State University. The results were compiled and given back to the students. The different styles were discussed as were the actions the students should take to increase their learning. Classroom techniques were also discussed that would be used to enhance their learning based on the results for each class.

In an effort to track the learning styles of these students, the students remaining in our department will re-take the learning styles surveys in their senior year to see if their learning style has changed.

Introduction

First year students at New Mexico State University arrive with various backgrounds, experiences, and abilities. In the freshman circuits class, even with a prerequisite of Trigonometry and College algebra, students are at different levels of mathematical competency. Each student has different needs.

In an effort to meet some of these needs, two learning style surveys {1, 2} are administered within the first week of school. The students receive homework credit for filling out the information and reporting the results. The instructor then analyzes the data and looks to see what the dominant learning styles are. Once the styles have been identified, the results of the survey are discussed with the class. Students are encouraged to use their learning style to their advantage and to follow the learning style recommendations for their particular learning style. The teaching style used in class is also modified as necessary to meet the needs of the students.

When the students are about to graduate, the survey will be administered again, and compared with their previous responses to see if their attitudes and styles have changed, or if they have remained the same.

Surveys

The first survey from Bringing Out the Giftedness in Your Child {1} contains 42 questions and is designed to help determine the preferred mode of learning. The four types of learning styles investigated in this survey are summarized in Table 1:

Learning Style	Indicated by	Recommendation
Visual	V	Read the material that will be covered in advance, that way you can concentrate on what is going on at the board. Sit in front of the class. Re-write your notes, and outline. You do best when you see things written down on the board, and when you make your own diagrams. You need to see the math steps listed on the board – you have trouble doing the math in your head.
Tactile	T	Skim through readings; underline major headings and important points. Draw charts or diagrams to summarize the material.
Kinesthetic	K	Review the readings before class while rocking in a rocking chair or on a stationary bike (be moving). Tape the lectures and listen to them later while walking. Movement enhances your learning.
Auditory	A	Lectures and discussions are your preferred mode of learning. Tape material and listen again later may help. Read out loud. Sit in the front of the class.

Table 1: Summary of preferred Learning Style {1}

The second survey {2} is used to help determine what types of interaction are best to aid in the learning process. This survey contains 24 questions. The four types of interaction are summarized in Table 2:

Preferred Interaction	Indicated by	Recommendation
Student-Faculty-Formal	SFF	Student prefers to interact with faculty in a formal environment (in class). You learn best by asking and answering questions during class. You need to participate in class.
Student-Faculty-Informal	SFI	Student prefers to interact with the faculty in an informal environment (outside of class). You learn best by asking questions one on one with the faculty member. You need to be sure you have time to meet with the faculty member outside of class.
Student-Student	SS	Student prefers to interact with other students both during and outside of class. You need to join a study group, participate in group projects, ask questions of fellow students and try to answer their questions.
Student-Self	Self	Student prefers to learn on his or her own. You would tend not to participate in study groups, class discussions, or participate in class.

Table 2: Summary of Interactive Learning Styles {2}

Results

The survey has been given for two semesters to the freshmen in the EE 111 Circuits course in the Klipsch School of Electrical and Computer Engineering at New Mexico State University. The responses obtained from the students are plotted in Figures 1-4. Figures 1 and 3 show the responses for the Dunn learning style survey {1}, and Figures 2 and 4 show the results for the interactive learning styles survey for the spring 1999 semester and the fall 1999 semester respectively. In the Dunn survey, the higher the possible response, the more predominate that learning style is. If all of the students indicate visual learning, then the responses would be high for the visual columns, and the number of people giving that response would be high. This is what is seen in Figures 1 and 3. For the interactive learning styles responses, again the dominant style is the response that has the highest possible response and a large number of people giving that response. The values in Figures 2 and 4 are not as obvious as they were in Figures 1 and 3.

To find the actual preference for each student, they answers given for each survey needs to be analyzed separately. The style that receives the highest value is the students preferred style. When just the largest style is examined a definite pattern can be seen. The results from the responses indicating only the styles with the maximum values are summarized in Figures 5 through 8. Figures 5 and 7 summarize the preferred learning style. It can be seen that style V (which refers to the visual learning style) is the definite favorite. Figures 6 and 8 indicate the preferred interactive learning style. In both cases the SS (student-student) interaction is the least preferred, but the number preferring this method is not insignificant. For the spring group, most students preferred working on their own. For the fall group, most preferred a formal student-faculty interaction. But still each preference is not dominate over the others.

Conclusions

Since most of the freshmen are visual learners, the freshmen can better prepare for class by reading the material ahead of time, and the class can be geared more to their style. For instance, all directions are put onto the board so that the students can see them and reading assignments are made so that they know what will be covered in the upcoming classes. Math steps are included as part of solving the problem, and are not skipped over. Visual contact with the students is also maintained to be sure they can see what is going on.

Accommodating the interactive learning styles is more difficult in that all of the styles show significant preferences. A lot of the interaction does depend on the student, so that if the student prefers learning by their self, calling on those students can be avoided. Taking time for questions during class, and allowing time for the students to respond will encourage the student-faculty formal students. Having extra office hours or allowing different types of access for the student-faculty informal is a way to aid these types of students. For the student-student preferences, the faculty member can help organize study groups, or suggest places where the student can obtain peer tutoring. Trying to accommodate the students at their level should benefit the student. So far, the class evaluations indicate that the students are satisfied with the class.

This work has just begun. In about 4 years these students will be asked to take the surveys again. Their responses will then be compared with the responses they made as freshmen to see if their preferred learning styles or interactions have changed. Many of our students are expected to work as teams in the workplace. Perhaps the survey will reflect a shift to the student-student interaction as they gain more experience. Time will tell. The actual surveys used are included in the appendix to this paper.

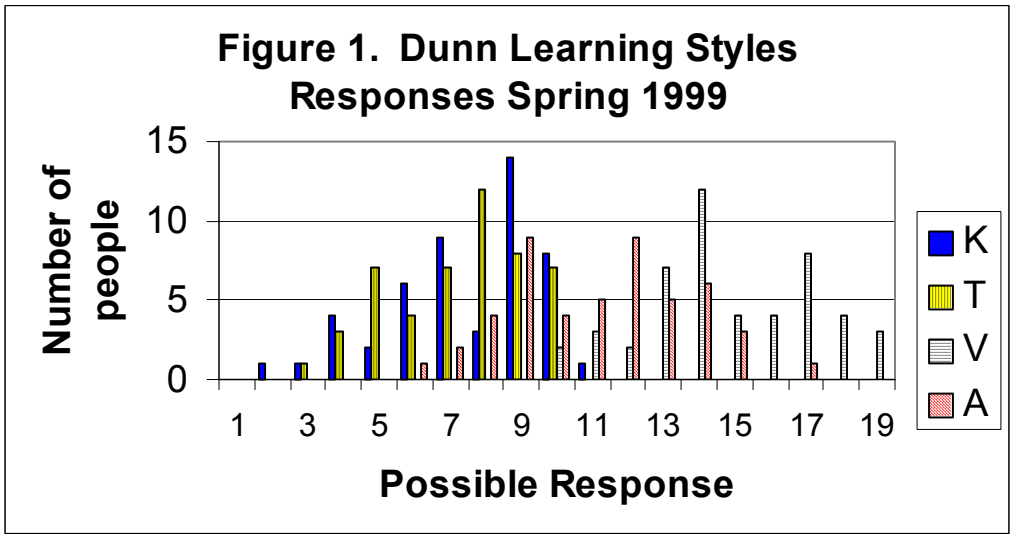
Figure 1. Dunn Learning Styles Responses Spring 1999
Number of people
15
10
5
0
1
3
5
7
9
11
13
15
17
19
Possible Response
K
T
V
A

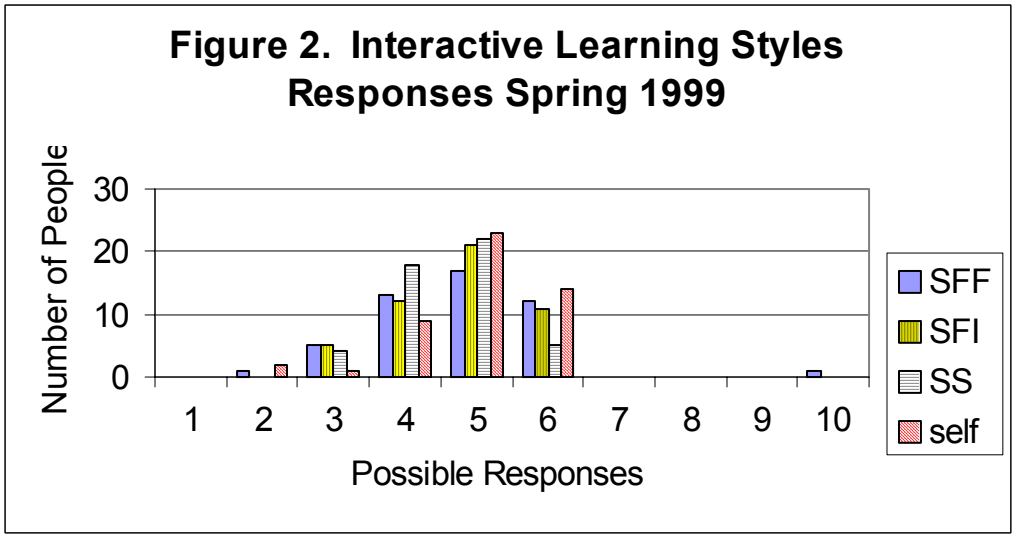
Figure 2. Interactive Learning Styles Responses Spring 1999
Number of People
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Possible Responses
SFF
SFI
SS
self

Figure 3. Dunn Learning Styles Responses
Fall 1999

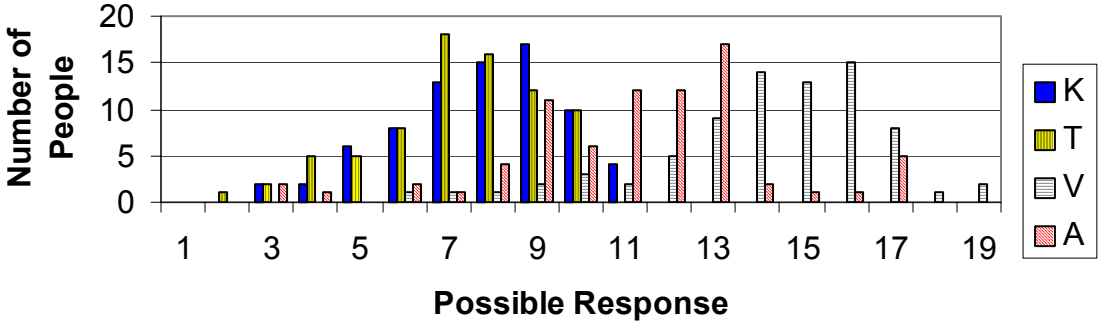

Figure 4. Interactive Learning Styles Responses
Fall 1999

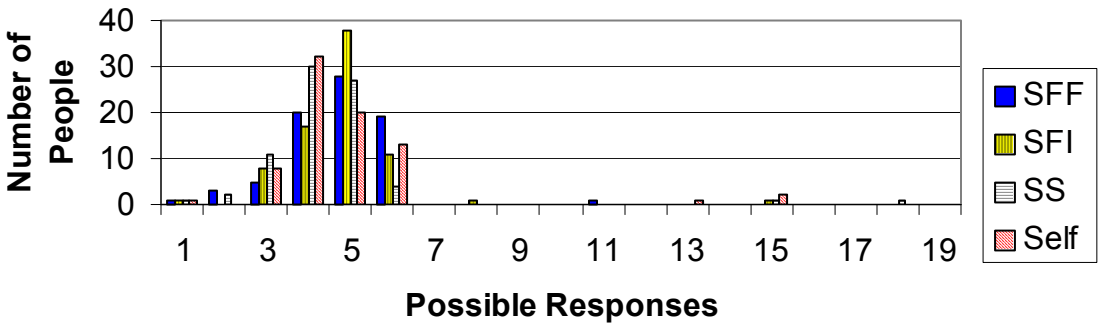

Figure 5. Preferred Learning Style Spring 1999

Figure 6. Preferred Interactive Learning Style Spring 1999

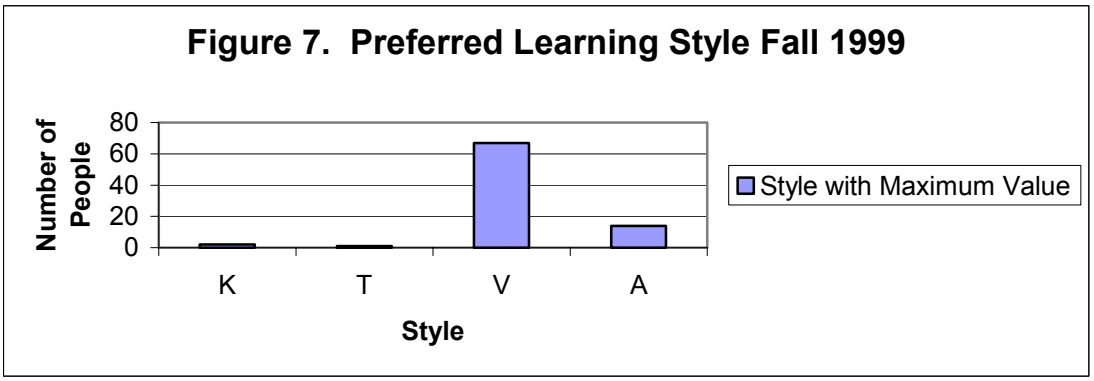
Figure 7. Preferred Learning Style Fall 1999
Number of People
80
60
40
20
0
K
T
V
A
Style
Style with Maximum Value

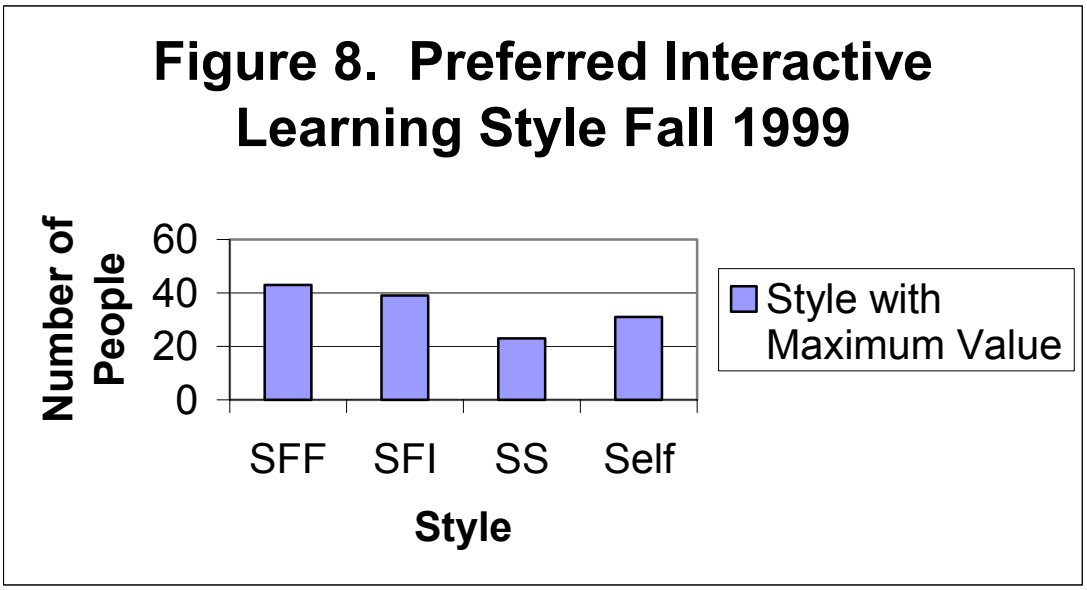
Figure 8. Preferred Interactive Learning Style Fall 1999
Number of People
60
40
20
0
SFF
SFI
SS
Self
Style
Style with Maximum Value

Bibliography

1. Dunn, R., Dunn, K., & Treffinger, D. (1992) What's your style? John Wiley, New York.
2. McShannon, J.R. (1998). Interactive Learning Styles Inventory. Las Cruces, NM.

Appendix

WHAT'S YOUR STYLE?

Studies show that most of us have one preferred mode of learning: visual (by reading), auditory (by listening), tactile (by handling), or kinesthetic (by experience or movement). To determine your preferred style of learning, mark true or false next to each question, then refer to the answer key on the back.

When I learn something new, I like to learn about it by:	True	False
1. reading about it	____	____
2. hearing a record	____	____
3. hearing a tape	____	____
4. seeing a filmstrip (no soundtrack)	____	____
5. seeing & hearing a movie	____	____
6. looking at pictures & having someone explain them	____	____
7. hearing my supervisor or teacher tell me	____	____
8. playing games	____	____
9. going someplace and seeing for myself	____	____
10. having someone show me	____	____

Things I remember best are things:	True	False
11. my supervisor or teacher tells me	____	____
12. someone other than my supervisor or teacher tells me	____	____
13. someone shows me	____	____
14. I learned about on trips	____	____
15. I read	____	____
16. I heard on records or tapes	____	____
17. I heard on the radio	____	____
18. I saw on the television	____	____
19. I read stories about	____	____
20. I saw in a movie	____	____
21. I tried or worked on	____	____
22. my friends & I talked about	____	____

I really like to:	True	False
23. read books, magazines, or newspapers	____	____
24. see movies	____	____
25. listen to records	____	____
26. make tapes on a tape recorder	____	____
27. draw or paint	____	____
28. look at pictures	____	____
29. play games	____	____
30. talk to people	____	____
31. listen to other people talk	____	____
32. listen to the radio	____	____
33. watch television	____	____
34. go on trips	____	____
35. learn new things with my hands	____	____
36. study with friends	____	____
37. build things	____	____
38. do experiments	____	____
39. take pictures or make movies/videos	____	____
40. use typewriters, computers, calculators, or other machines	____	____
41. go to the library	____	____
42. mold things with my hands	____	____

Adapted from *Bringing Out the Giftedness in Your Child*, by Rita Dunn, Kenneth Dunn, and Donald Treffinger (John Wiley, 1992).

Answer Key

Scoring: Circle the number for each "true" answer. Each answer is an indication of an auditory (A), visual (V), tactile (T), kinesthetic (K) perceptual style using this key. (Some answers correlate to more than one mode.) On the score section below, write the number of times each letter was circled as true. The letter that occurs most often indicates your dominant perceptual style. If you have a nearly equal number of each letter, you probably have equally distributed perceptual style preferences.

1. V	12. A	23. V	34. K
2. A	13. V	24. V	35. T
3. A	14. K	25. A	36. A
4. V	15. V	26. K	37. T, K
5. A, V	16. A	27. T	38. K
6. A, V	17. A	28. V	39. T, K
7. A, V	18. A, V	29. T, K	40. T
8. V, T, K	19. V	30. A	41. V
9. V, K	20. V	31. A	42. T
10. V	21. T, K	32. A	
11. A	22. A	33. V	

Score:

K=____
T=____
V=____
A=____

What Does it Mean?

Once you determine the type of learner you are, you can make adjustments in how you learn new material. Learning-styles consultants offer the following advice for how each type should approach a class lecture or discussion:

Visual: Find out what reading the session will be based on, and then read the material in advance.

Tactile: Skim through the readings and underline the major headings and important points. Draw charts and diagrams to summarize the material or take notes on your computer.

Kinesthetic: Review the readings before the lecture while sitting in a rocking chair or on a stationary bike. Tape the lectures and listen to them later while you walk.

Auditory: Lectures and discussions are your preferred mode, so tape written material.

Learning Style Tips

Audio Learners

Learn best when:
- professors lecture
- others talk
- read out loud
- sit in front of class

Have a hard time when:
- there are lots of graphs
- they can't hear the speaker
- professors have monotones/accepts
- there are background noises

Can improve if they:
- work on note taking skills
- take a public speaking course, you'll get a lot of listening practice
- carry cards to write down information presented orally
- study with a classmate who is an auditory learner

Visual Learners

Learn best when:
- they sit in the front of the class
- create 3x5 notecards to study
- outline for notes & tests
- re-write their notes
- see things written down on the board
- make their own diagrams

Have a hard time when:
- taking oral directions
- doing mental math
- can't concentrate on lecture unless they can see the mouth of the instructor

Can improve if they:
- learn when and how to draw diagrams
- copy and practice redrawing visuals the instructor provides
- practice redrawing visuals included in the textbook
- study the function of graphics
- study with a classmate who is a visual learner
- learn to notice and read visuals and graphics

Interactive Learning Style Inventory
Please do not write your name on this form

This inventory gives you the opportunity to describe how you **learn best**. There are no right or wrong answers. Read each statement and decide to what extent you agree or disagree with the statement. Think about what you do when you are learning something new and difficult, how do you **learn best**? Then give your immediate or first reaction to the statement. Don't base your response to the statement on what you do for this particular class or even at this college. Circle the one number that best describes what you do most of the time when you **learn best**.

Circle: 1 if you strongly disagree
2 if you disagree
3 if you are neutral
4 if you agree
5 if you strongly agree

The first two pages ask about what you do to learn best **during class**. The next page asks what you do to learn best **when studying**.

For the following statements, describe how you **learn best** *during class*. When you are learning something new or difficult *during class*, what do you do to **learn best**? Circle the one number that best describes what you do most of the time when you **learn best**.

Please read and respond to every statement.	Circle only one number.				
	Strongly Disagree		Neutral		Strongly Agree
1. During class, the way I learn best is asking the teacher questions.	1	2	3	4	5
2. During class, the way I learn best is, if I don't understand how the teacher is solving a problem, I ask a student for clarification.	1	2	3	4	5
3. During class, the way I learn best is, working things out for myself.	1	2	3	4	5
4. During class the way I learn best is, if I don't understand something, I work it out for myself.	1	2	3	4	5

5.	During class the way I learn best is, if I don't understand how the teacher is solving the problem, I ask the teacher for clarification.	1	2	3	4	5

6.	During class the way I learn best is, if I don't understand something, I ask a student sitting near me.	1	2	3	4	5

7.	During class the way I learn best is, if I don't understand how the teacher is solving a problem, I work the problem for myself.	1	2	3	4	5

8.	During class the way I learn best is, if I don't understand something, I ask the teacher.	1	2	3	4	5

9.	During class, the way I learn best is talking with the other students.	1	2	3	4	5

For the following statements, describe how you **learn best** *studying, outside of class*. When you are ***studying*** something new or difficult *outside of class* what do you do to learn **best**? Circle the one number that best describes what you do most of the time when you **learn best**.

Please read and respond to every statement.	Circle only one number. Strongly Disagree		Neutral		Strongly Agree
10. When studying the way I learn best is, if I don't understand something, I go ask the teacher.	1	2	3	4	5
11. When studying the way I learn best is, I ask the teacher questions.	1	2	3	4	5
12. When studying the way I learn best is, if I don't understand how to solve a problem, I ask a student for clarification.	1	2	3	4	5
13. When studying the way I learn best is, if I don't understand how to solve a problem, I ask the teacher for clarification.	1	2	3	4	5
14. When studying the way I learn best is, if I don't understand something, I work it out by myself.	1	2	3	4	5
15. When studying the way I learn best is, if I don't understand how to solve a problem, I work it through by myself.	1	2	3	4	5
16. When studying the way I learn best is, asking questions of the teacher.	1	2	3	4	5
17. When studying the way I learn best is, if I don't understand something, I ask another student.	1	2	3	4	5

Thank you!

Interactive Learning Style - Scoring

Directions:

1.Place the number you circled next to the question number in the table. For example the answer to question #1 is written in column 1 and the answer to questions #2 is written in column 3.
2.Add the total for each column.
3.Divide the sum by the number given.
4.The column which has the largest mean is your most important learning style. The column which has the second largest mean is your second most important learning style.

Student-Faculty Formal	Student-Faculty Informal	Student-Student	Student-Self
1=			
		2=	
			3=
			4=
5=			
		6=	
			7=
8=			
		9=	
	10=		
	11=		
		12=	
	13=		
			14=
			15=
	16=		
		17=	
Sum =	Sum =	Sum =	Sum =
Sum÷3=	Sum÷4=	Sum÷5=	Sum÷5=

Interactive Learning Style
Scoring Information

Your interactive learning style refers to the person or persons you interact with when you learn best. Do you interact with the faculty, with other students, or with no one? Do you interact with the faculty differently during class than after class? This information will help you develop study strategies to do your best both in class and outside of class.

Column #1: Student-Faculty-Formal: Refers to interacting with the faculty in a formal environment (during class). If this is your most important learning style you learn best by asking and answering questions during class. If this is your learning style you need to be sure to ask the faculty questions during class, answer questions the faculty asks during class, and participate in class discussions.

Column #2: Student-Faculty-Informal: Refers to interacting with the faculty in an informal environment (outside of class). If this is your most important learning style you learn best by asking questions of the faculty outside of class; before class, after class, during office hours, on the phone, or through email. If this is your learning style you need to be sure to find a way to talk to the faculty outside of class.

Column #3: Student-Student: Refers to interacting with other students, both during and outside of class. If this is your most important learning style you learn best by joining study groups, participating in project groups, and asking and answering questions other students ask.

Column #4: Student-Self: If this is your most important learning style you learn best by yourself. You do not participate in study groups, participate in class discussions, or ask or answer questions during class.