Teaching & Learning Engineering: a tango

Teaching & Learning Styles

Nikos J. Mourtos

Professor & Chair, Aerospace Engineering
San Jose State University
the Way they Learn
& the Way we Teach:
Bridging the Gap
Instruction begins when you, the teacher, learn from the learner. Put yourself in his place, so that you may understand what he learns and the way he understands it.
Session Objectives

- **Identify** the various characteristics of different learning styles
- **Discuss** instructional methods that address the needs of students with different learning styles
What is Learning Style?

- A student’s consistent way of responding to and using stimuli in the context of learning.
- A student’s preferred way of processing information.
Facts:

1. Students learn < what we teach!
2. How much they learn depends on:
   a. Native ability.
   b. Background.
   c. Motivation.
   d. Attitude.
   e. Match between their learning style and our teaching style.
3. We can’t do much about their ability, background, or learning style.
Conclusion:

To maximize student learning we must:

1. **Motivate (engage) them**!
2. **Change their attitudes**!
3. **Teach to their learning needs** (work on our teaching style)!
Learning Styles Models

- Myers-Briggs Type Indicator
- Kolb’s Learning Cycle
- Hermann Brain Dominance Model
- Grasha-Riechmann Teaching / Learning Styles
- Productivity Environmental Preference
- Howard Gardner’s Multiple Intelligences
- **Felder-Silverman Learning Style Model**
- Hill’s Cognitive Style Mapping
- Dunn and Dunn Learning Styles
- Gregorc Learning Styles
Questions to be explored:

- What are the different ways students process information? (LS)
- Which LS are favored by most students?
- Which LS are favored by most professors?
- What are the consequences of mismatches between TS and LS?
- What can we do to reach students with the full spectrum of LS?
LS Dimension: Perception

SENSING LEARNER
- Focus on sensory input
- Practical
- Observant
- Concrete: Facts + Data
- Repetition

INTUITIVE LEARNER
- Focus on subconscious
- Imaginative
- Look for meanings
- Abstract: Theory + Models
- Variety
LS Dimension : Perception

SENSING LEARNER
- Methodical
- Detail work
- Complaint :
  "Not the real world !"
- Tests : runs out of time

INTUITIVE LEARNER
- Quick
- Concept work
- Complaint :
  "Plug and chug"
- Tests : carelessness
"Algebra class will be important to you later in life because there's going to be a test six weeks from now."
What kind of learner are you
Sensor (S) or Intuitor (N) ?

S ______________________________N
strong    moderate   mild       moderate    strong

How strong is your preference ?
What kind of learner are you
Sensor (S) or Intuitor (N)?

1. Sensor =
2. Intuitor =
3. Balanced (can learn either way) =
LS Dimension : Perception

- Everyone is both S and N
- Everyone prefers one or the other
- Most undergraduates are S
- Most professors are N

MISMATCH!

- S-N balance depends on field, situation
- Both S and N make good professionals
Statistics from engineering courses, 1999

<table>
<thead>
<tr>
<th></th>
<th>S very strong</th>
<th>S moderate</th>
<th>Balanced</th>
<th>N moderate</th>
<th>N very strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 10</td>
<td>4 (10%)</td>
<td>12 (30%)</td>
<td>18 (45%)</td>
<td>6 (15%)</td>
<td>0</td>
</tr>
<tr>
<td>(N=40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 111</td>
<td>9 (15%)</td>
<td>16 (26%)</td>
<td>26 (43%)</td>
<td>8 (13%)</td>
<td>2 (3%)</td>
</tr>
<tr>
<td>(N=61)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mat.E</td>
<td>13 (10%)</td>
<td>42 (33%)</td>
<td>64 (50%)</td>
<td>7 (5.5%)</td>
<td>2 (1.5%)</td>
</tr>
<tr>
<td>153</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N=127)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16 February 2017

Nikos J. Mourtos
LS Dimension : Input Modality

**VISUAL LEARNER**

- “Show me”
  - pictures
  - diagrams
  - sketches
  - schematics
  - flow charts
  - plots

**VERBAL LEARNER**

- “Explain it to me”
  - spoken words
  - written words

16 February 2017

Nikos J. Mourtos
What kind of learner are you
Visual or Verbal?

<table>
<thead>
<tr>
<th>Visual</th>
<th>Verbal</th>
</tr>
</thead>
<tbody>
<tr>
<td>strong</td>
<td>strong</td>
</tr>
<tr>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>mild</td>
<td>mild</td>
</tr>
<tr>
<td>mild</td>
<td>moderate strong</td>
</tr>
</tbody>
</table>

How strong is your preference?
What kind of learner are you?

1. Visual =
2. Verbal =
3. Balanced (can learn either way) =
LS Dimension: Input Modality

- You learn more when information is presented in your preferred modality.
- You learn even more if you get it in both.
- Most people are visual learners.
- 90-95% of most course content is verbal.

Mismatch!
Statistics from engineering courses, 1999

<table>
<thead>
<tr>
<th>Course</th>
<th>Visual very strong</th>
<th>Visual moderate</th>
<th>Balanced</th>
<th>Verbal moderate</th>
<th>Verbal very strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 10</td>
<td>12 (30%)</td>
<td>19 (48%)</td>
<td>9 (22%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ME 111</td>
<td>21 (34%)</td>
<td>22 (36%)</td>
<td>17 (28%)</td>
<td>1 (2%)</td>
<td>0</td>
</tr>
<tr>
<td>Mat.E 153</td>
<td>32 (25%)</td>
<td>40 (32%)</td>
<td>46 (36%)</td>
<td>7 (5.5%)</td>
<td>2 (1.5%)</td>
</tr>
</tbody>
</table>

16 February 2017

Nikos J. Mourtos
LS Dimension: Organization

**INDUCTIVE LEARNER**
- Start w. observation
- Infer, explain

**DEDUCTIVE LEARNER**
- Start w. principles
- Deduce, derive
LS Dimension: Organization

**INDUCTION** is
- the natural human LS
- better for long-term retention, transfer
- Other names:
  - Problem-Based Learning
  - Inquiry-Based Learning
  - Discovery Learning

**DEDUCTION** is
- the natural college TS
- better for short-term retention of more information
LS Dimension : Organization

- Everyone learns both ways
- Everyone has a preference
- Most students learn better inductively
- Most professors teach deductively

MISMATCH !
Question 28 (n = 17): Please select either a OR b: When I introduce complex principles in my classes:

a. I usually start with specific examples that are easy to grasp, I continue with more complex examples, and finally, I generalize the principle 23.5%

b. I usually start with the general principle, I continue by making simplifying assumptions, and finally, I present specific examples. 76.5%
LS Dimension : Organization

- Purely deductive teaching makes students think the material is
  - straightforward for author / instructor
  - impossible for them

Both ideas are wrong!
**LS Dimension : Processing**

**ACTIVE LEARNERS**
- Process actively
- Think out loud
- “Let’s try it out!”
- Jump in prematurely
- Like group work

**REFLECTIVE LEARNERS**
- Process introspectively
- Work quietly
- “Let’s think about it!”
- Delay starting
- Like solo or pair work
What kind of learner are you
Active or Reflective?

A ________________________________ R
strong moderate mild mild moderate strong

How strong is your preference?
What kind of learner are you?

1. Active =
2. Reflective =
3. Balanced (can learn either way) =
LS Dimension: Processing

- Most classes have both active and reflective learners
- Most classrooms are passive
- Active learners don’t get to act
- Reflective learners don’t get to reflect

MISMATCH!
Statistics from engineering courses, 1999

<table>
<thead>
<tr>
<th>Course</th>
<th>Active very strong</th>
<th>Active moderate</th>
<th>Balanced</th>
<th>Reflect. moderate</th>
<th>Reflect. very strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 10</td>
<td>1 (2%)</td>
<td>14 (35%)</td>
<td>19 (48%)</td>
<td>6 (15%)</td>
<td>0</td>
</tr>
<tr>
<td>(N=40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 111</td>
<td>3 (5%)</td>
<td>18 (30%)</td>
<td>34 (55%)</td>
<td>4 (7%)</td>
<td>2</td>
</tr>
<tr>
<td>(N=61)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mat.E</td>
<td>8 (6%)</td>
<td>23 (18%)</td>
<td>75 (59%)</td>
<td>17 (13%)</td>
<td>4</td>
</tr>
<tr>
<td>153</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N=127)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16 February 2017

Nikos J. Mourtos
Question 14 (n = 18): *I lecture for most of the class period:*

- In every class session: 22.2%
- Once or more times a week: 38.9%
- Once or more times a month: 16.7%
- Once or more times per semester: 16.7%
- Never: 05.6%
Question 26 (n = 18): I use in-class small group (cooperative learning) activities:

- In every class session 27.8 %
- Once or more times a week 11.1 %
- Once or more times a month 38.9 %
- Once or more times per semester 16.7 %
- Never 05.6 %
LS Dimension : Understanding

SEQUENTIAL LEARNER
- Can function w. partial understanding
- Steady progress
- Explains easily
- Likes analysis, details (the trees)

GLOBAL LEARNER
- Needs the big picture to function
- Initially slow, then major leaps
- Can’t explain easily
- Likes synthesis, systems-ecological thinking (the forest)
What kind of learner are you
Sequential or Global?

S ________________________________ G
strong    moderate    mild    moderate strong

How strong is your preference?
What kind of learner are you?

1. Sequential =
2. Global =
3. Balanced (can learn either way) =
LS Dimension: Understanding

- Most students, instructors, courses, curricula are sequential.

BUT

- Global minority is
  - extremely important
  - systematically weeded out

- Serious loss to society!
## Statistics from engineering courses, 1999

<table>
<thead>
<tr>
<th>Course</th>
<th>Seq. very strong</th>
<th>Seq. moderate</th>
<th>Balanced</th>
<th>Global moderate</th>
<th>Global very strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 10</td>
<td>0</td>
<td>8</td>
<td>27</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>(N=40)</td>
<td>(20%)</td>
<td>(68%)</td>
<td>(12%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 111</td>
<td>4</td>
<td>12</td>
<td>38</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>(N=61)</td>
<td>(6%)</td>
<td>(20%)</td>
<td>(62%)</td>
<td>(10%)</td>
<td>(2%)</td>
</tr>
<tr>
<td>Mat.E 153</td>
<td>6</td>
<td>34</td>
<td>71</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>(N=127)</td>
<td>(5%)</td>
<td>(27%)</td>
<td>(56%)</td>
<td>(8%)</td>
<td>(5%)</td>
</tr>
</tbody>
</table>
Consequences of LS & TS mismatches

1. Many students can’t get what’s being taught. They may…
   ✓ become bored, inattentive, disruptive
   ✓ do poorly on tests
   ✓ get discouraged about the course, the program, and / or themselves
   ✓ change majors or drop out
Consequences of LS & TS mismatches

2. Low test scores, unresponsive or hostile classes, poor attendance, dropouts. Professors know something’s wrong.

They may
- get defensive or hostile, making things worse
- question their teaching ability
Consequences of LS & TS mismatches

3. Society loses potentially excellent professionals
   ✓ visual, active learners (most students)
   ✓ sensing, inductive learners
   ✓ global learners
Students may be
  ✓ Sensors or Intuitors
  ✓ Visual or Verbal
  ✓ Inductive or Deductive
  ✓ Active or Reflective
  ✓ Sequential or Global

All types are needed in every profession!
Summary

- Most teaching is
  - Abstract (intuitive)
  - Verbal
  - Deductive
  - Sequential
- Most classrooms are passive
- We are essentially addressing ONLY ONE out of 32 possible learning styles!
Reflection

What are some of the things you can do in your classes to accommodate

✓ Sensing and intuitive learners?
✓ Active and reflective learners?
✓ Verbal and visual learners?
✓ Sequential and global learners?
Teaching Objective : Balance !

- Professionals need to function on BOTH sides of ALL dimensions (S+N, A+R, …)
- If we teach only in students’ less preferred modes
  - ineffective learning
    - students will end up weak in both categories
- If we teach only in students’ preferred modes
  - imbalance
    - student will end up strong in one category, weak in less preferred one
Teaching Objective: Balance!

Solution: Teach to BOTH sides of EACH dimension → balanced strength

✓ student will end up strong in both categories
Teaching Tips

1. Establish relevance and provide applications for all course material. Before presenting theoretical material, provide graphic examples of the phenomena the theory describes or predicts

- sensing, inductive, global -

16 February 2017

Nikos J. Mourtos
Teaching Tips

2. Balance concrete information (facts, observations, data)
   - *sensing*
   and abstract information (principles, theories, models)
   - *intuitive*
   in all courses.
Teaching Tips

3. Make extensive use of pictures, schematics, graphs, and simple sketches before, during, and after presenting verbal material

- *sensing, visual* -
Teaching Tips

4. Use multimedia presentations.
5. Provide demonstrations, hands-on if possible

- *sensing, visual* -
Teaching Tips

6. Use some numbers in illustrative examples, not just algebraic variables

- sensing -
Teaching Tips

7. Give students time to think about what they have been told.

- Assign “minute papers”:
  - what was the main point of the lecture?
  - what was the muddiest point of the lecture?
  - write down one outstanding question you have!

- Require “learning logs”
  - reflective
8. Give small-group exercises in class.

- active, reflective, verbal -
9. Use computer-assisted instruction (if software is available that allows for experimentation and provides feedback)

- *sensing, active* -
Teaching Tips

10. Assign some drill exercises in homework

- sensing, active -

but don’t overdo it.

- intuitive, reflective -
Teaching Tips

11. Assign some open-ended problems / questions and exercises that call for creative thinking and critical judgement.

12. Ask students to cooperate on homework.

- all styles -
13. Limit new material, surprises, twists, etc., on timed tests and minimize speed as a critical factor.

- sensing -
Teaching Tips

14. Recognize and encourage creative solutions, even wrong ones.

- all styles -
15. Encourage students to assess their learning styles:
http://www.engr.ncsu.edu/learningstyles/ilsweb.html
http://www.keirsey.com/cgi-bin/keirsey/newkts.cgi
http://www.hbdi.com
Reflection on the workshop

- 3 interesting ideas you’re taking away.
- 2 things you’re ready to try in your class next week.
- 1 unanswered question?
The trouble with exciting teachers is that they are almost always mavericks, trotting blithely off into some distant sunset, where no one can brand them. The trouble with inspiring teachers is that they won’t stay put long enough to be measured, perhaps because they know that if they did, they would be expiring teachers.

Damn.