AC 2009-687: IMPROVING TOOLS AND TECHNIQUES OF TEACHING GRADUATE ENGINEERING COURSES BASED ON STUDENTS' LEARNING STYLES AND MULTIPLE INTELLIGENCES

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Improving Tools and Techniques of Teaching Graduate Engineering Courses Based on Students' Learning Styles and Multiple Intelligences

Abstract

Our study proposes to improve the tools and techniques of teaching graduate engineering courses using students' Learning Styles and Multiple Intelligences (MI). Thirty volunteers answered commercially available Learning Style and MI tests in our Electrical Engineering department. Learning styles are grouped as visual, auditory, and kinesthetic (VAK) and can determined by the VAK learning style test. Learning styles are reflected in different academic strengths, weaknesses, and skills. Studies show that the differences between learning styles will affect both a person's choice of profession and their success in this profession, both in education and in the world of business. People who work at something that fits their learning style have a better chance of becoming successful in it. In this study, tools and techniques are presented for the teaching of graduate courses in engineering education.

Introduction

Institutions of higher education are always looking for ways to improve their educational initiatives. In colleges and universities, teaching is a very important way to achieve institutional goals of increased effectiveness and the improvement of student learning. The inability to consciously control and manage the learning process in higher education in general and various classes in particular lies in a lack of understanding of the learning process itself, and this can serve as a substantial impediment to student learning and faculty teaching[1]. Instructors need to do more in utilizing accepted learning theories, principles, and teaching technology that will improve learning and assist students in developing themselves to their full potential. Researchers continually discuss ways to reform a university's teaching. While some of them focus on the learning styles of the students[2,3,4,5], others focus on the requirements for re-examination of fundamental assumptions about how universities function and consideration of empirical research about how students learn[6].

We offer effective teaching tools for different learning styles of engineering graduate students. If we teach exclusively in the students' preferred mode, the students may not develop the mental dexterity they need to reach their potential for achievement in school and as professionals. On the other hand, if we teach exclusively in a manner that favors the students' less preferred learning style modes, the students' discomfort level may be great enough to interfere with their learning. In 1990, Tobias pointed out two *tiers* of entering college students. The first tier goes on to earn science degrees and the second tier has the initial intention and the ability to do so but instead switches to nonscientific fields. The number of students in the second tier might in fact be a result of the teaching techniques that are used in engineering education[7].

Which teaching techniques should we use in the engineering classroom to engage more students? This is *the question* we need to answer. We focus on the students' learning styles and multiple intelligences to answer *this question*.

Thirty volunteers (five female, twenty five male) answered MI and VAK tests in our Electrical Engineering department. Subjects were international first semester engineering graduate students in ELEG 443-Digital Signal Processing. The age range of the group is between 23 and 25 years old. The MI test includes 40 questions, and the VAK test includes 30 questions, each designed to find our graduate (Master degree) students' strongest thinking and learning preferences. See Appendix A and B for MI test and VAK test questions. The MI test was used for finding the thinking styles and the VAK test was used for finding the learning styles. Thinking and learning styles show individual differences in academic performance that are related not to abilities but rather how people prefer to use their abilities[8].

Our MI test results show that 42% of graduate engineering students have strong visual/spatial intelligence, 17% have strong linguistic intelligence, 17% have strong kinesthetic intelligence, and 24% have strong logical-mathematical intelligence. Students with strong linguistic intelligence have highly developed auditory skills. They have the ability to use words and language. Interpersonal and intrapersonal preferences of the students are to be found 50-50. According to the VAK learning styles test, 50% prefer the auditory learning style, 35% prefer the visual/spatial learning style, and 15% prefer the kinesthetic learning style.

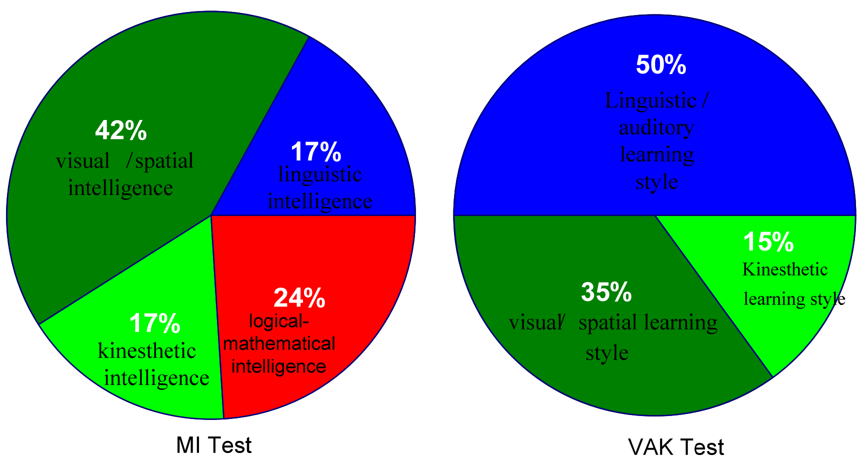

Figure 1: MI and VAK test profiles of the students in the ELEG 443-Digital signal processing course at the University of Bridgeport, spring 2008.

MI and VAK test results agree with each other when stating the preference for the kinesthetic and visual/spatial learning styles. They disagree when evaluating linguistic preference. See Figure 1. Results show that female students have a stronger linguistic intelligence than male students. From this, we propose several teaching tools and techniques to improve the students' performance in engineering courses that are strongly based on theory such as Digital signal processing, Speech signal processing, Bio-medical signal processing, and the other courses. Teaching tools and techniques are aimed to address different learning styles and MI in the classroom.

Two main learning styles among our engineering graduate students are the auditory learning style (17%-50%) and the Visual/spatial learning style (35%-42%). There are basic distinctions between these two learning styles. While auditory learners think primarily in words, have auditory strengths, relate well in time, learn by trial and error, follow oral directions well, can show steps of work easily, and develop fairly evenly, visual/spatial learners think primarily in pictures, have visual strengths, relate well to space, learn complex concepts easily, struggle with easy skills, arrive at correct solutions intuitively, and develop asynchronously[9].

In engineering education, there are two major types of courses: theoretical and experimental. Theoretical courses are usually held in the classroom. All the students sit and listen to the instructor. Experimental courses are usually held in the laboratory, and students can move around freely. Theoretical courses are predominantly an auditory environment in which the curriculum, textbooks, teaching methods, and the teachers themselves are sequential. The over-reliance on auditory-sequential methods in these courses works against the visual-spatial learners. Laboratory courses are predominantly a kinesthetic environment. The students who are visual-spatial learner face disadvantages in mastering material in the normal classroom setting where standard classroom techniques are used. Before presenting some teaching techniques for different thinking and learning styles, let us take a brief look into learning styles and MI in education.

Learning Styles

The VAK test classifies learning styles into three groups: Auditory, visual, and kinesthetic. Auditory learners learn best when information is presented in an auditory language format. They seem to learn best in classes that emphasize teacher lectures and class discussions. Listening to audio tapes helps them to learn better. They read aloud or talk things out to gain better understanding. This type of learner does very well in traditional classes[2].

Visual learners have two sub-channels: *linguistic* and *spatial*. *Visual-linguistic* learners like to learn through written language, such as reading and writing tasks. They remember what has been written down, even if they do not read it more than once. They like to write down directions and pay better attention to lectures if they watch them. Learners who are *visual-spatial* usually have difficulty with written language and do better with charts, demonstrations, videos, and other visual materials. They do extraordinarily well with tasks that have spatial components: solving puzzles, tracing mazes, duplicating block designs, counting three-dimensional arrays of blocks, visual transformations, and mental rotations. Spatial abilities underlie both mathematical talent and creativity, and are essential in a number of fields: mathematics, science, computer science, technological fields, architecture, mechanics, aeronautics, engineering, and most creative endeavors (visual arts, music, etc.). The advantages of this learning style include: perceiving the whole quickly, finding patterns easily, thinking graphically, and understanding dimensionality[12, 13]. These people may experience difficulty with verbal instructions, with sequential problem solving, and with drill and practice. An image is not improved through drill and practice. We can improve their learning while offering the right teaching method for them.

Kinesthetic learners do best while touching and moving. It also has two sub channels - kinesthetic (movement) and tactile (touch). They tend to lose concentration if there is little or no external stimulation or movement. When listening to lectures they may want to take notes. When reading, they like to scan the material first, and then focus in on the details (get the big picture first). They typically use color highlighters and take notes by drawing pictures, diagrams, or doodling. To integrate these three learning styles into the learning environment, we need to use various teaching techniques in our classroom.

Multiple Intelligences

MI theory was developed by Dr. Howard Gardner. The multiple intelligence theory denotes seven-eleven distinct units of intellectual functioning in a human being[14]. These units are separate intelligences with their own observable and measurable abilities. Multiple Intelligences are grouped as naturalistic, kinesthetic, linguistic, logical, interpersonal, intrapersonal, musical, and visual/spatial. The theory of multiple intelligences suggests several other ways in which the material might be presented to facilitate effective learning. It provides eight different potential pathways to learning. If an instructor is having difficulty reaching a student in the more traditional linguistic or logical ways of instruction, the theory of multiple intelligences gives several other ways in which the material might be presented to facilitate effective learning. These are:

1. Words (linguistic intelligence)
2. Numbers or logic (logical-mathematical intelligence)
3. Pictures (spatial intelligence)
4. Music (musical intelligence)
5. Self-reflection (intrapersonal intelligence)
6. A physical experience (bodily-kinesthetic intelligence)
7. A social experience (interpersonal intelligence)
8. and/or, an experience in the natural world (naturalist intelligence)

MI theory suggests that faculty think about a repertoire of approaches that tap into the various intelligences instead of only one approach[15]. MI theory might provide the intrinsic motivation for faculty to alter their approach to teaching because this theory is based on a realization that students have different intelligences. Most faculty and administrators believe in the need to develop people to meet their potential. This theory has been tested in hundreds of studies over the last twenty years, indicating that students' learning is enhanced by multiple intelligence instruction[16,17,18].

Learning style is defined as a manner in which different elements from five basic stimuli affect a person's ability to perceive, interact with, and respond to the learning environment (Dunn & Dunn [10]). Answering all or most of the learning style elements that are environmental, emotional, sociological, physical, and psychological stimulus in the classroom can provide an effective learning environment for all students with different learning styles. Linguistic intelligence, logical-mathematical intelligence, spatial intelligence, interpersonal intelligence, auditory, visual and kinesthetic learning styles are grouped under these stimuli at Table I.

Table I. Four stimuli (emotional, sociological, physical, and psychological) and the teaching approaches.

STIMULUS		TEACHING APPROACH
Emotional stimulus	High need for structure	Presenting the expected outcomes
	Low need for structure	Open-ended approaches
Sociological stimulus	Group preferences	Group activities, team work.
	Individual preferences	Self-sufficient, individual work.
Physical stimulus	Perceptual strengths (auditory, visual, kinesthetic)	Preferences of the auditory, visual, and kinesthetic strengths are given below.
Psychological stimulus	Global processors	Visual techniques. Holistic, visual-spatial, metaphoric.
	Analytical processors	Verbal techniques. Logical, sequential, verbal.

Emotional stimulus: high versus low need for structure: *...Clearly stated objectives are required by students who need structure. Therefore, just as has always been the case, instructors need to develop an outline for each course taught... (page.20, R. Dunn, S.A. Griggs, Practical approaches to using learning styles in higher education, 2000).*
Sociological stimulus: group versus individual sociological preferences
Physical stimulus: perceptual strengths such as auditory, visual, and kinesthetic
Psychological stimulus: global versus analytic, high versus low level of motivation [1].

Teaching Methods

Effective teaching in all fields requires flexibility and energy. Engineering education is no exception. It is important to create an optimal teaching– learning environment by utilizing a variety of teaching methods and teaching styles. If instructors use a variety of teaching methods and styles, students are exposed to both familiar and unfamiliar ways of learning that provide both comfort and tension during the process, ultimately giving students multiple ways to excel.

- **Showing the Application Areas of the Topics**

During the last one and a half decades, we have seen some very large technological developments. Areas based on signal processing theory/applications have become one of the most focused and desirable areas of engineering. Many theories, methods, and algorithms which were rarely used in the past have now found applications. Signal processing courses usually contain many equations and definitions. Although some students who have auditory, spatial learning style and logical-mathematical intelligence prefer to study using equations and definitions, some students with visual and kinesthetic learning styles do not prefer it. However, all learning style students would like to see the “big picture” before going deeply into the minute

details. To show the application areas of the topic is a great way to engage students in the class before introducing the theory required to make these applications work.
One of us (Barkana) teaches ELEG 454-Speech Signal Processing and ELEG 457-Speech Coding Courses at the University of Bridgeport, CT. These are heavy in theory. Fortunately, there are many areas of application: Speech Recognition, Speaker Verification/ Identification, Text-to-Speech, Speech Synthesis, and Speech Coding. Classes start with a presentation of a recent technological development; the theory comes later. Many companies have demos of their products on the Web: AT&T -- speech synthesis, QUALCOMM Inc. -- speech coding methods, Dragon Naturally Speaking -- speech recognition, etc. Students ask "How did they do it?", after they view the video demos. This is a sign that students are interested in what is going on in the classroom, and they are willing to learn no matter what teaching method is offered.

- **Integrating the old and new knowledge**

A logical extension of the view that new knowledge must be constructed from existing knowledge is that teachers need to pay attention to incomplete understandings, false beliefs, and naive renditions of concepts that learners bring to a given subject. Like *Fish Is Fish*, everything the people heard was incorporated into that pre-existing view:

> Fish Is Fish *describes a fish who is keenly interested in learning about what happens on land, but the fish cannot explore land because it can only breathe in water. It befriends a tadpole who grows into a frog and eventually goes out onto the land. The frog returns to the pond a few weeks later and reports on what he has seen. The frog describes all kinds of things like birds, cows, and people. The book shows pictures of the fish's representations of each of these descriptions: each is a fish-like form that is slightly adapted to accommodate the frog's descriptions—people are imagined to be fish who walk on their tailfins, birds are fish with wings, cows are fish with udders.[Lionni, 1970]*

This tale illustrates both the creative opportunities and dangers inherent in the fact that people construct new knowledge based on their current knowledge. Students integrate their previous knowledge with the new one presented to them. Instructors need to build on these ideas in ways that help each student achieve a more mature understanding. If students' initial ideas and beliefs are ignored, the understandings that they develop can be very different from what the instructor intends. There is a good deal of evidence that learning is enhanced when instructors pay attention to the knowledge and beliefs that learners bring to a learning task and use this knowledge as a starting point for new instruction[19].

Students would like to see a connection between the old and new knowledge. Visual/spatial learners can see this connection much faster while the other learners have a difficult time connecting the old and new knowledge without any help. It is the instructor's job to evaluate students' current knowledge before introducing new knowledge. As an example, before introducing the Modified Discrete Cosine Transform in Speech Coding, students are tested on their old knowledge, i.e. what they learned about Discrete Cosine Transforms in Digital Signal Processing. It takes less than ten minutes of class discussion to find out a great deal of information on the students' old knowledge of this topic. We not only build a bridge between old and new, but also we give students a chance to talk about it, and thus linguistic intelligence and the auditory learning style are addressed with this teaching technique.

- **Technology use in the classroom**

The traditional classroom structure is no longer enough for good engineering education. We must use the many technological tools available. Students can learn theory better and faster when they have the opportunity to apply it. Multimedia tools include the use of text, graphics, sounds, and video. They form a dynamic environment that allows supplemental information to be immediately available to the learner, depending on the type of lesson structure.

The goal is to enable the instructor and students to take full advantage of the technology options that are available to them. The potential for using technology in teaching provides new opportunities for higher education to meet the students' needs. Students have their own notebook or personal telecommunications system with Web access; such devices (such as portable WI-FI notebooks) are no longer expensive to today's student. Most universities, including ours, have wireless internet access in their buildings. Linking Web resources and multimedia tools provide search engines, e-books, e-journals, digital academic videos, text, graphics, and sound to each student. Davidson says that one of the distinct features of multimedia is to be able to modify the structure of the lesson by allowing learners to have various levels of control over the pace and pathways through the lesson[20]. Students easily access supplemental information related to the subject taught in class. This activity will engage students who have visual and kinesthetic learning styles. Using programming languages and tools will, in turn, develop a student's thinking skills and also give them the opportunity to do simulation of the theory. The Signal Processing Toolbox in MATLAB is one of the most used and well known tools in engineering fields. Using MATLAB in teaching courses in signal processing enables the student to not only develop a better understanding of the subject, but also it builds their overall programming skills.(Another software in the same subject area is COLEA.)

- **Presenting the Theory**

Although there are many studies [21, 22, 23] about presenting theoretical information to the students with different learning styles, it is impossible to formulate exact teaching methods for theoretical courses. During the presentation of the theory, it is important to offer technical definitions in *verbal or textual statements* for the students with auditory learning style and linguistic intelligence, *mathematical or analytical models, formulas, equations, flow charts, and algorithms* for the students with logical-mathematical intelligence, *graphical representations, pictures, simulations, numbers and the outline of the subject* for visual/spatial learners. The traditional classroom environment is not appropriate for the kinesthetic learner. Offering a laboratory course corresponding to each theory course at the same time will provide a learning environment for this type of learner.

- **Offering a Lab course for each theory course**

Many benefits for offering a laboratory course in engineering education have been reported. Laboratory courses are vital for engineering education. As a Signal Processing Group, we have established a Digital Signal Processing Laboratory course and an Audio Signal Processing Laboratory course to enhance the material and concepts covered in DSP, Speech Signal Processing, Speech Coding, and Multimedia Signal Processing courses at the University of

Bridgeport. Hands-on real-time experiments are based on the TMS320C6713, TMS320C5510 DSK, and MATLAB. Since the theory of the signal processing courses includes many symbols, formulations, and theorems, instructors have difficulty engaging students with a kinesthetic learning style. The following statements are given by the students who take the laboratory courses as well as the theoretical courses:

Student 1 → I finally see what is going on.

Student 2 → I could never figure out where the signal came from or went to…now I see the picture clearly.

By taking a lab, our students gain research experience, industrial experience, MATLAB programming skills, real-time DSP designing and implementation skills on their projects, writing skills, and teamwork.

- **Project based learning (PBL)**

Project-based learning is an educational process through which knowledge, principles and practices can be developed. Project-based learning is particularly pertinent in engineering education as the majority of professional engineering work is conducted through group projects. Therefore, it is logical to integrate project-based learning into graduate engineering education, alongside traditional, classroom-style coursework.
Project-based learning offers an engaging means of education for students in engineering courses. Traditional coursework consists of a large amount of engineering theory followed by a series of assignments, papers or examinations in order to assess the students understanding of the theoretical material. Project-based learning offers a medium through which students can apply this engineering knowledge in a real world project, in order to meet a real and practical project objective. Through this means the students are able to directly create the link between theoretical knowledge and the solution to a practical problem[24].

Both men and women benefit from working in small groups, hands-on activities, and interdisciplinary teaching. Projects with "real world" connections enhance the effect of working in small groups, interdisciplinary teaching and hands-on activities with regard to student interest and participation in engineering [25, 26]. Collaborative learning and working in groups to develop knowledge collectively has the potential to develop interpersonal and intrapersonal intelligences. Communications skills and management concepts are developed through team activity, and written and oral presentation of project progress reports. Library skills are developed through lectures, 'hands-on' tutorials, and exercises. The ability to search for and find information is essential to the project based learning approach, and it will be valuable throughout the engineering course [27].

PBL allows students work individually or collaboratively to construct their knowledge. It provides learners with an interpersonal intelligence and kinesthetic learning style to organize their ideas and their own learning experiences. PBL is crucial for courses based on signal processing because of the large amount of deep theoretical concepts. Instructors should organize the course and its grading system, including oral presentations, individual and group projects, and simulation assignments.

During Fall 2008 semester, one of the student projects in ELEG 454-Speech Signal Processing course was speaker verification system design which is shown in Figure 2. Microsoft Access is used as a database in this system. MATLAB was used to calculate the speaker's pitch period and formant frequencies. In this system, there are two main parts. The first part is Speech Collection System (SCS), and the other one is Speaker Verification System (SVS). For the SCS, a module is created for collecting the characteristics of the speaker's voice. ODBC includes this SCS in Figure 2. The SVS module verifies the speaker's identity.

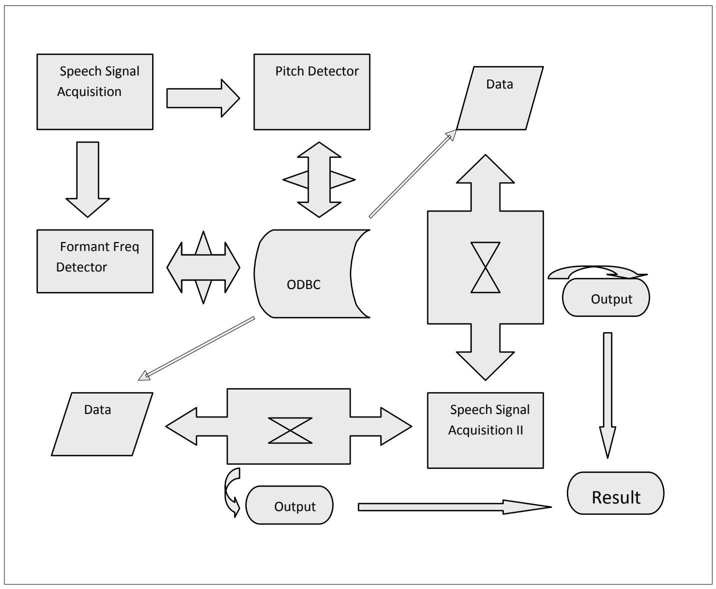

Figure 2. Flow Chart of Speaker verification system

This speaker verification system was design by two students in seven weeks. The system has 100% accuracy. At the end of this project, students informed me that they had a much better understanding of the theory.

- **Guest lecturers, linked courses/disciplines**

A guest lecturer is external authority who may make a presentation to the class, while the instructor remains responsible for arranging this and subsequent lectures. The instructor acting in unison with the guest lecturer will account for the success of the guest's class[28]. Guest lecturers give students the chance to meet people from industry: engineers, scientists, and researchers. The knowledge that the lecturer imparts comes from years of experience and gives students valuable insights into both industry and academia. At our school, the School of Engineering organizes 8 colloquia every semester to bring in guest speakers with unique expertise. Students see a guest lecturer as a role model while learning the application areas of the theory they have learned in the classroom.

Faculty engage in joint curriculum planning so as to help students understand connections between courses and disciplines. Students will have opportunities for deeper understanding of and integration of the material they are learning, and more interaction with one another and their teachers as fellow participants in the learning enterprise[29].

- **Recalling Lecture (RL) after every four-week of lecture**

In engineering courses, students need to discuss and question the subject in order to simulate a professional approach. Yet learning to speak like a professional in a strong academic context may be difficult because the student requires first a strong technical vocabulary with long, complex definitions. This is twice a hard for students who take Engineering courses taught in English, when their mother tongue is not English. Using RL activity, this problem can be solved. For theory classes, we have an RL after four-weeks of standard lectures. All students are encouraged to talk professionally about the previous topics they have learned. Students with auditory learning style enjoy this activity very much. In addition, it helps students to see and memorize the topics in too. Rewarding students who attend and contribute to the RL gives self-confidence and a feeling of achievement. One reward may be an extra homework grade to offset some of their previous lower grades. Also, some students do not want to talk in public (classroom). Debate activity is the answer to motivate and engage this type of learning style. They can contribute to their team by research, writing, or preparing a presentation instead of talking in public.

Conclusion

Tools and techniques are presented for the teaching of graduate courses in engineering education. These are used at the University of Bridgeport. They are based on students' learning styles and multiple intelligences. Students take in and process information in different ways such as seeing and hearing, reflecting and acting, reasoning logically and intuitively, analyzing and visualizing, steadily and in fits and starts. Instructors' teaching methods also vary. Some instructors lecture, others demonstrate or lead students to self-discovery; some focus on principles and others on applications; some emphasize memory and others understanding. Theoretical and laboratory courses require different skills. It is important to address all learning styles and the MIs during the teaching process.

We conclude strongly that independent of styles, it is a tremendous benefit for any theoretical course in engineering to have as its complement another lab based course addressing the same material. Not only is this of value for the signal processing courses cited here, but also we use this approach for courses in Controls, PLC (Programmable Logic controls), Analog Electronics design, Digital Electronics design, Fiber Optics, and Analog/Digital communications.

Other findings include the use of assigning projects (instead of just determining a student's grade from an exam). Also, group projects offer a dynamic that can often be better than that produced by assigning individual projects.

Our final conclusion is the reaffirmation of using both old and new tools to enhance the classroom experience. Old tools include bringing in a guest lecturer or having student presentations. New tools include the multimedia audio/video/wi-fi/portable computer/etc. tools that are now cheap and prevalent.

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APPENDIX A: VAK Learning Styles Self-Assessment Questionnaire

http://www.businessballs.com/vaklearningstylestest.htm

1. When I operate new equipment I generally:
   a) read the instructions first
   b) listen to an explanation from someone who has used it before
   c) go ahead and have a go, I can figure it out as I use it
2. When I need directions for travelling I usually:
   a) look at a map
   b) ask for spoken directions
   c) follow my nose and maybe use a compass
3. When I cook a new dish, I like to:
   a) follow a written recipe
   b) call a friend for an explanation
   c) follow my instincts, testing as I cook
4. If I am teaching someone something new, I tend to:
   a) write instructions down for them
   b) give them a verbal explanation
   c) demonstrate first and then let them have a go
5. I tend to say:
   a) watch how I do it
   b) listen to me explain
   c) you have a go
6. During my free time I most enjoy:
   a) going to museums and galleries
   b) listening to music and talking to my friends
   c) playing sport or doing DIY
7. When I go shopping for clothes, I tend to:
   a) imagine what they would look like on
   b) discuss them with the shop staff
   c) try them on and test them out
8. When I am choosing a holiday I usually:
   a) read lots of brochures
   b) listen to recommendations from friends
   c) imagine what it would be like to be there
9. If I was buying a new car, I would:
   a) read reviews in newspapers and magazines
   b) discuss what I need with my friends
   c) test-drive lots of different types
10. When I am learning a new skill, I am most comfortable:
    a) watching what the teacher is doing
    b) talking through with the teacher exactly what I'm supposed to do
    c) giving it a try myself and work it out as I go

11. If I am choosing food off a menu, I tend to:
    a) imagine what the food will look like
    b) talk through the options in my head or with my partner
    c) imagine what the food will taste like
12. When I listen to a band, I can't help:
    a) watching the band members and other people in the audience
    b) listening to the lyrics and the beats
    c) moving in time with the music
13. When I concentrate, I most often:
    a) focus on the words or the pictures in front of me
    b) discuss the problem and the possible solutions in my head
    c) move around a lot, fiddle with pens and pencils and touch things
14. I choose household furnishings because I like:
    a) their colours and how they look
    b) the descriptions the sales-people give me
    c) their textures and what it feels like to touch them
15. My first memory is of:
    a) looking at something
    b) being spoken to
    c) doing something
16. When I am anxious, I:
    a) visualise the worst-case scenarios
    b) talk over in my head what worries me most
    c) can't sit still, fiddle and move around constantly
17. I feel especially connected to other people because of:
    a) how they look
    b) what they say to me
    c) how they make me feel
18. When I have to revise for an exam, I generally:
    a) write lots of revision notes and diagrams
    b) talk over my notes, alone or with other people
    c) imagine making the movement or creating the formula
19. If I am explaining to someone I tend to:
    a) show them what I mean
    b) explain to them in different ways until they understand
    c) encourage them to try and talk them through my idea as they do it
20. I really love:
    a) watching films, photography, looking at art or people watching
    b) listening to music, the radio or talking to friends
    c) taking part in sporting activities, eating fine foods and wines or dancing
21. Most of my free time is spent:
    a) watching television
    b) talking to friends
    c) doing physical activity or making things
22. When I first contact a new person, I usually:
    a) arrange a face to face meeting
    b) talk to them on the telephone
    c) try to get together whilst doing something else, such as an activity or a meal
23. I first notice how people:
    a) look and dress
    b) sound and speak
    c) stand and move
24. If I am angry, I tend to:
    a) keep replaying in my mind what it is that has upset me
    b) raise my voice and tell people how I feel
    c) stamp about, slam doors and physically demonstrate my anger

25. I find it easiest to remember:
    a) faces
    b) names
    c) things I have done
26. I think that you can tell if someone is lying if:
    a) they avoid looking at you
    b) their voices changes
    c) they give me funny vibes
27. When I meet an old friend:
    a) I say "it's great to see you!"
    b) I say "it's great to hear from you!"
    c) I give them a hug or a handshake
28. I remember things best by:
    a) writing notes or keeping printed details
    b) saying them aloud or repeating words and key points in my head
    c) doing and practising the activity or imagining it being done
29. If I have to complain about faulty goods, I am most comfortable:
    a) writing a letter
    b) complaining over the phone
    c) taking the item back to the store or posting it to head office
30. I tend to say:
    a) I see what you mean
    b) I hear what you are saying
    c) I know how you feel

APPENDIX B: MI Questionnaire

http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks3/ict/multiple_int/questions/choose_lang.cfm
Questions are answered as: This is not like me at all, I am very rarely like this, This is a bit like me, This is sometimes like me, I am like this more often than not, I am always like this.

1. I like to think through problems while I walk or run
2. I am sensitive to the moods and feelings of others
3. I enjoy social events like parties
4. I get restless easily
5. I like working and thinking on my own and quietly
6. I learn best when I have to get up and do it for myself
7. I know myself well
8. I can picture scenes in my head when I remember things
9. I remember things like telephone numbers by repeating them to a rhythm
10. I like to use charts and diagrams in my learning
11. I can remember pieces of music easily
12. I like to work with a team
13. I enjoy being outdoors when I learn
14. I enjoy writing things down
15. I learn well from listening to others
16. I have a good sense of direction
17. I need to see something in it for me before I want to learn something
18. I can recognize and name different types of birds, trees and plants
19. I can take things apart and put them back together easily
20. I am good at mathematical problems and using numbers
21. I can link things together and pick out patterns easily.
22. I like to work with my hands
23. I always do things one-step at a time
24. I enjoy working on my own

25. I have a good sense of balance and like to move around a lot
26. I am interested in why people do the things they do.
27. I find it easy to explain to others
28. Pollution makes me angry
29. I can sort out arguments between friends
30. I enjoy logic problems and puzzles
31. I enjoy making music
32. I am an independent thinker. I know my own mind
33. I can use lots of different words to express myself
34. I like to make lists
35. I enjoy games involving other people
36. I can pick out different instruments when I listen to a piece of music
37. My mood changes when I listen to music
38. I am observant. I often see things that others miss
39. I keep or like pets
40. I like to think out loud