Board 46: Multiple intelligences and undergraduate engineering education

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Dr. Lee is a professor in the Dept. of Chemical & Biomedical Engineering and has a strong interest in philosophy of mind and epistemology and how these influence engineering education. Recent research has included investigations of problem solving, the creative process, and how engineering/science education can be informed by the visual and performing arts.

Multiple Intelligences and Undergraduate Engineering Education – WIP

This work-in-progress investigates the applicability and relevance of Harvard professor Howard Gardner's theory of multiple intelligences (MIs) to undergraduate engineering education. Gardner developed the theory of multiple intelligences in the early 1980's, initially identifying seven distinct intelligences (also referred to as learning styles in the MI literature): 1) visual-spacial; 2) bodily-kinesthetic; 3) musical; 4) interpersonal; 5) intrapersonal; 6) linguistic; and 7) logical-mathematical. Subsequent researchers have sought to add to this list (for example, "naturalistic"), but only Gardner's original seven MIs will be addressed within this investigation. According to Gardner: "students possess different kinds of minds and therefore learn, remember, perform, and understand in different ways" [1]. Similarly, Amy Brualdi observed: "… they (MIs) are used concurrently and typically complement each other as individuals develop skills and solve problems" [2]. Yet, Gardner opines (and many educators have observed) that the educational system often assumes that one learning style (usually extremely visual based) works for most (if not all) students just fine. Gardner's theories have made some impact in K-12 education and there is literature where the incorporation of MI-type thinking into the K-12 world has been explored (for example, see [3-6]). Barrington [7] argued that MIs can be (and should be) successfully integrated into higher education, more effectively addressing an increasingly diverse student population. Regarding engineering education specifically, there appears to be very little published literature regarding the application of MIs to the educational process and problem solving. One example is the work of Silva [7] where a civil engineering population was investigated for student self-evaluation of the extent to which MIs were addressed within the curriculum, focusing on the presence of logical-mathematical and spatial intelligences (which were in fact emphasized); other MIs were less developed. This research seeks to add to the MI literature as applied to engineering education by examining how undergraduate engineering students see themselves and their educational experiences from an MI viewpoint. This includes an assessment of the current status of MI presence in the undergraduate engineering curriculum and the extent to which it should be.

Methodology

A total of 210 senior engineering students have participated in the study, of which 85.3% were in the 18 – 25 year age group and 66.2% were male. Seniors were selected since the study focuses on undergraduate education and seniors would presumably be in the best position to reflect on their educational experiences from initial entry into engineering up to the final undergraduate year. A Qualtrics survey instrument was developed that probed: 1) self-perception of the extent to which the student had any characteristics of each MI; 2) the student's perception of the extent to which their engineering education has incorporated the development of each MIs; and 3) the students opinion of the extent to which their engineering education should be developing each of the MIs. Earlier versions of the instrument were explored with focus groups within engineering and educational psychology. In the employed survey, students were provided definitions of each

of the seven MIs (see Table 1) and then used a seven point Likert scale to evaluate a variety of questions regarding each MI (see Figure 1 below for an example question). Demographic questions allowed sorting by age group, engineering discipline, gender, parental educational achievement, and whether students had participated in pre-college multidisciplinary programs such as the International Baccalaureate (IB) program or were within a university-wide honors program or college. This study was approved by the university's IRB and all respondents were anonymous.

Table 1: Definitions of the individual multiple intelligences employed in the survey.

Linguistic: You are very good at communication and language (written and verbal). You can interpret and explain ideas, information, and concepts. You may have skills on more than one language.

Logical-mathematical: You are good at logical thinking, including detecting patterns, scientific reasoning, the analysis of problems, the performing of mathematical calculations, and understanding the relationship between cause and effect.

Musical: You have strong musical ability. You can recognize tonal and rhythmic patterns and understand the relationship between sound and feeling. You have skills at musical performance and/or composition.

Body-kinesthetic: You are skilled at body movement control, manual dexterity, physical agility and balance, and eye/body coordination.

Visual-spatial: You have good visual and spatial perception, the interpretation and creation of visual images, pictorial imagination and expression, and understand the relationship between images and meaning.

Intrapersonal: You have a strong ability to perceive other people's feelings and have a strong ability to relate to others. You can understand the relationships between people and their environmental and emotional situations.

Interpersonal: You have significant self-awareness, personal objectivity, the capability to understand oneself, and one's relationship to others and the world in general.

Results and Discussion

A summary of the responses is presented in Table 2. This represents all respondents combined. Figure 2 presents the summary of the extent to which an MI is currently addresses and the extent to which the MI should be addressed.

This study found that most students felt they had characteristics of at least 6 of the MIs, with many of the students feeling they were strong in logical-mathematical (80.6% responded either agree or strongly agree). Students felt this MI was being addressed and should be addressed in the undergraduate engineering curriculum (only 7 students expressed some level of disagreement on these points). With the exception of musical, students felt they had some level of a given MI.

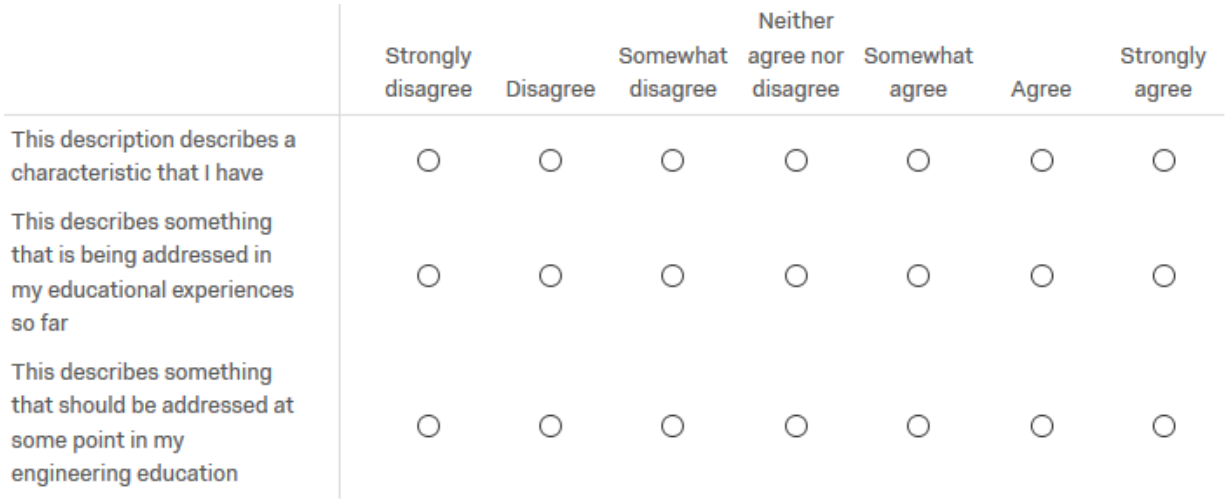

Figure 1: A sample question from the survey instrument that addressed each of the seven multiple intelligences. A specific intelligence would be identified along with a description of the intelligence immediately above each set of three statements.

Table 2: Summary of the responses (all respondents combined)[1]

Multiple Intelligence	Student self-assessment	Extent to which MI is addressed	Extent to which MI should be addressed
Visual-spacial	5.42 (1.08)	4.22 (1.70)	4.75 (1.54)
Bodily-kinesthetic	5.75 (1.09)	2.66 (1.73)	3.51 (2.03)
Musical	4.09 (1.77)	2.52 (1.61)	3.25 (1.81)
Interpersonal	5.78 (1.03)	3.50 (1.75)	4.72 (1.54)
Intrapersonal	5.60 (1.33)	3.21 (1.77)	4.66 (1.88)
Linguistic	5.66 (0.90)	4.97 (1.38)	5.98 (1.12)
Logical-Mathematical	6.08 (0.78)	5.86 (1.16)	6.19 (1.16)

[1]Mean and standard deviations are shown (n = 210). A 7-point Likert scale was employed.

Curiously, students felt that linguistic skills ("word smart" skills) should be strongly addressed within the undergraduate curriculum. While overall students saw some value in developing visual-spatial skills, civil and mechanical students rated the importance higher. Students generally did not indicate that body-kinesthetic, musical, interpersonal, or intrapersonal were

being addressed within the curriculum. Furthermore, they did not think that body-kinesthetic or musical should be addressed within the curriculum. However, they saw some value in addressing interpersonal and intrapersonal skills.

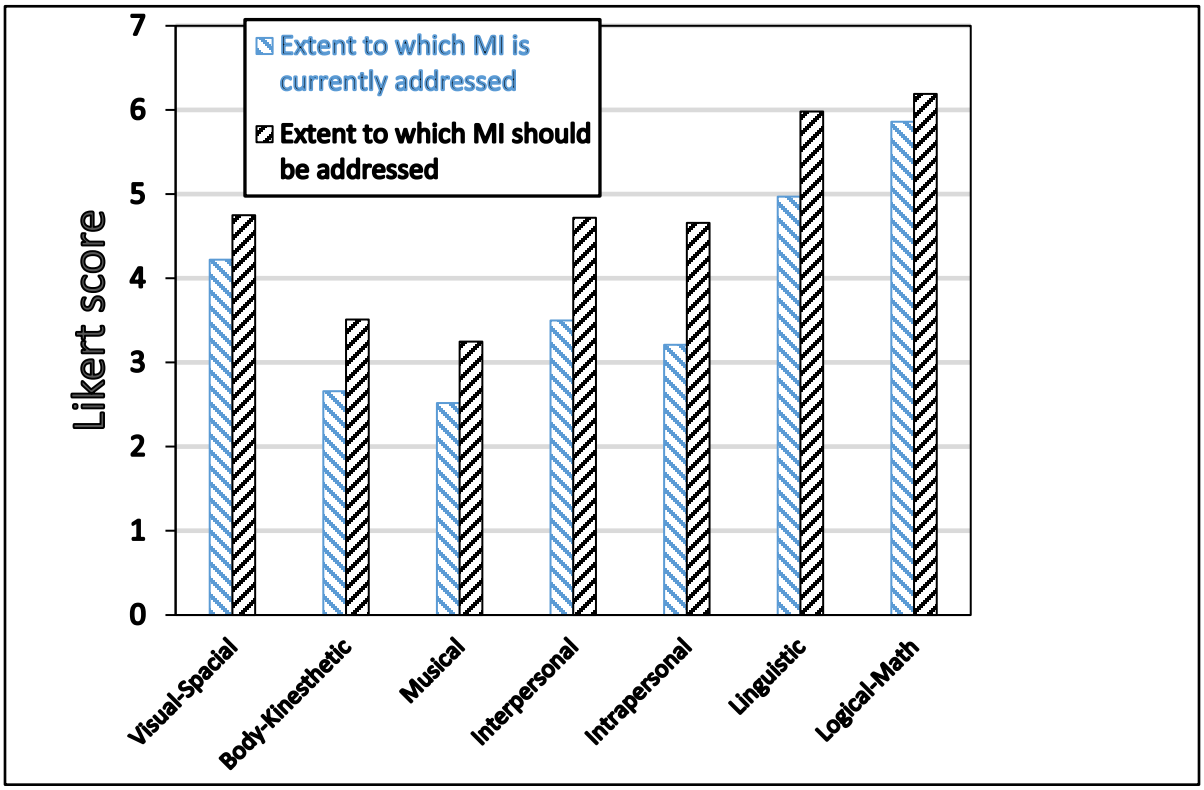

Figure 2: Student assessment of the extent to which an MI is currently addressed within the curriculum and the extent to which it should be addressed.

We did not observe any significant gender differences with one exception: females self-evaluated their intrapersonal skills at a higher level than males. There were only 6 respondents that graduated from IB programs, too few to allow any reasonable observations. Similarly, only 9 students were actively in the university-wide honors program.

Future work

In addition to increasing the number of participants, we intend to explore the following: 1) more insights into what students really mean by interpersonal and interpersonal, why it may be of value to their educational experience, and their views on how this might be accomplished; 2) explore faculty using the same (or perhaps expanded) survey instrument; and 3) continue to probe visual-spatial and how this may or should play a role in at least some of the engineering disciplines. Finally, we intend to collaborate with colleagues in the general educational area to explore how MIs are currently integrated into education and how this might be of benefit to undergraduate engineering education.

References

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