

# VALUES THAT FIRST YEAR ENGINEERING STUDENTS ASSOCIATE WITH MATHEMATICS LEARNING

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**ABSTRACT**—The international *What I Find Important [WIFI] in mathematics learning* project involves 21 teams from 17 countries, with a University of Johannesburg team involved since 2016. The international project strives is to collect data (from various contexts) on values (fundamental convictions that guide behaviour and influence learning orientation) that students associate with mathematics learning. This paper reports on the piloting of sections of the international questionnaire among a convenience sample of 62 first year engineering students. The aim is to determine what values students associate with mathematics learning. The engineering students evidently value *process* (how answers are obtained) over *product* (what answers are), *recalling* (remembering concepts, rules and formulae) over *creating* (discovering concepts and formulae) and *rationalism* (a theoretical approach to mathematics) over *objectivism* (a more pragmatic stance). An independent samples t-test detected a significant difference between students who passed mathematics versus those that failed. The ‘successful’ group values *effort* (hard work) in mathematics learning, while the ‘unsuccessful’ group values *ability* (talent and aptitude). This is a first pilot of the WIFI in mathematics learning project and the intention is to collect more data on values that first year students (in various areas of study and institutions) subscribe to.

**Keywords:** Values of mathematics students; Third wave project; First year engineering studies.

## 1. BACKGROUND CONTEXT, RESEARCH PROBLEM AND PURPOSE

The contribution of mathematics to engineering has been recognised for centuries and even more pertinently nowadays. Mathematics is anecdotally called the “mental tool” and “language” of scientists and engineers (Hamming, 1980, p. 81–82; Hockman, 2005), while “engineering speaks through an international language of mathematics, science, and technology” (National Academy of Engineering, 2004, p. 3). Most engineering-related challenges over the ages rely upon a proper knowledge and application of mathematics (Ramkrishna & Amundson, 2004; Steyn & Du Plessis, 2007). Higher Education Institutions (HEIs) need to continuously align engineering course content and pedagogical strategies with practices endorsed by industry (The Royal Academy of Engineering, 2007). Houston, Mather, Wood, Petocz, Reid, Harding, Engelbrecht and Smith (2010, p. 77) encourage mathematics educators “to create a dynamic curriculum and teaching and learning environment that inspire students to engage deeply with mathematical ideas”.

Unfortunately, the reality facing most South African mathematics learners at high school level is a world apart from the abovementioned ideals. In addition, the teaching of mathematics at first year level is burdened by the quality of students attracted to the discipline (Berger, 2010; Hockman, 2005). Part of the problem can be ascribed to a shortage of properly trained mathematics teachers, while the situation is also aggravated by teachers who “cannot teach what they do not know” (Spaull, 2013, p. 5). Almost a decade ago Scott, Yeld and Hendry (2007), warned that if South African HEIs are serious about alleviating the critical shortage of science and engineering graduates, they have to assist first-year students to bridge the ‘gap’ between school and higher education, especially in mathematics. As predicted, first-year mathematics students performed worse than in the past at South African HEIs after the introduction of the National Senior Certificate (NSC) in 2008. This is, in the view of Wolmarans, Smit, Collier-Reed and Leather (2010, p. 281) “...not a sudden or dramatic shift, but rather part of a gradual deterioration in the preparedness of these students”.

South African educationists and researchers are pertinently attending to the issue of poor and underachievement in Mathematics, especially at first year level, trying to find solutions, or to discover changed or new approaches or strategies that might improve the status quo. Recently, several mathematics educators-cum-researchers (Clarkson, Bishop & Seah, 2010; Jerrim, 2014; Law, Wong & Lee, 2011; Österling & Andersson, 2013; Seah, 2008; 2010a, 2010b, 2011a, 2011b), have put an emphasis on the culturally-referenced nature of Mathematics in their research. Broadfoot (2000, p. 362) points to “how deeply embedded these culturally-derived expectations are in the students themselves, and perhaps even more significantly, ...how such cultural influences are manifest in the nature of (mathematics) learning itself”. In the domain of school mathematics, Askew, Hodgen, Hossain and Bretscher (2010, p. 12) declare that “high attainment may be much more closely linked to student values than to specific mathematics teaching practices”. Jerrim (2014) and Dede (2009) pertinently declare that values also influence mathematics students at a higher education level.

The inquiry aims to determine what values first year engineering students associate with mathematics learning. The paper reports on the pilot study of a section of the project questionnaire among first year engineering students at the University of Johannesburg (UJ). The study aimed to determine possible differences in the values that students who were either successful or unsuccessful in mathematics subscribed to. Answers will be sought to the following two research questions, by collecting the views of a sample of first year engineering students:

What are the most important values that the participants associate with mathematics learning?

Are there significant differences between the values of participants, who have passed mathematics during the first semester of their first year, and the values of participants, who have failed mathematics during the corresponding period?

## **2. THEORETICAL PERSPECTIVES**

### **The international third wave project in mathematics education**

Over many years, mathematics educators and researchers worldwide have attempted to find an appropriate answer(s) to the question: *How can mathematics teaching & learning be made more effective* (Seah & Wong, 2012, p. 33)? Initial research foci were on *cognitive* approaches of which mental problem solving schemes, higher order thinking and the eradication of student misconceptions are examples. This is known as the first wave of research in mathematics education (Law, Wang & Lee, 2011, p. 72). The turn of the 21<sup>st</sup> century brought the second wave of research to the forefront. The emphasis has shifted towards *affective* matters – the beliefs, attitudes, emotions and motivation of both educators and students. A renewed interest in the socio-cultural nature of mathematics teaching and learning (Seah, 2010), gave rise to the discursive approach (Law, Wang & Lee, 2011, p. 72), with the intention of exploring discourses on important *values* in mathematics teaching and learning, across various cultures, countries and regions. This was seen as the start of the third wave of research in mathematics education. Where a belief or attitude is what somebody considers to be true, a value is regarded as the importance someone accords to this belief or attitude (Lazaridou, 2007). Values might thus be the principles or fundamental convictions that guide behaviour and decision-making, which are closely connected to someone’s integrity and identity (Halstead, 1996, p. 5).

In 2008, the ‘*Third wave project: A values approach to optimising mathematics education*’ was conceptualised by Seah (2008, 2010a, 2010b, 2011a). The project is conducted by a consortium of 21 research teams (from 17 countries) via parallel inquiries, of which the team at the UJ is one. The third stage of the project is geared at the validation of a new data collection instrument (questionnaire), entitled ‘*What I Find Important [WIFI] in mathematics learning*’ (Seah, 2011a). This inquiry thus forms part of the third stage of the international project.

### **2.2. Theoretical framework that underpins this study**

The inquiry is framed by two related value theories. The first is Alan Bishop's (1996) conception of values in mathematics education and more specifically his distinction among *mathematical*, *mathematics educational* and *educational* values in the mathematics 'classroom'. Bishop's (1988) initial three pairs of complementary values for (western) mathematics, namely *rationalism* and *objectivism*, *control* and *progress*, and *mystery* and *openness* (compare Shinno, Kinone & Baba, 2014) also serve as a pertinent theoretical underpinning. The second value theory informing the theoretical framework is the cultural dimensions of Geert Hofstede (1997). His discovery that every culture (teaching and learning contexts are also regarded as unique cultures) can be defined in a five-dimensional space (more about it in section 2.4 below) has particular relevance.

Values are regarded as *sociocultural*, rather than as affective by nature. They are thus characteristic of particular sociocultural contexts, drawing their sources from the discourses, practices and norms of participants and of the interactions amongst themselves and their lecturers or teachers. In the view of Seah, Atweh, Clarkson and Ellerton (2008), affective versus sociocultural values correspond with participants' internal/personal versus external/cultural origins. Values are not just embedded in the teaching and learning elements (McLaren, 1998), which a culture extends to its members, but are also intrinsic to the curriculum (Apple, 2000). Values are thus seen as sociocultural and/or personal convictions that an individual student considers important enough to integrate in his/her learning and behaviour.

### Values in mathematics education

Values in mathematics education are classified as mathematical, mathematics educational or simply educational (Bishop, 1996). Dede (2009, p. 1230) connects *educational* values to societal or communal values, *mathematical* values to the discipline of mathematics and *mathematics educational* values to the pedagogy (teaching and learning practices and norms) of mathematics. Opdenakker and Van Damme (2006, p. 16) acknowledge that a lecturer's cognitive and pedagogical behaviours are (perhaps unconsciously) guided by, and stem from a personally held system of beliefs, values and principles. Important though it may be, a lecturer's quality of teaching (her/his pedagogy) may just be a piece of puzzle in the overarching conceptualisation of effective mathematics learning. For example, anecdotal evidence suggests that there are many students who perform well in mathematics regardless of the lecturers they have, or the class they find themselves in. It is hypothesised that there are determinants other than cognitive and affective variables, which might enhance effective learning and teaching (of mathematics). A Nuffield Foundation review of more than 500 studies (Askew, Hodgen, Hossain & Bretscher, 2010, p. 12) finds that in respect of mathematics, "high attainment may be much more closely linked to cultural values than to specific mathematics teaching practices", in addition linking values to students' performance in mathematics.

### 2.4. Value categories

Bishop's (1996) three categories of values in mathematics education (section 2.3 above), have particular relevance in this study. *Mathematical* values relate to the extent to which an aspect(s) of Western mathematics is valued. Earlier, Bishop (1988) proposed three pairs of complementary mathematical values, namely rationalism and objectivism; control and progress; and mystery and openness.

*Mathematics educational* values express the extent to which aspects of lecturing venue norms and practices that relate to the teaching and learning of mathematics are considered as important. Specific examples in this category (Bishop, 1996, p. 20) are the values implied by the following instructions from the mathematics teacher or lecturer: "Make sure you show all your working in your answers" or "Don't just rely on your calculator when doing calculations". *General educational* values are not subject-specific, and are derived from the "general educational and socialising demands of society", for example to be honest and law-abiding (Bishop, 1996, p. 21).

Hofstede's (1997) theory (cited in Seah, 2011a, p. 10) postulates that every culture (a teaching and learning environment also possesses a unique culture) can be defined in a five-dimensional space along the cultural dimensions of (i) power–distance, (ii) collectivism–individualism, (iii) femininity–masculinity, (iv) uncertainty–avoidance, and (v) life orientation. The first stage of the WIFI project discovers that Hofstede's cultural dimensions don't specifically relate to Bishop's mathematical or mathematics educational values, but that they relate to the third category of general educational values. However, Hofstede's (1997) *cultural dimensions* and Bishop's (1996) *general educational values* are different in character. While Hofstede's cultural dimensions reflect norms and ways of thinking that are internalised by members of different cultures, Bishop's general educational values capture the range of ideals and standards, which a culture has selected to inculcate through education. Whereas a culture might not have much control over the historical development of the values encapsulated in the cultural dimensions, it does often make a conscious selection of values it wants to pass on to the next generation, as evidenced in curricula, assessments, websites and promotional documents. Where cultural dimensions are thus mostly implicit, general educational values manifest more explicitly (Seah, 2011a).

Seah (2005) reveals a need for a fourth category of values in the mathematics classroom or lecture venue to fully account for the principles and convictions that are valued and co-valued amongst all stakeholders, for example parents, alumni, the government, assessors, etc. This fourth category is known as *cultural values* (from Hofstede's (1996) cultural dimensions) and they have particular relevance in respect of multicultural mathematics lecturing and classroom settings. Thus, the data collected via the international project thus far have been interpreted in respect of these four sets of mathematical, mathematics education, general educational, and cultural values.

### **Mathematics educational values**

Bishop (1996) does not provide prototypes of mathematics educational values, only illustrations of mathematical and general educational values. The reason is probably the variety of mathematical pedagogies used in and by different cultures. Unfortunately, the problem is that any value displayed or expressed by students or lecturers in a mathematics teaching and learning setting might now be regarded as mathematics educational, which is not ideal. An enunciation of dimensions similar to Bishop's (1988) pairs of complementary mathematical values and Hofstede's (1997) five cultural dimensions, is, according to Seah (2011a) definitely necessary.

The first stage of the Third Wave project (Seah, 2010a; 2010b; 2011a, p. 12) explored values that learners/students associate with effective mathematics learning and eventually reports six (6) mathematics educational value dimensions, namely:

pleasure – effort,  
process – product,  
application – computation,  
facts and theories – ideas and practice,  
explanation – exploration, and  
recalling – creating.

These six value dimensions were hence compared with the five mathematics educational values (projected on different continua), recommended by Seah (1999) and Dede (2011):

formalistic – activist view of mathematics learning;  
relational – instrumental view of mathematics learning;  
relevance – theoretical view of mathematics learning;

accessibility – specialism view of mathematics learning; and,  
process – tool and procedural view of mathematics learning.

The comparison culminated in five mathematical value dimensions, reported as follows by Seah (2011a, p. 13):

The relevance view represents the *progress–control* dimension.

The accessibility view epitomises the *openness–mystery* dimension.

The formalistic view embodies the *explanation–exploration* dimension.

The relational view signifies the *recalling–creating* dimension.

The process (tool or procedural) view denotes the *process–product* dimension.

Each of these five mathematical value dimensions is presented (in the data collection instrument) in the form of a continuum between two extreme values. The assumption is that all mathematics teachers/lecturers value the two extremes to some extent along any continuum.

### 3. RESEARCH METHODOLOGY

#### 3.1. Research paradigm and method

The research *paradigm* is the researchers' worldview, as portrayed by the matrix of beliefs, perceptions and underlying assumptions, which guided them in approaching this inquiry. The main paradigm underlying this study relates to the quantification of first year engineering students' values, which they might associate with the learning of mathematics. The investigation was thus conducted from a post-positivist stance. Post-positivism is a milder form of positivism, allowing for measurement, comparison and scientific engagement with the participants (Phillips & Burbules, 2000).

The research *method* used is quasi-experimental and causal-comparative, conducted in an ex post facto manner (Baltimore County Public Schools, 2010; Gay, Mills & Airasian, 2006, p. 217). This implies that the views of two naturally formed groups of participants (students who have passed or failed mathematics) have been collected and compared in respect of the variable 'values in mathematics learning'. The authors agree that this study's 'reality' can never be known fully, but that measuring it in a scientific manner could disclose valid elements of its nature.

#### 3.2. Participants

The participants were a convenient sample of students (in one author's mathematics class) of 62 engineering students, in their first year of study during the first semester (February until June) of 2016. The overwhelming majority are *male* (n=52 or 83.9%), seven out of ten (69.4%) are *black*, two thirds (67.7%) are *indigenous African* language speakers, more than half (54.8%) are *19 years or younger* and about a further quarter of them (24.2%) are exactly *20 years* old.

Exactly half of the participants (n = 31, 27 males and 4 females) failed the first semester module in mathematics. Thirty of the 31 (96.8%) participants who passed the first semester module in mathematics, agreed or strongly agreed with the Likert Scale item, "*I did well in mathematics at SCHOOL level*", while just 7 of the 31 (22.6%) students who failed the mathematics module responded likewise. A similar trend is detected in respect of participants' responses to the Likert Scale item, "*I am CURRENTLY doing well in mathematics*". Twenty two (71%) of the participants who passed the first semester mathematics module agreed or strongly agreed with this statement, while just one of the 31 participants, who failed the first semester module did.

### 3.3. Data collection, administration and capturing

Two of the four components of the international project questionnaire (Seah, 2011a) were piloted in this inquiry. *Section A* collects relevant demographical information via a set of 13 closed and open-ended questions. *Section B* contains ten bi-polar items, exploring participants' views on mathematics learning, presented as semantic differentials. The semantic differential, devised by Osgood, Suci and Tannenbaum (1957), is widely acknowledged (Fennell & Baddeley, 2013) for effectively exploring connotative (affective) meanings. Participants were expected to take a stance from one of five positions on each item, on a horizontal line as follows: [left] -2...-1...0...+1...+2 [right]. In semantic differentials (Sapsford, 2007), two opposing adjectives are usually used, for example Cold–Hot or Tall–Short. The data collection instrument in this study presents two bipolar activities, which are not opposites in the same way as the opposing adjectives have been. The instrument was presented in an interactive online manner to participants during the June–July 2016 university recess and collected data were automatically captured in a Microsoft Excel worksheet.

### 3.4. Data analyses

The demographic data generated by Section A were analysed via the frequencies and cross-tabulations options of the Statistical Package for the Social Sciences (SPSS, version 23). The semantic differential data of Section B were analysed via select descriptive statistics, followed by testing for normality and hence for potential differences between the views (values) of successful and unsuccessful participants.

The Shapiro-Wilk W test was employed to determine whether data on the ten semantic differential items were normally distributed or not. The significance of the results indicates that normality cannot be assumed. A scrupulous analysis of the distributions' P-P and Q-Q plots, as well as 'common sense' (supported by the website: stats.stackexchange.com) led the authors to believe that a parametric test, like the independent samples t-test (via SPSS), would be sufficiently robust to handle this perceived 'non-normality'.

### 3.5. Ethical measures and participants' consent

The goal of the inquiry, the nature of the data collection instrument and participants' rights and responsibilities are outlined on the cover page of the data collection instrument. Individual written consent (via their electronic signatures) was obtained from all participants to safeguard the confidentiality of collected data and the anonymity of each first year engineering-cum-mathematics student.

### 3.6. Validity and reliability measures

Validity and reliability measures of the semantic differential section of the questionnaire are satisfactorily reported on (Österling, 2013). The validity of this section of the questionnaire (for the first time completed by a group of South African mathematics students) was explored via Principal Components Analysis (Aronson, 1979) using Kaiser's Varimax rotation. Three factors incorporating eight items, all displaying factor loadings above .45, which cumulatively accounted for 61.9% of the total variance, were generated. Cronbach's alpha coefficients were hence calculated in respect of the items of the three factors. Coefficients weren't high, but all three were above .715, representing acceptable internal consistency (reliability) measures. Additional validity and reliability measures will be conducted in future as part of the bigger WIFI in mathematics learning project.

## 4. FINDINGS AND DISCUSSION

### 4.1. Participants' values in respect of the ten semantic differential pairs

Four descriptive statistical measures, the mean, standard deviation, median and mode are presented for all participants in respect of the ten semantic differential items in Table 1.

**Table 1: Descriptive statistics for the semantic differential items: All participants (n=62)**

Semantic differential items	Values	Mean	Std dev	Mdn	Mode
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HOW the answer to a problem is obtained versus WHAT the answer to a problem is.	Process vs Product	-1.00	1.187	-1	-2
Feeling relaxed or having FUN versus hard WORK when doing mathematics.	Fun vs Work	0.16	1.357	0	0
Leaving it to ABILITY versus putting in EFFORT when doing mathematics.	Ability vs Effort	0.58	1.362	1	2
APPLYING mathematical concepts versus using a RULE or formula to solve a problem.	Application vs Computation	-0.13	1.385	0	0
Truth and FACTS that were discovered versus IDEAS and practices used in life.	Facts vs Ideas	0.26	1.354	0	0
Someone TEACHING or explaining to me versus EXPLORING mathematics myself.	Explanation vs Exploration	-0.55	1.263	-1	-2
REMEMBERING versus CREATING mathematics ideas, concepts, rules or formulae.	Recalling vs Creating	-0.74	1.070	-1	-2
TELLING what a triangle is versus letting me see concrete EXAMPLES first.	Rationalism vs Objectivism	0.48	1.597	1	2
Demonstrating and explaining mathematics to OTHERS versus keeping mathematics MAGICAL.	Openness vs Mystery	-1.31	0.822	-2	-2
Using mathematics to predict and explain (CONTROL) versus for development and PROGRESS	Control vs Progress	0.31	1.313	0	0

Four clearly *negative* means (items 1, 6, 7 and 9), all strongly supported by a mode score of -2, supplemented by two distinct *positive* means (items 3 and 8), both sturdily supported by a mode score of +2, indicate that the participants explicitly value:

*process* (how an answer is obtained) over *product* (what an answer is);

*explanation* (mathematics explained to me by someone else) over *exploration* (explore mathematics on my own);

*recalling* (to be able to remember ideas, concepts, rules and formulae) over *creating* (constructing or discovering ideas, rules, concepts and formulae);

*openness* (sharing mathematics with others) over *mystery* (maintaining mathematics' magical character);

*effort* (hard, regular and diligent work) over *ability* (talent and potential); and,

*rationalism* (a more theoretical approach to mathematics) over *objectivism* (a more pragmatic stance).

No clear value preferences emerged in respect of *item 2* (having fun versus hard work), *item 4* (applying mathematical concepts versus using rules and formulae to solve problems), *item 5* (discovering truths and facts versus ideas and practices in real life) and *item 10* (using mathematics for control or for progression purposes). Two of these findings, namely those in respect of items 2 and 4, are quite unforeseen. The authors generally expected that a group of engineering students in their first year of study, would have attached more value to hard work and to discovering truths and facts about mathematics. If the participants were for example in their third or fourth year of study, values like having fun and discovering authentic ideas and practices would probably have featured more pertinently?

In a study involving approximately 600 Grade 5 and 700 Grade 9 Japanese mathematics students, Shinno, Kinone and Baba (2014) discover that participants explicitly value *process, effort, openness and*

recalling over product, ability, mystery and creating. They were disappointed that the students valued the recall of mathematical ideas and concepts to a greater extent than discovery and creation, because the latter are seen as the cornerstones of Japan's mathematics pedagogy. What's more surprising to the authors is that the mathematics learning values projected by these Japanese school kids correspond almost exactly with those of the first year engineering students in this inquiry. This raises a number of questions, because of the substantial differences between the two groups of students. Potential value differences between students who have passed the first semester mathematics module and those who have failed it are hence explored.

#### 4.2. Values of 'successful' versus 'unsuccessful' students

The independent samples t-test, interrogating equality of means on all ten semantic differential items, was utilised to detect differences between the values that students who have passed mathematics associate with mathematics learning versus values that students who have failed mathematics subscribe to. Table 2 below displays relevant descriptive statistics, as well as the t- and p-values. The respective F-scores and p-values generated via Levene's test confirmed that all variances can be assumed as equal.

**Table 2: Group statistics and independent samples T-test findings**

Semantic diff values	Groups	Mean	Std dev	Mean diff	t-value	Sig. (2-tailed)
Process vs Product	Passed (n=31)	-1.16	1.098	-0.323	-1.071	.289
	Failed (n=31)	-0.84	1.267			
Fun vs Work	Passed	0.42	1.361	0.516	1.513	.136
	Failed	-0.10	1.326			
Ability vs Effort	Passed	0.97	1.224	0.774	2.317	.024 <sup>①</sup>
	Failed	0.19	1.400			
Application vs Computation	Passed	-0.26	1.237	-0.258	-.731	.468
	Failed	0.00	1.528			
Facts vs Ideas	Passed	0.32	1.400	0.129	.372	.711
	Failed	0.19	1.327			
Explanation vs Exploration	Passed	-0.74	1.094	-0.387	-1.211	.231
	Failed	-0.35	1.404			
Recalling vs Creating	Passed	-0.65	1.112	0.194	.709	.481
	Failed	-0.84	1.036			
Rationalism vs Objectivism	Passed	0.58	1.523	0.194	.474	.637
	Failed	0.39	1.687			
Openness vs Mystery	Passed	-1.42	0.765	-0.226	-1.084	.283
	Failed	-1.19	0.873			
Control vs Progress	Passed	0.29	1.296	-0.032	-.096	.924
	Failed	0.32	1.351			

① Significant at the 95% level of confidence

The independent-samples t-test indicates that the value that the participants attach to effort (and hard work) is significantly stronger for engineering students who have passed mathematics in the first semester of their first year ( $M = 0.97$ ,  $SD = 1.224$ ) than for students who have failed their first semester of mathematics ( $M = 0.19$ ,  $SD = 1.400$ ),  $t(60) = 2.317$ ,  $p < .05$ . Cohen's effect size ( $d = .59$ ) is in the medium to high interval (Thalheimer & Cook, 2002), which implies that the finding has moderate to high practical significance.

Chouinard, Karsenti and Roy (2007, p. 502–503) cite a number of reports, which highlight students' competence beliefs, and the values that they attach to mathematics, as two main predictors of achievement. They also emphasize Berndt and Miller's (1990) study, which proves that students of mathematics who attach lesser importance to effort, generally maintain lower success expectations and eventually underperform.

## 5. IN CONCLUSION

The two research questions that this study attempted to answer are:

What are the most important values that first year engineering students associate with mathematics learning?

Are there differences between the values of participants, who have passed versus those that have failed mathematics?

Values are regarded as sociocultural or personal convictions that students consider important enough to integrate in their day to day behaviour. The inquiry is firstly underpinned by Bishop's (1996) distinction among mathematical, mathematics educational and educational values. Hofstede's (1997) notion that every culture (also teaching and learning settings) can be delineated along five cultural dimensions, is the study's second theoretical lens. The study is thirdly also underpinned by Seah's (2005) so called cultural values, which have particular relevance in respect of multicultural lecturing or classroom settings.

The majority of the 62 first year engineering students seem to value: *how* answers to mathematics problems are acquired (as opposed to what the answers are); content being *explained* to them (as opposed to exploring it on their own); being able to *recall theory* (instead of constructing or discovering it); being exposed to *facts and demonstrations* (as opposed to the mystique of mathematics); *hard, regular and diligent work* (instead of depending on talent or ability) and attempting mathematics via *logical thinking and reasoning* (as opposed to being more pragmatic and concrete). Furthermore, students who passed mathematics in the first semester, attach significantly more value to *effort* (hard work) in their learning, than *ability* (talent), the value to which students who failed mathematics in the first semester mostly subscribe.

The regular detection of values that students associate with mathematics learning is an important activity to be undertaken by mathematics educators. However, it doesn't end there. Mathematics educators should also be able to facilitate **alignment** between what they and what their students' value. Such an activity, in the view of Seah and Andersson (2015, p. 3124), strengthens the lecturer-student relationship, and is one of the keys to more optimal learning.

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