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Values in Mathematics Education: Its Conative Nature, and How It Can Be Developed

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This article looks back and also looks forward at the values aspect of school mathematics teaching and learning. Looking back, it draws on existing academic knowledge to explain why the values construct has been regarded in recent writings as a conative variable, that is, associated with willingness and motivation. The discussion highlights the tripartite model of the human mind which was first conceptualised in the eighteenth century, emphasising the intertwined and mutually enabling processes of cognition, affect, and conation. The article also discusses what we already know about the nature of values, which suggests that values are both consistent and malleable. The trend in mathematics educational research into values over the last three decades or so is outlined. These allow for an updated definition of values in mathematics education to be offered in this article. Considering the categories of values that might be found in mathematics classrooms, an argument is also made for more attention to be paid to general educational values. After all, the potential of the values construct in mathematics education research extends beyond student understanding of and performance in mathematics, to realising an ethical mathematics education which is important for thriveability in the Fourth Industrial Revolution. Looking ahead, then, this article outlines a 4-step values development approach for implementation in the classroom, involving Justifying, Essaying, Declaring, and Identifying. With an acronym of JEDI, this novel approach has been informed by the theories of 'saying is believing', self-persuasion, insufficient justification, and abstract construals.

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ZDM classification: C20, C60, D20
2000 Mathematics Subject Classification: 97C20, 97C50, 97C60

I. THE MISSING PIECE OF THE PUZZLE

Over the last 150 years or so, mathematics education research has contributed much to our understanding of the teaching and learning of mathematics at school (and beyond), and to our knowledge of supporting and improving the teaching and learning processes (Kilpatrick, 1992).

Nevertheless, some issues in (mathematics) education have essentially persisted. For instance, student misconceptions with concepts like negative numbers and fractions have remained largely similar (Aksoy & Yazlik, 2017; Fuadiah, Suryadi, & Turmudi, 2017); one would expect that the research knowledge and findings we have accumulated in these areas would have ensured that the misconceptions are proactively considered, and preventive strategies integrated into the planning and delivery of mathematics lessons. Likewise, "despite … initiatives [over the last 40 years or so], females' participation … in particular in Mathematics, from primary through tertiary education to the career level is still very low" (Leder, 2015, p. 149). Referring to the recommendations of a 2003 report, Timms et al. (2018) wrote that "it is therefore concerning that a report written this long ago still accurately portrays the present state of affairs" (p. 9). We might thus ask questions such as, "Have we missed out some important variable(s) in our research?" and "How might we best motivate stakeholders to modify their practices to address learning issues?"

Over the years, student performance in mathematics and numeracy has also generally failed to improve. Amongst the 16 economies which took part in the Trends in International Mathematics and Science Study [TIMSS] in the 20-year period from 1995 to 2015, 9 showed significant gains but the 7 others demonstrated either no or negative gain (Thomson et al., 2017b). In the Programme for International Student Assessment [PISA], even though 6 economies had experienced significant gains in student performance from 2003 to 2015, 13 (i.e. more than double) demonstrated significant decline (Thomson et al., 2017a).

In Australia for example, students' performance in these two international large-scale student assessments has remained essentially flat in the last 15-20 years. In the 20-year period from 1995 to 2015, both Year 4 and Year 8 cohorts of Australian students showed no statistically significant change in mathematics scores in TIMSS assessments (Thomson et al., 2016). "At a time when mathematics is being internationally positioned as fundamental to innovation and development, Australian secondary students' lack of growth in mathematical ability is particularly concerning" (Murphy, 2018, n.p.). Over the 15 years in which six PISA assessments were held from 2000 to 2015, there was actually a decline in 15-year-old Australian students' numeracy performance (Masters, 2016). Even more representative of all students in Australia is the annual 'National Assessment Program – Literacy and Numeracy' [NAPLAN] assessments: numeracy performance at all assessed year levels remained flat in the ten years from 2008 to 2017 (ACARA, 2016). This situation is not good news, given that millions of dollars had been invested in mathematics and numeracy pre-service and in-service professional development, and also in education research into mathematics pedagogy. Some may even feel that the actual situation in Australia is worse, given that an increase in migrant students from certain countries have effectively pushed up Australia's numeracy performance (Jerrim, 2014). In fact, in PISA 2015, the numeracy scores of first-generation immigrant students in Australia are significantly higher than their Australian-born peers by the equivalent of approximately half a school year (Thomson, de Bortoli, & Underwood, 2017a).

Despite years of relevant research, interventions and policies, the persistence of mathematics pedagogical issues and the lack of improvement in students' performance in mathematics and numeracy highlight the complexity of related issues, and hint at the existence of variables or approaches which might not have been harnessed enough yet. The mathematics education research methodology around the world has traditionally been informed by education psychology theories and frameworks, with affective studies contributing to a richer understanding of learning and teaching more recently. Then there was the 'social turn' (Lerman, 2000) in the new millennium, which reminded us that any full understanding of how a student learns – and how a teacher teaches – mathematics cannot be achieved without situating the person in the sociocultural context (see also Bronfenbrenner, 1992). After all, teaching and learning are highly interactional and social activities.

But, with the dominance since the 1950s of cognition in psychology – to the extent that the term 'psychology' is often associated with cognition only – it can be easy for us to forget that we also have more than 260 years of knowledge about the tripartite components of the human mind (Hilgard, 1980). In fact, "for two hundred years many psychologists took for granted that the study of mind could be divided into three parts: cognition, affection, and conation" (Hilgard, 1980, p. 107; see also Reitan & Wolfson, 2000).

While cognition and affect may be associated with reasoning and feeling respectively, conation is associated with willingness and desire. In the words of Reitan and Wolfson (2000), conation reflects "the ability to focus and maintain persistent effort in order to achieve maximal production in performance of a task" (p. 444). Thus, it is concerned with this sense of personal energy and zeal to direct focus and maintain persistence, without diminishing the roles of cognition and affect. Conative variables might well be a powerful and useful resource which students can tap into in their learning journeys. Perhaps, this is an area which (mathematics) education research has not paid much attention to all these years: the missing piece in the mathematics pedagogy puzzle, and the very missing variable / approach mentioned earlier in this paper. This writing focuses on the construct of values to demonstrate its conative nature in facilitating student learning of mathematics, and to introduce the reader to an approach to developing values amongst students in schools.

II. THE TRIPARTITE MODEL OF THE HUMAN MIND

Our conceptualisation of the mind as being made up of cognition, affect, and conation can be traced to the Enlightenment period in Eighteenth Century Germany. In particular, Moses Mendelssohn in his 1755 writing referred to the fundamental faculties of understanding, feeling, and will (Hilgard, 1980) as underlining psychological thought and practices. At about the same time, there was a similar classification of the mind in Scotland, before travelling psychology academics introduced it to the United States.

These three components of the mind together guide our decisions and actions. Conation's role, given its function in directing effort to achieve tasks – can be perceived as being in the driver's seat, orchestrating relevant cognitive and affective processes which are needed for one to arrive at a decision and to enact it (Verweij et al, 2015). These intertwined and mutually enabling processes include synthesizing available information and data, reasoning amongst possible alternatives, feeling confident (or unsure) about the decision made, biasing and limiting our choices as a result of our admiration or jealousy, and executing the decision. This view might be in conflict with rational choice theory which had been popular and influential in political science and economics, but even it has been criticized (e.g. Verweij et al., 2015) for not considering non-cognitive processes that also play a part when choices and decisions are made. Figure 1 illustrates conation's role in the bridging of cognition and affect on the one hand, and behaviour in the forms of decisions and actions on the other.

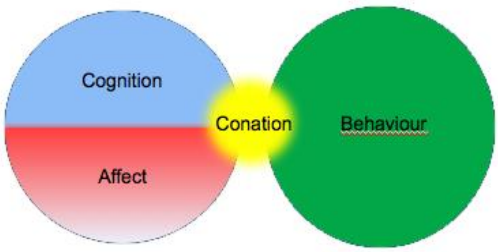

Figure 1. Conation as a bridge between cognition and affect, and behaviour

It is perhaps inevitable that as we seek in the recent few decades for a better understanding of the (mathematics) learning process that goes beyond cognitive psychology, that the conative dimension of mental functions is increasingly researched. Given conation's association with attributes such as will, motivation, and drive, conative constructs would include motivation (Middleton, 1995), mindsets (Dweck, 2006), grit (Duckworth, 2016), and values (Bishop, 1988, 1996).

III. VALUES AS A CONATIVE VARIABLE

Values represent the socially-mediated qualities that are considered important to us (Lewin, 1938). Atkinson (1957) and more recently, Eccles at al (1983), Higgins (2007) and Torelli and Kaikati (2009) extended this understanding to also regard valuing as a motivating force with which one gets what one wants. DeBellis and Goldin (2006) alluded to the deep-rootedness of values in asserting that

> values, including ethics and morals, refer to the deep, 'personal truths' or commitments cherished by individuals. They help motivate long-term choices and shorter-term priorities. They may also be highly structured, forming value systems. (p. 135)

The constructs of values and beliefs are sometimes used interchangeably. However, they refer to different qualities. In the opening chapter of the book 'Beliefs: A hidden variable in mathematics education?', Leder, Pehkonen and Törner (2003) highlighted Bar-Tal's (1990) definition of beliefs as being "what people consider as facts, opinions, hypotheses, as well as faith" (p. 12). On the other hand, "when we think of our values, we think of what is important to us" (Schwartz, 2012). The essence within these two quotes is commonly reflected in other definitions of beliefs and values as well. That is, beliefs reflect what are true (or false), and are thus contextualized, whereas values reflect what are personally important (or not important), and exist in a context-free manner. Neither is there a one-to-one relationship between beliefs and values; any belief might be an expression of two or more different values. For example, one may believe that the four-function calculator is a useful pedagogical tool in early primary mathematics lessons. Yet, the value(s) underlying this belief may be *efficiency* (one gets the answer quicker) or it may instead be *process* (having the answer computed by the calculator allows us to focus on the process of the mathematics work).

Thus, values form a strong driving force for an individual, community or culture. Perhaps this is why values are often associated with characteristics of persons or collectives. "To talk about culture is to talk about values" (Frade & Machado, 2008, p. 34). Values can thus provide us with the ability to focus and to maintain persistent effort which characterise conation. It is also easy to see how the values we hold would inform both cognitive and affective functioning. For example, one's valuing of *creativity* would shape one's approaches to problem-solving, such as through frequent attempts at searching for alternative, 'better' problem-solving strategies. At the same time, the valuing of *creativity* can also regulate one's affective functioning: one might experience admiration, fulfilment, joy and excitement when one comes across an alternative, 'better' problem-solving strategy. Certainly, the association of such positive emotions with the problem-solving process can only be beneficial for the cultivation or maintenance of one's self-efficacy and confidence.

We can also see how values drive affect in a recent revision of Fishbein and Ajzen's (1975) 'Theory of Reasoned Action'. After Vallerand et al (1992) had conducted a structural equation modeling to show the importance of normative beliefs and behavioural beliefs in contributing to an individual's attitudes, they proposed a set of beliefs which underlined them. "This type of beliefs, namely personal normative beliefs, refers to one's beliefs about what should be or ought to be done" (Vallerand et al, 1992, p. 106), which thus echoes how values are defined as well. In other words, what one values help to develop one's behavioural beliefs and normative beliefs, which together influence one's attitudes, then behavioural intentions, and eventually, behaviour.

It is important to emphasise that as the last sentence in the previous paragraph shows, behaviours do not automatically follow the relevant valuing. Citing Feather's (1995) research, in which 25% of the scenarios offered did not demonstrate value-behaviour congruency, Torelli and Kaikati (2009) made the point that "these findings reinforce the notion that the value-behavior relation is frequently moderated by multiple factors such as … task familiarity or task complexity" (p. 245).

IV. WHERE VALUES COME FROM

According to one of Benjamin Bloom's taxonomies of educational objectives (Krathwohl, Bloom, & Masia, 1964), values evolve from our attending and responding to stimulus phenomena. The stages of the valuing process are: (1) receiving, (2) responding, (3) valuing (i.e. the acceptance of and commitment to a value), (4) organisation (i.e. prioritizing of values into personal value systems), and (5) characterisation (i.e. having a values system which reliably guides one's decisions and actions). This needs not be perceived as a linear, one-way process, however. In other words, repeated exposure to similar phenomena should lead to ongoing refinements and adjustments to particular valuing, and also, to the value system.

As mentioned above, the valuing, organization and characterization stages would not have taken place if the individual's attention is not drawn to the stimulus phenomenon in the first place. Carl Roger's organismic valuing process (1951) provides some useful insights here. It emphasises an individual's innate ability to respond to things which are important, fulfilling and actualizing. "It is conceived of as not only an ability to recognize one's individual or selfish interests but also as an ability to know and choose what will simultaneously forward the interests of important others and of society as a whole"

(Sheldon et al., 2003, p. 836). Thus, then, the activation of the receiving and responding stages in the taxonomy would already reflect the individual's inclination for the attributes of the phenomenon, such that the ensuing valuing becomes a natural progression.

However, we should not also rule out other potential stimuli which we attend and respond to. While we will no doubt respond to phenomena which are fulfilling and actualising, we may also find ourselves in situations where a response is not a choice (e.g. natural disasters). In other words, to the extent that we have to attend to some phenomena, the experience can also lead to the adoption or consolidation of particular valuing. There are implications here for the planning of intervention exercises in the education setting, especially for groups of students.

It is worth noting that neither Bloom's taxonomy nor Roger's organismic valuing process suggests any end-point. That is, we can continue to internalise new or modified values. As long as we continue to react to stimuli, we are allowing ourselves to introduce a new value – or to modify/consolidate an existing one – to our own value system. What this implies is that we have the capacity to finetune our own individual value system throughout our own lives. That is, as much as values are consistent, they are also malleable. This might not appear evident if the environment around us does not evolve fast or significantly enough to generate stimulus phenomena which are noticeable. On the other hand, if we find ourselves working in a new job or living in a new country, the cultural difference that comes with it would bring about many novel experiences, exerting pressure on the individual's value system to reorganize what are valued, and how these are prioritized amongst themselves.

The sociocultural environment shapes our values and is in turned shaped by our values as well. This takes on a significance when this sociocultural environment includes one or more persons, for he/she/they will also be espousing what they value. In other words, the quality of human communication is mediated by what the people involved value individually, and also by the outcomes and implications of the values coming together.

Thus, given that (mathematics) pedagogy is very much about the interactions amongst people, we risk neglecting a huge piece of the puzzle – and continuing to experience the issues identified at the beginning of this paper – if we do not pay attention to the role which conation in general, and values in particular, plays in the mathematics classroom.

V. VALUES IN MATHEMATICS EDUCATION

Research into values in mathematics education began in the late 1980s, when Alan Bishop (1988) proposed in his seminal book, 'Mathematical enculturation: A cultural perspective on mathematics education', how Western mathematics as he saw it could be associated with 3 pairs of complementary values. These are, namely, *rationalism* and *objectism*, *control* and *progress*, and *mystery* and *openness*.

Speaking at a keynote address a few years later, Bishop (1996) advanced his conceptualisation further, by proposing that the values that are espoused in school mathematics classrooms can be categorised into three groups, namely, mathematical (i.e. values that are associated with the discipline of mathematics), mathematics educational (i.e. values that are associated with the teaching and learning of mathematics), and general educational (i.e. values that are associated with the objectives of school education in general). The category of mathematical values would consist of the 6 attributes of 'Western' mathematics in Bishop (1988). That they have not been revised in nearly three decades not only suggests that the 'Western' mathematics which Bishop was referring to has probably become the school mathematics that is being taught all over the world, but also that the nature of the school mathematics curriculum has not changed much even though societies have witnessed much changes around them.

Values are sometimes not explicitly defined in the literature, which perhaps reflects an assumption that it is commonly understood. Take for example Clément (2013), who began his section named 'definition of values' with the sentence, "Values guide individual and social actions", thus focusing on what values do rather than what they are. Similarly, Ö zsoyi, Akkaya, Tosun, Umurbek, Güçlü, and Eray (2018) declared in their writing that "values are significant for ensuring that societies continue to exist, maintain unity and solidarity, and individuals live in peace and security within a society" (p. 166).

Elsewhere, values have been regarded as either affective or conative / motivational by different researchers. In the field of mathematics education, Bishop (1996) was of the view that "values in mathematics education are the deep affective qualities which education aims to foster through the school subject of mathematics" (p.19). Regarding values as an affective variable was in line with Krathwohl et al (1964), which classified values into the affective domain of the three taxonomies of educational objectives.

The discussion so far in this writing, however, reflects an alignment with another view, that values constitute a conative construct. That is, values are related to will and motivation, in the same way that Schwartz (1992) and Matthews (2018), for examples, see them. Wigfield and Eccles' (2000) Expectancy-value Theory, in which values is one of the two key independent variables, is also a motivation model. When an attribute relating to mathematics learning/teaching, to mathematics, or to any aspect of life in general is being valued, this represents a conviction which one regards as personally important (Seah, 2018). It thus provides one with the will and motivation to interpret incidents and phenomena in one's sociocultural context, to make decisions and choices, and to act in accordance to the value. Of course, in reality, one possesses many values which together constitute the personal value system, and the relative valuing of one attribute over another within the value system can mean that not all that one values are observable in all instances. In this context, then, valuing is defined as an individual's embracing of convictions in mathematics pedagogy which are of importance and worth personally. It shapes the individual's willpower to embody the convictions in the choice of actions, contributing to the individual's thriveability in ethical mathematics pedagogy. In the process, the conative variable also regulates the individual's activation of cognitive skills and affective dispositions in complementary ways.

An examination of prior related research would reveal that amongst the three categories of values in mathematics education proposed by Bishop (1996), the general educational values are least discussed. Perhaps it is because unlike the other two categories, these values do not relate to mathematics learning and teaching directly. In fact, they are often the least identified category of values amongst students and teachers' responses (see, for example, Zhang, Barkatsas, Law, Leu, Seah & Wong, 2016). Given that these values "derive from the general educational and socialising demands of society" (Bishop, 1996, p. 20), they might have been considered by mathematics education researchers as being the civic, ethical and moral values that happen to be taught through the teaching of mathematics. As such, they might be considered irrelevant – and thus ignored – in a 'values through mathematics' context, in which the school mathematics subject is a vehicle for developing values in students.

Indeed, some may think that a focus on these values might be in conflict with a 'mathematics through values' research agenda, that is, the promotion of mathematics learning / performance / understanding through the inculcation amongst learners of enabling values. These enabling values are concerned with promoting student learning of mathematics, although some of them (i.e. the general educational values such as *equity* and *diversity*) also serve to promote student development of ethics and morality. Thus, questions may be asked of the possibility that these messages might distract students from focussing on learning mathematics well, or performing well in mathematics.

However, there are at least two reasons why we need to pay more attention to the roles played by general educational values in mathematics education. Both reasons hinge on the fact that ethical values (e.g. *empathy, respect* and *honesty*) constitute a sub-set of general educational values.

Firstly, when civic, ethical or moral values are intentionally built into the pedagogical materials, students are learning not only these general educational values. These values would also be exemplifying the applicational nature of mathematics concepts, and this can have implications towards strengthening the quality of the students' mathematics learning. In the words of Ernest (2019),

> including ethical issues in the mathematics curriculum in this way provides the mathematics teacher with an additional asset. Thus the benefits go beyond merely adding ethics to the curriculum, they both enliven study and help to develop students as balanced and rounded human beings. (p. 86)

Secondly, in this age of the Fourth Industrial Revolution which is characterised by automation and artificial intelligence, it is increasingly important that programs and algorithms are written – and technology applied – in ethical ways. Indeed, as we become more and more technologist, we should also become more and more humanist. The inclusion of civic, ethical and moral values in mathematics lessons would be essential in consolidating in students desirable general educational values (including ethical values) that are embedded in the subject, in the learning of the subject, and also in the application of the subject.

Then there are also the general educational values which are concurrently mathematical or mathematics educational values as well. These values are espoused when, for example, a teacher caters to the different learning needs of a mixed-ability class, or when s/he selects the context for a mathematics problem. In the former, the teacher's valuing of, say, *equity*, is both an ethical value and an attribute of mathematics teaching. In the latter, the teacher's choice reflects his/her application of values which can be both ethical (e.g. a problem context concerned with recycling) and mathematics educational at the same time (e.g. the chosen theme of recycling captures the attention and engagement of students). These practices exemplify what Ernest (2019) called 'ethical mathematics teaching', when teachers plan for and execute mathematics lessons, and how they engage with students, in ways which provide students with optimal opportunities to learn and maintain/enhance their mathematical wellbeing (Clarkson, Seah, & Bishop, 2010). In turn, how students respond to these would impact on their sense of wellbeing, with implications for the quality of mathematics learning (and mathematics performance). As Ernest (2019) wrote in the context of mathematics education, "one small negative interaction can have lasting deleterious effects" (p. 83).

VI. RESEARCHING VALUES IN MATHEMATICS EDUCATION

In the 30+ years since Bishop (1988) introduced the construct of values to mathematics education, related research has undergone through several phases of foci. While it is not the intention of this writing to review the research that had been conducted in this field, and the reader may refer to such publications as Clarkson, Seah and Pang

(2019), or to Bishop, Seah and Chin (2003) instead, an outline is given below to explain how we have reached a current focus in the research agenda.

In this regard, the 1990s can be characterised as a period of conceptualising and clarifying the values construct. It was during this time when values in the 'Western' mathematics classroom were classified (Bishop, 1996), and the three complementary pairs of mathematical values conceptualised (Bishop, 1988).

Much of the first decade of the new century saw research studies probing for values which were espoused by – or represented in – textbooks and teachers. Several studies were carried out to identify and investigate the values in school mathematics textbooks. Dede (2006), for example, analysed the values found in Turkish middle school mathematics textbooks. This study followed up on Bishop's (1988) assertion that there had not been equivalent emphases on the values within each of the three pairs of mathematical values, even though they were considered to be complementary. Cross-cultural studies were also made: Seah and Bishop (2000) compared the mathematical and mathematics educational values represented in Australian and Singapore lower secondary mathematics textbooks. Similarly, Cao, Seah and Bishop (2006) conducted a comparative study of mathematics textbooks used in mainland China and Australia, though this focussed on the mathematical values only.

Nationally-funded research projects focussing on teachers' values and valuing also took off in Australia and Taiwan (Bishop, FitzSimons, Seah, & Clarkson, 2001; Chin, Leu, & Lin, 2001) at the turn of the century. Led by Alan Bishop and Fou Lai Lin respectively, these projects worked with small groups of teachers to find out what valuing looked like in the planning and execution of mathematics lessons. A key finding was that most mathematics teachers, regardless of whether they were practising in East Asia or in the Western classroom, were not aware that they were value agents, let alone knowing what values were being taught to their respective students in mathematics lessons.

Amongst the studies with teachers, a few stood out for their foci on teachers' religious values and how these affect professional practice. Chan and Wong (2014) worked with Buddhist and Christian teachers in Hong Kong, whereas Leu and Wu (2002) researched with Buddhist teachers in Taiwan. The teachers' (personal) religious values were observed to influence teachers' pedagogical values and practices.

The research focus shifted to students in the 2010s, such as the introduction in the 2011 AERA conference of the construct of mathematical well-being (Clarkson & Seah, 2011), and how teachers play a role in promoting this in their students. In another study, values which promote or inhibit students' engagement in mathematics lessons were identified, with distinctions made between engagement as a state and as a trait (Kalogeropoulos & Bishop, 2017). Several studies were carried out across many countries to assess what students value in their mathematics learning, using a variety of methods such as children’s drawings (Seah & Ho, 2009) and photovoice (Lim, 2010). A particular big study during this period was ‘What I Find Important (in my mathematics learning)’ [WIFI], which assessed students’ values in mathematics learning using a questionnaire that was designed and validated for the study. More than 18,000 data were collected from 19 economies around the world (see, for example, Zhang et al, 2016). In the United States, Matthews (2018) examined how the valuing of mathematics by Black and Latino students in urban middle and high schools was related to the extent to which their mathematics teachers show the interconnectedness amongst concepts and applications of these concepts.

As we come to the end of the 2010s, the research focus is progressing from assessing what teachers and students value, to applying the knowledge we now have regarding values in mathematics education to school and classroom practices. Data have been collected in a few countries such as China, Korea, Portugal and Nepal to inform us how we might emulate effective teachers’ skills in values alignment in mathematics lessons. The assumption is that the ability of effective teachers to align their values with those of the students is instrumental in facilitating mathematics learning. An important program in this next stage of the values research agenda would be to set up an efficient and effective process of developing nominated values in mathematics education.

VII. DEVELOPING VALUES IN STUDENTS

In the context of the mathematics classroom, values are thus transmitted to – and internalised by – students for the purposes of mathematics learning and of education in general. While this takes place each time teachers interact with their students in the (mathematics) class, there are also situations when teachers intentionally plan for students to learn particular values, either to facilitate mathematics learning and/or for general educational goals which are part of the professional and ethical responsibiltiies of teaching.

Direct teaching of values during mathematics lessons, especially in the absence of any context, may not be an effective nor sustainable approach. As we saw in the Taxonomy of Learning Objectives, the valuing process begins with a willingness to attend to the phenomenon, which in this case would refer to the teacher’s direct, explicit teaching of attributes, and this by itself can be a challenge. Unless there is a captive audience predisposed to hearing and internalising what is being taught, such as in religious congregations, direct teaching of values is not likely going to be an effective approach to developing values.

One might suggest that values be introduced or inculcated indirectly then, through weakening the opposing values or the attitudes attached to the opposing values. However, it is unlikely that this will be effective. Blankenship, Wegener and Murray (2012) had found that

> when the … attitude is directly attacked, the connection of the attitude to the value might be one of the reasons that people are likely to generate negative thoughts about the message (counterarguments) and to resist the attack. (p. 617)

The approach being proposed here for mathematics education is based on a process used by the Chinese army during the Korean War and first documented by the American psychologist Edgar Schein (1956). It brings together several components which would be familiar to educational psychologists. In particular, it draws on the theories of 'saying is believing' (Higgins & Rholes, 1978), self-persuasion (Friedrich, 1990), insufficient justification (Festinger & Carlsmith, 1956), and abstract construals (Fujita, Trope, Liberman, & Levin-Sagi, 2006). It involves the following steps: Justifying, Essaying, Declaring, and Identifying. The acronym of the 4-step process constitutes the name of this approach, that is, 'JEDI'.

The JEDI approach has been undergoing through trials and finetuning with Melbourne mathematics teachers and principals in 2018 and 2019. Teachers need only put aside some 60 minutes to lead their students in class through the JEDI process, with immediate benefits in the form of individual acceptance of target values.

1. JUSTIFYING

For a student, the JEDI process begins with the identification of one value that is not yet embraced by him/her in mathematics learning and that would be the object of the value development process. This is thus the target value for the particular JEDI process. When implemented to a class, the classroom teacher would need to either identify a value that s/he wishes to develop for all the students in the class (which may not be easy), or the students may be organised into small groups each of which has a unique target value for development.

At this step, students are given about 5 minutes to think of reasons why the target value should be embraced. It is a thought-exercise that is similar to Freitas et al's (2004) 'why' construal level manipulation, in which the students are required to ask successive 'why' questions to themselves, starting with the target value. Each explanatory response becomes the basis of the next 'why' question. For example, a student might be asking herself/himself why *fluency* is important, realising that it is because s/he values the efficiency in how students solve mathematics problems fluently, and so then asking herself/himself why *efficiency* is important, and so on. Students may jot down their reasons, knowing that all written notes would stay private. Alternatively, a ‘worksheet’ might be distributed to the students to guide them in their recording of the reasons and justifications in response to each ‘why’ question. At this stage, there is no requirement for the students to discuss their responses publicly.

The underlying idea for this component of the JEDI process is the cultivation in students of abstract, psychologically distant representations. The successive asking of ‘why’ questions leads one to focus on increasingly symbolic and abstract reasons behind the target value. These high-level representations exert weight on what one values, prompting one to favour decisions or actions that are consistent with the target value. In fact, Torelli and Kaikati’s (2009) experiments showed that the priming of an abstract mindset promotes a stronger value-behaviour relationship. This exercise is known in problem-solving situations to lead to the identification of root causes. The ‘5 why technique’ devised by Toyota Corporation reflects this idea as well. When applied to the value development process here, students not only become aware of the importance of the target value (mirroring the first stage of the taxonomy discussed above), but the justifying experience would also help them to relate the target value to ideas which are higher-order and more goal-relevant.

2. ESSAYING

In this second step, students are then given time to write an essay arguing for the embracing of the target value. The experience from the pilot exercise suggests that some 15 minutes would be sufficient and ideal. A title such as ‘why we should value *fluency* (or *openness, visualisation* or *reasoning*)’ might be given to guide their writing. It is important that students are given sufficient time to write a few paragraphs at least, that they write in prose, and that they write freely. To facilitate this, students are assured that nobody will be reading their essays. It has also been found effective that students write in any language they feel most comfortable in, with which they can express their personal emotions best.

This step builds on the previous one, in which students’ awareness of the supportive reasons for embracing the target value is now represented more concretely in writing. Desired sustained changes in the writers come about through the effects of self-persuasion (e.g. Friedrich, 1990). Writing in prose facilitates clarity of thought and argument amongst the students, as they search for the right or best words to represent what they think and feel. In so doing,

> students would be motivated to consider arguments carefully in an attempt to produce a coherent piece of work. They should also be capable of comprehending and articulating appropriate arguments, particularly to the extent that relevant information has been covered in the context of readings, lectures, and/or laboratory activities. Furthermore, in the process of organising supportive arguments, favourable thoughts are likely to predominate in a way that makes memory salient and facilitates memory for critical information. (Friedrich, 1990, p. 24)

3. DECLARING

The coherent and supportive arguments which the students would have begun to develop in the essaying exercise above would be further internalised in this step, when they are invited to declare to their peers why one should embrace the target value. This can be done in different ways. For example, middle years students might be asked to design a poster or flyer for new students joining the first year of primary or secondary school, promoting the school and the mathematics discipline's valuing of *openness* (see Bishop, 1988). With older students, they might take part in a speed-dating style activity, in which they are required to repeat their arguments verbally over several rounds of about 3 minutes each. In each round, a student would, for example, explain to his/her partner why/how the valuing of *openness* is important to mathematics learning, to performance in mathematics assessments, and/or to contributing to life in a democratic society. S/he will also listen to what his/her partner has to share regarding the valuing of the similar attribute, or a different one. This step of the JEDI process can take up 20 – 30 minutes in total, depending on the nature of the learning tasks adopted. For instance, the poster design task can be a homework exercise.

The student's participation in this declaring component should lead to the experience of the 'saying-is-believing' effect (Hausmann, Levine, & Higgins, 2008; Higgins & Rholes, 1978), which refers to the lasting effect on one's recall and impression that comes about when one tailors one's message to suit the person(s) one is communicating with. The repeated opportunities to do so in speed-dating style of activities not only reinforces the 'saying-is-believing' effect, but subconsciously too, the student sharpens his/her case with each successive round as s/he tries to be even more convincing in his/her argument for a value that s/he had started off not embracing. This is a powerful component in the JEDI process, for each student is authoring the valuing message without feeling as if s/he had been forced to do so by someone else (Walton, 2014).

4. IDENTIFYING

The declaring stage is usually immediately followed by a phase of short duration in which recipients of a student's argument – the partners in the speed-dating exercise, the new students receiving the posters, for examples – would affirm what they have heard from her/him. This can take place concurrently with the declaring step too, and it might be as simple as a tap on the back from a peer to say that one has been effective or convincing in promoting the valuing of, say, *openness* or *fluency*.

Yet, the psychological effect can be as intense as in the previous steps. This last step in the JEDI process reinforces in the students the extent to which each of them had been successful in justifying, writing about, and arguing for the target value. Whereas the first two stages of the value development process are relatively private, in that the students do not need to share or present what they had written, the declaring stage deepens the participation and responsibility in each participant. S/he is now potentially influencing another person to embrace the target value. Receiving an affirming signal from a peer at this last step would have driven the message home further, that what s/he has been espousing is now really making an impact on someone else.

At all times throughout this 4-step process, it is important that students do not feel coerced into participating. This way, even though a student will be experiencing cognitive dissonance as s/he begins to value an attribute which s/he did not start off embracing, s/he will not be able to attribute it to any external cause. The experience of this insufficient justification effect (Festinger & Carlsmith, 1956) allows the student to recognise that the cause for the new valuing is internal, thereby resolving the cognitive dissonance.

Related studies have demonstrated that positive results can be expected straight after participants had experienced the writing exercises (Cohen, Garcia, Purdie-Vaughns, Apfel & Brzustoski, 2009; Hulleman & Harackiewicz, 2009), with long-lasting and sustainable effect (Walton, 2014). Nevertheless, it is important that teachers reinforce the newly-acquired value(s) by integrating it/them into the teaching practice, so that students can also appreciate its relevance in facilitating mathematics learning.

While it might be relatively easy to identify a value that has not yet been subscribed to by a few students, this can be a challenge when a larger group of students are involved at the same time, such as a class of students. As mentioned earlier, one good approach would be to divide the class into groups of 3-5 students, with each group sharing the same target value. This way, members of any one group can also join different groups at the 'declaring' step, pitching their arguments against peers most if not all of whom have probably not considered the arguments they would be presenting.

As an intervention approach, the steps in the JEDI process can be integrated easily into the 'normal' lesson experiences. This is one important feature of what Walton (2014) described as 'wise interventions', which are

> psychologically precise, often brief, and often aim to alter self-reinforcing processes that unfold over time and, thus, to improve people's outcomes in diverse circumstances and long into the future. (p. 74)

The other important feature of wise interventions which the JEDI process also shares is that the continual success or effectiveness is not dependent on the presence of resources (equipment, programs, manpower, etc). Walton (2014) elaborated that

> these interventions used reading-and-writing exercises to change people's psychology directly. They encouraged people to respond to ongoing experiences in more adaptive ways to remake their worlds. Many other interventions, however, introduce a new experience to people's lives (e.g., a tutoring program). Such experiences change people's psychology only indirectly; they can thus be less effective …. Moreover, relying on a new experience to change psychology can make an intervention vulnerable if that experience changes. (p. 79)

VIII. CONCLUDING WORDS

This paper aims to serve two aims. It first presents an argument for considering values as a conative construct and what this means for mathematics pedagogy. The second aim is to describe the design of a 4-step process which can be easily deployed to develop values amongst students, and indeed, amongst teachers as well. By arguing for values to be recognised as a conative construct, this article explains how values exert a powerful motivating force which guides how we reason, feel and learn/teach mathematics. The enabling values that we internalise define the 'want to' mindset we develop to draw on our cognitive and affective resources to learn/teach mathematics well.

At the same time, the JEDI process is easy to implement and, with some creative planning which teachers excel at, is not too intrusive to the daily mathematics lesson repertoire. In fact, it is hoped that this will stimulate more colleagues to adopt or adapt the process to their own mathematics pedagogical contexts, taking in consideration cultural needs and constraints, resulting in discussions and sharings of how we might be even more effective and efficient in fostering enabling values in mathematics education.

Several of the East Asian mathematics education systems that consistently perform very well in both TIMSS and PISA assessment exercises have been attracting many foreign fact-finding teams to visit, with the intention of identifying the secret to their success. It is quite often that many of these visitors – and especially those who came from

'Western' education systems – would return home feeling more puzzled than before. One of the visitors made a comment similar to this, which is indicative of the general impression, "This has been amazing! We came in search of innovative or effective mathematics teaching techniques. Instead, we found that the mathematics teaching strategies in mathematics classrooms in our countries are pretty similar. We also found that your students do not really like mathematics, and they often also ask why they need to learn mathematics."

Perhaps, a possible response to this might be, "What you said is true. However, what might have been hard to observe directly has been that our students and their teachers value particular convictions which motivate and drive them to use the relevant mental strategies, and to develop enabling emotions!"

Have we missed out some important variable in mathematics education research? This paper argues that values, a conative variable, might be one such variable. How might we best motivate stakeholders to modify their practices to address pedagogical issues? A short and easy-to-facilitate values development process, bearing the acronym JEDI, might well be the solution.

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