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Using Mathematical Equations to Communicate and Think About Karma

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Synopsis

Two equations are presented in this article to communicate a particular understanding of karma. The first equation relates future experiences to past and present actions. Although the equation uses variables and mathematical symbols such as the integral sign and summation symbol, it reads more like a literal translation of an English sentence. Based on the key idea in the first equation, a second equation is then created to highlight the viability of using math to communicate concepts that are not readily quantifiable. Analyzing such equations can stimulate thinking, enhance understanding of spiritual concepts, raise issues, and uncover tensions between our ordinary conceptions of external reality and transcendental aspects of spirituality.

KARMA

What goes around comes around.

Keep your circle positive.

Think good thoughts.

Speak good words.

Do good deeds.

1. Introduction

The first listed author of this paper, KHL, is Southeast Asian American, and grew up in a culture that embraces Buddhism and the concept of karma implicitly. The second author, CY, has been a student of Buddhism and meditation practices for much of his adult life. Contrary to popular interpretations, karma is more than simply, “you reap what you sow.” A simple Wikipedia search yields a definition of karma: “the spiritual principle of cause and effect where intent and actions of an individual (cause) influence the future of that individual (effect).” Consequently, we may interpret karma in a simple form as performing good deeds leads to future happiness and performing bad deeds leads to future suffering. Is karma simply a cause-effect relationship? If so, what other factors are involved in this relationship? Can this relationship be somehow quantified mathematically?

Much of the power of mathematics lies in its symbolism. Algebraic equations allow us to represent relationships among quantities. For example, the compound interest formula

$$A = P \left(1 + \frac{r}{n} \right)^{nt}$$

relates the current amount A of an investment to its principal amount after t years, based on the annual interest rate r and number of times n it is compounded per year. Differential equations allow us to represent dynamical systems: consider for example, the logistic growth equation

$$\frac{dN}{dt} = r_{max} N \left(\frac{K - N}{K} \right),$$

or the heat equation

$$\frac{du}{dt} = \alpha \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right).$$

Is there an equation that represents the cause-effect relationship of karma?

This article was inspired by an equation printed on the back of a T-shirt (Figure 1). The equation on the shirt is an attempt to describe karma using mathematical notation. We will refer to this equation as Peter’s Equation.

DHARMA MATH

$$\int L = \frac{PK \left[\sum_{i=1}^n Vi - \sum_{i=1}^n NVi \right] [AE^{-m}] [CE^y]_{(b \cdot f \cdot d \cdot s \cdot p)}}{NC}$$

L = Your future Life L is a function of
 PK = Past Karma, as modified by the sum of
 V = Virtuous actions in this life, minus the sum of the
 NV = Nonvirtuous actions in this life, as affected by a decrease in
 A = Afflictive emotions, based on one's
 E = effort in maintaining
 m = mindfulness, as further influence by an increase in
 C = compassion as a function of
 E = effort in maintaining
 y = equanimity

All of this is factored by:
 b = the blessings of the Lama
 f = one's faith
 d = one's devotion
 s = the strength of one's motivation and the
 p = power of one's practice

As the denominator approaches the value NC (Nonconceptual state) the result approaches limitlessness.

This exercise is intended as a respectful attempt to present the Dharma in the language of mathematics.

May all sentient beings realize the fruition of the teachings.

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Figure 1: Peter's Equation on a T-Shirt, named after peter@relativeview.net.

The title of the T-shirt is *Dharma Math*, which refers to the concept of *dharma*. Dharma can be loosely translated as *truth*, or *the way things are*; here, we take the expanded definition that dharma refers to the spiritual path that an individual travels as a means to attain enlightenment. While we will revisit the concept of enlightenment momentarily, suffice it to say that dharma has been studied extensively and is a nuanced idea. Relevant to us here is that while one traverses the path of dharma, one will undoubtedly accumulate karma through one's actions, speech, and intentions.

Upon seeing Peter's Equation, KHL was curious about its message and wondered whether it is consistent with his own understanding of dharma. Being a mathematics educator, he considered the viability of using it to generate discussion in a course for prospective teachers. After learning about the

Journal of Humanistic Mathematics, he got excited about writing an article to explore the viability of using mathematics to communicate religious concepts such as karma or dharma. Eventually CY joined the project. This endeavor turned out to be an interesting adventure for both of us, with ups and downs, and twists and turns. We were pleasantly surprised on several occasions as we gained new insights trying to refine an equation or make sense of a revised equation. The tension between being mathematically correct and being spiritually sensible gave us a sense of what humanistic mathematics could possibly mean.

The article is an attempt at highlighting the utility of math equations to introduce and communicate spiritual concepts that are not readily quantifiable, and the insights one can gain from investigating such equations. The first section focuses on interpreting Peter's Equation, with the intent to help readers gain some understanding about karma. Next, we present the issues with Peter's Equation. Following that, we introduce, analyze, and discuss Ken's Equation, another attempt at representing the concepts of karma in symbolic form. In the last section, we discuss the use of mathematics as a tool to communicate philosophical concepts and to stimulate thinking, and close with a concern about using mathematics in a non-quantifiable manner.

2. Interpreting Peter's Equation

At first sight, Peter's Equation seems overwhelming. Interpreting this complex-looking equation involves a certain level of mathematical maturity which involves an understanding of (1) the meaning of symbols such as the summation sign and integral sign; (2) the interpretation of operations like subtraction, multiplication, division, and exponentiation; and (3) concepts like integration and negative exponents. In addition to identifying the meaning of each variable or term (e.g., PK represents Past Karma), we need to attend to the structure of the equation. To ease comprehension, we employ the technique of chunking — combining and changing variables to hide complexity [2]. The various variables in the ratio

$$\frac{[AE^{-m}][CE^{-y}](b \cdot f \cdot d \cdot s \cdot p)}{NC} \quad (1)$$

can be chunked as one entity, which we will denote with M . Peter's Equation can thus be expressed as

$$\int L = PK \cdot \left[\sum_{i=1}^n Vi - \sum_{i=1}^n NVi \right] \cdot M. \quad (2)$$

This simplified equation is meant to highlight the relationship between future life L and the product of past karma, PK , and this life's karma (represented by the difference of the two summations), with the variable M accounting for other factors.

Despite the title on the T-shirt, we interpret Peter's Equation (2) as a statement about karma. In Sanskrit, the word karma literally means action(s). In English, we use it to refer to the functioning of action, cause, and effect [7]. Our current experiences “are the fruition of our karma” and “our own virtuous and non-virtuous actions of body, speech and mind make our happiness or suffering” (page 43). The Buddha taught his disciples to abandon non-virtuous actions, engage in virtue whenever possible, and tame their mind by subduing afflictive emotions. When Buddhists are harmed by a person or natural disaster, they should understand that the perpetrator or external circumstances are not the *cause*, but rather the *conditions* that lead to the ripening of a karmic seed that was planted in the past. In other words, the actual cause is an action that they themselves had committed in the past, including those in past lives. Faith in karma is beneficial because it reminds us to be mindful of our actions and to engage in positive deeds because our present actions will determine our future experiences.

Buddhists believe that the law of karma is infallible. Unfortunately, ordinary beings are not able to associate a specific effect with its specific cause. In addition, the ripening of a karmic seed depends on many confounding conditions. Constructing an equation that can accurately model the workings of karma is almost impossible, especially when there are many indeterminate factors at play. On the other hand, it may be possible to construct an equation that conveys a general idea about karma.

Peter's Equation is an attempt to use mathematical symbols to “present the Dharma in the language of mathematics.” Based on the way the letters in the equation are defined, we would consider the equation to be a literal translation of an English sentence, namely:

A person's future life is (1) determined by the person's past karma; (2) modified by the sum of virtuous actions in this life minus the sum of non-virtuous actions in this life; (3) affected by a decrease in afflicted emotions which depends on one's effort in maintaining mindfulness; (4) influenced by an increase in compassion which depends on one's effort in maintaining equanimity; (5) modified by one's faith, one's devotion, the blessings of the Lama (teacher), the strength of one's motivation, and the power of one's practice; and (6) enhanced by one's non-conceptual state of mind.

When KHL first saw Equation (2), he was rather impressed with Peter's understanding of Dharma because the equation captures many key components that affect one's future life. After a more careful look, KHL found several technical (mathematical, not spiritual) issues with Peter's Equation.

3. Critiquing Peter's Equation

A mathematician or mathematics educator will find Peter's Equation to be mathematically problematic. The letters (e.g., L , PK , and NK) are used as labels rather than as mathematical quantities with numerical values. Assuming that each letter in the equation does take a numerical value, we still need to consider what the value represents. Take future life L for example: we would need to identify the aspect of future life that we are trying to quantify. One option is to quantify a person's life in terms of perceived pleasant experiences (happiness) and unpleasant experiences (suffering). Next, we need to determine whether, and how, we can measure pleasant or unpleasant experiences. For the sake of discussion, let us assume that the variables in Peter's Equation are quantifiable. In the case of L , we stipulate that a positive value indicates happiness and a negative value indicates suffering.

Peter's Equation contains many variables. Even after we assume that each variable is quantifiable, we still need to decide whether its value is constant throughout one's current life. For example, it makes sense for PK to be a constant because the value refers to karma collected in past lives.¹

¹ While the concepts of past lives and reincarnation are interesting, discussing them

In contrast, L should not be a constant because we have ups and downs, and the value for L should vary according to actions performed in this life. Since L varies with time, L is be a function of time denoted by $L(t)$.

The letter E presents an issue. It was used as a label for *effort*, but the same letter appears in the equation twice to stand for two different kinds of effort. It is implausible that both the effort in maintaining mindfulness and the effort in maintaining equanimity will have the same numerical value all the time.

Finally, the denominator of the rational expression is simply NC , and the comment that “as the denominator approaches the value NC (Non-conceptual state) the result approaches limitlessness,” is self-contradictory because it does not make sense for the denominator, NC (variable) to approach NC (constant). Perhaps the intention was that NC is a variable quantity that can approach zero depending on the actions of the practitioner, which results in the right-hand side of the equation growing without bound (“the result approaches limitlessness”).

Although Peter’s Equation (2) is mathematically flawed, the exercise of trying to make sense of it made us think about the relationships among the terms in his equation. We were particularly intrigued by the relationship between the integral of future life experiences and the summation of past and present actions. Eventually KHL created another equation, which we will call Ken’s Equation, in order to investigate the consequences of equating the integral of future experiences with the summation of past actions.

4. Ken’s Equation and Interpretation

A being who has attained enlightenment is one who has become freed from the cycle of birth and death. In Buddhist philosophy, it is posited that sentient beings continually take one rebirth after another since beginningless time until he or she becomes enlightened. According to Vajrayana Buddhism, one of the major schools of Buddhist thought, all sentient beings have *Buddha-nature*, which is a primordially pure consciousness that is not affected by the constant fluctuations of thoughts and emotions.

here would take us too far astray. Suffice it to note that karma accumulated in past lives affects your current life.

Buddha-nature is the same for both ordinary beings and enlightened beings, but ordinary beings have mental obscurations that prevent them from directly perceiving this pure nature within their mind [7]. Attaining enlightenment or *Buddhahood* means awakening from the illusion of life by having completely removed all obscurations, perfecting all good qualities, and directly realizing the emptiness of self and the emptiness of phenomena. According to Buddhist philosophy, any sentient being can attain enlightenment, though it may take countless lifetimes. Naturally, one's actions in this and previous lives contribute to one's "progress" towards enlightenment, and so karma plays a central part in attaining enlightenment.

Without further ado we now present Ken's equation:

$$\int_T^Z L(t) dt = \left(\sum_{i=1}^N V_i \theta(T - t_i) \right) \cdot e^{-M(T)}. \quad (3)$$

The quantities involved are defined as follows:

- $L(t)$ is a density function representing the value of one's life experience;
- T represents the present moment (measured in units of time since first birth);
- Z represents the moment when one becomes enlightened (measured in units of time since first birth);
- N represents the total number of actions committed since first birth until one becomes enlightened;
- V_i represents the karmic value associated with the i^{th} action (negative for non-virtuous actions);
- t_i represents the moment when the i^{th} action occurs ($t_1 < t_2 < \dots < t_N$);
- $\theta(t)$ represents the Heaviside step function,² i.e., $\theta(t) = \frac{d}{dt} \max\{t, 0\}$;
- $M(T)$ represents the degree of mindful awareness at the present moment (a nonnegative function).

² The Heaviside step function is the integral of the Dirac delta function, i.e., $\theta(t) = \int_{-\infty}^t \delta(s) ds$. It is equal to the derivative of the ramp function, i.e., $\theta(t) = \frac{d}{dt} \left(\frac{t+|t|}{2} \right)$. If t is a discrete variable, then

$$\theta(t) = \begin{cases} 0 & \text{if } t < 0 \\ 1 & \text{if } t \geq 0. \end{cases}$$

The left-hand side of Ken's Equation (3)

$$\int_T^Z L(t) dt$$

represents the accumulation of all future life experiences from the present moment ($t = T$) until the moment a person becomes enlightened ($t = Z$). This may seem peculiar; indeed, it is meant to be a somewhat whimsical play on the interpretation of a common mathematical expression. We invite the reader to suspend their potential skepticism of the feasibility of quantifying one's future life experience and to contemplate this later.

The right hand side of Ken's Equation is a product of two factors. The first factor represents the sum of karmic values V_i associated with each action performed since one's first birth ($t = 0$) until one becomes enlightened ($t = t_N \leq Z$). By allowing V_i to take positive values for virtuous actions and negative values for non-virtuous actions, we collapse the two summations in Peter's Equation (2) into one in Ken's Equation (3). Each karmic value V_i is multiplied by a Heaviside step function $\theta(T - t_i)$ where t_i is the instant an action is performed. Thus,

$$V_i \theta(T - t_i) = \begin{cases} 0 & \text{for } T < t_i \\ V_i & \text{for } T \geq t_i \end{cases}.$$

We omit the PK term in Ken's Equation, since the summation allows for karmic actions performed in past, current, and future lives.

The second factor $e^{-M(T)}$ in Ken's Equation replaces the modifying factor

$$\frac{[AE^{-m}][CE^{-y}](b \cdot f \cdot d \cdot s \cdot p)}{NC} \quad (1)$$

in Peter's Equation. The value $M(T)$ depends on many factors including: (1) one's state of non-conceptuality; (2) one's recognition of afflicted emotions (attachment, anger, pride, jealousy); (3) the presence of virtuous mental states (loving kindness, compassion, rejoicing, and equanimity); (4) the blessings of one's Lama; (5) one's faith and devotion; and (6) one's understanding of dharma and one's spiritual realizations. These factors are not static and cannot be easily quantified; the function $M(t)$ is created to capture all these factors as a function of time.

If one is in a meditative state with strong mindful awareness in the present moment, T , then $M(T)$ takes a very large value, making $e^{-M(T)}$ very small. On the other hand, when one is agitated, anxious, angry, overly excited, or otherwise mentally dull, one loses one's mindful awareness and $M(T)$ takes a smaller value. Note that the range of $e^{-M(t)}$ is $(0, 1]$. The factor $e^{-M(t)}$ serves to diminish the effect of karmic actions on one's experiences. In other words, if one is mindfully aware of one's current action, then the collection of past karmic actions, regardless of whether they are virtuous or not, will have minimal impact on one's life experience.

For an enlightened being, $M(t)$ is infinitely large, making $e^{-M(t)}$ infinitesimally small. In fact, we have

$$\lim_{t \rightarrow Z} e^{-M(t)} = 0,$$

so that as one approaches the moment of enlightenment, the right-hand side of Ken's Equation (3) approaches 0. Correspondingly,

$$\lim_{T \rightarrow Z} \int_T^Z L(t) dt = 0.$$

An enlightened being is one who has transcended ordinary conceptions of good and bad and is free from karmic ripening, which corresponds to the integral being 0. In other words, an enlightened being's life experience can be thought of as net neutral, since they have removed themselves from the cycle of life, death and rebirth, and understand the ephemeral nature of life and reality. Finally, note that if a being lacks mindfulness altogether, then $M(T) = 0$, which means

$$\int_T^Z L(t) dt = \sum_{i=1}^N V_i \theta(T - t_i).$$

We can interpret this as meaning that the person's future experience will be completely influenced and tied to the karma produced by their actions.

In Buddhism, the path to enlightenment involves accumulating merits and accumulating wisdom [7]. We may view the summation

$$\sum_{i=1}^N V_i \theta(T - t_i)$$

in Ken's Equation as related to the accumulation of merits and the multiplier $e^{-M(t)}$ as somewhat related to the accumulation of wisdom. In terms of accumulation of merits, we want to accumulate karmic actions that have positive large values and avoid actions with negative values. Each karmic value V_i would depend on the severity of the action — e.g., while both are meritorious, saving a person's life is more meritorious than feeding a homeless person one meal — and its degree of completion, which has four aspects: correctly identifying the object (e.g. saving the person we intend to save); intention (e.g., with an altruistic motivation); carrying out the act (e.g., in a beneficial manner); and satisfaction (e.g., without regret). In terms of accumulation of wisdom, we are seeking to increase our mindful awareness so as to wake up from our illusion of ordinary conceptions.

5. Analyzing and Discussing Ken's Equation

The authors take much liberty with interpreting the quantities in Ken's Equation (3). For example, if there are countless rebirths on one's spiritual journey, then the values for T , Z , and N are possibly infinitely large. From a spiritual perspective, we are dealing with transcendence beyond our human conceptions; hence, we can give ourselves leeway to quantify infinite durations such as T and Z , and an uncountable number of actions, N . According to Buddhist philosophy, "time is only a concept and does not have real existence" [1, page 89] for it "must be perceived by a mind (consciousness) in relation to successions of events" (page 90). The concept of time belongs to the realm of conventional truth, which is based on our subjective interpretations of our experiences of worldly phenomena through our five senses. Attaining enlightenment is essentially realizing the ultimate truth, which necessarily transcends human conceptions of reality.

Ken's Equation is a statement about the present moment T , relating past karmic actions with future experiences. A reader may find it problematic to equate a value based on events that have not occurred (non-deterministic) with a value based on events that have occurred (deterministic). However, this equation is plausible if we accept that past, present, and future exist simultaneously [3]. Albert Einstein has said "people like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion." This view resonates with Buddhism, in which time does not exist from the perspective of enlightenment [5].

Kenyon [4] describes the fifth dimension as the first dimension of consciousness outside the constraints of space and time. It may be helpful to conceive Ken's Equation as an attempt to conceptualize a phenomenon where time is treated as a mental construct.

Our desire is to analyze Ken's Equation (3) further and see what other implications it suggests. If $\int_T^Z L(t) dt$ represents the collection of all future experiences, then $\int_0^T L(t) dt$ should represent the collection of all past experiences. Similarly, $\int_0^Z L(t) dt$ should represent the collective value of all experiences from the moment of one's first birth (i.e., the beginning of the illusion that a self exists inherently from its own perspective as an entity that is independent of others) to the moment one becomes enlightened (i.e., a realization of the emptiness of self and no more subsequent rebirths). For now, let us assume that $\int_0^Z L(t) dt$ takes a particular value, represented by E . Note that since

$$\int_T^Z L(t) dt = \int_0^Z L(t) dt - \int_0^T L(t) dt = E - \int_0^T L(t) dt,$$

we have

$$\int_0^T L(t) dt = E - \left(\sum_{i=1}^N V_i \theta(T - t_i) \right) \cdot e^{-M(T)}.$$

We differentiate to obtain an expression for $L(T)$:

$$L(T) = \frac{d}{dT} \left[E - \left(\sum_{i=1}^N V_i \theta(T - t_i) \right) \cdot e^{-M(T)} \right],$$

or

$$\begin{aligned} L(T) = & \frac{d}{dT}(E) + \left(\sum_{i=1}^N V_i \theta(T - t_i) \right) \cdot e^{-M(T)} \cdot M'(T) \\ & - \left(\sum_{i=1}^N V_i \delta(T - t_i) \right) \cdot e^{-M(T)}. \end{aligned}$$

This simplifies to

$$L(T) = \frac{d}{dT}(E) + \left(\sum_{i=1}^N V_i \theta(T - t_i) \right) \cdot e^{-M(T)} \cdot M'(T) - V_P \delta(T - t_P) \cdot e^{-M(T)}. \quad (4)$$

Recall that $L(T)$ can be interpreted as the value of the current experience at time T , positive if pleasant and negative if unpleasant. Naturally, this is subjective, and our analysis below will take this into account.

The derivation of Equation (4) above shows that $L(T)$ is the sum of three terms.

The first term, $\frac{d}{dT}(E)$, requires deep philosophical discussion, which we briefly touch on here. Since E represents the sum of all experiences from first birth to enlightenment, if one takes a deterministic point of view, then E may be assumed to be constant, so that $\frac{d}{dT}(E) = 0$. On the other hand, one may argue that E does not have a fixed value but rather changes from one present moment to the next. Under this assumption, $\frac{d}{dT}(E)$ may have either a positive or negative value depending on circumstances in the present moment. We opt not to take a firm stance here and leave this open for debate.

The second term is

$$\left(\sum_{i=1}^N V_i \theta(T - t_i) \right) \cdot e^{-M(T)} \cdot M'(T),$$

which can be more simply written as

$$\left(\sum_{i=1}^P V_i \right) \cdot e^{-M(T)} \cdot M'(T),$$

where P is the number of actions performed from the first birth until the present moment. Thus $\sum_{i=1}^P V_i$ represents the sum of karmic value associated with these actions. Here, $M'(T)$ is the instantaneous rate of change of the mindfulness function at the present moment. If one's mindful awareness is constant at the present moment T , then $M'(T) = 0$, and the second term does not contribute to one's current perceived value of life. This makes sense in that when one is able to *maintain* a level of mindfulness, even for a fleeting moment, they are momentarily free of the grasp of mental fluctuations. On the other hand, if our accumulated karmic value is negative, then becoming more mindfully aware of our negativity is associated with making $L(T)$ more negative, and becoming less aware of our negativity is associated with making $L(T)$ more positive. Perhaps this explains why people tend to avoid thinking about the negative actions they have performed.

The third term is

$$-V_P \delta(T - t_P) \cdot e^{-M(T)},$$

which is derived from a sum of delta functions, each of which is zero if $T \neq t_P$, since there is but one present moment t_P . The nonzero delta function at time $T = t_P$ implies that the intense yet instantaneous experience is imprinted on our mind, thereby creating a karmic seed. Because of the instantaneous nature, we may not be conscious of the intense experience although the intensity does leave an imprint on our mind.

Note that the minus sign in the expression implies that if we engage in a positive karmic action (i.e., $V_P > 0$), then this is a negative contribution to our present life experience (and vice-versa). This certainly seems counterintuitive! However, recall that for an enlightened being, $e^{-M(T)} \approx 0$, so this karmic action would contribute nothing. On the other hand, unenlightened beings like us, with $e^{-M(T)} > 0$, tend to experience a sense of separateness between self and others, which is an illusion from a Buddhist perspective, as all sentient beings are interconnected through a universal consciousness. Consequently, when performing a virtuous action, we experience a loss to self in relation to a gain for others. Such sense of loss results in a negative feeling for a self-centered person. Conversely, a self-centered person may momentarily experience a positive feeling when performing a non-virtuous action such as taking revenge or taking advantage of others. Unpleasant feelings of fear and guilt associated with a non-virtuous action are subsequent emotions that arise later due to conceptual thoughts. Thus the apparent counterintuitive negative sign in the third term of Equation (4) actually reflects the “immediate” karmic impact of one’s actions. We posit that a high degree of mindful awareness is associated with a high degree of realization of the interconnectedness between self and others. Thus, with a heightened sense of interconnectedness, such a mindful person does not experience a sense of loss when engaging in virtuous actions that benefit others.

6. Mathematics as a Method of Communication and a Means to Stimulate Thinking

Our intent in writing this article about using equations to communicate a Buddhist concept is to highlight the use of mathematics as a method to communicate general ideas or principles by relaxing the accuracy requirement. Ken’s Equation (3) only expresses the relationship among general

ideas: present experience $L(T)$, mindful awareness $M(T)$, karmic values V_i , and the time, t_i , when a karmic action is performed. KHL's initial exploration yielded several modifications of Peter's Equation (2) and he tried modifying them so that they could be interpreted sensibly in a manner that is consistent with Buddhist concepts. The process of coming up with an equation that "works" has challenged our understanding of Buddhist concepts as well as strengthened our ability to use mathematics to express relationships. In particular KHL encountered several contradictions, and on several occasions resolving one contradiction engendered other issues. For example,

$$\int_T^Z L(t) dt = \left[\sum_{i=1}^n V_i - \sum_{i=1}^m U_i \right] \cdot M(T)$$

was an earlier revision of Peter's Equation; adding the Heaviside function required grappling with the meaning of the delta function in the context of karma. Nevertheless, this endeavor was worthwhile for it forced us to consider the meaning of symbols and operators, pay attention to details, differentiate between discrete values and continuous functions, and grapple with Heaviside and delta functions. In summary, we hope this article gives readers a sense of what it means to use mathematics to communicate general concepts without being bogged down with actual quantification.

Interpreting and investigating Ken's Equation (3) has stimulated our thinking about dharma and its mathematical representation. For example, Equation (4), the derivative version of Ken's Equation, has a delta functions which may be difficult to interpret in the context of a person's experience. KHL almost abandoned Ken's Equation because the minus sign in front of the third term seemed to indicate that a positive karmic action would result in a negative spike in $L(T)$. However we eventually converged upon a workable interpretation, and in the discussion section, we offer some plausible explanations to make sense of the terms in equation. We are not claiming that Ken's Equation correctly expresses Buddha's teachings. Nevertheless, by assuming that Ken's Equation is valid and rewriting the equation in a different form, we could investigate the meaning of the equation and think more deeply about our understanding of dharma. Further investigations may reveal contradictions that could not be resolved; in that case we would have to reject the premise that Ken's Equation is valid.

Analyzing Ken's Equation uncovers for us a tension between perceived reality and transcendental reality. The knowledge gained through our senses

contributes to our perceived reality and the wisdom gained through spiritual practices contributes to one's realization of transcendental reality. The transcendental reality, however, cannot be perceived through our senses nor can it be understood conceptually. Nevertheless, we can try to use our human intellect to develop a conceptual understanding of the ultimate truth of the transcendental reality. In addition to using human languages to communicate spiritual concepts, perhaps we can use mathematical equations to represent them. Of course, a tension may arise when a term becomes ambiguous if interpreting it from a conventional reality perspective contradicts interpreting it from a transcendental perspective. For example, it is still undecided whether E (the total collection of all experiences from birth to enlightenment) should be a fixed value or a nonconstant function of T . It is good that this exercise allows us to deal with uncertainty and question our own understanding.

We profess that without Peter's Equation (2) as a starting point, KHL would not have come up with Ken's Equation. The revised equation has undergone several iterations, and still has room for further refinements. Nevertheless, we hope Ken's Equation may inspire others to come up with better equations that capture the workings of karma, or to consider using mathematical equations to convey their understanding of a spiritual concept.

CY joined the project later in the process and contributed to the analysis of Ken's Equation (3) and the interpretation of the quantities in it as they relate to ideas of karma and Buddhist concepts of the Dharma. The consequences of attempting to represent such complex ideas with mathematical formulas and following through with the mathematics (e.g. differentiating Ken's Equation) led us to some challenging notions about how our actions impact our lives and our sense of equanimity. Making sense of the third term in Equation (4) was particularly challenging and engaging.

This article offers an equation that seems plausible for communicating a general idea about karma. It would be great if other Buddhists and/or mathematicians come up with additional equations to extend the idea. For example, there could be an equation that relates a current karmic action to past karmic actions, given that we have a habitual tendency to engage in similar actions. Alternatively, one may come up with an equation modeling the ripening of a karmic action by relating a current karmic action to its karmic seed (an action performed in the past), external conditions, afflictive emotions, and so forth.

There are other major concepts, such as suffering, that may be modeled by an equation. (Buddha Shakyamuni's first sermon on the Four Noble Truths is about Dukkha, which means suffering or un-satisfactoriness.) One may come up with an equation that relates un-satisfactoriness with other concepts such as karmic actions or mindfulness. Collectively, it is plausible to develop a comprehensive set of equations that coherently highlights the interplay of key concepts in Buddhist philosophy. We suspect that this is only possible if we use mathematics as a tool for communicating general ideas in a non-quantifiable way.

Through this article we explore the use of mathematics in a relaxed matter to communicate ideas and to extend thinking. It raises a concern about the danger of allowing such soft use of mathematics. Mathematics is powerful because of its precision. On the one hand, we think mathematical precision should not be compromised. On the other hand, we also think it may be worthwhile to let go of the precision attribute if mathematics can be used to communicate ideas and engender insights. This article offers a context for the mathematics community to discuss this issue.

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