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Cover Page Footnote

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Creative Writing that Combines Mathematics and Literature

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Synopsis

In early 2015, the Mathematics-Literature Creativity Award was offered through competition for technological and vocational college students in Taiwan. This paper focuses on the two winning works, the poem *Parabola* and the flash-fiction, *Love Letters of a Science Student*, by analyzing the mathematical notions involved and their uses to enhance literary expression. The introduction surveys briefly the various ways of combining mathematics and literature in a piece of creative writing that enriches and supports communication in both disciplines.

Keywords: mathematical literature; mathematical poetry; flash fiction; creative writing; humanistic mathematics; Deborah's song

1. Introduction

Mathematician Godfrey Hardy [5] remarked,

> A mathematician, like a painter or a poet, is a maker of patterns... The mathematician's patterns must be beautiful and fit together in a harmonious way.

Following his idea, recently a few articles on the intriguing link between mathematics and literature appeared (see for example [4, 7]). Gizem Karaali [7] proposed that mathematical poetry, like mathematics, is a perfect model that involves three ingredients, namely cognition, consciousness, and creativity, and serves as an ambassador for a more humanistic understanding of mathematics.

Mathematics and poetry can form beautiful and holistic communication. Sarah Glaz [4] showed that poetry inspired by mathematics could address mathematical concerns and accomplishments of the day.

One may also use poetry to enrich the history of mathematical studies. The following short piece is an excellent example of this suggestion [13].

> Deborah knew two things. First, that the mountains flow, as everything flows. But, secondly, that they flowed before the Lord, and not before man, for the simple reason that man in his short lifetime cannot see them flowing, while the time of observation of God is infinite. We may therefore well define a nondimensional number the Deborah number,
>
> $$D = \frac{\text{time of relaxation}}{\text{time of observation}}.$$

This definition of the Deborah number is taken from the paper of an Israeli scientist, Markus Reiner, who introduced it in rheology [13]. The Deborah number is a dimensionless measure of the rate of change of flow conditions [8], often used in rheology, which is a branch of physics that deals with the deformation and flow of materials, both solids and fluids, even if solids may show relaxation of stress and consequently creep. Reiner [13] asserted that the classic utterance of the ancient Greek philosopher, Heraclitus, "everything flows," is far from satisfactory in discussing viscoelastic effects. To incorporate solids and their "flow" he proposed prophetess Deborah's famous song after the Israelites' victory over the Philistines as a more apt framing: *The mountains flowed before the Lord*. Deborah's song asserts that nothing is constant in the whole world, and the significant influencing factor is time. So, formally, the Deborah number, inspired by this Biblical context, defines the ratio of the relaxation time of the material to the observation time. According to this definition, if the observation time is long or the relaxation time of the material is short, then the material is in a liquid form capable of flowing. Conversely, if the relaxation time of the material is long or the observation time is short, then the Deborah number is high, and the material is in a solid form.

In [12], Rob Poole reviewed Reiner's paper and noted that in the latter's definition, the term "time of observation" should be modified as "the characteristic time for the deformation process." In addition, Poole indicated that another quantifying viscoelastic effect, the Weissenberg number, is equivalent to the Deborah number,

despite their different definitions. Based on these studies, my colleagues and I developed numerical methods for viscoelastic flows and investigated the effects of the physical parameters in [2, 8, 10]. But the way Reiner, in his [13], amalgamated the mathematical definition and the epic in the Old Testament to interpret the epic with a mathematical orientation and present the mathematical definition with the epic stayed with me. I felt strongly that his approach enhances and enriches that mathematical expression with a humanistic literary element.

Interpreting a Biblical song "mathematically" and including it in a mathematical paper is only one way to improve mathematical expression by blending literary elements. Another way is to use literature to create a "word problem" that enhances pedagogy. Glaz and Liang in [3] show the pedagogical use of poetry in a college course, preparing students with weak mathematics backgrounds for science courses. They use poetry projects to stimulate classroom participation and develop mathematical intuition. Furthermore, they demonstrate how to use the classical mathematical poetry from *Lilavati*, mathematical poems by Bhaskara (1114–1185), the well-known mathematician of ancient India, to create word-problems that enhance pedagogy.

Putting mathematics in a historical and social context adds to its appeal. For example, consider the classical Chinese prose pieces in mathematical literature [11]. These classical Chinese prose pieces are from *Jade Mirror of the Four Origins* [6], *Siyuan yujian*, a 1303 mathematical monograph by a mathematician Shijie Zhu (1271-1368) of the Yuan dynasty. We can also use classical poetry and prose in mathematical modeling to help students translate real-life phenomena into mathematical language by engaging historical narrative, as shown in [3, 9]. This paper focuses on another blending between mathematics and literature. It uses mathematical notions and concepts either directly or as metaphors to enhance poetry or poetic prose.

The Mathematics-Literature Creativity Award has been awarded since 2015 through a competition organised for technological and vocational college students in Taiwan [1]. The first aim of this activity was to encourage students to combine the rationality of mathematics and the sensitivity of literary works. We believed that it would be a helpful way to stimulate students' interest in mathematics and creative writing. Second, we wanted to encourage students in vocational education to engage in creative writing.

The competition has received many good writing samples. We will share two winning works in the next section.

2. Two winning works of the Mathematics-Literature Creativity Award

In the following, we present two winning works in Mathematics-Literature creative writing in poetry and flash fiction to illustrate the blending of mathematical and literary elements. *Parabola*, written by Yu-Tong Cheng [14], is a winning poem of the 2016 Mathematics-Literature Creativity Award. The poem is as follows:

Parabola
by Yu-Tong Cheng

Last year, time stood at the vertex.
I was on the focus; you were on the directrix.
Close together, we were full of expectations raised by an equal distance.
We looked forward to becoming each other's life apex.
However, the reality is that on that day, we separated.
From the highest point,
you and I started falling in different directions.

Time has come today to remember that day.
And I remember.
From the lowest vertex,
you and I are still moving in different directions.
It is the lowest peak of imperfection, yet we both matured.
Drawing a perfect arc,
we extend to infinity at both ends and no longer intersect.
A parabola goes on forever, it cannot be bent into a circle.
I know at least that we can smile
along the curve.

-The author is from the Digital Content Application and Management Department in Wenzao Ursuline University of Languages.

This very successful creative work combines mathematical concepts in a piece of literature. The author used the symbol of a parabola to discuss the axis of time, as shown in Figure 1. Figure 1 (left) shows that two people moved forward to the vertex from the parabola's directrix and focus, and they met and then separated at the top last year. Figure 1 (right) shows that currently, they are at the bottom of the valley, and they are still growing in their direction. They also convey best wishes to each other. Through succinct and straightforward words in mathematical poetry, the author gives good wishes to parting friends[9].

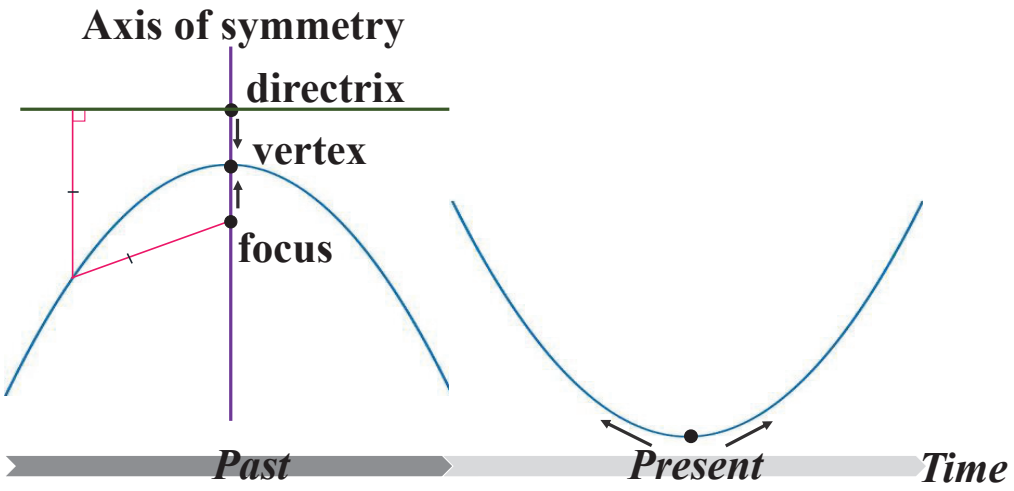

Figure 1: Part of a parabola (left, past), with various features: axis of symmetry, vertex, focus, and directrix. The complete parabola has no endpoints. Instead, this orientation extends infinitely to the left, right, and upward (right, present).

Next, we share the winning flash fiction in the 2015 Mathematics-Literature Creativity Award,*Love Letters of a Science Student*, written by Jian-Yi Fang [9]. Flash fiction is a favored genre among the English-speaking world's most celebrated writers for its ability to convey deep truths and universal human emotions in just a few short paragraphs. When done well, flash fiction can convey deep truths and resonate with readers from all walks of life. The full text of *Love Letters of a Science Student* is as follows:

Love Letters of a Science Student

by Jian-Yi Fang

Boy's confession

In the past, I was a zero without feelings, and I had nothing. When I met you and saw your face, I was thunderstruck. You gave me a heart. My heart is Cupid's arrow that pierced my body. Besides this, I have nothing; I am the empty set containing nothing.

A while ago, I was afraid I would meet a girl I liked here, and two years later we will separate, each of us going to a different place. We would leave each other because of distance, like the two focus points of an ellipse, which always keep their distance and never overlap. But now, I have met you, and all problems have vanished. If we are in different places, I will fly over to see you. If we are destined to be an ellipse, we will become an ellipse with overlapping focal points, be the first circle born of love. Believe me, if we stand together, no matter how immense life's difficulties are, the wave's crest appears after the trough. If we dislike the wave's trough, all we have to do is make a circle with our hands to form the absolute value of the function. Let only the wave crests we like appear; keep our love sweet forever.

Girl's confession

Girl: I want to ask you a few questions. Can you help?

Boy: Sure.

Girl: What is the $(4n+1)^{th}$ power of i?

Boy: $i^{4n+1} = i$.

Girl: This question is on the principle of conservation of energy. What is the work W done by friction divided by force F?

Boy: The answer is not simple, but ignoring external forces, the result W/F is the distance L.

Girl: A point P lies on a circle with a center at the origin and radius r. In polar coordinates, P can be expressed as $re^{r\theta}$. How is the center of the circle represented?

Boy: Because the circle's center is at the origin, O can represent it.

Girl: This Physics problem is about calculating the division of distance by time. How do you do it?

Boy: You can imagine countless distances S, divided by the infinite number of times T. The result S/T is always the velocity V.

Girl: What is the result of $\lim_{x\to\infty}(1+\frac{1}{x})^x \ldots$?

Boy: You should pay more attention in class. It seems complicated, but the result is 'e' after deformation.

Girl: What is this English chemical symbol? I don't understand it.

Boy: Uranium is the heaviest element in nature. The symbol for Uranium is U.

Girl: Me too.

Boy: What?

Girl: I love you, too.

Boy: ???!!!

Girl: Have you read all the symbols you gave answers to my questions?

Boy: i, l, o, v, e, U —— I love U. I Love You ?

Remarks: It is tough to confess your love to a science student.

-The author is from the English Department in Wenzao Ursuline University of Languages.

Love Letters of a Science Student comprises the confession of a boy and a girl. It is based on the perspective of science students showing two different flash fiction styles, through the genuine expression of the boy to the girl and the metaphorical expression of the girl. The boy's statement is full of poetic sentiments, while the girl's statement is presented as a dialogue between a boy and girl. In the whole passage of dialogue, we can observe both elements in mathematics and literature in the content. When the two are naturally connected, we also see the ingenuity that the author conveys to the reader.

In the boy's confession, the author used an empty set of mathematical knowledge in the first paragraph to confess his feeling. An empty set is a collection that does not contain any elements. Its symbol is ϕ. Anthropomorphism is employed in this article when the author uses zero to describe himself without feelings. He gains a heart again after Cupid's arrow shot him. First, he expresses love by using an empty set, and then he translates it into a written statement according to the mathematical definition of an empty set. Thus, the author says, "I also become an empty set that cannot contain anything." After this mathematical concept is translated into words, the concept of mathematics still exists, and it can be naturally incorporated into writing. Therefore, when the content is placed in a well-defined mathematical context, the sentiment can be better conveyed through the text. For instance, the author says, "I have a heart that is sent by your arrow, and I have become an empty set containing nothing." The text explains the mathematical concept of empty sets, conveying faithful love that cannot accept others anymore.

In the second paragraph, the author uses the image of an ellipse: that when the ellipse's two foci become a circle (see Figure 2) to express that even living in different places, he will overcome distance limits and try to see each other. This part of the boy's confession adds mathematical elements to literary writing, such as empty sets, ellipses, circles, and absolute values, so that the narrative has some artistic imagery. Therefore, it is a literary device that uses mathematical techniques as a medium to express the diversity of literary connotations, and it aims at a variety in literary appreciation.

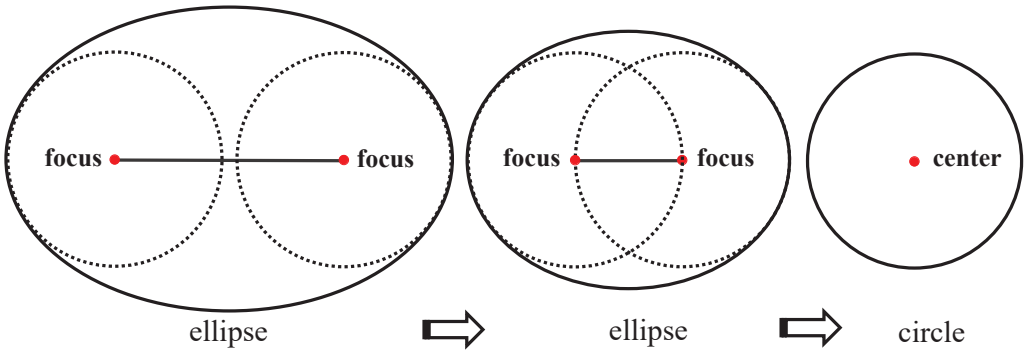

Figure 2: The ellipse with the two foci in the plane. When the foci overlap, the ellipse becomes a circle with a center.

The girl's statement is based on introducing different mathematical notions and equations. The "I Love You" is a metaphorical statement using mathematical concepts: I, the imaginary unit i in the complex plane, as shown in Figure 3; L, the distance L in the work equation, $W =$ Force $F \times$ distance L ; o, the origin O of the equation in polar coordinates of a circle, as shown in Figure 3; v, the speed V=distance L /time T; e, the exponential number $e = \lim_{x\to\infty}(1+\frac{1}{x})^x$; You, the symbol with U, as Uranium, the heaviest naturally occurring element. Through dialogue, the content is made dramatic so that the reader can see how basic knowledge of science, including mathematical complex numbers in polar form and the work equation in physics and chemical elements, comes into play.

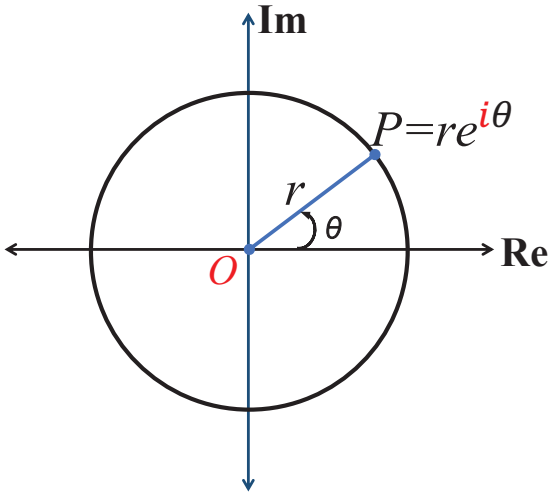

Figure 3: The circle with the radius r in the complex plane. The exponential function $e^{i\theta}$ is a unit complex number. Here θ is the angle that a line connecting the origin with a point on the circle makes with the positive real axis, measured counterclockwise and radians.

The author of this flash fiction, Jian-Yi Fang, is a second-year student in the humanities programme at a college in Taiwan. He came from China after studying in a mechanical college. The following is his creative writing expressing a lofty concept [9]:

> Stories result from creativity, and creativity comes from life. Unless it is a complete fantasy, a story is a mixture of what we see, hear, and experience. As the name suggests, literary mathematics is the skillful use of mathematical notions in creative writing work.

> It is not doing mathematical calculations or using cumbersome mathematical formulas or theorems. Instead, the focus is on the creative writing piece. Making sure that the emotions are integrated into your work, it is possible to add mathematical elements smoothly at any stage. Maybe this is a way to get better grades. I wrote this flash-prose piece because I once had a relatively unforgettable long-distance relationship. Although it ended in failure, I cannot forget it. Therefore, I wrote this poetic work.

Fang is an art student who studied science earlier, and so, he is skillful in manipulating mathematics and literary words. In his article, the author wishes to mobilise words to express a variety of mathematical knowledge. The creative concepts come from the life experience of the author. The images produced by the works are vibrant, and the expressed emotions are rich.

3. Conclusion

The aforementioned creative writing pieces reveal outstanding examples of mathematical literature with visible literary art in a mathematical context. Mathematics in literary arts connects mathematics and literature to inspire something unique, natural, and inspiring.

Mathematical literature is narrative writing to creatively express the beautiful integration of mathematical knowledge and literary images. Therefore, readers can obtain mathematical understanding through the verbal literary depiction of daily life. It is an art called mathematical communication. What distinguishes mathematical literature is the ability to lead people to understand the truth of mathematics while appreciating the beauty of literary writings with beautiful words while experiencing the clarity of narratives.

Learning mathematics should include learning to appreciate mathematical elements in creative writing. Based on the same theory, students should be encouraged to study mathematical literature and the history of science, which can help them think outside the box and deepen their understanding of mathematics. Students' creative writing in mathematical literature expresses their feelings through appropriate words or vocabulary in the context of mathematical concepts. Technological and vocational college students might not study advanced mathematics. However, they are encouraged to use mathematical concepts to express their sen-

timents in creative writing. In this exercise, they learn to direct their tentative thoughts towards a definite goal and inspire them to learn in a new way, which we call creative learning. Thus, we hope that mathematical literature will encourage students to grasp the humanistic aspect of mathematical knowledge and create a humanistic mathematics world.

Acknowledgments

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