

Poetry in the Lesson of Mathematics

Natalija Budinski¹ and Zsolt Lavicza²

¹Petro Kuzmjak School, Ruski Krstur, Serbia; nbudinski@yahoo.com

²Johannes Kepler University, Linz, Austria; zsolt.lavicza@jku.at

Abstract

In this paper we describe a case study on how poetry can be used in mathematics lessons as a teaching tool to make students understand complex mathematical concepts. Observations from school practice will be described showing that students in their high-school final year in Petro Kuzmjak school connected mathematical theories with poetry highlighting the mathematical concepts they learned throughout their education. This paper could be useful for educators who would like to introduce pedagogical innovations into their mathematical lessons, but also for a wider audience interested in combining poetry and mathematics in education.

Introduction

There are many educators breaking stereotypes and organizing classroom activities connecting and combining mathematics and poetry to illustrate the beauty of both disciplines [4], [7], [15], a common feature to both worlds is imagination. The famous English mathematician de Morgan stated that the power of inventions in mathematics is not reason, it is imagination. The creator of beauty in both disciplines are displacements and unexpected twists. Mathematics in the physical world is what poetry is to the world of emotions, both trying to find the inner logic of things [1].

Teaching Mathematics Poetry-Related Activities

As critical thinking has become one of the foci of contemporary education, involving poetry in mathematical lesson could be a supportive activity to encourage and develop such skills. Poetry could be used to introduce students to new mathematical ideas [15]. Also, it is a motivating activity for reviewing and exploring mathematical concepts [7]. Poetry has the power to engage students and raise their attention in the classroom and influence them positively, but also in understanding mathematical concepts and developing mathematical vocabulary. Prime numbers or contemporary mathematical discoveries such as fractals or the solution to the Poincare Conjecture could be highlighted to students through mathematical poems [5], [6], [7], [8], [13], [16]. Students respond positively to simple words rather than to abstract definitions, and a story or a poem's rhythm could provide intuitive understanding of a mathematical proof. Poetry has the potential to make students more receptive to mathematical symbols and proofs, stimulating a sense of curiosity and wonder [14].

Case Study of Mathematics and Poetry in the Classroom

Following literature recommendations described below, we organized a series of activities in the second term of the 2018/19 school year in Petro Kuzmjak school, where forty students of final high school year (age 18-19) were introduced to the concept of mathematical poetry. The activities were categorized into two types: formal and informal. Formal activities were presented at the regular lessons, while informal activities were used for promoting concepts of mathematical poetry in the local community. Through these activities we strived to highlight interactions between mathematics and poetry and enhance

students' learning and motivation with this process. We used poetry as something that could make mathematics more accessible to students, and mathematics can enrich poetic language with new mathematical metaphors [2], [14].

Formal activities. The first step was promoting mathematical poetry at several mathematical lessons where students were introduced to the concept of mathematical poetry. It started with inspirational stories of famous mathematicians and their reflections on the connection between mathematics and poetry. One of the stories was about David Hilbert, the famous mathematician, who noticed the absence of one of his students. After getting the answer that the student missed math classes in favor of poetry lessons, Hilbert responded that it didn't matter since he found that the student was lacking imagination, suggesting that mathematics needs more artistry and imaginary [1]. After creating a relaxed atmosphere in the classroom, we introduced students to various forms of mathematical poetry together with instructions on how to write mathematical poems, where strategies were illustrated with examples.

Two main categories were poems with mathematical structures and poems that used mathematical language and metaphors. For the illustrations of mathematical forms, we chose Fib-type poetry and geometrical shaped poems. Fib-types poetry is based on the Fibonacci sequence which starts as 0, 1, 1, 2, 3, 5, 8, 13, and so on. Fibonacci sequence starts with 0 and 1 and the next one would be the sum of the two previous ones. In a Fib-type poem the title represents zero, the first and the second lines have one syllabus, the third line has two syllabi, the third line has two syllabi, the fourth line five and so on. Most of the Fib-types poems have six lines, since longer composing requires significantly higher number of syllabi?. Geometrically shaped poems follow visual representation of geometrical shapes such as, for example, triangles, quadrilaterals, hexagonal, or any other. This kind of poetry provides artistic and aesthetic unity. It enables poets to go beyond usual forms of literature and focus on visual characteristics of the poem. In creating this kind of poems, authors should take into account the balance between words and structure to obtain the shape but also to convey the ideas [10], [11].

Besides specific forms, we have explored poems inspired by mathematics. Among the examples that we presented to the students were: "Pi" by Nobel Prize Winner Wislawa Szymborska or "Euclid alone has looked on Beauty bare" by Edna St. Vincent Millay [9], [12]. Both poems were read in English. In the Szymborska's poem, the metaphor of the number Pi, as infinity, was analyzed as the law of the nature, as kind of perfect imperfection (don't understand). Millay's poem offered a different perspective, since it is in sonnet form. It is often used by both mathematicians and poets to illustrate the definition of beauty in both fields. The idea of beauty is connected with the transparency, crispness and clarity which are also connected to geometry, which seems to be the subject matter for this sonnet. What was important to highlight to students is that the sonnet form of the poem is inherently mathematical [2]. Deeper meaning was also analyzed in order to make connections with students' knowledge of mathematics, for example with questions asking what mathematical concept they would find beautiful and why. Posting that kind of questions to students, enabled them to reflect on their previous mathematical knowledge, but without the traditional approach. After exploring different poems inspired by mathematics, students were encouraged to create their own poetry. We started with discussing and browsing students' ideas for metaphors based on mathematical contents that conveyed reflections or described emotions. Besides discussion, students noted their ideas in the form of diagrams. Students presented their concepts and together we were developing paths from mathematical contents to poetical sparks, generating inspiration from algebraic expressions, graphics or equations. In order to be successful, students needed to understand clearly the mathematical concept and find a way to connect it to non-mathematical aspects or real life. Some of the students' ideas for the metaphors were to connect the mathematical notion of right angle with the real-life aspect of right decision in life, or graphic of sinus function with ups and downs in life. At the end of the workshop students received were given a task to write a mathematical poem and use mathematical contents that they learned during the preceding lessons. Students participating in the workshop were in their final year of high school and their knowledge of mathematics was quite extensive. They were

familiar with different aspects of mathematics, from analytical geometry, algebra to calculus. As a result of students' research and creative homework, we received a collection of mathematical poems written by students. Figure 1 presents two poems written by students F. T. (male, 19 years old) and M.T. (female, 18 years old). Both students were considered good in mathematics, diligent and had a positive attitude towards mathematics. During their four years of high school students F. T. had very good marks (4/5), while M. T. had excellent marks (5/5). Both students wrote their poems in English. It can be noticed that F.T.'s poem is more general and describe his feelings towards mathematics as a school subject. The poem of M.T. is "deeper" and with several successfully used mathematical metaphors, comparing the lack of interest to flat line of linear function or insufficient closeness to loved person to parallel lines.

<p>When I practice maths, People always ask me am I sad But when they see my results, They all of a sudden feel very bad. Because when you practice maths a lot, It almost always pays off. Geometrics and trigonometry, Doing them is like reading a poetry Maths always looks very fine, This will be my last line.</p> <p style="text-align: center;">F.T.</p>	<p>You left my heartbeat flat Like constant function now Two parallel lines Is what we resemble Always close But never together My heavy soul is slumber Guess what I meant to you Was just another number You lost my vicinity As well as your dignity And who would say We once used to form divine Infinity</p> <p style="text-align: right;">M.T.</p>
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Figure 3: *Students' poems*

Informal activities. In order to promote students' work, but also to expose a wider audience to these ideas, we organized several promotional activities. One of the activities was a poetry workshop for students and teachers in our school that followed formal activities. It consisted of the introduction with interesting stories about connection between mathematics and poetry, reading mathematical poetry and instructions on how to write a mathematical poem. At the final part, participants were encouraged to create their own poems. The workshop was selected as one of the five best practices that promote mathematics in Serbia at the national competition organized by the Centre for Science Promotion [17]. The second activity was the result of the students' excellent response to poetry at mathematical lessons. Their idea was to add music to one of the poems they wrote, entitled "Calculus song", and they made a video [18]. The poem reflected ideas of calculus with a historical overview and the video was promoted through social media. Also, the local newspapers published a poetry edition dedicated to students' poems, and also promoted the concept in general. After finishing the activities, we asked students about their impressions and what they have learned. Student M. R. (female, 18 years old) said that it was very convenient way of learning mathematics, since she was not good in mathematics. The activities enabled her to approach mathematics in way that was close and acceptable for her. Student U. K. (male, 18 years old) said that he liked the "positive" vibes at classes, while D.N. (female, 18 years old) said that it helped her to understand that mathematics is more than just numbers. The activities helped her to grasp mathematics as much deeper than it was pictured during the regular classes.

Conclusion

Through the described activities we developed strategies that could be useful to other teachers and help them in the aim of incorporating poetry to mathematical lesson. Teachers could use them for illustrating advanced mathematical ideas to students, cultivate critical thinking, or just refresh learning experience and teach mathematics in innovative way. Strategies considered several steps: illustrating mathematical poetry with adequate examples, encourage students to connect mathematics they know to other aspects of reality or imagination through their own examples, motivate students to write poems related to

mathematics, and promote students' work through different channels such as social media or public events.

Through activity observations, we noticed that transfer between two different domains, poetry and mathematics, was very useful for developing students' knowledge. Students significantly changed their perspectives of mathematics. While looking for adequate metaphors, students actively revised mathematics which supported better understanding. Poetry in the contemporary world based on technological achievements should be open to the science and mathematics, but also mathematics and science should interact with humanities and art activities. This kind of approach could be beneficial to those who are developing their perceptions of the important aspects of human existence.

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