

Overview of Various Engagements for the Promotion of Mathematical Enlightenment

Mathematical enlightenment plays a crucial role in attaining the vision of world peace and prosperity for humankind. With this aspiration, it is essential to develop people with critical thinking skills, sound judgment, and creativity. For many years, the prevailing model for mathematical education vis-a-vis the promotion of mathematical enlightenment has plenty of room for improvement, not only in the aspect of nurturing competent experts in the fields of science and engineering but especially in accomplishing the dream of a good quality life for everyone.

Propelled by these ideas, Prof. Jin Akiyama has since devoted his life to the promotion of mathematical enlightenment, not just in Japan but also overseas. For his decades worth of significant effort and wide range of mathematical activities, Akiyama received awards from the Japan Society of Mathematical Education (1995), Japanese Math Society (2016), and the Ministry of Foreign Affairs (2017). His contributions can be broadly categorized as follows:

- A. Books and Other Publications
- B. Planning, Producing, and Hosting Mathematical Programs for Mass Media
- C. Curriculum Council, Ministry of Education, Culture, Sports, Science and Technology
- D. Experiential (Hands-on) Mathematics and the Establishment of Mathematics Museums
- E. Early Childhood Education and Education for the Gifted
- F. International Contributions through Mathematics

A summary of each category's activities are outlined below.

A. Books and Other Publications

(1) Book series on mathematical heuristics

University entrance examinations are highly valued in the Japanese education system. But oftentimes, these entrance examinations encourage students to focus in solving textbook or routine mathematics problems. As a result, some students end up hitting a wall whenever they are faced with mathematical problems that do not rely on mere memorized formulas or procedures. These students, therefore, lacked the training in solving mathematical problems on their own because they got used to only solving problems that they have probably already memorized in their textbook or review materials. To mitigate such situations, Akiyama collected and examined thousands of math-related problems from past university entrance examinations, graduate school entrance examinations, International Mathematical Olympiad, and other mathematics contests outside Japan to find out what kinds of ideas and techniques were used in solving mathematical problems. The output of his investigation is a seven-volume book entitled "Series of Mathematical Heuristics: How to find solutions for challenging math problems on your own," published by Sundai Bunko in 1989. This book compiled a judicious selection of mathematical problems across 30 different categories based on their concepts, heuristics, and techniques. In addition, these findings were discussed in all 30 episodes of NHK (Japan public broadcasting corporation) Educational TV's "Math Ability Improvement Course" in 1991 [B-3]. Initially written as a review material for students who are preparing for university entrance examinations, this book series has been deemed important, not only for solving mathematical problems, but also for enhancing one's mental ability to solve social and everyday life problems. Eventually, the book series was reprinted in 2014 by Morikita Publishing, and was promoted as a mathematics book for general readers [A-1, 2, 3, 4, 5, 6, 7]. The series had since become a bestseller for more than 30 years, with multiple editions and reprints, and a must-read not only for students preparing for entrance exams, but also for university students and mathematics teachers. The book series was also translated into Korean in 1994.

(2) Books for students and the general public

Akiyama authored more than 110 mathematical entertainment essays, mathematics recreational and educational books, reference books, and mathematical problem books. In 2017, Akiyama received the Mathematical Society of Japan Publication Award for his work in actively promoting mathematical culture to

readers of all ages [A-8, 9]. Akiyama wrote books that teaches mathematical thinking through classic puzzles and “magic” in mathematics, which allowed readers to enjoy the mysterious nature of geometry through hands-on crafts. Targeted specifically for elementary, middle, and high school students, these books have a unique perspective that incorporates entertainment elements, many of which have been translated into foreign languages including Korean, Chinese, and Thai. The most translated among these books is “A Day’s Adventure in Math Wonderland,” written in English by Akiyama with M. J. Ruiz. This book depicts a group of children who were very surprised and excited about learning the wonders of mathematical phenomena during their visit at the Math Experience Museum (see Section D). This book was published by the World Scientific in 2008 [D-8]; and has been translated into Chinese, Spanish, Russian, Khmer, Thai, Slovenian, Korean, German, Vietnamese, Japanese, and many other languages.

Insofar as writing for the general public, for example, Akiyama was the author of a weekly mathematics column in the Sankei Shinbun (a national newspaper) from January 2008 to June 2010. His weekly column spoke about interesting mathematical topics that appear in various situations in daily life, society, sports, art, music, and the natural world. The said column became so popular that it consistently ranked at the top of the access rankings in the electronic version of the newspaper. Akiyama’s writeups were compiled and then published in two books, namely, “Mathematics can be found in such unexpected places” and “Moreover Mathematics can be found in such unexpected places” in 2009 and 2010 [A-13 14, 15], respectively. These books were also translated into Korean and published in Korea in 2013 [A-12].

For undergraduate students, Akiyama, with the help of Yuji Ito, translated “Calculus” (authored by James Stewart) - a widely-used American textbook into Japanese. The said book came out in three separate volumes, published by Tokyo Kagaku Doujin in 2017, 2018 and 2019 [A-13, 14, 15]. The original book, which was 1423 pages long, is a heuristic exposition with abundant examples on applications of calculus across many branches, including economics, engineering, medicine, pharmacy, physics, chemistry, and biology. Unlike many Japanese textbooks that simply present rigorous definitions and established theorems, this book was written in the style of excavating the fundamental ideas of calculus from its core. Such a textbook with a heuristic teaching method presents an alternative way of learning and deciphering mathematics to undergraduate students in Japan. Publishing the Japanese version of Stewart’s textbook also revealed remarkable differences between Japan and the United States in terms of learning mathematics. Surprisingly, many people now think about what mathematics education should be like for undergraduate students enrolled in Japanese universities.

B. Planning, Producing and Hosting Mathematical Programs for Mass Media

In the spring of 1991, Akiyama was asked by NHK (a renowned radio and TV network in Japan) to be part of the planning and production (and eventually become the main host) of a mathematics program being prepared for high school students that has been scheduled for airing that summer (in time for those taking the university entrance examinations). NHK’s interest in Akiyama came after the release of his published books in 1989 and his series of lectures at Sundai Preparatory School, in which he garnered overwhelming response and support, especially from young people about to enter university. For this TV project, Akiyama designed a 30-part mathematics course that stimulates students to think more naturally and use heuristics in solving mathematical problems. To make it engaging for a TV audience, Akiyama gave enthusiastic lectures, used different hands-on activities, and included a short segment in which he performed some “mathematical magic”. Akiyama’s TV show was generally well-received, even enjoying high satisfaction ratings from its viewers.

In succeeding years, NHK continued to tap Akiyama to design and host mathematics programs for TV. This opportunity allowed Akiyama to develop mathematics education materials for elementary and junior high school students, which broadened his influence and popularity to a much younger audience. Since 1992 Akiyama has been designing and producing mathematical programs for NHK TV to help fuel young children’s interest in mathematics. This is in response to some international surveys (conducted by OECD and TIMSS), which found more young people in Japan who dislike mathematics compared to other countries. Akiyama’s TV program “I Love Math,” which was shown in 1992, won a silver prize at the International Festival of Educational Programming.

Akiyama’s partnership with NHK flourished for more than a decade since they started collaborating in 1991. As previously mentioned, he has produced and starred in several math programs including “High School Skills Up Course” (30 episodes) in 1991, “Interesting Math Course for Junior High School Students” (18 episodes) in 1993, “A Large Gathering of Math Haters” (12 episodes) in 1994, “High School Math Time Travel” (15 episodes) in 1995, “Math Wonderland” (15 episodes) in 1997, “Craft, Try and Deeply Understand Mathematics” (15 episodes) in 1998, “That’s Good Math” (10 episodes) in 1999, and “Fundamentals of

Mathematics” from 2003 to 2005. Akiyama also appeared in a total of 169 programs for elementary, junior high, and high school students. Some of these programs were even dubbed in English [B-1], French, Spanish [B-2], and other languages, and are still being shown in some territories around the world.

In addition to his TV work, NHK publishing also published nine of his textbooks [B-3, 4, 5, 6, 7, 8, 9, 10, 11]. Moreover, Akiyama’s other programs, namely, “Introduction to High School Mathematics” (173 episodes) and “Fundamentals of Mathematics: Applications of Mathematics in Everyday Life” (84 episodes) were broadcasted on NHK Radio 2 from 1991 to 2010, including reruns [B-12, 13]. With the aim of promoting mathematics culture, Akiyama also designed and produced a series of mathematics culture lectures that were meant for the general public, entitled “You will be Awakened to the Mathematical Truth” (13 lectures), which was broadcasted on NHK radio. A book, summarizing the contents of these lectures, called “Stories That Makes You Want to Fall in Love with Mathematics” was published by PHP Publishing in 2010 [B-14].

C. Curriculum Council, Ministry of Education, Culture, Sports, Science and Technology

Between 1997 and 2002, Akiyama served two terms as a member of the Curriculum Council of the Japanese Ministry of Education. Back in those days, deliberations regarding the new curriculum centered on two conflicting ideas. On one hand is the idea that in order to ensure academic ability at a high level, the competencies to be taught in schools should not be reduced, and so the traditional curriculum should be maintained. Another group believes that the traditional style of education should be changed because Japan has now become a developed country and, therefore, no longer a society that requires a large, obedient, and homogeneous workforce under a mass production economy. Along with this mindset, Japanese society should enable its citizens to make crucial decisions, act based on their own will, and generate new products and ideas that have value.

Akiyama was leaning on the side of promoting reform. He traveled to many parts of Japan, attending symposiums and debates, to express his thoughts on the matter [C-1, 2, 3, 4, 5, 6]. For Akiyama it goes without saying that the acquisition of the fundamentals is important, but at the same time, the ability to apply the acquired knowledge and skills and solve unprecedented problems must also be cultivated. He believes that this entails the enhancement of one’s ability to solve problems without necessarily relying on a particular procedure or manual. In addition, students should be encouraged to learn spontaneously based on their own interests and concerns. As non-passive learners, students develop their ability to find problems and challenges on their own.

Akiyama’s arguments are generally in line with the new curriculum, which introduces integrated learning time in the elementary, junior high, and high school curricula, and therefore, brought about the promotion of inquiry-based learning in the classroom. Moreover, in order to strengthen science and mathematics education, several high schools and secondary schools (currently 213 schools) around Japan have been designated as Super Science High Schools (SSH). Since 2002, SSH schools have implemented what is called “cross-curricular inquiry activities,” in which students are asked to identify personal issues of interest that they have to solve on their own (under the guidance of their instructors). From its inception in 2002 and until 2021, Akiyama was involved in these activities as a member of the SSH planning and evaluation committee for 20 years [C-7, 8].

D. Experiential (Hands-on Mathematics) and the Establishment of Mathematics Museums

Learning highly abstract concepts in mathematics is not always easy for many children and students. Thus, with his valuable experience of teaching on TV, Akiyama began to focus on creating works that visually explain mathematical principles and ideas. In fact, as early as 1990, he started to create teaching tools, models, experiments, and observation devices that enable students to have a multi-sensory experience in learning mathematical concepts, formulas, and theorems, which were later collectively called MA (Mathematical Art) works. Subsequently, these MA works were featured in a hands-on style exhibition event in Asahikawa, Hokkaido in 1998 [D-1,9], attracting more than 10,000 visitors, and in 2000 during the International Congress on Mathematics Education (ICME9) held at Makuhari Messe in Chiba, Japan [D-2]. Akiyama’s MA exhibitions got the attention of UNESCO, which led to his appointment as a member of the Executive Committee in 2004. This prompted him to organize and manage his traveling exhibition called “Experiencing Math” [D-3]. Starting in Paris, this traveling mathematics exhibition visited 75 cities across the globe, including major cities such as Barcelona, Copenhagen, and St. Petersburg, attracting a total of 1.5 million visitors.

In conjunction with his traveling mathematics exhibition, in 2005 Akiyama began to explore the

mathematics behind works of art such as painting, sculpture, design, and architecture with M. Kanzaki and Y. Yamaguchi. With the support of a Grant-in-Aid for Scientific Research on Innovative Areas (Grant-in-Aid for Scientific Research “Research on Sculptural Art Works Utilizing Mathematical Beauty”), he created hundreds of “repetitive pictures” and transformative figures [G-1 to G-3], which were also shown in Paris and many other cities [G-4], along with his traveling mathematics exhibition. These results that merge mathematics and art were later on picked up for a TV broadcast on NHK [G-5]. In addition, several elementary and junior high schools, including Kyoto Art High School [G-6] and junior high schools affiliated with Aichi University of Education, and Tamagawa Gakuen [G-7], showcased Akiyama’s mathematical techniques in creating unique art objects, making students realize the close relationship between mathematics and art.

Akiyama’s MA exhibition and the traveling mathematics exhibition also attracted a lot of attention in Japan, which led to the establishment of the “Okhotsk Math Wonderland” [D-4] in Abashiri City in 2005 (which closed in 2007), “Math Experience Hall” [D-5] at the Tokyo University of Science’s Kagurazaka Campus in 2012, and “Math and Mathematics Wonderland” [D-6] in Motosu City, Gifu Prefecture in 2017. Akiyama also contributed to the construction of a permanent “Museo de las Experiencia Matematica” in Santo Domingo, Dominican Republic in 2018 [D-7].

E. Early Childhood Education and Education for the Gifted

In 2009 Akiyama became the director of the National Association for Research on Early Childhood Education. To date he has conducted research on the importance of early childhood education, what young children should acquire at each stage of their development, and methods for creating the foundation for the development of skills in mathematics and science [E-1, 2], has conducted numerous lectures [E-3] and study groups throughout Japan. Together with Misae Shio, Akiyama has also been working to support Japanese kindergarten students overseas [E-4] as part of his work as director of the International Association for the Promotion of Early Childhood Education (IAJE) since 2015.

As part of his work with gifted children, Akiyama, together with Hiroshi Noguchi and Hiroshi Fujita, established the Japan Mathematical Olympiad Committee in 1990. Later, this committee became a public foundation, where Akiyama served as adviser [E-5]. In 1990, this committee sent a Japanese team to the International Mathematical Olympiad (IMO Beijing) for the first time, with Akiyama as team leader [E-6]. He again served as the team leader to the IMO in Uppsala, Sweden in 1991, and laid the groundwork for subsequent IMO activities. Very recently, Akiyama served as vice-chairman [E-7] of the 2023 IMO Japan Congress held at Makuhari Messe, where he was mainly involved in obtaining funds for its operations [E-8].

F. International Contributions through Mathematics

Throughout his career, Akiyama has been active in giving lectures and showcasing his MA exhibitions on all five continents. He has energetically visited various parts of China [F-1, 2], Taiwan, Korea [F-3], the Philippines [F-5], Thailand [F-6], Cambodia [F-7], India, Indonesia, Malaysia, Singapore, Spain [F-4], Russia [F-8], Hungary [F-9], Switzerland, Ghana [F-10, 11], Mexico, the Dominican Republic [F-12], the United States, Canada, and Australia, etc. For these achievements, Akiyama was awarded the Foreign Minister’s Commendation by the Ministry of Foreign Affairs in July 2018. In particular, at the request of the Ministry of Foreign Affairs, he has been continuing to support mathematics education in the Dominican Republic since 2017. In 2021, the President of the Dominican Republic, Luis Abinader, awarded him the Knight of the Order of Christopher Columbus in recognition of his achievements [F-13, 14, 15, 16]. In September 2023, with the support of the Japan Science and Technology Agency (JST), 10 mathematics researchers and educators from the Dominican Republic were invited to the Tokyo University of Science for 10 days of mathematics education training with Hiroyuki Makiuchi to deepen the exchange between the two countries [F-17, 18, 19, 20].

Akiyama finds it meaningful to make a contribution to the international community, especially in fostering support for mathematics education and promoting mathematical enlightenment and culture. This would not have been possible if not for the deep cooperation and friendship between like-minded people within and outside Japan.

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