

Results on research activity I engaged mainly in studying knot theory and low dimensional manifolds of topology. In particular, I studied Alexander polynomial, topological imitation theory and surfaces in the 4-dimensional space, etc. Among earlier works, there is a solution of the non-invertibility problem on the knot 8_{17} proposed by R. H. Fox, which has been standing as an unsolved problem for 50 years. This result was done in the study of Alexander polynomial during the 2 academic year stay at the Institute for Advanced Study, Princeton. In recent years, I started a study of a model in psychology using a knot and a study of a spatial graph to apply to string-shaped materials, called soft matters (Macromolecule, DNA, etc.) as applications of knot theory and topology. As a result, the game “Region Select” applying knot theory (developed with colleagues) was shown at the world same time in the Android market. In 1983, I started a joint seminar "KOOK seminar" organized by the knot theorists of 4 universities in Kansai, Kobe University, Osaka University, Osaka City University, Kansei Gakuin University. This became a driving force of the development of the knot theory study in Kansai and later in Japan. In particular, "Knot Theory" (Springer Verlag Tokyo, 1990) was published in Japanese as the first book of the whole knot theory in Japan under co-operations with KOOK Seminar members. Later, the English version “A Survey of Knot Theory” (Birkhäuser, 1996) was published abroad and gave knot theorists in the world an impact. KOOK Seminar develops into "N-KOOK Seminar" joining Nara Women's University, which plays a central role of studying knot theory in Japan afterwards. From April 2003 to March 2008 I was a program leader of the 21st COE program “Constitution of wide-angle mathematical basis focused on knots”. With this, I made an effort to establish Osaka City University Advanced Mathematical Institute (OCAMI). In the research area of education, I made an effort for introducing knot theory to school students and played a leading role in a study group of Osaka Kyoiku University. The result was settled as the text book “Teaching and learning of knot theory in school mathematics”, the first book of English mathematics education.

In the academic year 2015, I could publish a paper on a topological invariant characterizing a closed orientable 3-manifold studied for a long time, by which all closed orientable 3-manifolds can be described by one smooth function. I also published a paper confirming the smooth unknotting conjecture for a ribbon surface-knot (standing as an unsolved problem for 45 years). A paper on classifying 4-dimensional universes with every closed orientable 3-manifold embedded was also published. Japanese Patent of the game “Region Select” applying knot theory was registered. A verification of an active effect of brain on an elderly version of this game has been tried as a cooperative study with a day care center. A Japanese monograph “Theory of Knots” and cooperative research papers: a paper with I.Tayama-B. Burton on tabulation of 3-manifolds, a paper with Y. Bae-S. Cho on a P^2 -knot, and a paper with A. Shimizu on quantization of crossing number were published. Further, a paper on knot

theory for spatial graphs attached to a surface, a paper on splitting of a definite closed 4-manifold with fundamental group Z , a cooperative research paper with I. Tayama on representing all closed orientable 3-manifolds in the complex number plane, a cooperative research paper with Y. Joung-S. Kamada-S. Y. Lee on a polynomial invariant of a surface-knot, a paper on moves on a chord graph and a paper on a cross-section on an immersed sphere-links have been written.