Results on research activity I engaged in studying knot theory and low dimensional manifolds of topology. In particular, I studied Alexander polynomial, topological imitation theory, 4-manifol theory and surfaces in the 4-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 studies of Alexander polynomial and hyperbolic 3-manifolds. There are also earlier works on quadratic forms of 3-manifolds, descriptions of surfaces in the 4-space (with T. Shibuya and S. Suzuki), and proposals for unknotted surfaces in the 4-space (with F. Hosokawa). I started a joint seminar "KOOK seminar". Under co-operations with KOOK Seminar members, "Knot Theory" (Springer Verlag Tokyo, 1990) was published in Japanese as the first book of the whole knot theory in Japan. Later, the English version “A Survey of Knot Theory”（Birkhäuser, 1996） was published abroad. It seems that it influences researchers of knot theory around the world. In topological imitations, I studied analogous properties and flexibility on the topology od a 3-manifold. Using this idea, I solved the Simon-Wolcott conjecture and the Reni-Meccia-Zimmerman conjecture. Recently, I wrote a paper on topological splitting of a closed 4-manifold with fundamental group Z which I proposed on before. I also published a paper confirming the smooth unknotting conjecture for a ribbon surface-knot (standing as an unsolved problem for 45 years). As a supplement of this proof, I published a paper “Supplement to a chord diagram of a ribbon surface-link” in this academic year. I have studied on complete invariants characterizing 3-manifolds for a long time (the first paper is written by myself, and then some papers as joint works with I. Tayama and one paper as a joint work with I.Tayama and B. Burton). By developing this idea, the whole 3-manifolds is described as a real analytic function and (by a joint work with T. Tayama) as a complex analytic function. As another work, there is a paper on classifying 4-dimensional universes with every closed orientable 3-manifold embedded. In 2016, two papers (written by myself) were published, 4 papers (with 3 papers as joint works) are to appear and other 3 papers (written by myself) are in review. “From linear algebra to homology”, “Lecture on knot theory” and “Theory of knots” are monographs in Japanese written by myself. As applications of knot theory and topology, 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.). The game “Region Select” applying knot theory was jointly developed with A. Shimizu (a graduate student) and K. Kishimoto (an institute member) and shown at the world same time in the Android market and two related patents were registered. 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) and 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 school education on knots. A report collection “Introduction to school mathematics of knots No.5” (in Japanese) including reports on educations of knots in elementary schools in Meiji Period which I first learned in 2016 was published in this academic year.