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. Topological imitation proposes a method of constructing a 3-manifold analogous to a given 3-manifold. Using this idea, I solved the Simon-Wolcott conjecture and the Reni-Meccia-Zimmerman conjecture. In recent years, there are papers on a solution of the topological splitting of a closed 4-manifold with fundamental group Z which I proposed on before and on confirming the smooth unknotting conjecture for a ribbon surface-knot (standing as an unsolved problem for 45 years). For a long time, I have studied on complete invariants characterizing 3-manifolds, where the first paper was written by myself, the last paper as a joint work with I. Tayama and B. Burton and the other papers as joint works with I. Tayama. By developing this idea, the whole closed orientable 3-manifolds could be described as a real analytic function and (by a joint work with T. Tayama) as a complex analytic function. Among other papers, there is a paper on topologically classifying a 4D universe, namely a 4-dimensional manifold with every closed orientable 3-manifold embedded.

“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, there are papers on studying a model in psychology using a knot and on studying a spatial graph to apply to string-shaped materials, called soft matters. The game “Region Select” applying knot theory was jointly developed with A. Shimizu (a graduate student) and K. Kishimoto (an institute member) together with two related patents registered and shown at the world same time in the Android market. 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). I also made an effort for introducing knot theory to school students and played a leading role in a study group (represented by T. Yanagimoto) of Osaka Kyoiku University. As results, reports (No.1-No.5) on school education on knots and the text book “Teaching and learning of knot theory in school mathematics” (joint editor with T.

Yanagimoto) in English are published.

In 2017, there are 7 published papers (with 4 papers as joint works) and 7 publish-preparing papers (with 4 papers as joint works). Among them, there are results on a description of the whole closed orientable 3-manifolds as a complex analytic function (a joint work) as noted above, the non-existence of an exotic surface-link in the ribbon surface-links, an introduction of complexities to a knitting pattern, and the existence of an immersed 2-knot with essential singularity.