TOWARD A SYSTEMIC UNDERSTANDING OF EDUCATION: INTEGRATING MICRO–MACRO PERSPECTIVES THROUGH STATISTICAL AND SOCIAL-PHYSICS

MASANORI FUKUI

Mie University, Japan
E-mail: fukui@info.mie-u.ac.jp

In recent years, the fields of educational research and educational psychology have made remarkable progress in studies focusing on micro-level aspects such as learners' cognitive characteristics, motivation, self-regulated learning, and emotional regulation. Numerous action research projects have also been conducted in school settings, both as classroom-based studies and as practical initiatives aimed at improving instruction, providing a theoretical foundation for addressing issues in educational practice. In addition, large-scale survey studies employing statistical methods have advanced, expanding data-driven efforts to understand educational phenomena. Collectively, these studies have greatly contributed to enhancing educational quality and realizing individualized optimization, and their significance is undeniable.However, education is inherently an endeavour that unfolds within broader macro-level structures—transcending the boundaries of individuals or classrooms—where teachers' networks, school organizations, local communities, and cultural or institutional factors interact and influence one another. For instance, the spread of inquiry-based learning, the adoption of ICT and AI education, and the acceptance of educational innovations cannot be fully explained by individual factors alone; rather, they emerge from the complex interplay among social networks, institutional constraints, and cultural values.Therefore, future educational research must integrate a macro perspective that conceptualizes educational phenomena as system-wide dynamics, complementing micro-level studies that meticulously analyse the psychological and behavioural processes of individuals and groups. This presentation proposes such a new perspective: a statistical mechanics (statistical physics) and sociophysics (social physics) approach that models educational phenomena as interacting multi-agent systems. Specifically, it introduces attempts to mathematically analyse the diffusion, penetration, and stabilization processes of educational innovations by applying frameworks from information statistical mechanics—such as the Ising model, percolation model, and maximum entropy method—to educational research.This approach enables us to theoretically clarify how educational innovations spread through teacher networks and under what conditions they reach critical phase transitions. Furthermore, by theoretically representing the interactions that occur among learners, teachers, schools, and local communities, this framework bridges educational practice and educational policy, offering a new direction for educational research that integrates the understanding of individuals, groups, and society.

Keywords - Diffusion Model; Inquiry-based Learning; Ising Model; Micro–Macro Dynamics; Sociophysics; Socio-Physical Modeling; Statistical Mechanics