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## THE DEVELOPMENT OF MICROSCALE LABORATORY (ML) IN CHINA

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### ABSTRACT

The development of microscale laboratory (ML) over the past 30 years is outlined, indicating the extent of support the concept has received during this period. The importance of the concept is linked with the aims of green chemistry as well as with a general enhancement of the quality of science education. A series of National ML Symposia has been held, the latest (10th) being held in Macau in 2019 with some 80 participants. [*African Journal of Chemical Education—AJCE 9(3), November 2019*]

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## State of Microscale Laboratory in China

Thirty years ago, I introduced ML into China, focusing on solving the problems that students do little or no experiments. Practice shows that ML not only realizes that each student has a set of micro-apparatus, but also can carry out experiments, which strengthened students' practical ability.

ML has also aroused interest in motivating positive learning, fostering environmental awareness, and stimulating innovative thinking. ML is not a simplification or miniaturization of normal experiments, but an innovative change of chemical experiments under the guidance of green chemistry and quality education.

Innovation runs through the design and development of both micro-apparatus (hardware) and ML schemes (software). For example, my colleagues have designed a variety of micro-apparatus and different experimental schemes for the generation and properties of gases specifically.

Among the various micro-apparatus, those with good results have been included in the teaching equipment catalogue of the Ministry of Education for primary and secondary schools, requiring schools to prepare the equipment in China. This provided a solid physical condition for the promotion of ML.

Since 1990, we have held 10 National Symposia on ML (NSML). Among them, the largest was the 4th NSML held at Hangzhou in 1998, which was attended by more than 240 scholars in China, including from four places across the Taiwan Strait. Professor T.S. Ma, the International Editor of *Microchemistry*, and Dr. Zvi Szafran, member of the American ML Center, also participated. The proceedings of the conference were published in the *Journal of Hangzhou Normal College* and the *Collection of Normal Education*. At the same time, Mr. Dai Anbang, a

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professor of Nanjing University and academician of the Chinese Academy of Sciences, now aged 97, who has always attached importance to chemical experiment teaching, wrote an important inscription about the vigorous implementation of ML in middle schools throughout the country, which gives us great encouragement.

So far, more than 1700 academic articles and 40 books related to ML have been published in China. Some of them are about micro-experiments of physics and biology in middle and primary schools. That's why, we adopt ML.

There are many teaching projects with ML as the core component. Eight of them have won the National Excellent Teaching Achievement Award. The 10th NSML was just recently (2019) held in Macao. This year marks the 150th anniversary of Mendeleev's discovery of the periodic table of the elements, the International Year of the Periodic Table of the Chemical Elements of the United Nations (IYPT2019), the 70th anniversary of the People's Republic of China, the 20th anniversary of Macao's return to the motherland, and the 130th anniversary of Peizheng Middle School. In these festive days, the 10th NSML was successfully held in Macao from 23 to 25 July, with the full cooperation of the Chinese ML Center, the Macau Peizheng Middle School and the Macau Society of Science and Artificial Intelligence Education. More than 80 scholars and teachers from four places across the Taiwan Strait participated. The conference included “ The Course Establishment of Microscale & Semi-Microscale Organic Chemistry Experiments”, "Innovation Three-in-one Model: let ML Blossom in Chongqing", "Promotion of ML Exploration in University Chemistry Teaching", "Sustainable Development Education and ML", "Creative Interesting Physics and Chemistry ML" ,”The Development and Application of ML Resources in Middle Schools”, “The Application of Digital Sensors in ML”,”STEM education in Hong Kong and DSE Chemical Innovation ML”, and “The 10th International ML Symposium Briefing ” —

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comprising the nine thematic reports and the presentation of ML instruments, experimental demonstrations, and talks with poster papers. The progress of ML in four places across the Straits in recent years was vividly described, shown and communicated effectively. The main content of the meeting is presented in the book “Progress of ML in the Past 30 Years”, which has just been published. In addition to the selected papers, the book also contains the inscriptions and messages about ML by five predecessor scientists such as Academician Diane Bong. In memory of Mr Dia’s outstanding contribution to Chinese chemistry, the participants were deeply inspired and educated by his 128-word inscription on the significance and requirements of ML development.

We have doubled our confidence. We must continue our work of ML, which is beneficial to our country, and will do better, so that ML can truly become an effective way to practice the construction of an ecological civilization and implement quality education. The book also illustrates the ML instrument developed in China, the development process of ML in the past 30 years and the status of academic exchanges. It fully reflects the struggle process of the ML project, winning eight national excellent teaching achievement awards and a number of provincial and ministerial awards. These achievements are the result of ML’s attention and support from educational administrations at all levels and the Chinese Chemical Society, and the Macao Bureau of Education and Youth also gave great support to the meeting. Macau Peizheng Secondary School and Macau Society of Science and Artificial Intelligence Education have carefully organized and implemented the agenda of the conference in accordance with the norms of international academic conferences, which made the delegates of the conference generally feel that they had opened their eyes and gained a lot. A group of young ML researchers emerged at the conference, which shows that there are successors for ML in China.

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Recently, we have optimized the design and put into operation a new six-holes well plate with multiple functions, which will further promote the popularization of ML.

We look forward to making the research and application of ML to a higher level through communication and cooperation with international counterparts.

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