Collaborative Advantages in Developing an Research-oriented Education-Science Popularization Hybrid Platform: Taking the Cooperation between the Pharmaceutical Discipline of Sichuan University and the South Sichuan Institute of Translational Medicine an Example

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Abstract: During the 13th Five Year Plan period, science popularization in China has achieved significant results, and the scientific literacy of citizens is constantly improving. The Pharmaceutical Discipline of Sichuan University (PDSCU) and the South Sichuan Institute of Translational Medicine (SSITM) have made a series of beneficial attempts to explore the combination of education-science popularization through close cooperation. The paper introduced some experiences for the platform construction, project implementation, research-oriented model for integrating education and studies, science popularization approach of the combination of observation and practice, implementation effect evaluation and audience feedback, etc, which aimed to provide some meaningful reference for current educators.

Key Concepts:
Education-Science Popularization, Research-oriented, Collaborative model, medicine plus pharmaceutics

1. Introduction

With the rapid development of modern society, science popularization plays an increasingly important role in national education, which can inspire people's intelligence and improve their quality (Wang, Huang, & Chen, 2020). During the 13th Five Year Plan period, the proportion of citizens with scientific literacy has reached 10.56%. Among the six key tasks mentioned in the "14th Five Year Plan for National Science and Technology Popularization and Development", promoting the coordinated development of science popularization and technological innovation, and conducting science popularization exchanges and cooperation are become the goals of many educators and researchers (Ren, Liu, & Ma, 2021). Various regions are using high-level science popularization to support high-quality development, laying a solid foundation for cultivating innovative reserve talents and achieving high-level technological self-reliance and self-improvement (Qiu, 2020).

At present, science popularization in China has gone through its unique development path (Miao & Zhao, 2016). The current cross-unit science popularization cooperation has attracted great attention from the public, and a new "big science popularization" pattern (including "government+enterprise", "school+community", "market+public welfare", etc) with the participation of the whole society is taking shape in China (Liu, Ma, & Ren, 2019). Rich science popularization resources and distinctive activity forms have brought the public closer to technological innovation and created a strong atmosphere for teenagers to "love science, learn science, and use science" (Tang, 2019). Moreover, combining science popularization with undergraduate education can not only enhance students' scientific literacy and enlighten their professional awareness, but also cultivate their innovative thinking and practical abilities (Liu, Kazmi, Zaman, & Jalees, 2016). Since the establishment of the South Sichuan Cancer & Degenerative Disease Cell Therapy and Drug Development Platform in 2022 through cooperation between the pharmaceutical discipline of Sichuan University and Southwest Medical University/South Sichuan Institute of Translational Medicine, a series of beneficial attempts have been carried out in scientific popularization while adhering to the mutual benefits and advantages in medicine-pharmaceutics integration. This article will explore the practical gains of exploring new scientific popularization cooperation models from the aspects of preliminary foundation, method innovation, content design, teacher-student communication, resource sharing and integration, etc.

2. Platform construction

Based on the research fields, representative achievements, and advantageous directions of two units, the main elements of science popularization education have been clarified. "Making life infinitely possible" has become the theme of the entire museum, which presents a group of life travelers who are actively exploring and painstakingly studying in the field of medical research (symbolized by the mascot - Dr. Blue); they show reverence for life and cherishing it, striving to make life infinitely possible. Moreover, "shouldering the mission of popularizing stem cells and regenerative medicine, assuming the responsibility of research technology and medicine, and being a cell storage bank in the era of great health" has been identified as the main goals. On this basis, the value points of “medicine+pharmaceutics” of the science popularization museum have been deeply explored. The construction of the entire exhibition hall follows the design concept of "one spaceship, three major zones, and four major hotspots", focusing on the cell exploration trilogy of "Medical Research Corridor (4F Cultural Corridor), Source Energy World (Rest and Reception Room), and Cell Universe (Science Popularization Exhibition Hall)", achieving the "exploration, shuttle, and decryption" of life, and ultimately ushering in a "new life". **Figure 1** shows the layout and conditions of the education-science popularization platform.

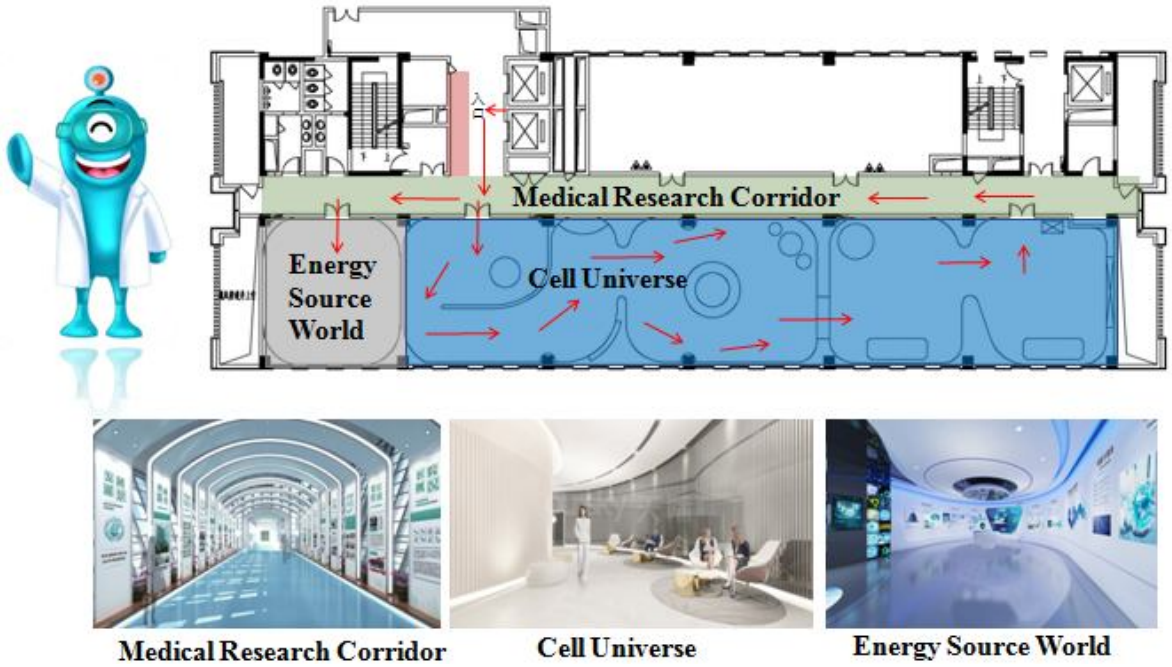

Figure 1: The layout and conditions of the education-science popularization platform.

3. Project implementation

Before the start of the project construction, both parties conducted thorough investigation and information collection. Sichuan University is one of the earliest higher education institutions in China to establish the Pharmaceutical Engineering major (1998). For many years, this major has ranked among the top two in the country and responsible discipline team has rich experiences in teaching research and reform (Yao, Cheng, Song & Liang, 2012); meanwhile, the South Sichuan Institute of Translational Medicine (2019) focuses on the medical field and has a good foundation in the construction of non-profit science popularization platform, which have had certain impact on the entire South Sichuan region. In terms of information sharing, the two units carry out regular

information exchange, share science popularization resources and information on the development of science popularization industry; besides, the main participants timely exchange related policies and projects of science popularization, develop a long-term cooperation mechanism and interactive platform, and jointly seek opportunities for further development. In addition, the two parts carry out project cooperation in (1) science researches, (2) science popularization activities, (3) science popularization industry, (4) science popularization research, (5) open sharing of instruments and equipments to public, and (6) science & technology resource popularization. Both the units actively organize members to carry out various forms of experience exchange, project docking, work discussions, etc., and continuously promote deep level cooperation between the two sides in theory exploration, operation management, activity development, science popularization exhibition and other aspects. In terms of talent cultivation, the joint platform continuously promotes various promotional activities and cooperates in organizing science popularization training, and the two units carry out high-end talent exchanges and member visits, and help to improve the quality of the science popularization talent team as well as create a new business card for cross regional exchange and cooperation of science and education.

4. Research-oriented model to integrating education and studies

Based on the Key Laboratory of Pharmaceutical Engineering and Technology in Sichuan Province, PDSCU is currently conducting a series of basic and applied researches in the field of green pharmaceutics, mainly including green drug releasing systems, green medical/biomedical materials, green quality control techniques, green production techniques and so on. Based on cutting-edge technologies such as new generation gene sequencing technology, big data bioinformatics analysis technology, and gene editing technology, SSITM are committed to the research and development of personalized immune diagnosis and treatment projects for tumors, and the anti-tumor field is one of common scope for the two units. As a new type of model animal, zebrafish has tissues, organs, and systems similar to humans. Its genes and signaling pathways are 87% similar to humans, and its physiology, development, and metabolism are also highly similar to mammals (Hutson & Liang, 2009). It is currently the only higher vertebrate animal suitable for high-throughput drug screening. Compared to naked mice, zebrafish embryos have advantages such as short experimental cycles, small sample sizes, low experimental costs, and easy in vivo imaging. Additionally, zebrafish embryos are transparent throughout the body, making them highly valuable for preclinical drug research and education (Forecki, Morales, & Merzdorf, 2023).

Zebrafish only has non-specific immunity in the early stage and does not have complete specific immunity. It does not have a rejection reaction against human tumor cells and can be directly inoculated into human tumor cells to screen for broad-spectrum anti-tumor drugs. In addition, zebrafish and human tumors have similar signaling pathways related to apoptosis, VEGF, Wnt, ALK, etc., which can be used for screening targeted anti-tumor drugs (Chatti, 2014). For teenagers and untrained lower grade undergraduates, this experimental animal is safer than rodents and rabbits, which is not only suitable for observation, but also for some simple hands-on operation and personal experience. After reading the learning files distributed by the tutors/commentators before the science popularization, they were encouraged to collect more knowledge and information related to this project in the library or through internet, so that their self-learning ability and literature retrieval ability began to take off. Before it, many audiences may not be unfamiliar with the structure and lifestyle of similar fishes, but it is the first time to observe even dissect such a small fish microscopically, which requires the guidance and help of tutors.

5. Science Popularization Approach of the Combination of Observation and Practice

Through the following activity, the public will be made aware of the unique advantages of zebrafish in screening anti-tumor drugs and its application in biomedical research, thereby enhancing interest and understanding in biomedical research. Before the start of the activities, both parties repeatedly discussed the implementation details and specific plans, and formulated a detailed activity plan and evaluation method (see **Figure 2a**).

(1) Zebrafish cultivation: Place zebrafish in a suitable living environment, maintain water temperature at around 28^{o}C, and feed twice a day to ensure healthy growth of zebrafish. During this process, everyone can understand the living habits and environment of zebrafish, and then master its internal composition through simple dissection together with microscopic observation (see **Figure 2b**).

(2) Tumor cell preparation: Fluorescence labeling of human tumor cell lines to observe their growth and metastasis in zebrafish. This stage will be operated by professionals, with the audience mainly focused on observation. Teenagers can observe the entire process through cameras and large screen (see **Figure 2c**), while low-grade professional undergraduates can observe up close on-site.

(3) Tumor cell transplantation: Select a certain number of zebrafish and transplant fluorescent labeled tumor cells into the zebrafish body through microinjection technology. The specific operation is as follows: put the zebrafish on the agarose gel mold, and use the microinjection needle to inject the tumor cells into the zebrafish body.

(4) Drug treatment: The zebrafish transplanted with tumor cells were divided into several groups, and each group was treated with different types of anti-tumor drugs. The control group was not given any medication treatment.

(5) Observation record: Regularly use a microscope to observe the growth and metastasis of tumor cells in zebrafish, and collect images for recording. Simultaneously record the survival status of zebrafish to evaluate the efficacy of anti-tumor drugs. Finally, the experimental data and analysis results are presented in the form of charts, images, etc., to enable the public to have a more intuitive understanding of the experimental results.

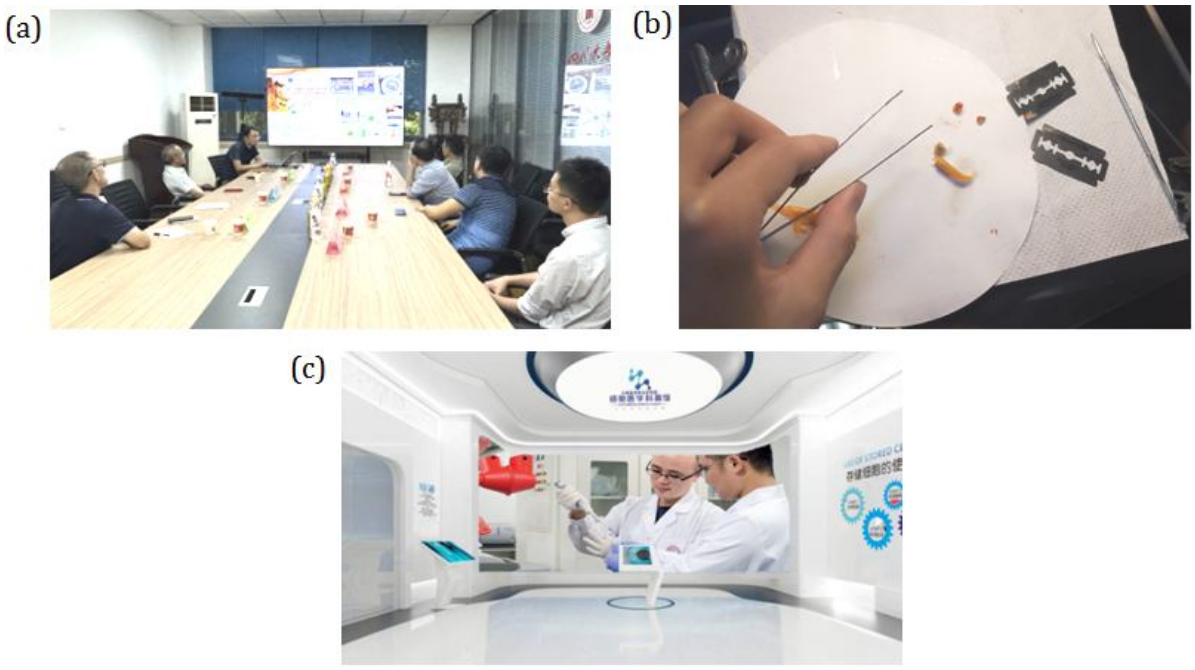

Figure 2: Science popularization process of the hybrid of observation and practice.

6. Implementation effect evaluation and audience feedback

Taking the above-mentioned science popularization activities as an example, through the screening experiment of zebrafish anti-tumor drugs, the public was informed about the unique advantages of zebrafish in biomedical research and its application in anti-tumor drug screening. The results indicate that zebrafish can serve as an ideal biological model for screening and studying anti-tumor drugs. Meanwhile, the results also demonstrated the differences in therapeutic effects of different anti-tumor drugs, providing a reference for clinical medication. In the discussion, experts and scholars were invited to interpret and analyze the results as well as key findings, further deepening the understanding and comprehension of related knowledge. At the end of the activity, a printed questionnaire with ten questions was distributed to each participant immediately, and then it was completed on the spot. The main questions included: How much did you know about biomedicine？ Do you like animal experiments? Do you have any family members or relatives working in the biomedical or pharmaceutical industry? Do you have any more specific comments or suggestions? Please give your final score for this project (10 as the highest score), etc. After collecting all the questionnaires, we conducted statistical analysis on the results and summarized the common opinions and suggestions. As a whole, the evaluation of the majority is good, but there are also a few cases of low scores and extreme dissatisfaction. Some children think they don't understand well and don't have enough observation equipment, meanwhile some low-grade undergraduates feel that their participation is not sufficient, and the content is not rich enough. Based on the final data (partly see **Figure 3**) and feedback, all the organizers discussed the shortcomings and identified the direction for further improvement. Through a long-term cooperation mechanism, scientific planning was carried out for the next science popularization activity.

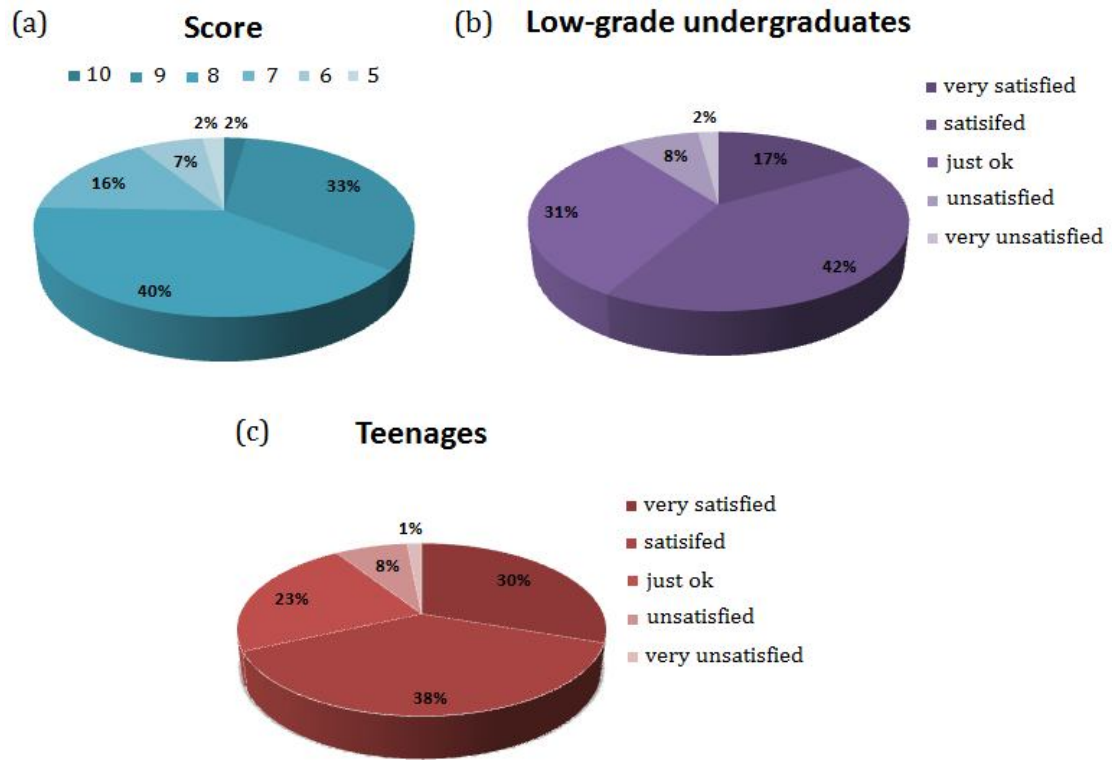

Figure 3: Evaluation results and audience feedback.

7. Conclusions

After a year and a half of construction, more than half a year of planning and design, PDSCU and SSITM have teamed up to build a research-oriented education+science popularization platform. It spans across regions, units, and disciplines, satisfying the thirst for knowledge of both professional and non professional audiences. Its model, case studies, and operation all have reference and promotional value. Through joint exploration in scientific research by both parties, relevant science popularization activities are carefully designed and implemented; and good results and evaluations are received, both in terms of overall effectiveness and audience feedback. This platform is a model that can provide reference for more collaborations, whether they are related to scientific research, education, or popular science, benefiting the entire society.

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Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions:

All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

References

Wang, D., Huang, R., & Chen, L. (2020). "Enhancing science popularization capacity of scientists in context of combination of scientific research and popularization", *Bulletin of Chinese Academy of Sciences*, vol. 35, pp. 1390-1397. https://doi.org/ 10.16418/j.issn.1000-3045.20200706003.

Ren, F., Liu, X., & Ma, J. (2021). "Emerging practices based on new media in the chinese science popularization industry: Transformation in the new era of science communication", In: Schiele, B., Liu, X., & Bauer, M.W. (eds) Science Cultures in a Diverse World: Knowing, Sharing, Caring. Springer, Singapore. https://doi.org/10.1007/978-981-16-5379-7_15

Qiu, J. (2020). "Science communication in china: a critical component of the global science powerhouse", *National Science Review*, vol. 7, pp. 824-829. https://doi.org/10.1093/nsr/nwaa035.

Liu, X., Ma, J.Q., & Ren, F.J. (2019). Research on the development approach of the science popularization industry in china under the perspective of sharing economy", 2019 Portland International Conference on Management of Engineering and Technology (PICMET). https://doi.org/10.23919/PICMET.2019.8893812.

Tang, S. (2019). "Some reflections on science popularization and science culture in China", *Cultures of Science*, *2*(3), pp. 227-234. https://doi.org/10.1177/209660831900200306.

Liu, C., Kazmi, S., Zaman, S., & Jalees, T. (2016). "A study of evaluation of science popularization of science and technology association in china", *National Research Conference on Business Management*, vol. 1. https://escholarship.org/uc/item/5p434703.

Miao, R., & Zhao, J. (2016). "A comparative study on Popular Science between China and the United States", *2016 International Symposium on Educational Technology (ISET)*, Beijing, China, pp. 115-121. https://doi.org/10.1109/ISET.2016.29.

Hutson L.D., & Liang, J.O. (2009). "Making an impact: zebrafish in education", *Zebrafish*, vol. 6, pp. 119-120. https://doi.org/10.1089/zeb.2009.9996.

Chatti, K. (2014). "FishPharm: zebrafish in pharmacology education and research", *The FASEB Journal*, vol. 28, pp. 1058.5. https://doi.org/10.1096/fasebj.28.1_supplement.1058.5.

Forecki, J., Morales, C., & Merzdorf, C. (2023). "Trails to research: an inquiry-based course using zebrafish to provide research experience to tribal college students", *Journal of Microbiology & Biology Education*. vol. 24, pp. e00243-22. https://doi.org/10.1128/jmbe.00243-22

Yao, S., Cheng, Q., Song, H., Liang B. (2012). "The development of PAT (Process Analytical Technology) for drug production and the requirements for domestic pharmaceutical engineering education", *Creative Education*, vol. 3, pp. 76-79. https://doi.org/10.4236/ce.2012.37B019.