Journal of Artificial Intelligence Practice (2024)
Clausius Scientific Press, Canada
DOI: 10.23977/jaip.2024.070116
ISSN 2371-8412 Vol. 7 Num. 1

The Construction of ACM Practice Bases for the Cultivation of University Students' Technological

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Keywords: Practice base, ACM, university students' technologica

Abstract: The construction of ACM (Association for Computing Machinery) practice bases dedicated to enhancing technological innovation capabilities among university students represents a pivotal shift in academic emphasis towards applied learning and practical skill development, particularly within the Information and Computational Science disciplines. This abstract outlines the strategic framework and impact of these practice bases, highlighting their role in equipping students with the necessary tools and experiences to thrive in the technological sector. ACM practice bases serve as an integral bridge between theoretical knowledge and real-world application, providing a structured environment where students can engage in hands-on projects, collaborative research, and competitive programming challenges. The initiative aims to foster a comprehensive skill set among students, including coding, problem-solving, innovative thinking, and teamwork. Through access to advanced computing resources and mentorship from faculty and industry experts, students are encouraged to explore complex computational problems and develop solutions that contribute to technological innovation. The implementation of these bases involves curricular integration that balances theoretical study with practical exercises, promoting an active learning environment that stimulates student engagement and curiosity. Collaboration is a cornerstone of the ACM practice bases, with students working in teams to tackle projects that mirror real-life scenarios, thereby enhancing their technical abilities while cultivating soft skills essential for professional success. A case study within the Information and Computational Science program demonstrates the effectiveness of ACM practice bases in achieving these educational objectives. Despite challenges related to resource allocation, curriculum development, and maintaining student interest, the case study reveals significant improvements in students' practical skills, innovation capacity, and readiness for the technology-driven workforce. In summary, ACM practice bases represent a significant advancement in higher education's approach to nurturing technological innovation among students. By providing a rich, applied learning environment, these bases prepare students for the complexities of the tech industry, fostering a generation of skilled, innovative professionals ready to contribute to global technological advancements.

1. Introduction

The establishment of ACM (Association for Computing Machinery) practice bases for the cultivation of technological innovation capabilities among university students is a crucial subject that intersects with the broader objectives of enhancing educational outcomes, fostering innovation, and addressing the evolving needs of the global economy and society [1]-[2]. This research delves into the significance of this initiative, analyzes the current state and development trends in both domestic and international contexts, and explores its scientific and practical implications in line with the trends in scientific research development and the pressing technological challenges facing national economies and societies. The significance of constructing ACM practice bases in universities lies in its direct response to the urgent need for a workforce that is not only technically proficient but also innovative and adaptable to the rapid advancements in technology. In the era of the Fourth Industrial Revolution, where artificial intelligence, big data, and cybersecurity are reshaping industries, the ability to innovate and apply knowledge practically is more crucial than ever [3]. These bases serve as a catalyst for developing such competencies, integrating academic learning with practical application and research in computing and information sciences.

Globally, there is a growing emphasis on STEM (Science, Technology, Engineering, and Mathematics) education, with numerous initiatives aimed at bridging the gap between theoretical knowledge and practical skills [4]. Countries like the United States, China, and members of the European Union have invested significantly in educational reforms and infrastructure to support experiential learning, interdisciplinary research, and innovation. For instance, the National Science Foundation (NSF) in the U.S. supports several programs that encourage undergraduate research and innovation in computing fields. In contrast, developing countries are still in the process of establishing similar infrastructures, facing challenges such as limited funding, access to advanced technological tools, and integration of such programs into the traditional curriculum. However, the trend is positive, with increasing recognition of the importance of practical, research-based education in fostering innovation and economic growth. The development of ACM practice bases specifically combines the global emphasis on STEM education with the unique requirements of the computing and information sciences disciplines [5]. These bases not only provide access to state-of-the-art computing facilities but also create an ecosystem for students to engage in collaborative projects, research, and competitions that stimulate innovation and problem-solving skills.

From a scientific perspective, the establishment of ACM practice bases is aligned with the current trends in research and development, which prioritize interdisciplinary approaches, practical innovation, and the application of computing technologies to solve complex problems. These bases prepare students to contribute to scientific advancements by providing them with the skills to apply computational methods and tools across different research domains, from climate modeling and bioinformatics to artificial intelligence and quantum computing.

In terms of application prospects, the need for technological innovation capabilities is evident across all sectors of the national economy and society. Key technological challenges that require immediate attention include cybersecurity threats, sustainable energy solutions, healthcare innovations, and the digital transformation of industries. Graduates who have honed their skills in ACM practice bases are well-equipped to tackle these challenges, contributing to the development of solutions that are not only technologically advanced but also socially responsible and sustainable [6-8].

Furthermore, the integration of ACM practice bases into university curricula supports the broader goals of national economic and social development plans, which increasingly rely on technological innovation as a driver of growth, competitiveness, and societal well-being [9].

In conclusion, the construction of ACM practice bases for the cultivation of technological innovation capabilities among university students holds significant potential to impact both scientific research and practical applications. By fostering a new generation of skilled, innovative professionals, these bases contribute to addressing some of the most pressing challenges facing our world today. As such, continued investment and research into the development and optimization of these educational platforms are essential for realizing their full potential in advancing scientific knowledge and contributing to sustainable economic and social development.

2. Construction background: Introduction to ACM

The history of the ACM International Collegiate Programming Contest (ICPC) can be traced back to 1970. As an innovative method for discovering and nurturing top computer science students, the contest quickly received positive responses from universities across the United States and Canada. In 1977, the first finals were held during the ACM Computer Science Conference, evolving into an annual international competition with multi-national participation.

The ACM-ICPC is an annual competition designed to showcase the innovative abilities, team spirit, and capabilities of college students to write programs, analyze, and solve problems under pressure. Competing in teams representing their schools, each team consists of three members. During the competition, each team uses one computer and has five hours to solve 7 to 11 problems using one of the programming languages among C, C++, Pascal, or Java. Thus, in addition to solid professional knowledge, good teamwork and psychological quality are also key to winning.

After more than four decades of development, the ACM International Collegiate Programming Contest has grown into the most influential computer competition for university students. The ACM contest is hailed as the "Olympics" of the computing world. The annual winners are almost invariably eagerly recruited by major companies like Google, Microsoft, Alibaba, and Baidu, with many of these firms sponsoring the ACM contest to position themselves advantageously close to emerging talent, gaining an edge over competitors in talent acquisition. Those deeply involved in ACM problem-solving typically possess high levels of mathematical and computing literacy, as well as strong analytical and practical skills, enabling them to tackle advanced and complex challenges. This is the primary reason why ACM talents are highly sought after by major companies.

3. Current Situation of ACM Practice base Construction in Universities

3.1. The Scale and Scope of on-campus Innovation Practice Bases are Limited

Currently, the construction of teaching resources at our school is steadily progressing. However, from the perspective of various majors, practical teaching resources available to students are still scarce, inhibiting the expansion of students' abilities for autonomous and inquiry-based learning. Specifically, for the Information and Computational Science major, students require practice bases to reinforce theoretical knowledge and expand professional skills. The ACM practice base precisely fills the gap in resources for cultivating students' innovation and entrepreneurship capabilities in this discipline.

3.2. Some Teaching Segments are Outdated, and Existing Experimental Techniques Urgently need Improvement

The practical teaching segments, such as experiments, internships, and design, mainly involve the verification and repetition of knowledge in known fields. There is a lack of cultivation and training for students in experimental techniques, design, methodology, and the capacity to engage in experimental work independently, making it difficult to develop innovative experimental research abilities. There is a lack of organic linkage between course settings and practical innovation, insufficient settings for adjacent and interdisciplinary subjects, reducing students' opportunities to engage with the cutting edge of various disciplines. This leads to slow knowledge updates and makes it challenging to transfer knowledge across related disciplines.

3.3. Innovation Practice, Theoretical Teaching, and Course Design are Relatively Independent and Lack Interconnectedness

The principle of "student-centered, outcome-oriented, continuous improvement" needs further integration. To cultivate university students' innovation capabilities, it is necessary to organically integrate on-campus practice segments (experiments, course design, academic competitions), off-campus practice segments (production internships), and the tripartite practice segments of school-enterprise cooperation in teaching, learning, and research. This integration should form a comprehensive student practice learning platform for all students, encompassing multi-angle, multi-level aspects through a combination of off-campus production internship bases, on-campus innovation practice bases, and school-enterprise joint R and D centers. Establishing practice innovation bases as a bridge to coordinate the operation mechanisms of on-campus and off-campus student practice segments will promote collaboration and mutual growth among these three aspects. This approach aims to achieve a win-win situation for students, schools, and enterprises, effectively enhancing university students' innovation capabilities.

4. Significance of ACM Practice Base Construction in Universities

The concept of nurturing innovative talent must be led by a shift in educational thoughts and ideas, centering on cultivating students' innovation and practical abilities. Relying on existing teaching resources, it aims to strengthen the students' agency, apply teaching methods tailored to individual talents, and strive to create an environment conducive to the creative and personal development of students. This approach actively guides students to undertake autonomous learning and innovation, forming a favorable environment for nurturing innovative talents.

The foundation of innovative education is practice. To cultivate university students' innovation abilities, it is essential to construct robust practical platforms for them. Therefore, the development of practice bases serves as a carrier for the "student-centered, outcome-oriented, continuous improvement" philosophy, providing a platform for nurturing the technological innovation abilities of university students and reflecting the crucial role of higher education in the construction of an innovative country. The main significance is reflected in the following aspects:

(1) The construction of practice bases can enhance the overall professional quality of the teaching staff, attracting more responsible, experienced, and highly skilled teachers and engineering technicians to guide students in innovative activities.

(2) It allows for the full exploitation of advantages in discipline construction and scientific research, strengthening the close integration of students' innovative practical activities with teachers' scientific research work, forming a virtuous mechanism for teacher-student active participation in innovative activities. It emphasizes teaching students in accordance with their aptitudes, respecting students' personal development, and exploring research-based learning programs carried through innovative research projects.

(3) Practice bases, while being developed and utilized simultaneously, coordinate with the ACM International Collegiate Programming Contest and the Shandong Province ACM Collegiate Programming Contest to coach and train students, enhancing their hands-on innovation abilities. Students can choose research projects provided by the base or select projects according to their research interests, conducting technological innovation project research individually or in teams.

(4) Creating a free and open learning space for students, stimulating and unleashing students' passion for innovation, enabling students to learn to independently analyze and solve problems. Conducting innovative project research with application prospects enhances undergraduates'

participation in academic research and their ability to engage in scientific paper writing.

(5) As the practice base continues to operate and gradually expand its influence, expanding the selection of participating students lays a solid foundation for achieving excellent results. Emphasizing interdisciplinary crossover and combining disciplinary advantages actively attracts students from electronics and information, information science, natural sciences, and digital media, among others. This allows students to exercise their innovative thinking abilities in an interdisciplinary atmosphere, unleashing their innovative potential and nurturing versatile innovative talents.

5. Construction Content

(1) Make full use of existing teaching resources, and through rational integration and allocation, proceed with the construction in a planned and stepwise manner to achieve as much teaching resource sharing as possible. This approach avoids duplication and cross-setting, enhancing the utilization rate of existing teaching resources. The principle of resource sharing is emphasized.

(2) Regarding the investment in construction funds and management, the main approach is co-construction by the university and colleges, with colleges responsible for specific organization and daily management. The university provides policy guidance, process inspection, qualification review, and financial support, reflecting the principle of joint construction by the departments.

(3) Guided by the principles of "student-centered, outcome-oriented, continuous improvement," with the core objective of cultivating students' innovative spirit, practical abilities, and innovation capabilities, specific measures such as changing educational concepts, updating teaching content, improving the training mechanism, deepening teaching reform, and innovating student scientific research incentive mechanisms are adopted to actively carry out student scientific and technological innovation practice activities. The construction and operation of innovation practice bases always rely on the construction of related disciplines and majors. In aspects such as staffing of the bases and the establishment of innovative research directions, they are closely integrated with the advantages of disciplines and reflect the characteristics of disciplines, enabling the practice bases to develop together with disciplinary construction, full of vitality.

(4) Establish a scientific and standardized operation mechanism and a complete management system to ensure orderly work. By setting up a comprehensive reward system, the enthusiasm of teachers and students is fully mobilized, encouraging teachers to actively involve outstanding students in scientific research projects and urging students to actively participate in various scientific and technological competitions, thematic research, research and development, and academic paper writing. In the process of innovative practice, a mechanism that combines teacher-student interaction, autonomy, and guidance is established to cultivate university students' interest in innovation and stimulate their desire for innovation.

Based on the work philosophy of openness, innovation, effectiveness, and long-term perspective, adhering to the principles of standardized management, strengthened guidance, and expanded participation, the construction of the innovation practice base is carried out following the guiding principles of curriculum leading, interest driving, autonomous practice, teacher guidance, project management, and policy incentives. Stage, medium-term, and long-term plans for university students' scientific and technological innovation activities are formulated, aiming to create a strong academic and technological atmosphere. The improvement of students' professional quality, innovative thinking, innovative spirit, practical ability, and innovation capability is integrated into a comprehensive implementation plan, ensuring the smooth realization of the goals of practice base construction and innovative talent cultivation.

6. Feasibility Analysis

Constructing an ACM Innovation Practice Base is a strategic initiative aimed at bolstering technological innovation and practical skills among university students, particularly in the realms of computer science and technology. This feasibility analysis explores the potential impacts, challenges, and the overarching benefits of such a venture, drawing upon the discussed objectives, resources, and methodologies.

(1) Educational and Technological Landscape

The demand for graduates with strong practical skills, innovative capabilities, and experience in computer science is escalating in the face of rapid technological advancements and digital transformation across industries. An ACM Innovation Practice Base stands as a direct response to this demand, providing a structured platform for students to engage deeply with complex computational problems, coding practices, and team-based projects.

(2) Resource Utilization and Institutional Support

The initiative capitalizes on existing educational resources, including advanced computing facilities, software, and expert faculty, thereby minimizing additional resource requirements. The planned integration with the current curriculum and extracurricular activities, such as ACM contests and collaborative research projects, ensures that the practice base enhances, rather than duplicates, the educational offerings. With institutional support, as seen in shared responsibilities between schools and departments, the base benefits from a sustainable model of operation, policy guidance, and financial backing.

(3) Curriculum Integration and Teaching Methodologies

By fostering a "student-centered, outcome-oriented, and continuously improving" approach, the practice base aligns with contemporary educational philosophies that prioritize hands-on learning, critical thinking, and problem-solving skills. The engagement of high-level teaching staff and the adoption of modern teaching tools and methods, including online resources and platforms for course practice and competition preparation, guarantee a high-quality learning environment.

(4) Innovation and Interdisciplinary Collaboration

The ACM Innovation Practice Base serves as a catalyst for innovation, not only within the realm of computer science but also in interdisciplinary fields where computing technology plays a pivotal role. By encouraging participation in ACM contests and other tech competitions, the base provides students with invaluable opportunities to apply their skills in real-world scenarios, fostering a spirit of innovation and collaboration.

(5) Challenges and Solutions

Key challenges include maintaining up-to-date technology and resources, ensuring continued faculty engagement, and attracting a diverse student body. To address these challenges, the base plans to establish partnerships with industry leaders for resource support and guest lectures, implement ongoing faculty development programs, and actively recruit students from various disciplines, ensuring a broad and inclusive approach to innovation.

(6) Sustainability and Impact

The sustainability of the ACM Innovation Practice Base is underpinned by a robust incentive system for all stakeholders, including students, faculty, and administrative staff. Continuous evaluation and adaptation strategies are in place to respond to the evolving educational and technological landscapes. The expected impact includes enhanced student employability, strengthened institutional reputation in computer science education, and a significant contribution to the tech industry's talent pipeline.

The feasibility of constructing an ACM Innovation Practice Base is strongly supported by the alignment with educational trends, institutional capacities, and industry needs. While challenges exist, careful planning, resource allocation, and the engagement of all stakeholders are key to realizing the potential of such a venture. Ultimately, the practice base promises to enrich the academic experience for students, equipping them with the skills and mindset needed to thrive in the rapidly evolving tech landscape, thereby contributing to the broader goals of innovation and technological advancement in society.

7. Conclusions

The establishment of an ACM Innovation Practice Base represents a strategic advancement in the realm of computer science education, aiming to equip students with the essential skills required in the rapidly evolving technological landscape. This initiative is not only a response to the increasing demand for technologically proficient graduates but also a testament to the commitment towards fostering innovation and practical problem-solving abilities among students. By leveraging existing educational resources, integrating cutting-edge teaching methodologies, and promoting interdisciplinary collaboration, the practice base is positioned to offer a unique and enriching learning experience that bridges the gap between theoretical knowledge and real-world application.

The feasibility analysis underscores the importance of institutional support, highlighting the synergistic role of schools and departments in providing the necessary infrastructure, policy guidance, and financial backing. With a curriculum that is thoughtfully designed to enhance students' analytical, coding, and teamwork skills, coupled with the engagement of high-level teaching staff and the use of advanced technological tools, the practice base is set to deliver an educational experience that is both comprehensive and cutting-edge. Key to the success of this initiative is the focus on sustainability and continuous improvement, ensuring that the practice base evolves in alignment with technological advancements and educational best practices. Challenges such as maintaining state-of-the-art resources, ensuring faculty engagement, and attracting a diverse student population are acknowledged, with strategic solutions proposed to address these issues effectively.

In summary, the construction of an ACM Innovation Practice Base stands as a pivotal step towards nurturing a new generation of innovators and problem-solvers, ready to tackle the challenges of the 21st century. This initiative not only enhances the employability of graduates but also contributes significantly to the academic and research excellence of the institution. By fostering a culture of innovation, collaboration, and continuous learning, the ACM Innovation Practice Base promises to play a crucial role in shaping the future of technology education and, by extension, the technological advancement of society.

Acknowledgements

This work was supported by the Support Plan on Science and Technology for Youth Innovation of Universities in Shandong Province (Grant No. 2021KJ086) and the National Natural Science Foundation of China (Grant No. 62003234), the Natural Science Foundation of Shandong Province (Grant No. ZR2020QF048).

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