

Research on the Interdisciplinary “AI+X” Innovation and Entrepreneurship Education Paradigm at Local Application-Oriented Universities Driven by AI for Science (AI4S)

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Abstract: The new era of AI for Science (AI4S) promises changing the paradigms of science and industry research, offering local application-focused universities a new chance to address long-term challenges in the field of innovation and entrepreneurship education. To address widespread issues such as strict disciplinary boundaries, the disconnect between education in innovation and entrepreneurship and professional education, and shallow AI integration, this paper presents an interdisciplinary "AI+X" paradigm of innovation and entrepreneurship education that is based on AI4S. This paradigm uses real research and industrial problems as its basis and data-driven approaches and interdisciplinary integration as the main mechanisms. The course cluster-project workshop-platform ecosystem-evaluation incentive four-dimensional synergy leads students through basic AI literacy to domain specific innovative application, finally reaching a progressive improvement of innovation and entrepreneurial abilities. The paper explains the theoretical rationale and structural framework of the paradigm and suggests implementation strategies that include reconstructing curricula, hybrid virtual-physical practice platforms, mentor teams of industry-education, and cascades of progressive incubation. It also discusses the initial experience of an "Intelligent Seed Industry" AI4S project in an application-oriented university. It can be concluded that local application-oriented universities ought to actively integrate into the AI4S ecosystem and convert regional industrial features into the resources of interdisciplinary innovation and entrepreneurship education, thus producing high quality applied personnel who are endowed with AI thinking, interdisciplinary competence and entrepreneurial spirit.

Keywords: AI for Science; AI+X; Local Application-oriented Universities; Interdisciplinary; Innovation and Entrepreneurship Education Paradigm.

1. Introduction

The intersection of artificial intelligence and scientific investigation, also called AI for Science (AI4S), has become a transformative power that is redefining the nature of knowledge creation and technological development. The evolution of human-machine cooperation has been documented by researchers, who show that AI has evolved as a sensor and computational aid into a cognitive partner, where intelligent systems are now actively involved in scientific reasoning, hypothesis formulation, and even experimental design [1]. Such cognitive collaboration, as they claim, signifies a radical change in the concept of co-working to co-thinking, which fundamentally changes the interaction between scientists and the tools they use. At the same time, the concept of data-intensive science discovery - or what Jim Gray infamously referred to as the "Fourth Paradigm" - has been subjected to critical analysis, which has shown that it has a double logic as both a scientific method and a disciplining device, and warns that the neo-empiricism that underpins this paradigm can undo the constructive nature of human reason in scientific research [2]. All these theoretical bases imply that AI4S is not an ordinary technical update but a major epistemological shift with significant consequences on the ways of production, dissemination, and application of scientific knowledge in institutional settings.

Strategic significance of AI4S has been officially acknowledged by leading economies around the world.

Scientific research based on AI has taken the central stage within the national science and technology strategy of China, where the Four New disciplines [3] have been used as a holistic model of transforming higher education to satisfy the needs of intelligent age. It is expressed with special urgency that New Engineering education should go beyond the old disciplinary borders by moving beyond the discipline-centered paradigm of learning to an industry-demand oriented model, incorporate cross-boundary integration, and move beyond passive accommodation to active encouragement and leadership in the advancement of technology [3]. Such institutional necessity is also strengthened by suggestions that artificial intelligence enables high-quality educational growth in seven critical areas, namely student learning, teacher development, school building, home-school cooperation, education management, assessment, and equity, thus offering a holistic guide to intelligent educational change [4]. Taking this reasoning further, subsequent works explain the underlying principles behind the integration of AI and education by charting its historical development between media representation and the digitalization phases and identifying some of the long-standing issues such as technological suspension due to mismatched supply and demand, subjectivity alienation of teachers and students, the Matthew effect of digital divides, and ethical governance responsibility vacuums [5]. All these analyses help to conclude that the deep integration of AI into education is not only the historical inevitability but also a sophisticated systemic problem which needs multi-dimensional solutions.

Under this larger framework of educational change, the local application-based schools, which are the biggest part of the higher education system in China, are experiencing especially urgent difficulties in adjusting to the AI4S paradigm. Particular limitations of such institutions are a shortage of statistical and computer science faculty, lack of computing infrastructure, and the challenge of attracting leading AI scholars to areas that are not well known [6]. Although these limitations exist, it is suggested that local universities may find ways to use their unique disciplinary strengths, including beneficial mathematics programs, and establish strategic alliances with regional industries to generate functional talent cultivation models. Nevertheless, a deeper issue is recognized: most application-oriented universities offer an isolated approach to education in the fields of innovation and entrepreneurship, with strict barriers between disciplines, a shallow coverage of AI content, and poor connections with real-world industry needs [8]. The innovation ecosystem theory has led to a multi-dimensional model in which the cross-boundary integration of talent cultivation models, full-process, and digitally-enabled integrated practice platforms are considered. Nonetheless, as it can be shown by the empirical experiments of AI and virtual reality integration into classrooms, successful adoption of such frameworks is largely contingent on the reduction of the discrepancy between the technologies at hand and their instructional potential- a gap that is especially wide in resource-constrained local institutions [7].

The new paradigm of AI4S promises a possible revolution in this age-old conundrum. In contrast to the usual generic AI solutions that tend to be isolated to real problems in science or engineering, AI4S is naturally problem-driven, interdisciplinary, and data-intensive: traits which can fit into the pedagogical requirements of innovation and entrepreneurship education with astonishing accuracy. There is also a strong emphasis on the fact that AI4S projects are usually based on real scientific or industrial issues and involve collaborative problem solving between several fields and produce concrete results that can be immediately converted into innovation products or startups. This natural framework indicates that AI4S can offer the real project-based learning experiences that innovation and entrepreneurship education has been trying to deliver but has seldom managed[8]. Further, although data-driven methods should be balanced by theoretical reasoning, the fact that AI4S builds upon a methodology of data-intensity allows students with different disciplinary backgrounds to engage in meaningful interdisciplinary research and therefore participate in cutting-edge science [2]. To regional innovation ecosystem players like local application-oriented universities, which frequently are kept out of the elite research networks, AI4S is therefore not a danger to their conventional mandate but a chance to re-imagine their positions in the regional innovation ecosystems.

Based on these theoretical and practical backgrounds, this paper suggests an interdisciplinary education paradigm of AI and X based on AI4S, which is a particular type of innovation and entrepreneurship education intended to be implemented in local application-oriented universities[9]. The paradigm begins with real research and industrial challenges and uses data-driven methods and interdisciplinary integration as its main mechanisms, and leads students to innovative application in specific fields via a four-dimensional synergy of course clusters-project workshops-platform ecosystems-

evaluation incentives. This paper will detail the theoretical basis and structural framework of this paradigm, make suggestions to implement it through the reconstruction of curricula, virtual-physical integrated practice platforms, industry-education integrated mentor teams, and progressive incubation chains based on the theoretical knowledge of innovation ecosystems [8], cognitive collaboration framework [1] and the logic of discipline construction known as the Four New [3]. The paper also discusses an initial practice in a local application-oriented university, with both the accomplishments and the ongoing contradictions. The conclusion of the study is that local application-oriented universities need to actively integrate themselves into the AI4S ecosystem, converting regional industrial features into opportunities of interdisciplinary innovation and entrepreneurship education, thus fostering excellent applied talents who possess AI thinking, interdisciplinary skills, and entrepreneurship[10]. The rest of the paper is organized as follows: Section 2 creates the logical connection between AI4S and innovation and entrepreneurship education; Section 3 defines the meaning and framework of the concept of the paradigm of "AI+X"; Section 4 provides implementation pathways; Section 5 gives preliminary practice and reflections; and Section 6 provides conclusions.

2. Logical Coupling between AI4S and Innovation and Entrepreneurship Education at Local Application-Oriented Universities

2.1. Core Features and Educational Implications of AI4S

AI4S is an outcome of close association of artificial intelligence with both pure and applied sciences and has three prominent properties. Firstly, it is problem-oriented (all algorithms and models are aimed at solving some clear-cut scientific problem like material property prediction or pathological image recognition). Secondly, it is interdisciplinary, and requires synergistic efforts in computer science, mathematics and domain sciences (e.g. biology, chemistry, mechanics). Finally, it operates on both data and knowledge, and incorporates domain prior knowledge into deep learning models to improve interpretability and generalization. Such properties imply that AI4S workflow is essentially interdisciplinary practical project, which can be used as a high quality project carrier in the context of innovation and entrepreneurship education.

2.2. Realistic Dilemmas of Innovation and Entrepreneurship Education at Local Application-Oriented Universities

The mission of the local application-oriented universities is to provide service to the regional economy and society, and they raise the applied talents who can address practical and front-line production issues. But there are three disconnections in their innovation and entrepreneurship education. The first one is disconnection in curriculum: most AI related courses are taught separately by computer science departments and examples are not linked to regional leading industries including agriculture, manufacturing and cultural creativity, and students find it hard to transfer and use their knowledge. The second one is disconnection in project: student innovations and entrepreneurship projects usually

start with obscure ideas or to satisfy teachers' requirement to write a title paper, without actual demands, and are terminated after being done. The third one is disconnection in ecosystem: cooperation between the universities and local companies or research organizations is usually limited to signing ceremonies, unable to efficiently integrate innovation and entrepreneurship education into the regional innovation chain.

2.3. Coupling Mechanism Driven by AI4S

The AI4S can offer an organized approach to the above challenges. To begin with, AI4S projects derive from real life issues in science or the industry, e.g., early prediction of orchard pests and diseases using UAV remote sensing and deep learning. These are very natural topics where the participation of students in other fields, like computer science or plant protection or agricultural machinery, is inevitable and this naturally destroys the boundaries between disciplines. Secondly, the process of solving problems is an entire innovation cycle- starting with data gathering and design of models to implementation and validation. Equipped in the right way, it can easily give birth to technical solutions or in more extreme cases startup companies, reaching a continuum of research project-innovation and entrepreneurship training-achievement transformation. Lastly, the regional characteristic industries-related AI4S projects may lead local application-oriented universities to establish close collaborative closed circuits with the major local companies and research institutions where: the industry raises the issue, teachers and students address the issue, and results are returned to the company - which enables long-term ecological support of education in innovation and entrepreneurship.

3. Connotation and Framework of the Interdisciplinary “AI+X” Innovation and Entrepreneurship Education Paradigm

According to the logic provided, the paper suggests a paradigm model of the form of one axis, two drivers, three tiers, and four dimensions in interdisciplinary educational innovation and entrepreneurship that is based on the concept of AI+X.

The so-called one-axis is to use genuine AI4S initiatives as the axis that passes through the whole talent development process. Student learning starts with being exposed to AI4S enlightenment cases in the first year and ends with participating in particular domain project teams in the final years, organizing their studies on the theme of using AI to address a concrete issue. The dual drives are an internal disciplinary drive and an external industrial drive: the former restructures the disciplinary knowledge into integrated modules consisting of AI plus X; the latter introduces a sustainable iterative momentum due to the actual needs of industry companies. The three tiers stand for students capability levels at different stages: foundational tier (AI literacy and data literacy), integration tier (core knowledge of domain X plus AI application methods), and innovation tier (interdisciplinary innovation and entrepreneurship practice). This is complemented by the four dimensions of synergy, which include curriculum system, practice platform, mentor team and evaluation mechanism.

In this paradigm, the linear paradigm of learning all theories followed by practical work has been abandoned in favor of a project-based learning paradigm of problem-first,

cognitive apprenticeship. Beginning with a particular AI4S micro-problem, learners in collaboration with mentors will engage in autonomous acquisition of the necessary AI tools and domain knowledge as they go through the entire process of defining problems, preparing data, modeling, validating and iterating on models, and presenting outcomes. Teachers serve both as domain specialists and data professionals who realize that they are learning through practice and simultaneously creating. The paradigm is able to focus limited resources of local application-oriented universities on a cluster of problems that concern certain regional-specific industries, establishing accumulable datasets, model libraries, and case repositories, which in turn can reduce the marginal cost of future education over time.

4. Pathways for Paradigm Implementation

4.1. Reconstructing “Building Block” Interdisciplinary Course Clusters

The habit of designing courses based on first-level disciplines should be broken and instead, the curriculum must be based on local industries and AI4S application scenarios. It contains a general module entitled Introduction to AI + Data Thinking, a methods module entitled Computer Vision/Natural Language Processing + Industry Data, and X-direction modules entitled Smart Agriculture, Smart Manufacturing and Smart Health. Micro-credentials programs need to be supported to motivate learners undertaking agriculture studies, mechanics or chemical engineering to minor in AI + Industry. The course content must contain desensitized data and actual cases of regional companies, so that the course remains up-to-date with the industry changes.

4.2. Building “Virtual-Physical” Integrated Innovation Workshops

Based on the existing university experimental platforms, open AI4S innovation laboratories need to be created, which are supplied with the required GPU computing power, public datasets, and model development environments. On the other hand, the concept of the so-called "AI+X" joint workshops must be jointly established with major local businesses, converting the enterprise pre-research projects and technological issues into student innovation problems. Implementation of project curricularization is needed: teachers break down the horizontal projects of research into smaller projects that can be worked on by undergraduate students, use them as part of the course assessment or innovation and entrepreneurship points, and have them done by students in groups, creating a closed loop of learning output - project results - enterprise use.

4.3. Establishing a Dual-Tutor System Integrating Industry and Education

Enterprise AI engineers and industry professionals are to be used as industry mentors who will join campus-based professional teachers to jointly oversee interdisciplinary teams. Industry mentors focus on defining the boundaries of a problem and engineering implementation whereas on-campus mentors focus on making it scientifically deep and integrate knowledge. Conducting regular AI4S Innovation Hackathons regularly enable the students to organize cross-

disciplinary teams in 48 hours to address the short-cycle challenges posed by enterprises, thus identifying promising projects and talent. At the same time, new teachers need to be placed in cooperative companies to undertake six-month residencies and bring their practical experience back into teaching.

4.4. Building a Progressive “Ideation–Prototype–Startup” Incubation Chain

The stepwise incubation system must be built: “course project-national student innovation training program-subject competition-entrepreneurship nursery-university science park.” It should focus on the discovery of AI4S issues and data insights during the ideation stage, minimum viable products, i.e., a working pest diagnosis application, at the prototype stage, and connections with venture capital and industrial capital assist students in setting up startups when they reach the startup stage. The assessment system should also be reorganized, with technical prototypes based on AI4S, the level of quality of the constructed datasets, and the extent to which contributions were made during the interdisciplinary collaboration process being prioritized over merely presenting a business plan.

5. Preliminary Practice and Reflections

A practice-based university, making use of its agricultural capabilities, initiated the AI4S project on innovation and entrepreneurship which is known as “Intelligent Seed Industry”. In reaction to the demand of a major local seed company, the university established an interdisciplinary group of staff and students of data science, agronomy, and automation, who aim at selecting quality seeds with machine vision and hyperspectral imaging technology. Within one year, the team has built a dataset of tens of thousands of seed images, trained a lightweight model with a recognition rate of 96 percent, and prototyped a mobile seed sorter. The project received an honor award at the provincial level in the form of the Challenge Cup and successfully launched an agricultural technology startup that offers AI testing services to small and medium-size local seed companies. Throughout the process, students of agronomy learned the art of data annotation, model evaluation and students of computer science developed a profound understanding of the biological features of seeds, really attaining cross-fertilization of the form of AI + X.

The practice at the same time revealed a number of underlying contradictions. To start with, the AI literacy of teachers was insufficient: certain domain educators could not convert their own expertise into computable problems in science, which led to unclear instructions on projects in initial phases. Secondly, there were clashes between disciplinary cultural mindsets as the engineering culture of accuracy came into conflict with the interpretation culture of domains at times. Third, there was a constriction of computing power and data resources, and reliance on external cloud services raised the question of cost and sustainability. As a result, the university is developing an AI4S Teacher Training Program, setting up interdisciplinary virtual teaching and research divisions to enable regular conversations, and working with the municipal government to create shared edge computers to remove the obstacles. The practices imply that AI4S-induced innovation and entrepreneurship learning in local application-focused universities is not going to be done in a single night

but will take the process of ecosystem enhancement.

6. Summary

AI for Science is not just a paradigm shift in research paradigm, it is also a concept renewal and practical direction on interdisciplinary innovation and entrepreneurship education at local application-oriented universities. The paradigm of AI+X supported by AI4S, which is based on real-world problem-based learning, integration of domain knowledge, and synergy between industry-education ecosystems has the potential to close the gap between the competency constructs of the applied talents and the requirements of the industry. Regional industrial characteristics must be considered as the basis of local application-oriented universities, AI4S must be deconstructed as an elite research institution discourse into educational practice to nurture applied innovative talents, and systematic reform of curricula, platforms, faculty and assessment should be planned carefully. In the future, with the greater accessibility of multimodal large models, automated machine learning, and other technologies, AI4S will infiltrate scientific issues in all fields. It is the duty and capability of local application-focused universities to write a new chapter in interdisciplinary AI + X innovation and entrepreneurship education in this transformational process and take advantage of the opportunity

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