普通高等教育机电类规划教材

知识创新学

刘助柏　梁　辰　著

机械工业出版社

本书是一部关于自然科学与社会科学交融于科学研究——知识创新领域的专著。它的研究对象是知识创新能力、知识创新规律、知识创新教育及其相互关系，这些内容形成了《知识创新学》的基本理论与实践体系；它的任务是启迪与诱发大学生及读者的创造力；撰写此书的目的是引导大学生及读者加速创新入门与缩短尔后生产知识——取得科研成果的时间。

本书共分5篇：导论、知识创新能力、知识创新规律、知识创新教育及理学与工学知识创新的特征。包括16章：创新与思维的发展，知识创新与知识经济；知识创新能力理论框架，创新基础，创新智能，创新意识，创新方法；知识创新规律理论框架，课题来源于三大信息，发现问题与解决问题的科学划分，正确进行知识创新的四大要素，知识创新认识发展的总过程及其模式；知识创新教育理论框架，创新教育的实施；院士思维选例，理学和工学知识创新的规律。

本书适用于高等院校理工类大学生教育，也可作为理工类年轻教师培训教材；可供从事自然科学领域研究的科研人员、工程技术工作者阅读，也可供大专院校教师和管理干部参考。

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前　言

本书是一部关于知识创新范畴内容的著作，取名为《知识创新学》。

——如何全面推进素质教育，如何在高等教育中落实“培养大学生的创新能力、实践能力和创业精神”[1]，是摆在高等教育工作者面前的一项急需解决的神圣任务。

——江泽民指出：“关于加紧培养人才的问题，我一九九八年参加两院大会时曾经突出地讲过。今天，我还要强调一下这个问题。我们党和国家事业的兴旺发达和长治久安，需要一大批各行各业的优秀人才。我国科技事业的发展，也需要培养和造就一代年轻科技人才。这是一项十分紧迫而重大的战略性任务。现在看得越来越清楚，当今和未来世界的竞争，从根本上说是人才的竞争。我国要跟上世界科技进步的步伐，加快科技创新和知识创新，必须有一批又一批的优秀年轻人才脱颖而出。”[2]

作者想在“全面推进素质教育”和“培养人才”方面，尽力做些工作，故欣然应约，撰写此书。

本书阐述主要内容：知识创新能力，知识创新规律，知识创新教育及其相互关系。这些内容形成了《知识创新学》的基本理论与实践体系。本书的任务是启迪与诱发大学生及读者的创造力。撰写此书的目的是引导大学生及读者加速创新入门与缩短尔后生产知识——取得科研成果的时间；明确目标，加大科教兴国的力度与增强国家的创新能力。

为此，在撰写此书的过程中，努力按着下列原则进行：一，根据“创新是一个民族进步的灵魂”[3]“创新是人的能动性的最高表现”[4]和“科学的本质就是创新”[5]，来界定创新的内涵与理念；二，按着理论“与时代同行”[6]，“踏在跨世纪的台阶上”[7]满腔热忱地迎接知识经济的到来；三，遵循“不丢老祖宗，发展老祖宗”[8]的思想来看待自然，看待社会，看待知识创新。

通过艰辛努力，本书写成5篇：导论、知识创新能力、知识创新规律、知识创新教育及理学与工学知识创新的特征。包括16章：创新与思维的发展，知识创新与知识经济；知识创新能力理论框架，创新基础，创新智能，创新意识，创

新方法；知识创新规律理论框架，课题来源于三大信息，发现问题与解决问题的科学划分，正确进行知识创新的四大要素，知识创新认识发展的总过程及其模式；知识创新教育理论框架，创新教育的实施；院士思维选例，理学和工学知识创新的规律。

从上述内容中，可以看出该书的特点。

第一个特点是自然科学与社会科学融于一体。过去，在高等学校的教育中，自然科学与社会科学是脱离的，“鸡犬之声相闻，老死不相往来”。《知识创新学》的内容自然地把它们两者紧紧地捆在一起。

第二个特点是选中了在高等教育中全面实施素质教育的最佳切入点。在高等学校，“实施素质教育，把德育、智育、体育、美育等有机地统一在教育活动的各个环节中。”[1]具体怎样统一？《知识创新学》全面解答了这一问题。

第三个特点是能做到教与学的统一。在高等教育中，“智育工作要转变观念，改革人才培养模式，积极实行启发式和讨论式教学，激发学生独立思考和创新的意识，切实提高教学质量。要让学生感受、理解知识产生和发展的过程，培养学生的科学精神和创新思维习惯，重视培养学生收集处理信息的能力、获取新知识的能力、分析和解决问题的能力、语言文字表达能力以及团结协作和社会活动的能力”[1]这要求做到教与学的统一，才能真正实现。所以，《知识创新学》既是大学生学习的教材，也是教师，尤其是年轻教师必读的课本。

关于加强培养人才的问题，江泽民主席1998年参加两院大会时曾经突出地讲过，并在2000年6月5日的两院大会上又强调这个问题。为什么？这个问题太重要了！“形势逼人啊！我们不加紧努力，与世界先进水平的差距就会进一步拉开。”“有没有创新能力，能不能进行创新，是当今世界范围内经济和科技竞争的决定性因素。”[2]

《知识创新学》将在理论与实践上涉及这些问题。培养出来的人才“有没有创新能力”？首先，培养者和被培养者应明确创新能力的内涵是什么；如何从创新能力这个整体出发，从哪几部分相互整合，去揭示或建构整体大于部分之总和的框架，这是一个理论问题，也是一个等待实践的问题。作者试探性地对该问题进行了探讨，发现并提出了知识创新能力构成系统[9]，该构成系统称作知识创新能力的理论框架，并对它进行了科学解析。

“能不能进行创新”？取决于培养出的人才是否掌握了创新规律。创新规律是客观存在的。有成就的科学家，无论他有意还是无意，总是按着一定的规律在进行科学创新活动。创新规律在科研实践中可以自己摸索。但到自己摸索已掌握该规律时，人的最佳创新年华可能已过。加强创新思维、规律与方法的学习，掌握创新规律，可赶上或提前进入人的最佳创新年华，是很有意义的。

作者对已有成就(包括自然辩证法中“科学技术方法论”)和自己的科技创新实践[10,11]，进行了综合、分析与概括，形成了知识创新系统工程图及其5个子系统——形成科研问题(感温具体)、科学抽象(理性认识)、科学实验(抽象第一具体)、科学结论(抽象第二具体)和承认与评价(真理的客观性)。知识创新系统工程图，又称为知识创新规律的理论框架[12]。

而培养出来的人才“有没有创新能力”和“能不能进行创新”，关键在于教育。根据创新能力的构成系统，创新教育的内涵可以综合由创新基础教育、创新智能教育、创新意识教育、创新方法教育所组成与相互交织一起，自然科学与社会科学交融于一体的教育系统。这个系统是一个理论与实践、自然科学与社会科学融于一体的知识创新教育的理论框架[13]。理论框架的实施，使大学生“坚持学习科学文化与加强思想修养的统一，坚持学习书本知识与投身社会实践的统一，坚持实现自身价值与服务祖国人民的统一，坚持树立远大理想与进行艰苦奋斗的统一”[1]。

为了更好地综合与学习理学与工学知识创新的特征，我们选用了23位中国院士的“院士思维”。每位分四个栏目：简介、思维特色形成背景、主要贡献与思维之光。其中多数是从《院士思维》卷一卷二中引用的。少数几位是作者特约邀请撰写，其中路甬祥院士用毛笔手书，使作者感激不已。在此我们并代表读者对他们深表谢意。

本书的结构和体系是创新构建的。在填充该结构与体系的空间时，引用与综合了众多作者的文章内容。在此，对被引用与综合的文章作者致以真诚的感谢。

知识创新是一门软科学系统工程，有着极为丰富的内涵。作者企望《知识创新学》的出版，能起到一个抛砖引玉的作用，能得到关心此研究课题的同行们重视，大家来完善它，作者也就感到由衷欣慰了。限于作者水平，书中错误与不妥之处在所难免，恳请读者批评指正。

“创业维艰，奋斗已成。历史的胜利与成功，永远属于具有崇高理想、坚定信念的艰苦奋斗的人们”[14]。

祝愿我们的国家早日跨进世界科技强国之列！

作　者

于燕山大学

PREFACE

This book, named on knowledge innovation, discusses questions about knowledge innovation.

——It is an urgent great mission before higher-educators how to improve the quality education wholly and how to realize the cultivation of college students with the innovation ability, the practice ability and the carving-out ideas.

——Chairman Jiang Zemin pointed out, "I stressed the issue with regard to quickening cultivation of talents at the meeting of two academies in 1998. Now, I reiterate the point. Prosperity and long peace of our Party & national undertaking depend upon lots of intellectuals from all woks of life. The development of sciences and technologies necessitates generations of young scientific and technological talents to be cultivated and developed. It is an urgent grand strategic task. More and more obviously, competition in nature at present and in the future is that for talents. In order to keep pace with scientific and technological development in the world and to accelerate scientific & technological innovation and knowledge innovation, generations of young talents should stand out."

With the concept of doing some work in improving the quality education comprehensively and cultivating talents, the authors were pleased to accept suggestion of writing the book.

The ability of knowledge innovation, the laws of knowledge innovation, the education on knowledge innovation and their relationships between each other are included and form the basic theories and practice system. The task and purpose of the book is to enlighten and guide college students and other readers to creativity, and to guide them to speed up innovation and shorten the period span of producing knowledge and to set up a clear goal of making our thriving country through science & education and namely making scientific research achievements, enhancing national creativity.

Therefore, the following principles are followed in writing the book: the first one is to give a definition of innovation and to explain its connotation according to the ideas that ***innovation is the key to national progress*** and ***science in nature is innovation and innova-***

tion tops initiative. The second one is to welcome the knowledge economy in high spirits according to the ideas of ***go with the times*** and ***step on the threshold of cross-century***. The last one is to treat the nature, the society and the knowledge innovation in the opinion of ***developing ancestors' theories instead of discarding them***.

With much effort, the book is completed in five parts: Introduction, the Ability of Knowledge Innovation, the Laws of Knowledge Innovation, the Education on Knowledge Innovation and the Features of Knowledge Innovation in Science and Engineering. Further, it is divided into 16 chapters: Development of Innovation and Thoughts, Knowledge Innovation and Knowledge Economy, Theory Framework of Knowledge Innovation Ability, Bases of Innovation, Innovation Intelligence, Innovation Consciousness, Methods of Innovation, Theory Framework of Knowledge Innovation Laws, Projects are from Three Channels, Reasonable Classification of Perceiving Problems and Solving Problems, Four Elements of Knowledge Innovation, General Process and Mode of Recognition Development of Knowledge Innovation, Theory Framework of Education on Knowledge Innovation, Implementation of Innovation Education, Selection of Thoughts of Academicians, Laws of Knowledge Innovation in Science and Engineering.

The features of the book are shown by the contents above as follows:

The first one is combination of science with social science, which was separated from each other in the past higher education, just as a Chinese saying, hens and dogs never communicate although they hear each other. They are unified in the book logically here.

The second one is that the book is finished just when quality education is carried out in higher education. Quality education should be implemented in higher education to unify virtue education, intelligence education, physical education and aesthetics education in the whole education system. How to unify them? The book gives the answer comprehen sively.

The last one is the unification of teaching and studying. In higher education, intelligence education workers should change ideas, innovate in talent cultivating mode, implement actively heuristic and discussing teaching, induce students to independent thinking and innovation and improve teaching quality substantially. In addition, they should make students appreciate and understand the process of knowledge creation and development, develop students with scientific spirits and innovative thinking habits, pay attention to the fostering of students' abilities of collecting and processing information, acquiring new knowledge, analyzing and solving problems, expressing in writing & speech and cooperating in team and social activities. The task cannot be done until the unification of teaching and studying is accomplished. Thus, the book is not only the teaching material for college students but also

the indispensable reference for teachers, especially for young ones.

With regard to the cultivation of talents, Chairman Jiang Zemin stressed it in the meeting of two academies in 1998. He repeated it in the meeting of two academies on June 5, 2000. Why? This is a very important issue. The situation is urgent! "We must take efforts. Otherwise the advanced level in the world will leave us behind far away." "Owning innovation ability is the decisive factor when we are competing in economy and science and technology in the modern world."

On Knowledge Innovation covers these topics in theory and practice. To cultivate talents with innovation ability, cultivators and cultivatees should understand the connotation of the innovation ability at first. How to reveal or construct the frame that the whole body is larger than summation of all parts beginning with generalization of the innovation ability and reconstruction of some parts? It is a theoretical problem and also practical one. Discussing tentatively the problem, the authors found and presented the architecture of knowledge innovation ability called the theory frame of knowledge innovation ability on which a scientific analysis is given.

The key to the innovation ability is to master the innovation laws that exist objectively. A successful scientist follows a certain law in activities of scientific innovation although he or she might not realize the fact. The ability of knowledge innovation, the laws of knowledge innovation, the education on knowledge innovation and their relationships between each ofther are included and form the basic theories and practice system. The task and purpose of the book is to enlighten and guide college students and other readers to creativity, to speed up innovation and shorten the period span of producing knowledge, namely making scientific research achievements, and to set up a clear goal of making our thriving country through science & education and enhancing national creativity.

The authors synthesize, analyze and summarize the existing achievements (including ***on Scientific and Technological Methods*** in nature dialectics) and their own innovation experience in sciences and technologies and give the system engineering diagram of knowledge innovation and its five subsystems that include finding scientific& technological research projects (apperceiving and reviewing concretization), scientific abstraction (rational recognition), scientific experiments (first concretization of abstraction), scientific conclusions (second concretization of abstraction) and recognition and valuation (objectivity of truth). The system-engineering diagram of knowledge innovation is also called the theory frame of knowledge innovation laws.

To develop talents with innovation ability depends on education. According to the ar-

chitecture of innovation ability, the innovation education includes education on innovation base, innovation intelligence, innovation consciousness, innovation methods that constitute a system of education combining science and social science. The system is a theory frame of knowledge innovation education unifying theories and practice and combining science and social science. The application of the frame helps college students to unify study of scientific knowledge and improvement of virtue quality, written knowledge and social practice, ego-valuation and nationalism, setup of great ambitions and hard working.

In order to synthesize and study better the features of knowledge innovation in science and engineering, academician' s thoughts of 22 academicians are selected. There are four columns: Introduction, Background of Thinking Features, Main Contributions and Thinking Inspiration. The majority of them are cited from volume 1 and volume 2 of Academician' s Thoughts while some academicians themselves write others. Among other things, Lu Yongxiang, the head of Chinese Academy wrote a part in brush pen and the authors appreciate deeply his support. Herein, we are thankful for them on behalf of readers.

The architecture of the book is based on innovation. When it is substantiated, the authors cite and synthesize many writers' papers. Sincere thanks go to them.

As a systemic engineering of soft science, the knowledge innovation owns plentiful contents. The authors hope the publication of this book will attract people to present better ideas and get researchers in the field to pay attention and to improve it. If so, the authors will be pleased. With the limit to the authors' knowledge, there should some faults or even mistakes about which we are glad to know from readers.

"Carving out is difficult while efforts counts. Accomplishments and achievements should at last go to those who have grand ideals and Attic faith and stick to them."

Wish our country became one of strong powers in the world in the field of sciences and technologies earlier!

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