Analysis of Academic Career Characteristics and Influencing Factors of Researchers Based on Life Cycle Theory: Postprint

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Date: 2023-10-08T00:00:00+00:00

Abstract

[Purpose / Significance] This study dissects the current research status of academic lifecycles, analyzes deficiencies and omissions in existing studies, and proposes directions for improvement and priorities for future research.

[Method / Process] The characteristics of each stage of the academic lifecycle and existing classifications of influencing factors are analyzed, the features of current research are examined, and their deficiencies are identified.

[Results / Conclusion] Problems in current research include: a predominance of qualitative studies with limited quantitative research; consideration of only long-term, singular influencing factors; neglect of inter-disciplinary differences; and biases and limitations in sample selection. Future research prospects: Through the integration of qualitative and quantitative methods combined with specific data analysis, derive the growth patterns of researchers while considering disciplinary differences and inherent variations among research groups, thereby providing references for researchers' academic career planning and supporting national and institutional talent policy formulation.

Full Text

Analysis of Characteristics and Influencing Factors of Researchers' Academic Careers Based on Life Cycle Theory

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Abstract: [Purpose/significance] This study examines the current state of academic life cycle research, analyzes existing shortcomings and omissions, and proposes directions for improvement and future research priorities.

[Method/process] We analyze the characteristics of each stage of the academic life cycle and existing classifications of influencing factors, evaluating the features of current research and identifying its deficiencies. [Result/conclusion] Current research suffers from several problems: an over-reliance on qualitative methods with insufficient quantitative analysis; consideration of only long-term, singular influencing factors; neglect of disciplinary differences; and bias and limitations in sample selection. Future research should combine qualitative and quantitative methods with concrete data analysis to uncover the growth patterns of researchers, while accounting for differences across disciplines and research groups, thereby providing references for researchers' career planning and informing talent policy development for nations and institutions.

Keywords: academic life cycle; academic career; talent growth patterns; talent policy
Classification Number: G316
Citation Format: Zhao Yue, Xiao Xiantao. Analysis of Characteristics and Influencing Factors of Researchers' Academic Careers Based on Life Cycle Theory [J/OL]. Knowledge Management Forum, 2017, 2(2): 136-144.

In the era of knowledge economy, the knowledge industry has become a leading sector, with knowledge creation and accumulation closely related to technological progress and social development. Researchers, as the primary agents of knowledge creation and accumulation, are profoundly important to study in terms of the factors influencing their knowledge production. Physiological age, as one such factor, serves not only as a temporal marker but also as a conceptual lens for understanding the characteristics of different stages in a researcher's academic career. Today, as the cultivation and development of research talent have become institutionalized and professionalized, the correlation between researchers' academic performance and their physiological age has grown increasingly strong. For researchers themselves, these findings offer valuable references for career planning, helping them quantify their academic performance throughout their careers and identify their position and direction for improvement. For research institutions and nations, the results can not only help discover talent growth patterns but also inform the rationality of various academic system and policy designs.

This paper synthesizes existing academic life cycle theories and literature on researchers' careers, primarily analyzing relevant concepts, research status, major problems, and future research priorities regarding researchers' academic life cycles and their influencing factors.

1. Concept and Connotation of Academic Life Cycle

The life-cycle approach was first proposed by A. K. Karman in 1966, dividing the development process of things into initial, growth, maturity, and decline stages. For an individual, the life cycle comprises infancy, adolescence, adulthood, and old age; for a product, it includes production, formation, development, and decline stages. Since its inception, life cycle theory has gained widespread attention and been applied across various industries, from traditional domains like enterprise and product life cycles to more innovative applications such as network information life cycles and urban life cycles. Similarly, researchers' academic careers follow life cycle patterns, representing a long-term, continuous process of knowledge creation.

In summary, this paper defines researchers' academic life cycle as the entire process from entering academic research to exiting it, aiming to analyze the research status, identify existing problems, and propose directions for improvement and future research priorities.

2. Stages of Researchers' Academic Life Cycle Based on Life Cycle Theory

Domestic and international research on researchers' academic careers has emerged, with scholars beginning to propose the concept of academic life cycle (see). Despite varying definitions, existing perspectives generally agree that researchers' academic life cycles follow the pattern of "startup—development—maturity—decline."

** Scholars' Perspectives on Academic Life Cycle**

Scholar	Perspective
Yuan Xilin et al. [1]	Research talent development generally experiences startup and growth, standardization and stability, individuality and creativity, and aging and decline stages
Gui Zhaoming [2]	Those who achieve greatness in research typically undergo 10-15 years of continuous accumulation, passing through entry, growth, maturity, and expertise stages
Jin Zhenxin et al. [3]	Distinguishes stages of scientific talent growth based on innovative output; the entire life cycle experiences "seed" stage → "core" growth stage → "core" formation state → development stage → stability stage → transition stage
Wang Haifeng et al. [4]	Young scientific and technological innovation talent growth can be divided into learning preparation, adaptation and growth, maturity and stability, and peak and decline stages

Scholar	Perspective
L.G. Katz [5]	Four career development stages for researchers: survival, consolidation, renewal, and maturity
A. F. Gregoric [6]	Four stages of researcher career development: formation, growth, maturity, and full specialization
D. F. Demoulin et al. [7]	Four stages of teacher career development: provisional, developmental, transitional, and declining; decline begins after reaching the peak
S. E. Dreyfus [8]	An expert's growth process roughly divides into five stages: novice, advanced beginner, competent, proficient, and expert

2.1 Startup Stage

Researchers in this stage have typically just obtained their degrees and represent potential assets in the research talent pipeline, characterized by strong innovative consciousness and high research enthusiasm. They possess the latest knowledge and skills, and although their research output is just beginning, they have substantial development space with their careers on an upward trajectory. Simultaneously, startup-stage researchers exhibit considerable instability, not yet fully committed to research careers, and are less mature in thinking compared to those in other stages. Their choices regarding research institutions and living environments also lack stability.

Existing research on this period primarily focuses on discussions about training models and innovation capacity development for these researchers, emphasizing qualitative studies. For example, Zuckerman noted that "elite scientists demonstrate precocious characteristics early in their careers through publishing papers" [9]. Wang Haifeng et al. analyzed potential influencing factors on young scientific and technological innovation talent growth during the startup stage, including personal, family, and social factors, and proposed relevant training model recommendations based on these influences [4]. Additionally, some research concentrates on analyzing researchers' educational backgrounds, such as highest degree attainment, mentorship experiences, and overseas training.

2.2 Development Stage

Upon entering the development stage, researchers gradually achieve results, demonstrate their talents, maintain stable research output, and begin securing projects and funding, with their research careers flourishing. Research on this stage primarily focuses on role transformation. In this phase, research talent individuals have completed training in theoretical knowledge, professional ethics, and research methods, and their work extends beyond scientific research to creative labor in teaching and other positions, yielding certain research outcomes. Researchers in practical disciplines emphasize the alternation and mutual transformation of practice and creative achievements. Moreover, scholars in this stage gradually begin emphasizing collaboration, including international cooperation. Scientific research requires individual dedication and 攻关 (breakthrough efforts), but even more importantly, requires good collaboration among researchers to promote more excellent results.

2.3 Maturity Stage

Research on the maturity stage of academic careers concentrates primarily on the peak period of research output. Although scholars use different terminology for this peak period, the core connotation remains the same: focusing on the golden age of research output and proposing recommendations for research investment and talent policy. Major perspectives from existing research are listed in .

** Concepts Related to Research Output Peak Period**

Concept	Definition
Optimal Age for Scientific Discovery [10]	The period in a researcher's life when both memory and comprehension are strong, i.e., the "golden age" or "optimal age zone"
Creative Peak Age [11]	The age at which major scientific and technological achievements are obtained within a certain period is defined as the researcher's creative peak age
Research Output Peak Period [12]	The appropriate time when researchers achieve major scientific and technological results and maintain relatively high output after the peak
Output Peak Age [13]	The year corresponding to the maximum output value within an analyzed time interval is defined as the output peak year
peak age of achievement [14] H.C. Lehman	The most important achievements of scholars in fields including scientists, physicians, physiologists, musicians, philosophers, artists, and writers
creative productivity as a function of individual age [15] D. K. Simonton	The age at which individual researchers produce the most creative research results
peak age of scholarly creativity [16] K. L. Horner et al.	The age at which researchers produce more output than peers at the same or lower level

Concept	Definition
peak of age-achievement relation [17] B. A. Weinberg et al.	The age at which the most highly cited articles in Web of Science are published
achievements [18] B. F. Jones	The age at which major discoveries are made
age of peak creative performance [19] K. H. Frosch	The age at which major scientific and technological innovations (including publications, major awards, and important inventions) are produced

2.4 Decline Stage

After development through the previous three stages, researchers have reached considerable heights in knowledge accumulation and academic experience. However, their knowledge gradually becomes outdated compared to researchers in earlier stages, making them prone to fixed thinking patterns and significantly diminished creativity. Only a 极少数 (very small minority) maintain a continuous upward trend in research output; most researchers shift their research energy toward mentoring and cultivating talent, with research outcomes diversifying into forms such as monographs, academic conferences, and supervised master's and doctoral students.

Most scholars agree that research output shows a declining trend during this stage. Notably, some studies indicate that for researchers engaged in creative work, the relationship between age and performance may exhibit a bimodal distribution.

3. Research Status on Influencing Factors of Academic Life Cycle

Domestic and international research offers rich perspectives on factors influencing research output across the academic life cycle. This paper summarizes common influencing factors in existing studies, categorizing them into long-term factors and stage-specific factors (see), and elaborates on each in detail.

** Summary of Academic Life Cycle Influencing Factors**

Category	Main Related Factors
Long-term Factors	Gender, birthplace region, family background, "research quotient"

Category	Main Related Factors
Stage-specific Factors	Disciplinary and educational background differences, academic age, mentorship relationships, marital status, opportunities, administrative appointments, research collaboration, talent cultivation, academic achievements

3.1 Long-term Factors

Most existing research on factors influencing academic performance focuses on long-term factors such as gender and birthplace region. These factors often begin affecting researchers' academic performance from the startup stage of their academic life cycle and persist throughout their entire careers.

3.1.1 Gender J. R. Cole's 1979 publication *Fair Science: Women in the Scientific Community* addressed gender's impact on research careers [20]. P. P. Zhu et al. explored direct and indirect influencing factors in female talent development [21]. Beyond traditional factors, the article divided influences and effects into two stages and proposed conclusions and recommendations for female talent growth. Dong Lijuan et al. analyzed the current status of Chinese female scientific talent in terms of science awards, Outstanding Young Scientist Fund awards, and gender ratios among academicians, preliminarily evaluating the implementation effects of China's female scientific talent policies [22].

3.1.2 Social Background **(1) Birthplace Region**
Regional economic conditions significantly influence cultural atmosphere. In modern society, regional differences in education levels have narrowed, and birthplace region's impact on researchers primarily manifests in cultural atmosphere differences. Most researchers experience different cultural atmospheres due to political and economic variations in their birthplace regions. From psychological and physiological perspectives, these external environments substantially influence researchers' knowledge reserves and creative output, creating differences in future career development.

Xu Fei et al., in their study of modern Chinese scientists, mentioned and statistically analyzed birthplace region's impact on scientists' growth. Results showed that scientists from seven economically and culturally developed provinces and municipalities—Jiangsu, Zhejiang, Guangdong, Shanghai, Fujian, Hebei, and Beijing—accounted for 68% of all modern Chinese scientists [23].

(2) Family Background
Family background includes not only household income but also family members' occupations and education levels. On one hand, good economic support provides essential material conditions for researcher development. On the other

hand, family cultural background determines the emphasis placed on children's education, with parents' occupations and education levels subtly influencing children's learning habits and perspectives.

Scholars consistently agree, whether through sample analysis or personal examples, that family background significantly influences value formation and research careers. Some argue that good economic conditions and parental emphasis on education provided fundamental guarantees for the development of National Highest Science and Technology Award winners [24].

In November 2016, R. Sinatra et al. published *Quantifying the Evolution of Individual Scientific Impact* in *Science*, introducing the concept of "research quotient" (RQ). Analogous to IQ, RQ can be understood as a score representing a scientist's research capability. Sinatra et al. argued that a scientist's RQ remains largely unchanged throughout their career, like IQ, and that outstanding research results (high-impact achievements) depend on two factors: RQ and luck [25]. The authors do not suggest that academic accumulation and effort are useless, but rather that RQ has a greater influence.

3.2 Stage-specific Factors

The factors discussed above—gender, birthplace region, etc.—are singular factors that influence researchers' academic performance from the initial stage and throughout their careers. However, factors affecting the academic life cycle result from multiple factors working together, with different dominant factors at different stages. To better understand each factor's role at different academic life cycle stages, this paper discusses influencing factors on researchers' academic performance by stage.

3.2.1 Startup Stage (1) School, Discipline, and Education Differences

Differences in schools and disciplines objectively affect academic performance. Li Yu demonstrated C9 universities' research scale, advantageous disciplines, and development speed in interdisciplinary research from perspectives of output quantity, leading conditions, research fields, and themes, dividing the nine universities' research output into three tiers [26]. Xu Fei et al. analyzed the alma maters of Nobel laureates from the US, UK, Germany, and France, finding that a small number of top research universities produced the vast majority of Nobel Prize winners. "Students entering prestigious universities not only have more promising futures but also access superior learning resources, including first-class research facilities, research traditions, cultural atmospheres, interpersonal resources of core scientists, and geographic advantages in science, all of which facilitate research achievement when effectively utilized" [27].

(2) Academic Age

Miao Yajun et al. marked the year of a highly cited scientist's first publication as the origin of academic age, arguing that analyzing researchers' academic productivity and impact from the academic age perspective is essential [28]. Zhou Daya specifically studied the academic age characteristics of distinguished scholars at the Chinese Academy of Social Sciences [29]. In recent years, international research has also recognized academic age applications. S. Milojević applied academic age in analyzing researchers' citation behaviors, research output, and collaboration patterns [30]. B. Primack et al., when studying factors influencing journal review decisions, defined submitters' age as academic age [31].

(3) Mentorship Relationships
Mentor guidance significantly influences academic performance. Current research lacks specific boundaries for defining mentorship relationships, including relationships between advisors and graduate students, postdocs, visiting scholars, and research assistants, with some scholars even recognizing parent-child relationships as mentorship. Mentors influence research careers by guiding research direction selection, determining research topics, and providing concrete, accurate, and effective guidance throughout the research process, helping students avoid detours.

3.2.2 Development and Maturity Stages (1) Marital Status

International perspectives on factors affecting research output are relatively rich, with some scholars arguing that marital status should be considered. E. S. Loh, using white males as a sample, discussed marriage's impact on output, concluding that marriage inhibits research productivity [32]. Domestic research rarely considers marital status, focusing mainly on its impact on female scientists. Luan Jingjing, when analyzing key factors influencing graduate students' research outcomes, identified 11 factors affecting total research output, including marital status [33].

(2) Opportunities
Opportunities sometimes matter more than choices and efforts. For researchers, national research policy advantages, professional title promotions, academic achievement awards, major research project assignments, and research funding acquisition can all be considered career opportunities. National research policy advantages can stimulate researchers' innovation and initiative. Professional promotions and academic awards bring not only honors but also access to more academic resources and capital. Major project assignments and funding provide opportunities for training and adequate financial support for future research.

Li Zuchao et al., analyzing factors contributing to the success of 24 National Highest Science and Technology Award winners, argued that besides personal effort and diligence, opportunities played a significant role [34]. E. K. Chung incorporated researchers' professional titles into analyses of collaboration relationships throughout research careers [35].

(3) Administrative Appointments
Merton identified four main social roles for scientists: research, teaching, man-

agement, and gatekeeping [36]. The management role refers to "administrative appointments." Merton also noted that "for outstanding scientists, consistently adhering to academic research should be the optimal career choice."

Regarding administrative appointments' impact on the academic life cycle, Wang Shi et al. conducted in-depth research. Xu Fei et al., comparing administrative appointments between Nobel laureates and Chinese academicians, found significant contrasts between the two groups, concluding that administrative appointments do more harm than good to outstanding scientists' research innovation [37]. Xu Xiangyun et al. argued that administrative appointments for outstanding scientists are "undoubtedly more harmful than beneficial for scientific research activities requiring a spirit of free innovation" [38].

3.2.3 Decline Stage Research output from researchers in the academic life cycle decline stage manifests primarily through co-authorship with peers and cultivated talent, and through diverse output types such as monographs, academic reports, and conference presentations. Therefore, the main factors influencing academic performance in this stage are research collaboration, talent cultivation, and academic achievement diversification.

4. Major Problems and Limitations in Existing Research

Current research on researchers' academic life cycles is uneven, with most studies merely preliminary explorations containing many problems. These can be specifically summarized as follows:

4.1 Predominance of Qualitative Research, Scarcity of Quantitative Studies

Early discussions on the relationship between academic performance and age mostly 局限于 (were limited to) qualitative research, using induction and deduction, analysis and synthesis, and abstraction and generalization to mentally process materials about researchers without using data to reveal academic performance patterns, thus lacking precise data support. The few existing quantitative studies are limited to simple, superficial descriptive analyses, such as verifying pairwise independence between selected indicators, lacking relatively complex mathematical statistical analysis.

4.2 Analysis Limited to Long-term, Singular Influencing Factors

In analyzing influencing factors, existing research mostly considers long-term, singular factors' impact on research output, rarely analyzing how various factors affect different academic life cycle stages. Researchers operate in complex academic environments where many factors, interactions between factors, and individual differences all influence the academic life cycle, creating diverse academic performance. Specific manifestations include: (1) Complex internal factors. Researchers' different internal factors such as gender, marital status, and academic age lead to different perceptions of research environments, creating different research behaviors and performance. (2) Numerous external factors. Administrative appointments, mentorship experiences, disciplinary and school differences, and peer competition all influence researcher behavior with varying effects. (3) Dynamic changes and interactions among factors. Both internal and external environmental factors change dynamically with different combinations and intensities, resulting in nonlinear influence effects.

4.3 Neglect of Disciplinary Differences

Disciplines differ in knowledge attributes, development history, application fields, and social recognition, creating boundaries and increasingly apparent academic differences between fields. These differences exist not only in researcher and institution evaluation but also constitute an urgent problem across various research domains. Applied to academic life cycle research, this means different disciplines show different academic performance, and using uniform evaluation standards inevitably creates research bias.

4.4 Sample Selection Bias and Limitations

A few studies select samples from single research institutions or university faculty groups for unified analysis. This one-size-fits-all approach lacks specificity, as researchers differ by discipline, research resources, and academic achievements—a phenomenon known as academic stratification. Meanwhile, existing studies considering scientific stratification tend to favor elite groups such as academicians, Nobel laureates, or highly cited scientists. While research on these outstanding scientists provides exemplary models, the rarity of these samples makes it difficult to generalize findings, limiting the reference value of results.

Research on key components of the researcher population remains seriously insufficient.

5. Future Research Directions for Academic Life Cycle

Current academic life cycle research remains in a preliminary stage, with no specific data analysis or results showing researchers' academic performance patterns. Future research space is broad, and this paper suggests in-depth exploration of the following aspects.

First, assign appropriate weights to influencing factors at different academic life cycle stages to help describe researchers' academic performance patterns. Combining qualitative and quantitative methods with researchers' academic achievements and performance data as sources can summarize academic life cycle patterns, providing references for scientific and reasonable career planning.

Second, apply academic life cycle theory. Human life cycles are dynamic processes, and due to extended lifespans, academic training periods, and varying research output cycles, academic life cycles demonstrate distinctive characteristics. For example, researchers in basic disciplines require long-term knowledge accumulation with longer output cycles, so their startup and development stages may occupy larger proportions of their academic life cycles. Therefore, academic life cycle patterns are not universally applicable, and applications must consider disciplinary differences.

Third, the scientific community exhibits differentiation in research resources, achievements, and awards, creating differences within research groups themselves. Future research should, based on summarizing academic life cycle characteristics and influencing factors, further analyze stage-specific patterns, performance characteristics, and personalized manifestations across different research groups (by gender, professional title, honors received, etc.).

Fourth, based on academic performance patterns across researchers' academic life cycles, propose recommendations for talent identification, cultivation, recruitment, and research investment to inform national and institutional science and technology policies. Optimized talent allocation can maximize knowledge creation and contribute more to society. Fully utilizing academic life cycle patterns as references to focus on cultivating and funding key talent in relevant fields and critical stages can maximize the promotion of China's scientific and technological innovation development.

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Author Contributions:

Zhao Yue: Designed paper structure and wrote the manuscript;
Xiao Xiantao: Proposed research ideas, designed research framework, and revised the manuscript.

Knowledge Management Forum
ISSN 2095-5472
CN 11-6036/C
E-mail: kmf@mail.las.ac.cn
http://www.kmf.ac.cn