Study on the Evolution & Basic Status of Professional Education of Traditional Chinese Medicine Informatics in China

Hai-feng YANG¹, Gao-liang WANG¹ and Zhen ZHAO²,*

¹Information Engineering College of Hubei University of Traditional Chinese Medicine, No.1, Huangjia Lake West Road, Hongshan District, Wuhan City, Hubei Province, China 430065
²Network and Educational Technology Center of Hubei University of Traditional Chinese Medicine, No.1, Huangjia Lake West Road, Hongshan District, Wuhan City, Hubei Province, China 430065

*Corresponding author

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Abstract. This study was aimed to summarize regularities and reflect basic status for professional education in Traditional Chinese Medicine (TCM) Informatics in China. Based on the locale research results carried out recently for 3 years by School of Information Engineering in Hubei university of TCM, a vast amount of information was further collected by interviewing with experts in TCM informatics education, or from official websites of TCM institutes. And then, we made a retrospective analysis on the TCM Informatics education development from aspects, such as specialty, cultivation specification, discipline construction, laboratory construction and as well as enrollment plan. The results indicated that the professional education in TCM Informatics had obtained fast development for the latest 20 years, which could be probably divided into three stages, including start-up stage, exploratory stage and developmental stage, and characters for each stage were obvious as follows: a) professional settings and cultivation mode gone formalized; b) cultivation scale tended to be stable; c) academic discipline construction was promoted along with the deepened multi-disciplinary integration. However, significant differences still existed in educational resources and cultivation quality compared with social requirement. It drawn a conclusion that the development modal must be shift from extensive development to intensive development, so as to outstand the characteristics and advantages more distinctly, which should be the right way for the professional education in TCM informatics for the next decade.

Introduction

TCM Informatics, as a new developing discipline, has been formed in the wide application of Information and Communication technologies (ICT). Although there is still lack of authorized definition and specialty scopes of TCM Informatics, it is generally acknowledged to research TCM information to reveal the objective laws governing information movement in TCM system. In order to sort out the development skeleton of professional education in TCM Informatics, specialties or professional directions set up in TCM institutes based on Computer Science or Informatics, were considered as the professional branches of TCM Informatics, such as Computer Science & Technology, Information Management & System, Medical Information Engineering, Software Engineering, Biological Informatics, Internet of Things Engineering and so on.

In recent 10 years, Chinese government has been speeding up the informatization construction in population, health care and TCM, and TCM institutes established several specialties or major fields, which have trained a large number of qualified talents. Although, the data from retrieving CNKI, WANFANG, VIP database etc. by authors, showed that there were more researches about the development process, present situation and future direction of Medical Informatics professional education, and fewer articles relevant with TCM Informatics professional education. Actually, some significant differences existed between them, such as discipline basis, social context, development conditions, and also evolutionary process. Currently, the policy environment, technical and social requirement for TCM Informatics professional education were profoundly changing, so it’s very
important and fundamental to study the evolution and basic status, which will be useful for making
the strategic plan of TCM Informatics professional education.

Development Process

Stage Division

Stage division, as a scientific research method, is usually used to study history by dividing the history
period, aiming at uncovering essence differences between stages, and to discover features and rules of
development. To divide professional education development stage correctly, we need collecting
informative history materials especially important events, and then comparing, analyzing and
summarizing the whole evolutionary process on the basic law of relevant discipline development. There
is rare achievement about TCM Informatics professional education development. In this paper,
we divided the recent 20 years of its evolutionary process into three stages: inception stage (before
2002), exploratory stage (from 2003 to 2012) and development stage (after 2013), according to the
integration degree of multidisciplinary background and the temporal distribution of all kinds of
specialties established in TCM institutes in China.

As it was shown above in figure 1 and 2, the inception stage was characterized with no formal
profession of TCM Informatics established and only some major fields about informatics under single
discipline like Computer Science or TCM. In the exploratory stage, a number of specialties named
variously were established. Although these specialties emphasized for crosses and integration among
disciplines, such as TCM, Informatics, Computer Science, Management Science, their focus were
different and had discrepancies in orientation of talent cultivation. For the development stage,
formally set up specialties were relatively concentrated and normatively named, at the same time, the
degree of multidiscipline integration relied on by all kinds of specialties was deepened, and
characteristics for each specialty gradually formed.
Note: The total enrolments of Medical Information Engineering in Chengdu University of TCM in 2014 and 2015 are unknown and uncontained.

Figure 2. Number of Colleges & Universities, Specialties or Professional Directions and Total Enrolment of TCM Informatics Professional Education in TCM institutes in China from 1999 to 2015[2,3].

Significant Events and Main Features of Each Stage

Initial stage (Before 2002). TCM Informatics education in Chinese originated from the application of computer in domains of TCM scientific research data management, TCM Expert System, TCM hospitals management, etc. In the early 1970s, information technology, especially computer technology, was fleetly concerned by TCM academia, since computer had been applied in the study of mechanism of acupuncture anesthesia. A decade later, several TCM institutes established computer centers to provide application training for researchers and computer basic teaching for internal students. Commissioned by the Ministry of Health, Hubei University of TCM has successfully conducted three national TCM computer application seminars since 1984. These one-and-half-year seminars had explored the extensive development of TCM informatics education and cultivated a batch of qualified personnel for TCM industry. In 1994, Beijing University of TCM established the specialty of Information management & System, as a direction of Healthcare Management talent cultivation. After that, the specialty of Computer Science & Technology was set up in Guangzhou University of TCM in 1997, and then in Jiangxi University of TCM two years later. Until 2000, Heilongjiang University of TCM established the specialty of Computer Engineering, as a Direction of TCM, which marked the formal start of TCM Informatics professional education in China.

The main features of this stage could be summarized as follows: Firstly, TCM Informatics education was mainly carried on with computer programming and algorithms design in the form of academic lectures or continuing education from 1970s to 1980s, which were aimed to meet the requirements of Control Theory of TCM or TCM Expert System Research. Secondly, training programs were turned into the major way of TCM Informatics education in 1990s, which were effectively geared to the demand for rapid development of Hospital Information System (HIS). Thirdly, TCM Informatics had not been presented officially as the name of a new subordinate discipline in TCM, and also no normalized specialty name were put forward in this period. Some TCM institutes had merely set up directions relevant with informatics under TCM or Management Discipline, variously named like Computer Engineering, Medical Computer Science, TCM Information Engineering, etc., and distinct differences existed among these institutions. For example, the length of schooling varied from 4 years to 7 years, and students were awarded with multifarious bachelor's degree, like Medicine, Science or Engineering etc. for lack of unified standards, which usually brought out inconsistencies with the training objectives of directions or specialties alleged by those institutions. What's more, the employment of graduates encountered with great difficulty. Lastly,
the teaching staffs in most institutions were consisted of staffs or teachers who had worked at Computer Networking Center of TCM institutes, or mainly undertaken computer basic courses. A few of these institutions had set up specialties with the help of some comprehensive universities. For example, Zhejiang University of TCM established the specialty of Computer Science & Technology with the utilization of computer education resources in Zhejiang University. Therefore the starting of TCM Informatics professional education was different from Medical Informatics, which was developed from Medical Library and Information Science education.

Exploring stage (2002-2012). In 2002, the specialty of Information Management & Systems was set up and enrolled for the first time in Anhui University of TCM and Hubei University of TCM in all TCM institutions. They were clearly aimed at cultivating compound professional talents with the multidiscipline background of TCM and Informatics, which indicated that TCM Informatics professional education was developed into a new period. Especially, Chinese government paid great attention to the informatization construction in Health and of course TCM contained, after SARS broke out in 2003, which stimulated ICT increasingly applied in various fields of Health and TCM, and also forced great need demands for Medical or TCM information professionals. Meanwhile, Chinese higher education institutions were universal in epochs of development and expansion, characterized as enlarging enrollment scale and expanding campus, but it was difficult for TCM institutes to take advantage of this opportunity, for their relative more single, independent disciplines, and also small enrollment size limited by clinical teaching resources. Against the background, TCM institutes adopted the strategy of taking TCM as the principal discipline with multidiscipline coordinate development, so as to enlarge the educational scale and improve the educational effectiveness, or claim for renaming from TCM College to TCM University. And then, some TCM institutes established one or more specialties of TCM Informatics based on their discipline characteristics and educational resources structure, through integrating teaching resources, including common courses, Computer basis courses, TCM literature study and so on.

There were 5 other TCM institutes established the specialty of Computer Science & Technology before 2006, since what had been done in Jiangxi University of TCM, Hunan University of TCM and Zhejiang University of TCM, but the differences of training goals, directions and curriculums almost did not exist compared with comprehensiveness universities.

During the same time, although the number of TCM institutes setting up the specialty of Information Management & System started from scratch, and increased to 5, and further added up to 9 until 2011, their training goals were different. For instance, the training direction of Hubei University of TCM and Beijing University of TCM was medical information management; however the training direction of Shandong University of TCM and Nanjing University of TCM was medical library information. But all of them were awarded with bachelors of management when graduated. Meanwhile, the discipline construction of TCM Informatics was brought to forefront officially. In 2007, the eleventh five-year plan outline of TCM Informatization development released by Chinese State Administration of Traditional Chinese Medicine (SATCM) proposed that: encouraging and guiding TCM institutes to set up the specialty of TCM information management to cultivate a batch of compound talents who know both TCM knowledge and information technology. And in 2009, TCM Informatics, along with TCM Engineering Science and TCM Clinical Informatics, were identified as a new discipline to be intensively cultivated by SATCM, and Hubei University of TCM and institute of information on TCM in CACMS were evaluated as the first batch of construction units of national key disciplines by SATCM. It should be pointed out that TCM Information Engineering, which was set up as a direction of TCM specialty in Heilongjiang University of TCM, Liaoning University of TCM and Guiyang College of TCM, had been stopped enrollment because of their relative lower recognition degree in society and employment problems.

During 2011-2012, the specialty of Medical Information Engineering, after being set up firstly in Hubei University of TCM in 2005, was established increasingly in other 7 TCM institutes. And although its training goals aimed diversely in different TCM institutions, like digital medical equipment, data mining in TCM or software development for medicine, it was finally brought into the
specialty category for higher education institutes released by Chinese Ministry of Education in 2012, and normalized to award the bachelor degree of engineering.

The main features of this stage could be summarized as follows:

Firstly, the majority of specialies established for training TCM Informatics talents in TCM institutes, could be identified as a result of the intrinsic motivation to supply academic platforms for teachers working in computer basis teaching or technical staffs of Computer Networking Centre, or claim for renaming to TCM University, and stimulated by social demands for informatization construction in Health or TCM.

Secondly, the professional directions initially established for TCM Informatics education in TCM or Management discipline, were gradually transited to normalized specialties in accordance with the specialty category for higher education institute. And of course, the name and length of schooling of specialties were trend to uniformity, and training goals were consistent with the awarded bachelor degree. Especially, recognition degree in society was enhanced and employment problems were relieved.

Thirdly, the structure of TCM Informatics professional education was stable and mainly comprised with three specialties, including Computer Science & Technology, Information Management & System, and Medical Information Engineering. There were no unified training objectives and curriculum setting standards for each specialty, and greatly relying on the conditions of school operation, and also different from comprehensive universities.

Lastly, most of TCM institutes had set up school of information or computer to develop TCM Informatics professional education, and seldom developed that by school of management.

Development stage (2013 - present). In 2012, Chinese Ministry of Health proposed to implement Practical Health Information Technology Talented Person Project and Combined Health Informatization Talents Project in the Several Opinions on Strengthening Construction of Health Statistics and Informatization Talent [6], and strengthening the discipline construction of TCM Informatics was proposed in the Twelfth Five-year Plan for Informatization Construction in TCM promulgated by SATCM[7]. Since then, 8 TCM institutes like Beijing University of TCM and 3 hospitals like Guang’anmen Hospital of CACMS, had been evaluated as the second batch of construction units of national key disciplines by SATCM, which stood for that TCM Informatics professional education had stepping into the stage of steady development. At this stage, more and more TCM institutes established relevant specialities like Medical Information Engineering, Information Management & System. Under the sponsorship of School of Information Engineering of Hubei University of TCM, three national academic conferences of TCM information education were held respectively in Wuhan, Nanchang and Hangzhou during 2011-2013, which promoted the establishment of TCM Informatics education academic organization, and also exchanging experience on TCM information education in China.

The main characteristics at this stage could be summarized as follows:

Firstly, TCM Informatics was officially identified as the key discipline by SATCM, and talents who contributed to TCM Informatics professional education or scientific research, got a rapid growth.

Secondly, training goals of the specialties in TCM Informatics were much clearer, and training patterns were tending to be more normalized, and the idea of connotative development was paid great attention and putting into practice.

Thirdly, the scale of undergraduate training tended to be stable, and the postgraduate education of TCM Informatics had developed rapidly.

Lastly, researching on TCM Informatics education became much livelier, and the scopes of scientific researches were relatively concentrated and stable, and also the academic organizations and social groups in TCM Informatics education gradually formed.
Basic Situation
Through the flexuous development for more than 10 years recently, TCM informatics professional education has achieved remarkable results on all aspect, such as specialty setting, training specification, scale, discipline construction, postgraduate education, academic communication platform and so on.

Specialty Setup
At present, the amount of TCM institutes undertaking TCM Informatics professional education has get up to 20 in the 25 independent TCM institutes in China. And until May 1 in 2017, there were 14 TCM institutes set up the specialty of Medical Information Engineering, 11 set up the specialty of Information Management & System, 9 set up the specialty of Computer Science & Technology, 7 set up the specialty of Biological Informatics, and 1 set up the specialty of Internet of Things Engineering.

Training Specification
Training specifications of TCM Informatics professional talents are formed. In terms of knowledge structure, TCM knowledge is accentuated to reflect the discipline cross and integration of TCM and Informatics. In respect of ability structure, the skill of organizing and utilizing TCM information resources, and the skill of developing, implementing, applying and maintaining medical information system, and especially the skill of processing, analyzing or mining TCM data like TCM clinical big data, are acknowledged as the core three abilities. Regarding the employment direction, it’s mainly oriented to units in health industry, such as health management departments, medical institutions and medical software enterprises, and also shows relatively strong adaptability for others.

Discipline Construction
At least 1 institute, 9 colleges or universities and 3 hospitals in TCM industry have identified as the construction units of national key disciplines by SATCM, which have exerted a great significant effect on improving TCM Informatics professional education and promoting the informatization construction of TCM.

Undergraduate Scale
According to administrative volume in yearbook of TCM of China (2014), the statistical results showed that in 2015, the number of students in 18 TCM institutes undertaking TCM Informatics professional education had risen to 8584, accounting for 4.59 percent of the total number of students in all kinds of undergraduate specialties in these institutes. Three institutes had more than 1000 undergraduate students in TCM Informatics specialties, including Anhui University of TCM, Henan University of TCM and Shandong University of TCM. The top 5 for the percentage of TCM Informatics professional undergraduate students were Anhui University of TCM (11.45%), Shanxi College of TCM (7.42%), Jiangxi University of TCM (7.27%), Henan University of TCM (6.84%), Nanjing University of TCM (6.61%).

Postgraduate Education
The postgraduate education of TCM Informatics has been developing rapidly and begun to take shape, with the promotion of researches on objectification of four diagnostics of TCM, information standardization, data analysis and also knowledge engineering. In terms of master education, there were 16 TCM institutes cultivating postgraduates on various kinds of research directions, for example, History and Literature of TCM, Social Medicine & Health Management, Management Science & Engineering, Computer Science & Technology, and Biomedical Engineering, and additionally, CACMS also trained postgraduates in Library and Information Science. Most of these institutes awarded the master degree of Medical Science, and then Management Science, Engineering.
However, a few of these institutes were qualified to award master degree at the first-level discipline, only Hubei University of TCM and Jiangxi University of TCM could do that in 2013.

As for the doctoral education of TCM Informatics, except for CACMS implementing PhD diagrams of management on the direction of TCM informatics, Shandong University of TCM and Nanjing University of TCM were also offering doctoral education, but the former focused on research about TCM literature informatization, as one direction of History and literature of TCM specialty, while the latter emphasized on TCM Informatics & big data analytics, as one direction of TCM specialty.

Academic Communication Platform Construction

The academic association of TCM Informatics education has been set up gradually. Chinese Health Information Association Special Committee for TCM Information (CHIA-SCTCMI) was founded in August, 2013. Then, July on the next year, China Information Association for TCM and Pharmacy Special Committee for Information Education (CIATCM–SCIE) was established. Since then, it had successfully sponsored three national academic conferences of TCM Informatics education, which caught wide attention of domestic medical information education and were endorsed by almost all of TCM colleges and universities in China. Overall, these academic communication platforms had a great effect on reforming the reform of TCM Informatics professional education, and also exploring the training rule of TCM Informatics professional talents.

Furthermore, 14 of 18 TCM institutes, which were undertaking TCM Informatics professional education, had set up school of information engineering or school of information & technology. And most of them had stable professional teaching staff, and possessed basic conditions like literature material and laboratories. Overall the education system of TCM Informatics was initially formed with reflecting the features of TCM to a certain degree.

Problems and Difficulties

Of course, there are still some problems and difficulties in TCM Informatics professional education. The problems mainly manifest that more efforts are needed for improving specialty positioning, training goals, curriculum provision, practical teaching, teaching materials and faculties, and the talents training system should be structured more systematically and scientifically, which will be crucial for dismissing the gaps between talents training and social requirements. Meanwhile, TCM Informatics professional education is confronted with three primary difficulties: a) discipline foundation is still instability, and available education resources are insufficient, and knowledge structure of teachers is too single to satisfy the need for training goals; b) professional training practices are not enough to support for cultivating the core abilities, and high level of professional leaders, difficult to bring high-end talent; c) government policy support is lack of strength and pertinence, and especially financial investment for TCM Informatics professional education and teaching is serious shortages.

Conclusions

TCM Informatics professional education in China has experienced the starting, exploring, development stages, and is now going ahead towards the mature and stable stages. Compared to medical informatics professional education, the development speed and level of TCM Informatics professional education still lags behind, on account of weaker foundation, extremely scarce for high quality education resource, and lack of referable experiences. And also, there exists a big gap with the social demands in TCM industry. With the deep integration of informatization, health, demography and TCM, the development pattern of TCM Informatics professional education will change from extensive development to connotative development, and the development way will switch from adding specialty, expanding size to stabilize scale and improve quality. Several basic principles for
developing TCM Informatics professional education are very important and should be hung on. Firstly, it should not be isolated with reality as discussed above on the premise of following the rules of professional education development. Secondly, school-running pattern and talents cultivation modal should be innovated persistently, to adapt the development tendency of population health informatization in domestic and overseas, and also correspond with the stream of modern education at information times. Thirdly, it's crucial to form and protrude characteristics and advantages of TCM Informatics professional education, by means of introducing and fostering excellent education resources. Lastly, it's also necessary to strengthen communications with institutes, government, and enterprises etc., so as to seek for more favorable policies and financial support, and also build a better social environment for the development of TCM Informatics professional education.

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