Informal learning during the standardized residency training in the context of “Internet plus”: an empirical research

Lei Li¹, Jun Ma²ᵃ, Xiaoling Tian³ᵇ, Huixian Cui²ᵇ, Zhifen Yang⁴ᶜ

ᵃCorrespondence: Department of Obstetrics and Gynecology of the Fourth Hospital of Hebei Medical University, No.12 Jiankang Rd. Shijiazhuang City, Hebei Province, cxsxfy@126.com

Abstract

Background

Informal learning refers to learners-sponsored, monitored and regulated learning method, which lays the foundation for medical life-long education of residents with sustainable self-learning ability and permanent learning behaviors. In this article the authors explore the academic value and significance in informal learning to improve the effectiveness for the standardized residency training in the context of “Internet plus” which combines technology with education to promote reforms for learning patterns. Standardized residency training started relatively late in China and there are less empirical studies targeted for the medical students in this phase. Based on it, this study aims to explore online informal learning behavior of medical students in residency training.

Methods

An empirical study was performed at the Fourth Hospital of Hebei Medical University in China where postgraduate medical education is being conducted. The study was implemented by questionnaire of the following aspects related to informal learning of residents as learning attitude, motivation, behavior and utilization of learning resources. Learning efficiency before and during COVID-19 is specifically surveyed and analyzed. 451 valid samples were collected to understand the situation of informal learning in the context of “Internet plus” and to find out interconnections
among variables. The data from questionnaire has been analyzed through descriptive analysis, difference analysis and correlation regression analysis.

**Results**

Informal learning attitudes of residents in standardized training are of high recognition and strong learning belief but need better self-management; The intervention between informal learning motivation and behavior among the levels of self-control, learning target and utilization of online resources resulting in great influence of environmental and individual factors on self-efficacy. Relative weak ability appears in choosing, screening and utilizing effective information online without effective guidance from teachers.

**Conclusions**

In this study we innovatively propose appropriate and practical suggestions for researching methods in informal learning of postgraduate medical education in clinical setting and during intensive online learning during COVID-19 period. The findings of this research have great significance in guiding learning paths, effects and development for informal learning of residents and put forward effective measures for the development of positive and sustainable informal learning in future career of the doctors-to-be.

**key words:** Standardized residency training, Internet plus, Informal learning, Online learning, COVID-19, Life-long education

**Background**

Medical education is of a prominent feature of life-long learning, which motivates the medical practitioners to further learning ability and update the knowledge system. Standardized residency
training is the crucial step for the rapid and successful transition to clinicians for medical students.

And this step is work-oriented from traditional class-based learning to non-traditional practice-based clinical learning. On the one hand informal learning consolidates the efficacy of formal learning, on the other hand provides a new path to life-long learning for learners. In this training period, the motivation of self-learning, improvement of learning ability and cultivation of learning habits are the guarantee for the sustainable development of permanent learning.

In the context of “Internet plus”, education reforms and methods are advanced in depth progressively, and medical students can make use of the internet to break through the limitation of learning spaces and class time to achieve the learning whenever and wherever possible as well as in any settings. However, the negative factors as over-opening and over-diversified internet resources, too-fragmentated information and absence of self-screening ability bring learners more challenges in self-management and in-depth learning during informal learning. It is of great value studying how to make use of informal learning through internet and what are the situations, problems and solutions to it.

1. Informal learning

Definition and development of informal learning

Informal learning becomes one of the most effective ways of learning and improvement for various learning groups in the era of highly-advanced technology, massively-combined information and frequently-exchanging industries.

The theory of informal learning dates to ancient philosophical ideas. Colley’s view of informal learning is that the modern concept was originated from the statement of “non-formal education” firstly presented by UNESO (United Nations of Educational, Scientific and Cultural Organization).
And the definition was firstly put forward by American scholar Knowles in *Adults' Informal Learning*. During its development, the understanding of informal learning is progressively furthered and well rounded. American adult education specialists Victoria J. Marsick and Karen E. Watkins pointed out in their book *Informal and Incidental Learning*: informal learning is a learning pattern which could happen in public institution, and classrooms sometimes are not a must and it is free from distinct organization and system as well[1]. In 2018, Wolfson interpreted it furtherly to make a clear definition that informal learning is a new, work-oriented learning pattern and its essential factor is that it is beyond programs of formal learning and it is a self-organized intentional learning behavior[2].

The theoretical study of informal learning in China started comparatively late in 2002, Yu Shengquan and Mao Fang were generally considered to firstly put forward the definition of informal learning, that is, it is a new learning pattern happened at informal time and places while at work or in social situation to gain knowledge through self-sponsoring and self-responsive method not the traditional teaching-learning way[3].

**Practical significance of informal learning**

With the advancement of technology, there are great changes in learning perception, learning pattern and learn approach. Informal learning plays no longer the role of being complementary, and its multiple characteristics of being self-controlled, sociable, contextual and cooperative make it not be limited by contexts, time and locations anymore. Learners could utilize the modern technological learning approaches, such as online learning, apps on mobile devices and social network, beyond the limitation from formal learning of places, objects and resources. They enhance the learning approaches, enrich the learning resources and improve learning spaces from the need, identity and
self-ability. Informal learning during this process has been recognized, advanced and associated with intensive working rhythm, accessibility to resources, self-identification of learning and fast-developing technologies.

Mutual promotion between lifelong learning and informal learning

In 2016, International Society for Technology in Education released the latest edition of National Educational Technology Standard for Students. In the standard, it is pointed out that students are seven-multiple-role complex, among which empowered learner refers to students with self-directed learning ability [4]. In Chinese Ten-year Plan of Education Informationization (2011-2020) [5] and Core Competencies and Values for Chinese Students' Development [6], they both focus on the ability of self-learning, students’ learning awareness and the concept of lifelong learning.

Mutual development of formal and informal learning in the modern social and educational background contributes to the concept of lifelong learning, which is permanent, extensive and universal. The awareness of voluntary learning and pattern of self-learning are the two main factors for lifelong learning. The two main factors are acquired through informal learning due to its features of self-sponsorship, self-construction and self-completeness, which is all beneficial to the cultivation of lifelong learning from both objective and subjective perspectives.

Specific option for objects under theory of informal learning

Features of informal learning embody more prominently in medicine, and in Resnick’s definition of informal learning specifically mentioned a context-specific forms of knowledge which indicated the flexibility in choosing the studying contexts and selectivity of both knowledge and skills. Medical Knowledge keeps updates and the core of modern medical education is to cultivate the students to be the real principal body of every studying phase solving clinical issues with what
they have learned. The sustainable training and development of the medical students rely largely on
the work-oriented learning which happens on, during and off working-hour. In 2013, Cunningham
and Hillier held the viewpoint that informal learning based on working context accounted for
70%[7], and even 90% \(^8\) from Flynn, Eddy and Tannenbaum. The proportion enlightens us to foster
the concepts of lifelong education through informal learning to have learners develop voluntary,
self-disciplined learning habits and cultivate them to be self-updated and self-managed in making
full use of knowledge.

Postgraduate medical education refers to the training phase for a doctor becoming qualified
and independent after graduation from medical school. Even though during internship there are
opportunities for organized training in hospitals, informal learning totally takes large proportion on,
during and off working-hour, which is in accordance with the theory of Wolfson on the work-
oriented factors of informal learning.

Objects of the Study is just the postgraduate education group --- medical students who now are
receiving standardized residency training (shortened for residents).

2. Standardized residency training in China and informal learning

Education practice of medicine in and abroad amply proves that it is an essential road to
becoming a doctor from medical graduates to clinicians through Standardized residency training, it
is an emphatical key transition from students to doctors. The trainees in the Standardized residency
training play multiple roles working in clinical context which specifically requires new teaching
pattern and evaluation mode.

Definition and historical evolution of standardized residency training

Standardized Residency Training refers to the normalized and systematic training for medical
students who have achieved the medical school education. This training of theoretical knowledge of medicine, clinical practices and thinking require the whole process of being a qualified medical practitioner with basic qualities of clinical works and ethical principles.

In late 19th century, professor Langenbeck in University of Berlin in Germany firstly put forward the concept of building the training system for residents and then carried it out. In 1889, the very first training base for standardized residency has been established which underwent more than 100 years development and half century application in western developed countries. Now the training has been embraced by different countries in the world. In 2015, Ludmerer mentioned that it is the beginning of a doctor to acquire specialized knowledge and skills, forming occupation identity, through which the habit, behavior, attitude and as well values have been developed during the training course[9].

Formation and development of standardized residency training in China

Medical education in China has been improved and developed since the foundation of the country for 70 years. Now we are building the three-phase medical education mode of medical school, postgraduate training and continuing education[10]. In contrast with medical system in U.S and European countries, postgraduate medical education in China started relatively late and slowly developed, becoming the weakest part of the whole medical education unity. In China, postgraduate medical education is composed of cohesively connected two parts--- Standardized residency training and Standardized training for specialist physicians. On Jan.17th 2014, the National Health and Family Planning Commission issued Guidelines on Establishing Standardized Residency Training System which marked the beginning of the training of residents in China. It is a very important milestone to promote the residency training substantially.
The management of medical education is categorized into two stages as pre-service and post-service, which respectively correspond to medical school education and postgraduate and continuing medical education. The residency training belonging to the category of post-service has the significance of the transition from formal learning in medical school to the learning in clinical context. Referring to the learning content, residents are on the point of turning from theoretical knowledge to clinical skills; Referring to cultivated target, they are on the point of identity changing from medical students to residency doctors; Referring to learning method and context, they are from classroom-learning to working-oriented learning. It is the vital stage of transition and breakthrough aiming to practice the clinical thinking and skill applications, which lays the solid foundation for the independent clinical solution in the future.

The implementation of informal learning for standardized residency training

Different from formal learning in classroom, when residents begin their study in clinical context, informal learning takes larger account. How to optimize the learning method, improve the learning effectiveness and develop good habit become the key issue for us. Therefore, we need to focus more on the learning course during training, particularly the relevance with factors of informal learning in order to make it standard and systematical. Based on the context, there’s great match between residents and method of informal learning, due to their special identity, clinical context, skill requirement and occupation prospect. Medical students must make great endeavor to keep with the constantly renewed knowledge and skills because of fast update of medical information and complicated practical medical environment. “Internet plus” context just meets the requirement of medical learning and development. Based on this, we take informal learning of the residents as our major purpose of study so as to explore the application of informal learning in the context of
“Internet plus” by thorough theoretical and practical research.

3. The research significance on informal learning of residents in the context of “Internet plus”

Chinese Premier Li Keqiang firstly put forward the innovative concept and implementation of project “Internet Plus” to national level in the government report in March, 2015. Project “Internet Plus” is to profoundly integrate innovative achievement of internet with all different fields in economic society to advance the technical progress, improve efficiency and organizational reforms, promote the innovation and productivity of substantial economy, finally forming the new developmental pattern of economic society on the basis of internet as innovative elements and fundamental facility[11].

“Internet plus” is to add internet factors to different traditional industries, which is not a simple addition but a developing ecology of industrial integration between internet and traditional fields using information-communication technology and internet platform[12]. Our research in the wider historical context is to deeply consider the different possibilities of “Internet Plus Education” focusing on changes among educational concepts, characters, patterns and achievements by the technological innovation trigger. The residents group has in high correspondence with the concept of “Internet plus” in aspects of knowledge hierarchy, learning pattern, learning method and efficacy of learning. And the internet features of shareability, openness, autonomy and acquirement present informal learning with an accessible resource platform.

Standardized residency training as the main body of postgraduate medical education in the “Internet plus” context has three following features as a. Effective cognization of knowledge. For the residents group, they have already accomplished basic knowledge learning in medical school and equipped with the ability of self-regulation and expertise of learning. They to some extent can
identify the abundant and open learning resources online, which becomes guarantee for the internet informal learning. b. The dynamic exchange course of teaching and learning. The essence of “Internet plus education” is changing the traditional form of teaching and learning by making use of internet skills and thinking mode for the issues in educational field[13]. During this process the self-learning ability of residents are keeping being enforced due to the change of traditional teaching pattern. c. The efficacious durability of learning. Resources on internet keep updating which ensure the efficacy of learning and the intersection point of different fields of knowledge. We can actively utilize the effective information to confront with the new issues and challenges in clinical setting.

4. Special significance and value of the research during COVID-19 period

During the research, China is inside with COVID-19 and medical practitioners are the definite main body of fighting against the disease. In this very particular period, all the universities in China postpone the new term, change the traditional teaching method and begin online classes according to the national arrangement and regulation[14]. Online teaching and learning fully utilize the resources and platform to realize the goal of continuous education in this situation. This action achieves the new form of “Internet plus education” in a unprecedented large scale to motivate the activity of both teaching and learning. Medicine is subject of great practicality and the standardized residency training requires both theory and practice critically. Informal learning used to appear unorganized and not applicable. Now during the preventing and controlling period, online education is highly intensive which is beneficial for us to furtherly study the related factors of informal learning. And according to this, we can explore the special significance of informal learning in the context of “Internet plus” and pandemics.

Methods
**Design**

**Study-Dimension identification and questionnaire design**

We are exploring the informal learning behaviors of residents from the Fourth Hospital of Hebei Medical University in the context of “Internet plus”. Our goal is effectively to regulate the learning pattern of medical students from theoretical class-based learning to practice-based informal learning in the workplace; to comprehensively study the situation of informal learning or residents to find out the learning pattern and the solution to it. In the context of “Internet plus”, this investigation in terms of the features of standardized residency training in China and the occupational situation of the group is scientifically designed, integrally structured, clearly purposed and comprehensively considered.

The questionnaire with open questions was self-designed in a small scale. Four aspects related to informal learning as learning attitude, learning motivation, learning behavior and online learning resources were presented in the questionnaire as the following three parts: a. Basic information concerning informant’s gender, academic grade, specialty and option for internet resources. b. Online learning situation before and inside with COVID-19. For this part Likert five-rating scale was used. c. Cognition and expectation for the informal learning.

**Implementation of empirical research**

The questionnaire took the anonymous form in order to enhance trust and ensure confidentiality. Random sampling method was used to select resident samples involving different academic grades and specialties. The samples are referring to residents (2017-2019) in the standardized training from grade one to three specializing in internal medicine, surgery, gynaecology and obstetrics, pediatrics and anesthesiology. This questionnaire was made by WJX.com (Professional Website for
investigation in China) and sent in form of interlinkage online in order to make sure the distribution of specialties and grades.

Data collection

Descriptive statistics, correlation analysis and regression analysis were conducted in the investigation data by using SPSS 24.0. Step 1: Questionnaire distribution, data collection and preliminary analysis of descriptive statistics were done to understand the situation of residents informal learning in the context of “Internet plus”. Step 2: Scientific quantitative analysis were done to find out interconnections among variables, based on which relative conclusion of the research was obtained.

Results

1. Descriptive analysis of investigation data

Analysis of sample information

451 valid samples have been collected containing 147 males and 304 females. Sample Structure was shown in Table 1: 159 students are from grade one and both 146 from grade two and three. Genders and grades of samples are evenly distributed, and the authenticity of the samples is based on the real situation, which lays the foundation for the future study of residents’ informal learning in the context of “Internet plus”.

Analysis of learning attitude to informal learning

Residents’ learning attitude to informal learning is considered from the following two aspects: one is the acceptance of informal learning, and the other is the willingness for the residents to utilize online resources when learning in the context of “Internet plus”. From Fig.1-1, Fig.1-2, and Fig.1-3, it is shown that 88.02% residents recognize the importance and frequency of informal learning
During training, 66.74% residents perform informal learning on cellphones through online resources, next to phones, 24.83% use computers and other mobile devices take account for only 10%.

As it is indicated in the data, there are high recognition and strong learning belief of positive informal learning. And also, mobile devices that all residents own are indispensable during learning online, supplying satisfactory hardware condition of web-based learning.

**Analysis of learning motivation for informal learning**

According to the self-determination theory from Deci&Ryan[^1] in 2000, learning motivation can be divided into autonomous motivation and controlled motivation. As indicated in Fig.2-1, controlled motivation for completing the online course and autonomous motivation for learning fundamental knowledge and clinical skills are both functioning for the learning behavior of residents.

In Fig.2-2, Fig 2-3, there is great influence of environmental and personal factors on the process of informal learning, and over 50% of residents hold the viewpoint that the influential factors of environment involve lack of effective guidance, insufficient learning atmosphere, the payment of network resource and so on. Therefore, which motivation plays major role in the process of informal learning and how the personal, environmental and motivated factors interact with each other will be discussed in the following part of the research.

**Analysis of informal learning behavior**

Postgraduate education focuses the learning pattern based on the workplace and working experiences and it stresses the comprehensive evaluation on performances. Our research on informal learning process is conducted from the following three aspects as plan management, process management and self-efficacy to make a further investigation into the self-efficacy of the residents during learning. This research now is inside with COVID-19 in China, all national universities...
initiate new education pattern of online teaching, mainly in the forms of live broadcast, recorded
broadcast, and assistant teacher-guidance off-line. From Fig.2, before massive, centralized online
education, residents hold relatively stronger recognition of positive effect of informal learning, but
recognition appears weaker in the aspects of setting the learning target and joining the discussion
online. 46.78% residents have informal learning plans but only 6.87% frequently being active in the
discussion. After new pattern of massive and intensive online learning during COVID-19 period,
the following factors are highly recognized, as the importance of online learning, the improvement
of online learning behaviors and the guidance from teachers during online learning. It shows that
there is great possibility for residents being modified on target setting and self-management for
informal learning online.

Analysis of online learning resources in the context of “Internet plus”

In virtue of internet platform, we can realize learning whenever and wherever possible as well
as in any settings unlimitedly to construct meaningful knowledge system. As in Fig.3-1, the chief
advantage of online learning is the convenience of information accessibility, accounting up to
82.26%. The following advantages are unlimited learning time and places, and extensive access to
information, respectively accounting for 72.51% and 64.30%. “Internet plus education” utilizes the
modern informative technology to break through the limitation of time, space and contexts, which
is beneficial for the character-changing from students to residents and improvement of learning
pattern.

Confronting with massive learning resources online, whether the learner could identify the
effective information to some extent determines the effectiveness of their learning. From Fig.3-2
and Fig.3-3, there are few paths to choosing online courses or software, Baidu Netdisk ranks first
for the apps they use, and 78.71% residents choose it. The second app is Bilibili, only 34.59%. From the percentage, the shareability of knowledge online doesn’t show the positive effect, which leads to severe restricted consequences of fragmentized learning. Fig.3-4 and Fig 3-5 indicate that 52.33% of residents autonomously obtain resources, only 22.17% from the teachers. For the knowledge management, 80% of them take notes on notebooks or apps, but only 5% would share what they have learned, which shows the similar presentation with the low participation in discussion.

The analysis above illustrates that residents need to focus some aspects during informal learning: how to make full use of the advantages of “Internet plus education” and through network platform interacting with abundant resources, openness and shareability features, so as to promote the positive development of informal learning activities for residents, and develop the target for active guiding of the effectiveness.

2. Statistical analysis of investigation data

The current situation of online informal learning has been analyzed from the questionnaire presentation of descriptive data, but the differences of investigative dimensions still need to be indicated. For this part, SPSS24.0 was used to make the differences statistics ranging from gender, grade, learning behavior and efficiency to thoroughly analyze the problems existed in the informal learning of residents.

Gender and grade differences

Overlapping analysis of gender, grade with learning attitude, behavior and efficiency has been done respectively by Wilcoxon rank sum test and kruskal-wallis rank sum test, It means that the difference has statistical significance（P<0.05）. As shown in Table 3-1, Table 3-2, no obvious difference was found illustrating the consistency of performance that residents hold a positive
attitude to the cognition of the importance of informal learning, also approve the important way of
learning, but they are in a situation of lower learning self-efficacy, due to lack of reasonable learning
plan, lower degree of learning participation or discussion, and lower in peer review as well.

Correlation analysis of gender, grade with learning motivation, learning resources and
influential factors has been done by chi-square test. It means that the difference has statistical
significance (P<0.05). As in Table 3-3, differences appear to be less significant in approaches to
learning resources but significant in different genders. 62.59% male students voluntarily choose
online resources and 32.66% are recommended by teachers or classmates, however, respectively
47.37% and 48.03% female student. Through cross-over analysis of gender, grade and learning
motivation, male students appear to have more significant performance of self-directed learning,
and less in controlled motivation. In terms of learning influential factors, no significant differences
between grades but from gender dimension, relatively weaker ability of collecting online resources
sees in female students. And female students are more prone to be influenced by learning
atmosphere, different from male students being influenced by online garbage resources. Inactive
learning initiative and weak willpower could be commonly seen in all grades and genders.

Correlation regression analysis between learning efficiency and influential factors

We have analyzed the four different dimensions of learning attitude, learning motivation,
learning behaviors and online learning resources, and for this part the satisfactory correlation
between learning efficiency and influential factors are discussed. By SPSS24.0, Logistic regression
analysis has been made among personal, environmental and learning factors. According to
efficiency, we categorized “excellence” as 1 and others as 0. In the single-factor analysis, these were
included in the multi-factor analysis model(P < 0.2), and indicated that the difference was
statistically significant (OR value < 1 and 95%CI between 0 and 1). As shown in Table 4, the regression analysis of learning enthusiasm, willpower, learning atmosphere with learning efficiency were all significantly (OR value < 1), showing a significant positive correlation.

2. In-depth investigation analysis

Last question in the questionnaire is in form of subjective gap-filling to investigate into the attitude of residents to informal learning and improvement measures. There are 103 perspectives in total, by analysis of words frequency it is shown in Fig.4 that residents all hold high recognition and acceptance of online informal learning. From learning motivation, during the process internal and external motivations both exist and interact one another. From the learning initiative, similar to outcome of questionnaire, it is shown the needing improvement due to poor self-control, unclear learning target and insufficient utilization of online resources. From learning efficacy, in-depth investigation indicates the high recognition and affirmation of teamwork in aspects of sharing, discussing and reflection. In terms of online learning resources, learning without time and space limitation is positively affirmed but poor identification of network platform and online resources still needs standardized training.

Conclusions

1. Improvement of informal learning ability of residents

Investigation into informal learning has been carried out from three dimensions as learning attitude, learning behavior and knowledge management. The residents group has strong motivation and there is positive impact of active learning attitude and affirmation of online learning on further persistence and promotion of informal learning. However, there are still some defectiveness of pre-learning plan, regulation of learning process, and knowledge management, meanwhile self-efficacy
needs to be enhanced. For the evaluation of post-graduate education, formative evaluation is beneficial for learners to find out the self-deficiency and improving possibility and then to regulate future self-learning and behaviors.

2. Construction and utilization of resources platform online

The function of learning online is the essential guarantee for the development of our research, and the two key factors are completion of online platform resources and extensive coverage of the learning content. Online learning is the major pattern of learning for residents in our research, which plays effective role during residency. Problems are the limited and simplex approaches to online resources and lack of efficient selecting and screening ability for the resources. More importantly, the “Internet plus” advantages of openness, abundance and shareability aren’t made the best use of. Internet resources of all kinds of information involves both abundant learning content and many entertaining and tempting distractions, which requires resident’s capacity of resisting disturbances. Healthy online platform should supply resources of high quality with sustainability and inspiration for the self-directed learning of residents and the promotion of timeliness of informal learning in the context of “Internet plus”.

3. Advances of informal learning in skill-guidance and humanity factors in the work-oriented context

Informal learning is a non-formal and non-structural learning, and during it learning individual intentionally acquires new knowledge, and skills. Our study investigates simultaneously from two dimensions as teacher-guidance factor and resident-learning factor to find out the situations of unclear target, relative informational encapsulation, disunified organization and low efficacy. It is incorporated in lack of standardized training in pre-learning plans and insufficient discussion during
learning and rare systematic summarization in post-learning.

Through investigation into centralized and regulated online learning during COVID-19 outbreak period, it is indicated that residents appear to have stronger perception of affiliation and attachment. Related policies and technical supports ensure the heated atmosphere of online learning, and residents have more active responses to the informal learning online and teachers’ guidance, presenting high confidence in informal learning in depth in the future.

Self-directed work and diverse skills could be realized by supplying of learning opportunities and broaden intellectual fields to promote learning (Parker, 2017) [16] and sincere leaders influence active behaviors of employees by affectionate empathy (Wang Zhen, Song Meng, Sun Jianmin, 2014) [17]. In terms of survey data, teachers or supervisors should show more concerns to instruct the students to observe and find out the issues, needs, and values in clinical context, help them to expand clinical thinking and construct the system, supervise them to have regulatory learning behavior, and more importantly endow them with the new trials by using the knowledge learned in clinical setting and give them positive and instant feedbacks. Our aim is to promote the self-construction of residents in informal learning to make the real transformation of self-efficacy.

Discussions

Specific suggestions for the improvement of residents’ informal learning in context of “Internet plus”

Informal learning isn’t an isolated course but a dynamic one. In 2017 Tews[18] studied that subjective initiative for someone is more prone to knowledge acquirement, acceptance of new knowledge, and improvement of creativity and learning capacity. Therefore, driven by learning motivation in clinical context, different learning behaviors and activities are mutually interacted. In
high development of information, learning online does be equipped with advantages of openness and shareability, but it may present to be like a double-edged sword due to its information overload and intervention from entertaining factors, which to some extent result in underestimated learning effect.

Our research based on the concept and features of informal learning, combines it with context of “Internet plus” and takes online learning as the carrier to furtherly study the current situation, advantages, modification and improvement of informal learning for residents from dimensions of learning attitude, motivation, behavior and internet resources. Particularly, to compare the differences &similarities and emphasis on online informal learning pre/during COVID-19 effectively and to have comprehensive evaluation on the performance and efficacy of informal learning for the group will put forward effective intervention measures for the development of positive and sustainable informal learning in the context of future career.

1. Resident level solution

Accelerating the change of learning attitude, effectively stimulating the learning motivation

Medical specialized learning is endowed with double features of knowledge and skill. Training for self-regulation of learning and clinical communicative competency could be overlooked due to over endeavor for theoretical learning tasks of complicated learning contents, and too-wide learning ranges. Informal learning is appropriate for the needing and features of learning in standardized residency training. Residents have both self-leading and self-dominance in specialized learning which ensure sustainable learning and satisfactory effect of the group.

Informal learning is not the unplanned and aimless self-autonomous learning and on the other hand self-autonomous learning is one of the most important parts of it. Survey showed that residents
have relatively weak ability of self-learning awareness and goals, also low degree of adaptability when conducting self-autonomous learning by the informal learning way. To instantly transform to the positive learning attitude towards informal learning, we need to cultivate self-learning awareness and motivate the learning initiatives of the students. What’s more, we should also focus the role of sponsoring, promoting, sustaining and regulating of learning motivation to effectively adjust self-autonomous and controlled learning. To heighten the learning interests and aspiration for new knowledge, we need to boost informal learning behavior with sustainable impetus by rewarding and encouraging students’ learning motivations from the controlled to the autonomy.

**Increasing evaluation frequency and persisting learning-behavior modification**

Researches on informal learning mainly focus on the learning form, mode and effect in the domestic and overseas, and seldom explore the learner's autonomous learning ability. This paper attempts to investigate the strength of autonomous learning ability of residents by studying the behavior of informal learning. The results demonstrate that residents lack communication, discussion and evaluation in the learning process, which isolates the interaction with similar learners, and also slow down or block the feedback effect of mutual evaluation and self-evaluation in the learning process. Elimination of the above disadvantages can correctly evaluate the rationality of learning styles, continue to optimize learning styles, meanwhile conducive to get rid of the loneliness of online learning.

Learning in clinical context is a specific educational environment, and the procedural evaluation of a qualified resident requires to be composed of formative and summative evaluation. Formative evaluation emphasizes the problems and continuous improvement for them during self-autonomous learning avoiding ingrained bad habits. The limitation of single summative evaluation
is not affirmative to the continuous improvement. Therefore, residents need to initiate from goal-
setting, temporal-planning and learning-management and then optimize and adjust learning
strategies so as to heighten knowledge self-management intentionally, make effective transition of
knowledge from explicit to implicit level and finally construct their own knowledge structural
system through work-oriented practices.

3. Academy level solution

Improvement for online learning platform and optimization of online learning resources

Informal learning is of great contextual features (Marsick, Watkins, Scully-Russ &
Nicolaides, 2017) [19], the influential factors that should not be ignored (Jagušt, Botički & So,
2018) [20]. In fast development of “Internet plus” era, online informal learning is the part of learning
historical process and the current appropriate options and future development trend. Confronting
with the numerous and disorderly learning resources online, to improve the learning platform,
optimize the resources and construct well-organized context is the main task for us to enhance the
positive effect of informal learning online now. a. Building up encouraging online learning
atmosphere: One is to regulate specific codes of conduct of guiding the residents. The other is to
eliminate the negative information online, reducing disturbing factors for informal learning.
b. Enhancing the construction of online learning resources: With development of information
technology, there are more and more online learning materials but varying differently in qualities.
We ought to categorize online learning materials systematically and advance the construction of
highly scientific and effective learning platform. c. Integrating fragmented learning resources:
During training process, residents are too busy to have complete time having informal learning.
Even though informal learning could be realized whenever and wherever without limitation of
contexts, decentralized characteristics of online learning resources need to be sorted out systematically. More forms of knowledge should be integrated like pictures, videos or concentrated words to initiate interests and effectiveness of study.

With the new form of “Internet plus education”, firstly a clear-directed, reasonable-arranged and convenient-viewed internet platform need to be developed. Secondly, high-quality of learning material and highly updated learning content should be supplied and overall construction of learning platform should be conducted, all of which will systematically integrate the informal learning of residents from fragmented learning time, knowledge and thinking mode into an intact unification.

3. Teacher level solution

Fostering teachers’ guidance and integrating teaching mode

In 2018, Wolfson stressed that more concerns should be focused on the personal and contextual influencing factors on informal learning. There are three types of intentional behaviors, firstly experiment or new experience should be set for the individuals to have new task finished and new skills acquired. Secondly, feedback or reflection is needed to help individuals with necessary suggestions or experiences to gain worthy information resources. Thirdly, substitute for own learning behavior enables individuals to observe others to find out beneficial information for self-improvement.

Standardized residency training is the critical phase for residents to grow up to be skillfully and independently practiced practitioners who can safely and appropriately have patients disposed. Informal learning happened in this phase is a self-sponsored and self-managed randomized non-formal leaning pattern but with the essential guidance of clinical teachers. First, clinical teachers should create a favorable clinical atmosphere to enable the resident group to be a learning unity
among which problems encountered on the level of learning or affection will both be concerned and solved. In this case, residents may feel the sympathy from the mentors and learning aspiration would be motivated. In addition, we need to persist in resident-centered principle, actively ordinating modern technologies, expanding new learning pattern, focusing on practical education and enhancing self-autonomous learning. It is especially stressed that guiding teachers need to bring themselves into the informal learning process of the residents and enlarge the leading role for them. Residents and clinical teachers together carry out optimization of learning pattern, improvement of self-autonomous learning in multi-level and the enhancement of knowledge storage orderly. Especially for the residents in grade one, they have relatively fewer access to learning resources, depending on teachers’ guidance to a large extent.

**Future prospect**

Our research explores that during standardized residency training informal learning is the major learning pattern for residents. And informal learning pattern is in accordance with the learning features and motivations for residents in this phase especially in the context of “Internet plus”. The practical significance and value is more prominent when different types of learning platform and the shareability feature are combined aiming to have further study of informal learning in this context (Mutual effect of different factors can be seen in Fig.5). In the process of the learning, our research initiate studying approach to informal learning in the clinical context, expanding the path, effects and future development of it for residents. Medical students are endowed with the lifelong learning ability through informal learning. Autonomic learning ability makes the possibility of lifelong learning, and for exploration, reflection, analysis and integration of knowledge should be focused more to inspire medical students for the
future study. How to make full use of the guidance from the clinical teachers in this learning pattern, how to help residents construct knowledge system scientifically, how to integrate into online learning for idea exchanges, learning discussion and problem solution. Meanwhile, affective interaction and humanity spirit should also be supplemented during informal learning in clinical context and association with nature and society like knowledge about COVID-19 or medical care to ensure medical students of self-responsibility and to enhance their learning belief.

With the further development and improvement of internet technology, online learning resources and platform still need to be overall planed, systematically categorized and have less negative influential factors, for learners more concentrated and clearer learning space should be endowed. Simultaneously, in terms of characteristics of different disciplines and different needs of working context, we need to integrate fragmented and decentralized learning resources in attempt to promote learning efficiency and pertinence for learners. Learning in the context of “Internet plus” should be realized without limitation of time, location, resources.

Influenced by trend of globalization, it is not changeless for postgraduate education which is constantly being developed. Through exploring online informal learning situation of residents, reforms on blended teaching pattern for residents will be performed in the future in the form of on/offline and finally targeted for improving quality of standardized residency training.

Abbreviation

COVID-19: Coronavirus Disease 2019;
UNESCO: United Nations of Educational, Scientific and Cultural Organization;
SPSS: Statistic Package for Social Science

Declarations
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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Author’s contributions

LL conducted the literature search for the background of the study, and contributed to writing the article.

ZfY collected data for the study, analyzed and interpreted statistical data, and contributed to writing the article.

JM and XIT were involved in study planning, data processing, and revising the article.

HxC contributed to study design and oversaw the study.

All authors read and approved the final manuscript.

Author’s information

1 Foreign Language Teaching Department, Hebei Medical University, Hebei Province, Shijiazhuang, 050017

2 Human Anatomy Department, Hebei Medical University, Hebei Province, Shijiazhuang, 050017

3 Educational Administration Office, the Fourth Hospital of Hebei Medical University, Hebei Province, Shijiazhuang, 050011

4 Department of Obstetrics and Gynecology, the Fourth Hospital of Hebei Medical University, Hebei Province, Shijiazhuang, 050011

b Co-corresponding author

a Co-first author

Ethics approval and consent to participate

At the time of the study, approval from an ethical committee was not required for educational research in Hebei China. Participation in the study involved no risks to the participants. All reports
were approved by all participants. The participants who agreed to participate in the interview were informed of the aims, methods and confidentiality of the study prior to participation, and all gave informed consent. Participants were allowed to withdraw from the study at any time. The informed consent obtained from study participants was verbal. In order to protect the privacy and confidentiality of the participants, no names were used in the observation reports.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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