

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

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1 Abstract

2 Background

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

11 Methods

12 An empirical study was performed at the Fourth Hospital of Hebei Medical University in China
13 where postgraduate medical education is being conducted. The study was implemented by
14 questionnaire of the following aspects related to informal learning of residents as learning attitude,
15 motivation, behavior and utilization of learning resources. Learning efficiency before and during
16 COVID-19 is specifically surveyed and analyzed. 451 valid samples were collected to understand
17 the situation of informal learning in the context of “Internet plus” and to find out interconnections

18 among variables. The data from questionnaire has been analyzed through descriptive analysis,
19 difference analysis and correlation regression analysis.

20 **Results**

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

27 **Conclusions**

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

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

36

37 **Background**

38 Medical education is of a prominent feature of life-long learning, which motivates the medical
39 practitioners to further learning ability and update the knowledge system. Standardized residency

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

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

54 **1. Informal learning**

55 **Definition and development of informal learning**

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

59 The theory of informal learning dates to ancient philosophical ideas. Colley’s view of informal
60 learning is that the modern concept was originated from the statement of “non-formal education”
61 firstly presented by UNESO (United Nations of Educational, Scientific and Cultural Organization).

62 And the definition was firstly put forward by American scholar Knowles in *Adults' Informal*
63 *Learning*. During its development, the understanding of informal learning is progressively furthered
64 and well rounded. American adult education specialists Victoria J.Marsick and Karen E.Watkins
65 pointed out in their book *Informal and Incidental Learning*: informal learning is a learning pattern
66 which could happen in public institution, and classrooms sometimes are not a must and it is free
67 from distinct organization and system as well[1]. In 2018, Wolfson interpreted it furtherly to make
68 a clear definition that informal learning is a new, work-oriented learning pattern and its essential
69 factor is that it is beyond programs of formal learning and it is a self-organized intentional learning
70 behavior[2].

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

76 **Practical significance of informal learning**

77 With the advancement of technology, there are great changes in learning perception, learning
78 pattern and learn approach. Informal learning plays no longer the role of being complementary, and
79 its multiple characteristics of being self-controlled, sociable, contextual and cooperative make it not
80 be limited by contexts, time and locations anymore. Learners could utilize the modern technological
81 learning approaches, such as online learning, apps on mobile devices and social network, beyond
82 the limitation from formal learning of places, objects and resources. They enhance the learning
83 approaches, enrich the learning resources and improve learning spaces from the need, identity and

84 self-ability. Informal learning during this process has been recognized, advanced and associated
85 with intensive working rhythm, accessibility to resources, self-identification of learning and fast-
86 developing technologies.

87 **Mutual promotion between lifelong learning and informal learning**

88 In 2016, International Society for Technology in Education released the latest edition of
89 National Educational Technology Standard for Students. In the standard, it is pointed out that
90 students are seven-multiple-role complex, among which empowered learner refers to students with
91 self-directed learning ability [4]. In *Chinese Ten-year Plan of Education Infomationization (2011-*
92 *2020)* [5]and *Core Competencies and Values for Chinese Students' Development*[6], they both focus
93 on the ability of self-learning , students' learning awareness and the concept of lifelong learning.

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

100 **Specific option for objects under theory of informal learning**

101 Features of informal learning embody more prominently in medicine, and in Resnick's
102 definition of informal learning specifically mentioned a context-specific forms of knowledge which
103 indicated the flexibility in choosing the studying contexts and selectivity of both knowledge and
104 skills. Medical Knowledge keeps updates and the core of modern medical education is to cultivate
105 the students to be the real principal body of every studying phase solving clinical issues with what

106 they have learned. The sustainable training and development of the medical students rely largely on
107 the work-oriented learning which happens on, during and off working-hour. In 2013, Cunningham
108 and Hillier held the viewpoint that informal learning based on working context accounted for
109 70%^[7], and even 90%⁸ from Flynn, Eddy and Tannenbaum. The proportion enlightens us to foster
110 the concepts of lifelong education through informal learning to have learners develop voluntary,
111 self-disciplined learning habits and cultivate them to be self-updated and self-managed in making
112 full use of knowledge.

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

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

120 **2. Standardized residency training in China and informal learning**

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

126 **Definition and historical evolution of standardized residency training**

127 Standardized Residency Training refers to the normalized and systematic training for medical

128 students who have achieved the medical school education. This training of theoretical knowledge
129 of medicine, clinical practices and thinking require the whole process of being a qualified medical
130 practitioner with basic qualities of clinical works and ethical principles.

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

139 **Formation and development of standardized residency training in China**

140 Medical education in China has been improved and developed since the foundation of the
141 country for 70 years. Now we are building the three-phase medical education mode of medical
142 school, postgraduate training and continuing education[10]. In contrast with medical system in U.S
143 and European countries, postgraduate medical education in China started relatively late and slowly
144 developed, becoming the weakest part of the whole medical education unity. In China, postgraduate
145 medical education is composed of cohesively connected two parts--- Standardized residency
146 training and Standardized training for specialist physicians. On Jan.17th 2014, the National Health
147 and Family Planning Commission issued *Guidelines on Establishing Standardized Residency*
148 *Training System* which marked the beginning of the training of residents in China. It is a very
149 important milestone to promote the residency training substantially.

150 The management of medical education is categorized into two stages as pre-service and post-
151 service, which respectively correspond to medical school education and postgraduate and
152 continuing medical education. The residency training belonging to the category of post-service has
153 the significance of the transition from formal learning in medical school to the learning in clinical
154 context. Referring to the learning content, residents are on the point of turning from theoretical
155 knowledge to clinical skills; Referring to cultivated target, they are on the point of identity changing
156 from medical students to residency doctors; Referring to learning method and context, they are from
157 classroom-learning to working-oriented learning. It is the vital stage of transition and breakthrough
158 aiming to practice the clinical thinking and skill applications, which lays the solid foundation for
159 the independent clinical solution in the future.

160 **The implementation of informal learning for standardized residency training**

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

172 “Internet plus” by thorough theoretical and practical research.

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

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

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

190 Standardized residency training as the main body of postgraduate medical education in the
191 “Internet plus” context has three following features as a. Effective cognization of knowledge. For
192 the residents group, they have already accomplished basic knowledge learning in medical school
193 and equipped with the ability of self-regulation and expertise of learning. They to some extent can

194 identify the abundant and open learning resources online, which becomes guarantee for the internet
195 informal learning. b. The dynamic exchange course of teaching and learning. The essence of
196 “Internet plus education” is changing the traditional form of teaching and learning by making use
197 of internet skills and thinking mode for the issues in educational field[13]. During this process the
198 self-learning ability of residents are keeping being enforced due to the change of traditional teaching
199 pattern. c. The efficacious durability of learning. Resources on internet keep updating which ensure
200 the efficacy of learning and the intersection point of different fields of knowledge. We can actively
201 utilize the effective information to confront with the new issues and challenges in clinical setting.

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

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

215 **Methods**

216 **Design**

217 **Study-Dimension identification and questionnaire design**

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

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

232 **Implementation of empirical research**

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

238 investigation in China) and sent in form of interlinkage online in order to make sure the distribution
239 of specialties and grades.

240 **Data collection**

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

247 **Results**

248 **1. Descriptive analysis of investigation data**

249 **Analysis of sample information**

250 451 valid samples have been collected containing 147 males and 304 females. Sample Structure
251 was shown in Table 1: 159 students are from grade one and both 146 from grade two and three.
252 Genders and grades of samples are evenly distributed, and the authenticity of the samples is based
253 on the real situation, which lays the foundation for the future study of residents’ informal learning
254 in the context of “Internet plus”.

255 **Analysis of learning attitude to informal learning**

256 Residents’ learning attitude to informal learning is considered from the following two aspects:
257 one is the acceptance of informal learning, and the other is the willingness for the residents to utilize
258 online resources when learning in the context of “Internet plus”. From Fig.1-1, Fig.1-2, and Fig.1-
259 3, it is shown that 88.02% residents recognize the importance and frequency of informal learning

260 during training. 66.74% residents perform informal learning on cellphones through online resources,
261 next to phones, 24.83% use computers and other mobile devices take account for only 10%.

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

265 **Analysis of learning motivation for informal learning**

266 According to the self-determination theory from Deci&Ryan¹⁵ in 2000, learning motivation can
267 be divided into autonomous motivation and controlled motivation. As indicated in Fig.2-1,
268 controlled motivation for completing the online course and autonomous motivation for learning
269 fundamental knowledge and clinical skills are both functioning for the learning behavior of residents.
270 In Fig.2-2, Fig 2-3, there is great influence of environmental and personal factors on the process of
271 informal learning, and over 50% of residents hold the viewpoint that the influential factors of
272 environment involve lack of effective guidance, insufficient learning atmosphere, the payment of
273 network resource and so on. Therefore, which motivation plays major role in the process of informal
274 learning and how the personal, environmental and motivated factors interact with each other will be
275 discussed in the following part of the research.

276 **Analysis of informal learning behavior**

277 Postgraduate education focuses the learning pattern based on the workplace and working
278 experiences and it stresses the comprehensive evaluation on performances. Our research on informal
279 learning process is conducted from the following three aspects as plan management, process
280 management and self-efficacy to make a further investigation into the self-efficacy of the residents
281 during learning. This research now is inside with COVID-19 in China, all national universities

282 initiate new education pattern of online teaching, mainly in the forms of live broadcast, recorded
283 broadcast, and assistant teacher-guidance off-line. From Fig.2, before massive, centralized online
284 education, residents hold relatively stronger recognition of positive effect of informal learning, but
285 recognition appears weaker in the aspects of setting the learning target and joining the discussion
286 online. 46.78% residents have informal learning plans but only 6.87% frequently being active in the
287 discussion. After new pattern of massive and intensive online learning during COVID-19 period,
288 the following factors are highly recognized, as the importance of online learning, the improvement
289 of online learning behaviors and the guidance from teachers during online learning. It shows that
290 there is great possibility for residents being modified on target setting and self-management for
291 informal learning online.

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

293 In virtue of internet platform, we can realize learning whenever and wherever possible as well
294 as in any settings unlimitedly to construct meaningful knowledge system. As in Fig.3-1, the chief
295 advantage of online learning is the convenience of information accessibility, accounting up to
296 82.26%. The following advantages are unlimited learning time and places, and extensive access to
297 information, respectively accounting for 72.51% and 64.30%. “Internet plus education” utilizes the
298 modern informative technology to break through the limitation of time, space and contexts, which
299 is beneficial for the character-changing from students to residents and improvement of learning
300 pattern.

301 Confronting with massive learning resources online, whether the learner could identify the
302 effective information to some extent determines the effectiveness of their learning. From Fig.3-2
303 and Fig.3-3, there are few paths to choosing online courses or software, Baidu Netdisk ranks first

304 for the apps they use, and 78.71% residents choose it. The second app is Bilibili, only 34.59%. From
305 the percentage, the shareability of knowledge online doesn't show the positive effect, which leads
306 to severe restricted consequences of fragmentized learning. Fig.3-4 and Fig 3-5 indicate that 52.33%
307 of residents autonomously obtain resources, only 22.17% from the teachers. For the knowledge
308 management, 80% of them take notes on notebooks or apps, but only 5% would share what they
309 have learned, which shows the similar presentation with the low participation in discussion.

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

315 **2. Statistical analysis of investigation data**

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

321 **Gender and grade differences**

322 Overlapping analysis of gender, grade with learning attitude, behavior and efficiency has been
323 done respectively by Wilcoxon rank sum test and kruskal-wallis rank sum test , It means that the
324 difference has statistical significance ($P < 0.05$) . As shown in Table 3-1, Table 3-2, no obvious
325 difference was found illustrating the consistency of performance that residents hold a positive

326 attitude to the cognition of the importance of informal learning, also approve the important way of
327 learning, but they are in a situation of lower learning self-efficacy, due to lack of reasonable learning
328 plan, lower degree of learning participation or discussion, and lower in peer review as well.

329 Correlation analysis of gender, grade with learning motivation , learning resources and
330 influential factors has been done by chi-square test. It means that the difference has statistical
331 significance ($P < 0.05$) . As in Table 3-3, differences appear to be less significant in approaches to
332 learning resources but significant in different genders. 62.59% male students voluntarily choose
333 online resources and 32.66% are recommended by teachers or classmates, however, respectively
334 47.37% and 48.03% female student. Through cross-over analysis of gender, grade and learning
335 motivation, male students appear to have more significant performance of self-directed learning,
336 and less in controlled motivation. In terms of learning influential factors, no significant differences
337 between grades but from gender dimension, relatively weaker ability of collecting online resources
338 sees in female students. And female students are more prone to be influenced by learning
339 atmosphere, different from male students being influenced by online garbage resources. Inactive
340 learning initiative and weak willpower could be commonly seen in all grades and genders.

341 **Correlation regression analysis between learning efficiency and influential factors**

342 We have analyzed the four different dimensions of learning attitude, learning motivation,
343 learning behaviors and online learning resources, and for this part the satisfactory correlation
344 between learning efficiency and influential factors are discussed. By SPSS24.0, Logistic regression
345 analysis has been made among personal, environmental and learning factors. According to
346 efficiency, we categorized “excellence” as 1 and others as 0. In the single-factor analysis, these were
347 included in the multi-factor analysis model($P < 0.2$), and indicated that the difference was

348 statistically significant (OR value < 1 and 95%CI between 0 and 1) . As shown in Table 4, the
349 regression analysis of learning enthusiasm, willpower, learning atmosphere with learning efficiency
350 were all significantly (OR value<1), showing a significant positive correlation.

351 **2. In-depth investigation analysis**

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

363 **Conclusions**

364 **1. Improvement of informal learning ability of residents**

365 Investigation into informal learning has been carried out from three dimensions as learning
366 attitude, learning behavior and knowledge management. The residents group has strong motivation
367 and there is positive impact of active learning attitude and affirmation of online learning on further
368 persistence and promotion of informal learning. However, there are still some defectiveness of pre-
369 learning plan, regulation of learning process, and knowledge management, meanwhile self-efficacy

370 needs to be enhanced. For the evaluation of post-graduate education, formative evaluation is
371 beneficial for learners to find out the self-deficiency and improving possibility and then to regulate
372 future self-learning and behaviors.

373 **2. Construction and utilization of resources platform online**

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

385 **3. Advances of informal learning in skill-guidance and humanity factors in the** 386 **work-oriented context**

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

392 learning and rare systematic summarization in post-learning.

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

398 Self-directed work and diverse skills could be realized by supplying of learning opportunities
399 and broaden intellectual fields to promote learning (Parker, 2017) [16]and sincere leaders influence
400 active behaviors of employees by affectionate empathy (Wang Zhen, Song Meng, Sun Jianmin,
401 2014) [17]. In terms of survey data, teachers or supervisors should show more concerns to instruct
402 the students to observe and find out the issues, needs, and values in clinical context, help them to
403 expand clinical thinking and construct the system, supervise them to have regulatory learning
404 behavior, and more importantly endow them with the new trials by using the knowledge learned in
405 clinical setting and give them positive and instant feedbacks. Our aim is to promote the self-
406 constructing of residents in informal learning to make the real transformation of self-efficacy.

407 **Discussions**

408 **Specific suggestions for the improvement of residents' informal learning in context** 409 **of "Internet plus"**

410 Informal learning isn't an isolated course but a dynamic one. In 2017 Tews[18] studied that
411 subjective initiative for someone is more prone to knowledge acquirement, acceptance of new
412 knowledge, and improvement of creativity and learning capacity. Therefore, driven by learning
413 motivation in clinical context, different learning behaviors and activities are mutually interacted. In

414 high development of information, learning online does be equipped with advantages of openness
415 and shareability, but it may present to be like a double-edged sword due to its information overload
416 and intervention from entertaining factors, which to some extent result in underestimated learning
417 effect.

418 Our research based on the concept and features of informal learning, combines it with
419 context of “Internet plus” and takes online learning as the carrier to furtherly study the current
420 situation, advantages, modification and improvement of informal learning for residents from
421 dimensions of learning attitude, motivation, behavior and internet resources. Particularly, to
422 compare the differences & similarities and emphasis on online informal learning pre/during COVID-
423 19 effectively and to have comprehensive evaluation on the performance and efficacy of informal
424 learning for the group will put forward effective intervention measures for the development of
425 positive and sustainable informal learning in the context of future career.

426 **1. Resident level solution**

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

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

434 Informal learning is not the unplanned and aimless self-autonomous learning and on the other
435 hand self-autonomous learning is one of the most important parts of it. Survey showed that residents

436 have relatively weak ability of self-learning awareness and goals, also low degree of adaptability
437 when conducting self-autonomous learning by the informal learning way. To instantly transform to
438 the positive learning attitude towards informal learning, we need to cultivate self-learning awareness
439 and motivate the learning initiatives of the students. What's more, we should also focus the role of
440 sponsoring, promoting, sustaining and regulating of learning motivation to effectively adjust self-
441 autonomous and controlled learning. To heighten the learning interests and aspiration for new
442 knowledge, we need to boost informal learning behavior with sustainable impetus by rewarding and
443 encouraging students' learning motivations from the controlled to the autonomy.

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

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

454 Learning in clinical context is a specific educational environment, and the procedural
455 evaluation of a qualified resident requires to be composed of formative and summative evaluation.
456 Formative evaluation emphasizes the problems and continuous improvement for them during self-
457 autonomous learning avoiding ingrained bad habits. The limitation of single summative evaluation

458 is not affirmative to the continuous improvement. Therefore, residents need to initiate from goal-
459 setting, temporal-planning and learning-management and then optimize and adjust learning
460 strategies so as to heighten knowledge self-management intentionally , make effective transition of
461 knowledge from explicit to implicit level and finally construct their own knowledge structural
462 system through work-oriented practices.

463 **3. Academy level solution**

464 **Improvement for online learning platform and optimization of online learning resources**

465 Informal learning is of great contextual features (Marsick,Watkins,Scully-Russ &
466 Nicolaides,2017) [19], the influential factors that should not be ignored (Jagušt, Botički & So,
467 2018)[20]. In fast development of“Internet plus” era, online informal learning is the part of learning
468 historical process and the current appropriate options and future development trend. Confronting
469 with the numerous and disorderly learning resources online, to improve the learning platform,
470 optimize the resources and construct well-organized context is the main task for us to enhance the
471 positive effect of informal learning online now. a. Building up encouraging online learning
472 atmosphere: One is to regulate specific codes of conduct of guiding the residents. The other is to
473 eliminate the negative information online, reducing disturbing factors for informal learning.
474 b. Enhancing the construction of online learning resources: With development of information
475 technology, there are more and more online learning materials but varying differently in qualities.
476 We ought to categorize online learning materials systematically and advance the construction of
477 highly scientific and effective learning platform. c. Integrating fragmented learning resources:
478 During training process, residents are too busy to have complete time having informal learning.
479 Even though informal learning could be realized whenever and wherever without limitation of

480 contexts, decentralized characteristics of online learning resources need to be sorted out
481 systematically. More forms of knowledge should be integrated like pictures, videos or concentrated
482 words to initiate interests and effectiveness of study.

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

488 **3. Teacher level solution**

489 **Fostering teachers’ guidance and integrating teaching mode**

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

497 Standardized residency training is the critical phase for residents to grow up to be skillfully
498 and independently practiced practitioners who can safely and appropriately have patients disposed.
499 Informal learning happened in this phase is a self-sponsored and self-managed randomized non-
500 formal leaning pattern but with the essential guidance of clinical teachers. First, clinical teachers
501 should create a favorable clinical atmosphere to enable the resident group to be a learning unity

502 among which problems encountered on the level of learning or affection will both be concerned and
503 solved. In this case, residents may feel the sympathy from the mentors and learning aspiration would
504 be motivated. In addition, we need to persist in resident-centered principle, actively ordinating
505 modern technologies, expanding new learning pattern, focusing on practical education and
506 enhancing self-autonomous learning. It is especially stressed that guiding teachers need to bring
507 themselves into the informal learning process of the residents and enlarge the leading role for them.
508 Residents and clinical teachers together carry out optimization of learning pattern, improvement of
509 self-autonomous learning in multi-level and the enhancement of knowledge storage orderly.
510 Especially for the residents in grade one, they have relatively fewer access to learning resources,
511 depending on teachers' guidance to a large extent.

512 **Future prospect**

513 Our research explores that during standardized residency training informal learning is the
514 major learning pattern for residents. And informal learning pattern is in accordance with the learning
515 features and motivations for residents in this phase especially in the context of "Internet plus". The
516 practical significance and value is more prominent when different types of learning platform and
517 the shareability feature are combined aiming to have further study of informal learning in this
518 context(Mutual effect of different factors can be seen in Fig.5).In the process of the learning, our
519 research initiate studying approach to informal learning in the clinical context, expanding the path,
520 effects and future development of it for residents.

521 Medical students are endowed with the lifelong learning ability through informal learning.
522 Autonomic learning ability makes the possibility of lifelong learning, and for exploration, reflection,
523 analysis and integration of knowledge should be focused more to inspire medical students for the

524 future study. How to make full use of the guidance from the clinical teachers in this learning pattern,
525 how to help residents construct knowledge system scientifically, how to integrate into online
526 learning for idea exchanges, learning discussion and problem solution. Meanwhile, affective
527 interaction and humanity spirit should also be supplemented during informal learning in clinical
528 context and association with nature and society like knowledge about COVID-19 or medical care
529 to ensure medical students of self-responsibility and to enhance their learning belief.

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

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

541

542 **Abbreviation**

543 COVID-19: Coronavirus Disease 2019;

544 UNESO: United Nations of Educational, Scientific and Cultural Organization;

545 SPSS: Statistic Package for Social Science

546

547 **Declarations**

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555 **Availability of data and materials**

556 The datasets used and/or analysed during the current study are available from the corresponding
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558

559 **Author's contributions**

560 LL conducted the literature search for the background of the study, and contributed to writing the
561 article.
562 ZfY collected data for the study, analyzed and interpreted statistical data, and contributed to writing
563 the article.
564 JM and XIT were involved in study planning, data processing, and revising the article.
565 HxC contributed to study design and oversaw the study.
566 All authors read and approved the final manuscript.

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579 **Ethics approval and consent to participate**

580 At the time of the study, approval from an ethical committee was not required for educational

581 research in Hebei China. Participation in the study involved no risks to the participants. All reports

582 were approved by all participants. The participants who agreed to participate in the interview were
583 informed of the aims, methods and confidentiality of the study prior to participation, and all gave
584 informed consent. Participants were allowed to withdraw from the study at any time. The
585 informed consent obtained from study participants was verbal. In order to protect the privacy and
586 confidentiality of the participants, no names were used in the observation reports.

587

588 **Consent for publication**

589 Not applicable.

590

591 **Competing interests**

592 The authors declare that they have no competing interests.

593

594 **References**

- 595 1. Zeng Lihong, Gao Zhimin. Study exploration on informal learning and occasional
596 learning – based on research from Marisick and Watkins [J]. *Chengren Jiaoyu*,
597 2006(03):3-7.
- 598 2. Wolfson, M. A., Tannenbaum, S. I., Mathieu, J. E., & Maynard, M. T.(2018). A
599 cross-level investigation of informal field-based learning and performance
600 improvements. *Journal of Applied Psychology*, 103, 14–36.
- 601 3. Yu Shengquan, Mao Fang. Informal learning - new field of research and practices
602 on e-Learning[J] *e-Education Research*, 2005(10):19-24.
- 603 4. Standards of educational technology for US students. [EB/OL].
604 <https://www.iste.org/standards/for-students.2018-11-16>.
- 605 5. Chinese Ten-year Plan of Education Infomationization [DB/OL].
606 http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/s3342/201203/xxgk_133

- 607 322.html.2018-10-22.
- 608 6. Core competencies and values research group. Core competencies and values for
609 Chinese students' development[J]. Journal of The Chinese Society of
610 Education,2016(10):1-3.
- 611 7. Cunningham, J., & Hillier, E. (2013). Informal learning in the workplace: Key
612 activities and processes. *Education+ Training*, 55 (1), 37-51.
- 613 8. Flynn, D., Eddy, E. R., & Tannenbaum, S. I. (2006). The impact of national culture
614 on the continuous learning environment: Exploratory findings from multiple
615 countries. *Journal of East-West Business*, 12 (2-3), 85-107.
- 616 9. Ludmerer, K.M., 2015. Let me heal: the opportunity to preserve excellence
617 in American medicine. Oxford University Press, Oxford, p. 2.
- 618 10. Wu Fan, Wang Ling. The 70-year achievements of medical education in China and
619 the path of reform in the new era[J]. *Chinese Health Resources*, 2019,22(4):254-
620 257
- 621 11. Notification of actions for “Internet plus” from National Development and Reform
622 Commission [EB/OL].(2015-03-16).
- 623 12. Hu Lele. Discussion of opportunities and challenges for the development of
624 education of China in the context of “Internet plus”[J]. *Modern Educational
625 Technology*, 2015(12):26-32.
- 626 13. Chen Yiming. Research on subject teaching environment and teaching mode in the
627 context of “Internet plus”[J].*Journal of Southeast China Normal University(Natura
628 Science Edition)* 2016, 41 (4): 282-232.
- 629 14. Guidance suggestion on online teaching organization and management during
630 COVID-19 preventing and controlling period. Ministry of Education of the
631 People’s Republic of China [2020] 2号 (2020-2-5) .
- 632 15. Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human
633 needs and the self-determination of behavior. *Psychological Inquiry*, 11 (4), 227-
634 268.
- 635 16. Parker, S. K. (2017). Work Design Growth Model: How work characteristics

636 promote learning and development.

637 17. Wang Zhen, Sone Meng, Sun Jianmin. (2014) .Authentic Leadership: Concept、
638 Measurement、 Formation and Function. *Advances in Psychological Science*, 22
639 (3), 458-473.

640 18. Tews, M. J., Michel, J. W., & Noe, R. A. (2017). Does fun promote learning? The
641 relationship between fun in the workplace and informal learning. *Journal of*
642 *Vocational Behavior*, 98, 46-55.

643 19. Marsick, V. J., Watkins, K. E., Scully-Russ, E., & Nicolaidis, A. (2017). Rethinking
644 informal and incidental learning in terms of complexity and the social context.
645 *Journal of Adult Learning, Knowledge and Innovation*, 1 (1), 27-34.

646 20. Jaguš, T., Botički, I., & So, H. J. (2018). A review of research on bridging the gap
647 between formal and informal learning with technology in primary school contexts.
648 *Journal of Computer Assisted Learning*, (2), 1-12.