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Relationship of adaptive expertise of health professions educators with age, experience, academic rank, and their work performance during an altered academic environment

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Abstract

Background Health professionals and health professions educators (HPEs) worldwide were confronted by the COVID-19 pandemic, which disrupted standard practice and forced HPEs to develop creative, alternative modes of training and education. The ability of people to work successfully and efficiently in non-standard situations can be called adaptive expertise in which people quickly overcome changes in work requirements using their expert knowledge in novel ways. The objectives of the current study were to investigate how the adaptive expertise of a group of HPEs influenced perceived work performance in a non-standard situation and to see whether there were relationships between the level of adaptive expertise and academic ranking and work experience of HPEs.

Methods A descriptive, cross-sectional, single-site study was conducted using a self-reported study tool about adaptive expertise developed by Carbonell et al. (2016), and three questions were asked about participants' perceptions of work performance, amount of work done, and teaching quality. The sample consisted of HPEs from the University of Twente, Netherlands.

Results Among 123 eligible participants, 40 individuals completed the survey. Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity indicated the adequacy of the sample size (KMO = 0.633, $P < 0.0001$). Participants were lecturers, senior lecturers, assistant professors, associate professors and full professors. The average adaptive expertise score of the sample was 4.18 ± 0.57 on a scale from 1 (low) to 5 (high). The domain and innovative skills are the principal distinct dimensions of adaptive expertise among HPEs. Professors showed higher adaptive expertise scores than the other ranks. Statistically significant correlations were found between scores of adaptive expertise and perceived work performance ($r = 0.41$, $p < 0.05$ and academic ranking ($r = 0.42$, $p < 0.05$). Adaptive expertise scores were not associated with work experience or HPEs' age.

Conclusions Our finding of a lack of relationships between self-reported level of adaptive expertise and experience and age but significant relationships with work performance and academic ranking of HPEs suggests that adaptive

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expertise is not auto-generated or acquired with seniority and experience but is a 'mastery' that should be developed deliberately.

Keywords Adaptive performance, Educators, Efficiency, Health sciences, Innovations, Lecturers, Work performance, COVID-19 pandemic

Practical implications

- Improving adaptive expertise skills among university teachers is essential to increase their work performance and prevent the interruption of academic programs during constrained situations.
- Adaptive expertise is not automatically acquired with seniority and experience but needs to be developed deliberately.
- Institutions should pay attention to conducting staff development programs irrespective of the age and seniority of the university teacher, and the training should encompass a variety of contexts, intensities, and learning activities that have substantiative variability from one another and meaningful insight focusing on in-depth reflection.

Background

Clinical practice continually faces evolving challenges. Taking care of the health of human communities is complex and often variable [1]. Clinical research regularly results in the need to adjust previously standard ways of practice and often produces new knowledge that must be mastered [1]. Furthermore, the responsibility of healthcare professionals extends beyond routine clinical practice; it encompasses the management of complex and often unpredictable human health issues [2]. In other words, the healthcare workforce needs to be prepared for a constantly changing work environment, and future-proof health professionals need to be trained [3].

The COVID-19 pandemic profoundly disrupted standard practices globally across all sectors and fields, including education at every level. With the COVID-19 pandemic, almost all the universities and schools in affected countries had to shift to alternative modes of teaching and learning, which are quite challenging for many teachers in the universities and schools [4]. Although advanced technology is used in many universities currently, still most teaching is based on the traditional model unless the program is delivered in distance learning or an online mode [5]. When face-to-face teaching sessions are abruptly shifted to an online mode, they need additional preparations, technological skills, and creativity, which could be quite challenging for most teachers. It is more challenging if teachers lack an awareness of how they can exploit their routines from adaptive perspectives [6]. Therefore, readiness and acceptance of the challenge by university teachers play a crucial role in the success of the continuation of uninterrupted sound teaching programs irrespective of unstable situations they have to face. While some people quickly overcome changes in work requirements by inventing new procedures and using their expert knowledge in novel ways, others do not possess this ability and find themselves thrown back, performing as novices [7, 8].

Adaptive versus routine expertise

Hatano & Inagaki [7] coined the term adaptive expertise and distinguished it from routine expertise. Experts are masters in their respective domains through deliberate practice or expert guidance [7]. Expertise reflects increasing competence as the person moves from the early cognitive stage to well-practised autonomous skill execution through practice [9]. Adaptive expertise enables professionals to respond to novel situations more effectively and innovatively than routine experts [10]. Hatano and Inagaki conceptualized routine expertise and adaptive expertise as two poles of one dimension, whereby routine expertise is the execution of high-quality procedures to act efficiently and accurately. In contrast, adaptive expertise encompasses the capability to devise novel solutions to professional challenges, as well as the ability to develop innovative problem-solving methodologies, particularly in unprecedented situations [7]. Individuals with adaptive expertise can face novel and challenging situations with success, irrespective of the unfamiliarity of the circumstance [11].

The key difference between adaptive and routine experts was their ability to work productively when confronted with novel situations [7]. Routine expertise enables experts to exhibit speed and accuracy in solving problems that fall into previously experienced, well-established patterns [12]. Therefore, routine experts are successful in standard situations but struggle with novel problems in which the task, method, or desired results are not known in advance [10]. In contrast, adaptive experts respond to novel or unexpected situations more effectively, efficiently, and innovatively than routine experts [10]. This is the concept of the optimal adaptability corridor where individuals are high on both dimensions of innovation and efficiency [10]. Therefore, adaptive experts adapt and overcome uncertainty by displaying high performance levels.

Adaptive expertise is a multi-faceted construct encompassing a range of dimensions as defined by

different authors [6, 7]. Widely, adaptive expertise has been described and measured using several dimensions [4, 7, 13, 14]. Domain-specific skills, metacognitive skills, and innovative skills are three of the main dimensions that have been used widely among researchers [6, 7, 13, 14]. Domain-specific skills are a critical dimension of adaptive expertise, encompassing declarative knowledge (knowing that), procedural knowledge (knowing how), and conditional knowledge (knowing when and where) [15]. Unlike novices, experts display a distinctive knowledge representation in terms of extent, organization, abstraction, and consolidation, which significantly influences their problem-solving capabilities [10, 11, 16]. While both adaptive and routine experts possess a similar breadth of knowledge, they differ in their knowledge representations in terms of extent, organization, abstraction, consolidation, and information retrieval. Therefore, problem-solving approaches may vary between the two groups [10, 11, 16]. Adaptive experts' knowledge representation is characterized by organization, abstraction, and consolidation and is independent of situational contexts (de-contextualization) [11]. Consequently, contextual knowledge has less influence on adaptive expertise than structured and abstract knowledge. This enables adaptive experts to apply known solutions to new situations more easily. Essentially, adaptive expertise facilitates the organization of knowledge in a way that enhances its applicability across various scenarios [11]. Moreover, adaptive experts exhibit greater cognitive flexibility and superior problem-solving skills than their routine counterparts [17], underpinned by their ability to engage in analogical reasoning using their organized knowledge base [18].

Metacognition, simply put, refers to 'thinking about thinking,' or our capacity to understand what we know and what we do not know [19]. Costa and Kallick [19] further emphasize that better metacognitive skills enable individuals to assess their knowledge and identify gaps, which is crucial for strategic learning and application of knowledge in unfamiliar contexts. People with high adaptive expertise demonstrate a strong ability to self-assess their expertise, knowledge, learning, and problem-solving abilities [20, 21]. Despite their apparent importance, the role of metacognitive skills in adaptive expertise is still debated. Carbonell et al. [13] argue that while metacognitive skills are valuable, they may not be definitive in distinguishing adaptive expertise from routine expertise, based on a study conducted among multiple professional categories and different geographical backgrounds [13].

The innovation dimension of adaptive expertise typically involves transcending established routines and often requires individuals to reconsider fundamental ideas, practices, and values to facilitate change [10, 17]. Schwartz et al. [10] describe adaptive expertise as a balance between efficiency and innovation, where efficiency relates to an individual's ability to fluently apply domain knowledge and skills in familiar situations. In contrast, innovation involves devising solutions for new scenarios where no precedents exist. This process necessitates recognizing how previously acquired knowledge can be adapted to novel circumstances, indicating that the knowledge used in the innovation process is both nuanced and complex [22]. Furthermore, innovation may lead to the enhancement of existing ideas or the discovery of entirely new approaches to problem-solving.

Chi [18] has described that adaptive experts acquire a deep conceptual understanding of the skill within their domain by intentionally seeking challenges, reflecting on their performance, and thus engaging in continuous learning. Adaptive expertise is a set of skills or dispositions, influenced by cognitive, motivational, and personality factors, that enables individuals to devise and implement new solutions effectively through a deep conceptual understanding of the problem's nature and context [7, 21]. Therefore, adaptive experts are more motivated to achieve a deep understanding of domain-related knowledge and skills. Further, they are keen on why and under which condition a specific domain-relevant skill must be applied, or new methods need to be devised [13]. Also, adaptive experts show a hierarchical knowledge representation [16] and an abstract representation of the problem at a deeper or more theoretical level [19]. Thus, adaptive expertise involves deeper knowledge processing, suggesting a more causally interconnected knowledge base. Therefore, adaptive experts can apply knowledge flexibly and strategically to meet their goals and succeed when facing novel situations in unexpected circumstances. Furthermore, they can modify ways of working to address specific needs and constraints of a task [7]. Thereby, they can create innovative solutions suited to the situation to find effective answers for unprecedented problems.

Adaptive expertise in teaching

Previous studies showed that schoolteachers with greater adaptive expertise can create more workable ideas and implement innovative teaching approaches than teachers with lower levels of adaptive expertise [6]. Mannikko and Husu [6] reported that primary school teachers with a high level of adaptive expertise were able to benefit from their routines and develop them further to concentrate on the situation and its demands. Additionally, they reported that highly adaptive teachers attempted to build more analytical and creative adaptations, indicating the importance of adaptive expertise among teachers.

University teachers are academics with responsibilities for teaching, research and development. They, therefore, should be knowledgeable and up-to-date by

continuously acquiring new knowledge and skills in their domain. Like schoolteachers, we expect university teachers to have different levels of adaptive expertise, with some being routine experts while others might be more inclined to innovate their teaching practices. Van Dijk et al. [23] argue that for adequate academic professional development of university teachers, there should be a link between the disciplinary knowledge that university teachers possess and develop on the one hand and adaptive expertise development on the other. Ultimately, adaptive expertise is expressed through visible performance [23].

University teachers, who balance teaching, research, and administrative duties, exhibit various forms of work performance. Research shows that work performance is dynamic, fluctuating within individuals over time [24, 25]. Additionally, workplace factors can influence performance [26]. Teachers with adaptive expertise will likely leverage their problem-solving skills to navigate challenges effectively, suggesting their work performance remains stable despite changing circumstances or work demands.

University teachers with higher academic rankings often have more extensive exposure to complex problems and a richer array of experiences in navigating academic challenges. This exposure can enhance the hierarchical and abstract knowledge representation, as well as the ability to engage in innovative problem-solving, traits associated with adaptive expertise [19]. Additionally, extensive work experience may contribute to a deeper, more causally interconnected knowledge base. Furthermore, university teachers with higher academic rankings are also more likely to have had more opportunities for practice and training, which are crucial for skill development [19]. As individuals progress in their academic careers, they acquire extensive domain-specific knowledge and skills through (deliberate) practice and experience. In academia, increasing experience, research innovations, and various other academic involvements often correlate with higher academic rankings, reflecting greater competence and mastery in one's field [27, 28]. The dynamic nature of academic work requires faculty members to manage responsibilities ranging from pedagogy to research. Factors such as a positive mindset, deeper understanding, innovative skills, and the ability to apply and devise new methods as required by specific conditions contribute to the development of adaptive expertise [7, 29]. Given that higher academic ranks are often achieved through years of experience and continuous learning, it is plausible to speculate that there is a relationship between adaptive expertise and academic ranking.

Adapting university teaching during the COVID-19 pandemic

Health Professional Educators (HPEs), like many other professionals, had to adapt to unprecedented working conditions during the COVID-19 pandemic rapidly. These extraordinary challenges that were faced during the Covid-19 pandemic, placed an added burden on HPEs who were at the frontline of patient care provision. Amid the pandemic, HPEs had to develop creative, alternative modes for training and education in the shortest amount of time possible. Our study aimed to understand how HPEs navigate and adapt to unprecedented circumstances, ensuring success amidst change. While the pandemic certainly intensified stress levels for HPEs, investigating adaptive expertise during this period offers valuable insights into how educators cope with difficulty and perform their duties. Carbonell, et al., highlighted the need for non-standard but realistic tasks is the best to evaluate adaptive expertise [13]. These tasks mimic real-world challenges that are unpredictable and require innovative problem-solving. They reveal how individuals can adapt and develop new solutions when confronted with novel and complex challenges, a critical ability during unprecedented events like the COVID-19 pandemic. In this context, this study provides a unique opportunity to explore HPEs' adaptive expertise. Additionally, since our study is situated within the context of the COVID-19 pandemic, the broader trends of technical innovations and evolving job demands in HPEs are indeed relevant and contribute to the ongoing discourse on educator adaptation.

HPE's in the current study were required to working from home. Working from home not only affected how work was organized but also affected job satisfaction and work performance [30]. Many studies have focused on the impact of online learning on health professional students' performance, well-being and perceived teaching quality. Few studies [31, 32] also examined the effect of working from home during the COVID-19 pandemic from the university teachers' perspective. This study aimed to investigate how the adaptive expertise of a group of HPEs influences perceived work performance in the altered academic environment and to explore the relationships between adaptive expertise and the academic ranking of university HPEs and their work experience.

Methods

Study design

A descriptive, cross-sectional, single-site study was carried out as this work investigated the subjective assessment (self-reported) of the adaptive expertise of a previously uncharted population. Quantitative data was collected from the demographic information and questionnaire responses of the participants using an online

survey. The demographic information included age, sex, present and past work experiences, the field of expertise, and present academic rank. A tool developed by Carbonell et al. [13] was used to measure the participants' adaptive expertise. Three questions with a visual analogue scale were used to measure perceived work performance during the pandemic.

Study sample

Like in many other universities, HPEs at the University of Twente (UT) had to shift all the teaching and learning activities into a fully online mode as the UT was closed from mid-March 2020. This is the time during which when enrolment in new courses starts in the second semester of the academic calendar of the UT. The data were collected from June to July 2020 when HPEs worked from home and engaged in online teaching.

The HPEs at the Technical Medicine, Biomedical Engineering, and Health Sciences educational programmes of the University of Twente are university teachers comprising lecturers, senior lecturers and assistant, associate, and full professors. According to the registry, there were 123 university teachers involved in the Health Professions Education study programs of UT. All 123 teachers were invited to participate in the study.

Study tool

After a literature survey, the latest available tool for measuring adaptive expertise developed by Carbonell et al. [13] was used for data collection. This self-reported study tool developed by Carbonell et al. [13] has been used to subjectively measure adaptive expertise in several populations [14, 33, 34]. The tool is a questionnaire containing 17 items and Likert scale responses ranging from 1 (never or only rarely true of me) to 5 (always or almost always true of me). Although both English and Dutch versions of the questionnaire are available, the English version was used in this study as both Dutch and non-Dutch university teachers work at the UT. Some items were modified slightly to suit the academic environment and the HPEs without changing the core meaning. The revised survey was pilot-tested using a few staff members [6] of the Technical Medicine Department, and some items were modified slightly to improve clarity and understanding.

Three questions about work performance, amount of work done, and teaching quality were added to measure perceived work performance during the pandemic. A scale ranging from 1 (Extremely poor) to 10 (Extremely good) was used to identify the perceived level of satisfaction with the work performed.

Study procedure

Ethical approval was obtained from the Ethical Review Committee of the Faculty of Behavioural Management and Social Science (BMS) of the UT. All participants were informed about the study via email. Informed consent was requested from the participants in accordance with the guidelines of the Ethical Review Committee of BMS faculty before proceeding to the survey link (questionnaire) on Qualtrics XM (USA). The participants' identities were anonymised, and data were exported to an excel file (Microsoft Office Excel) and handled confidentially.

Data analysis

Respondents without teaching involvement during the pandemic or with incomplete data were excluded from the analyses. Only the lecturers, senior lecturers, and professors were considered for the analysis of the relationship between adaptive expertise and academic ranking, and research staff was not considered. The latent variables were adaptive expertise and perceived work performance, while observable variables were the responses to the questionnaire items. The dependent variables were the scores of adaptive expertise and perceived work performance, whereas the independent variables were age (continuous variable), gender, work experience, and academic rank (categorical variables). Descriptive statistics was employed to inspect the distributions of the variables.

For adaptive expertise, the responses of 17 items were scored (1 to 5). Negative items were reverse-scored. The mean values were calculated to create a composite score of adaptive expertise (cumulative adaptive score) for each participant across the sample.

The Excel file exported from Qualtrics XM software was imported into SPSS, and data was labeled by assigning appropriate codes. The Kaiser-Meyer-Olkin measure of Sampling Adequacy and Bartlett's Test of Sphericity were performed before conducting statistical analysis to ensure the sample size was adequate. The latent variable adaptive expertise was measured using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

The tool of 17 items used in the present study has been tested and validated for some professions [15, 16] but not for university teachers. Statisticians recommend that once a tool has been developed using Exploratory Factor Analysis (EFA) or other techniques, Confirmatory Factor Analysis (CFA) should be carried out to decide whether the tool (inventory) has the same structure across a certain population [35]. CFA enables the determination of how different the structure and function of a measurement tool are across groups [36]. In other words, CFA is conducted to assess whether the factor structure produced by the EFA fits the data [35].

Instrument validation

To select the best-fit model, CFA was performed twice using the R statistics package. In the first CFA, data from the items identified by Carbonell et al. [13] were used. Secondly, independent factor extraction was performed using EFA followed by CFA. For factor extraction, Principal Components Analysis (PCA) was selected, and components were rotated by applying a direct Oblimin method. The minimum factor loading was considered as 0.4, and items were sorted by their size. Finally, the best-fit model was selected using fit indices. A composite score of adaptive expertise (cumulative adaptive score) for each participant was calculated using statistically significant items selected for the best model and calculating their mean values. These composite scores were used for comparisons and correlation statistics.

Assessing relationships

Spearman Rank Correlation was used to check all the correlations as it does not carry any assumptions about the distribution of the data and is the appropriate correlation analysis tool for variables measured on an ordinal or ranking scale [37].

Perceived work performance was measured using a rating scale (1 to 10) given for the three statements about work performance, the amount of work done, and teaching quality. The mean score of the three questions was taken to measure perceived work performance. Respondents with no teaching involvement during the pandemic or incomplete data were excluded from the calculations.

Work experience was categorized according to the number of years of employment (less than a year, 1 to 5 years, 6 to 10 years, 11 to 15 years, and more than 15 years). Age was recorded in numbers. Academic ranks (positions) were ranked based on the ranking system generally used in universities. However, the researcher category was excluded when analyzing the relationship between academic rankings and the scores for adaptive expertise due to a low representation of them in the sample and inadequate details of their academic background. Therefore, the ranking order used in the analysis was: lecturer, senior lecturer, assistant professor, associate professor, and full professor.

A normality test was also performed before running the EFA and CFA. Cronbach's alpha values were calculated for all factors (dimensions) to check for internal consistency. Descriptive statistics were employed to inspect the profile of the sample. $P<0.05$ was considered statistically significant in all calculations.

Results

Among 123 eligible participants, 58 individuals consented to participate in the study via an online questionnaire, giving a 47.15% response rate. However, only 40 individuals completed the survey, and the final response rate was 32.52%. Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity indicated the adequacy of the number of the present sample for valid statistical analysis (KMO = 0.633, $P<0.0001$) [38].

Demographic information of the sample

The sample consisted of 20 females and 19 males, and one participant did not disclose their gender identity. Participants' age ranged from 27 to 64 (mean age was 46 ± 11.8 years). HPEs of various academic ranks were included in the sample, from the starting grade of lecturer to full professor. Most participants were lecturers, followed by assistant professors, full professors, senior lecturers, and associate professors, while two members did not reveal their academic ranking (Table 1). The mean years of work experience of each academic rank are shown in Table 1. Four main fields of teaching expertise identified among 40 participants were medical sciences (14), social sciences (7), technical (8) and professional skills (11).

Adaptive expertise among health professions educators

Tables 2 and 3 both present the results of the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA); Table 2 included analyses for all 17 items, whereas Table 3 focused on those items that were statistically significant. Accordingly, all the items in the domain dimension showed a higher significance while some items of the

Table 1 Demographic composition of the sample

		Age	Work Experience (present rank)		Gender		
Academic Ranking	***No.***	***Mean*** **±SD**	**Median**	***Mean*** **±SD**	**Male**	**Female**	**Not Revealed**
Lecturer	10	43±12.61	3	2.9±1.2	2	8	
Senior lecturer	5	53.2± 11.03	4	4±1.22	2	3	
Senior researcher	1	55	1		1		
PhD student	2	28.5±2.12	2	2	-	2	
Post -Doc	1	30	2		1	-	
Assistant professor	9	45±10.6	2	2.89±1.36	5	4	
Associate professor	3	44.33±6.43	4	3.33±2.08	2	1	
Full professor	7	56.43±3.87	5	4.71±049	5	1	1
Not revealed	2	33.5±9.19	1.5	1.5±071	1	1	

Table 2 CFA analysis showing the significance levels and factor loading for all 17 items

	Estimate	*P*	Factor loading
Items of Domain skill			
1. I realized that I need to learn continuously to become and stay an expert in my field	0.749	0.000	0.774***
2. I realized that knowledge in my discipline keeps on developing	0.280	0.003	0.443**
3. I gained a better understanding of concepts in my discipline	0.544	0.000	0.788***
5. I concerned myself with the latest development in the domain of my discipline	0.629	0.000	0.648***
7. I was able to develop and integrate new knowledge with what I learned in the past	0.471	0.000	0.797***
Items of Metacognitive skill			
4. I was able to indicate the cause of any obstacles which emerged	0.126	0.153	0.254
10. I sought out feedback	0.074	0.606	0.089
13. I was able to assess when my knowledge is insufficient to perform a specific task or solve a particular problem	0.528	0.004	0.900**
14. I was able to assess what skills I do not possess to perform a certain/specific task or solve a particular problem	0.422	0.008	0.686**
Items of Innovative skill			
6. I showed that I am willing to keep on learning new aspects related to my discipline	0.649	0.000	0.731***
8. I focused on new challenges in my academic environment	0.422	0.000	0.559***
9. I approached new tasks/projects in similar ways as I worked in the past	-0.130	0.273	-0.134
11. I was able to keep on performing at a high level when confronted with unfamiliar situations or tasks	0.241	0.014	0.327*
12. I was able to apply my knowledge flexibly to the different tasks in my academic environment	0.086	0.218	0.151
15. I applied my knowledge in new and unfamiliar situations in areas related to my discipline with a degree of success	-0.063	0.325	-0.120
16. I was able to adapt my work habits to the needs of the situation	0.052	0.490	0.083
17. When I was confronted with obstacles or difficult situations, I gave up	-0.044	0.634	-0.057

Note. Significance level * $p<0.05$. ** $p<0.01$. *** $p<0.001$

Table 3 CFA analysis showing factor loading when insignificant items were excluded from the model

	Estimate	Std.Err	Z - value	P(> I z I)	Std. Iv	Std. all (Factor loading)
Domain =~						
Item 1	0.740	0.130	5.686	0.000	0.740	0.766***
Item 2	0.271	0.096	2.805	0.005	0.271	0.428**
Item 3	0.554	0.091	6.076	0.000	0.554	0.802***
Item 5	0.619	0.139	4.452	0.000	0.619	0.637***
Item 7	0.474	0.078	6.077	0.000	0.474	0.802***
Metacognitive =~						
Item 13	0.496	0.401	1.238	0.216	0.496	0.845
Item 14	0.451	0.368	1.227	0.220	0.451	0.734
Innovative =~						
Item 6	0.650	0.126	5.171	0.000	0.650	0.732***
Item 8	0.445	0.109	4.073	0.000	0.445	0.590***
Item 11	0.256	0.101	2.540	0.011	0.256	0.346*

Note. Significance level * $p<0.05$. ** $p<0.01$. *** $p<0.001$

Table 4 Comparison of Model Fit Indices

Models	CFI	TLI	AIC	BIC	RMSEA	SRMR
1	0.782	0.744	1347.561	1410.050	0.098	0.154
2	0.970	0.957	758.208	797.052	0.062	0.085

Note. Model 1 considered all 17 items with no removal of any items; Model 2 considered only significant items. As model 2 shows, the highest CFI and TLI values and lowest in the AIC, BIC, RMSEA and SRMR. Accordingly model 2 was selected as the best fit.

metacognitive and innovative domains were shown to be insignificant.

When statistically not significant items were excluded in CFA, only the items of the domain and innovative dimensions contributed to the adaptive expertise of the present sample. A comparison of fit indices of the two models indicated that the model comprised of significant items had the best fit (Table 4). Schmitt [39] reported that a good model fit has the following indices: RMSEA (Root Mean Square Error of Approximation) and SRMR (Standardized Root Mean Square Residual) should be below 0.08 and CFI (Confirmatory Factor Index) and TLI

Table 5 Mean Scores of Adaptive Expertise and its Dimensions Among Different Academic Ranks

		Domain		Innovative		Total (Adaptive Expertise)	
Academic rank	***N***	***M***	***(SD)***	***M***	***(SD)***	***M***	***(SD)***
Lecturer	10	3.82	0.77	3.75	0.35	3.74	0.75
Senior lecturer	5	4.16	0.80	3.93	0.22	4.07	0.62
Senior researcher	1	4.20	-	4.00	-	4.25	-
PhD student	2	4.60	0	4.00	0	4.50	0
Post -Doc	1	4.60	-	4.25	-	4.62	-
Assistant professor	9	4.44	0.33	3.96	0.34	4.36	0.33
Associate professor	3	4.53	0.50	3.75	0.22	4.46	0.52
Full professor	7	4.48	0.51	3.89	0.54	4.36	0.53
Not revealed	2	4.30	0.14	3.87	0	4.31	0.09
Total sample	40	4.26	0.60	3.87	0.34	4.18	0.57

Table 6 Internal Consistency of Three Different Constructs

Name of Construct	Cronbach Apha
Adaptive Expertise	0.72
Domain skill dimension	0.81
Innovative skill dimension	0.57
Perceived work performance	0.63

Table 7 Spearman's Rank Correlations Results Indicating Relationships of Adaptive Expertise Score

Variables	*N*	*r*	*p*
Perceived work performance & adaptive expertise	32	0.406*	0.021
Perceived work performance & domain skill	32	0.371*	0.014
Perceived work performance & innovative skill	32	0.363*	0.041
Academic ranking & adaptive expertise score	34	0.423*	0.013
Academic ranking & Domain skill	34	0.427*	0.012
Academic ranking & Innovative skill	34	0.348*	0.044
Experience (PP) & adaptive expertise score	40	-0.166	0.305
Experience (PP) & domain skill score	40	-0.116	0.475
Experience (PP) & Innovative skill score	40	-0.23	0.148
Age & adaptive expertise	40	0.124	0.522

Note. Significance level * $p<0.05$

(Tucker Lewis Index) index should be above 0.9. Accordingly adaptive scores were calculated using only the statistically significant items.

Table 5 illustrates the mean score values for the adaptive expertise along with the domain and innovative skills dimensions. The average score of adaptive expertise of the sample was 4.18 ± 0.57. It is noted that the professors scored higher on self-reported adaptive expertise than lecturers and senior lecturers (Table 5). Reliability analysis is necessary to assess the consistency of a measure. Internal consistency measurements (Cronbach alpha values) of domain and innovative skill dimensions and adaptive expertise are shown in Table 6.

Relationships of adaptive expertise score with age, experience, work performance, and academic ranking

Lecturers, senior lecturers and three categories of professors were considered for the correlation analyses. Spearman's Rank correlation indicated statistically significant positive associations between adaptive expertise and perceived work performance ($r=0.41$, $p<0.05$) and academic ranking ($\rho=0.42$, $p<0.05$ (Table 7). However, an increase in adaptive expertise scores was not associated with increased work experience or the age of HPEs (Table 7). Besides, age did not show any relationship with academic ranking. However, a strong positive relationship was observed between age and experience ($\rho=0.79$, $p<0.001$).

Discussion

It is beneficial to compare the findings of our current study with those of Carbonell et al., [13] since both studies used the same tool. The present study, along with the research conducted by Carbonell et al., [13, 40] affirms that the dual dimensions of the domain and innovative skills constitute essential components of adaptive expertise, without the inclusion of metacognitive skills as a distinct dimension. They [13, 41] further posited that while domain skills evaluate an individual's capacity for adaptation, innovative skills are crucial for the modification of existing knowledge and skills in response to emerging challenges. Notably, the majority of items under the domain skill dimension display significant agreement across both studies, affirming their relevance and validity in measuring adaptive expertise. This consistency underscores the robustness of domain skills as a foundational component of adaptive expertise. However, within the dimension of innovative skills, although both studies initially proposed eight items to depict this dimension, our findings and those of Carbonell et al. [13] differ slightly in the items that were statistically significant. In our current study, only three items were statistically significant compared to five in the Carbonell et al. study [13]. This discrepancy suggests variability that may be attributable to differences in sample populations or sizes and indicates a need for further refinement of these items.

Adaptive expertise and perceived work performance

The present result of a significantly positive and moderate relationship between adaptive expertise and perceived work performance suggest that the HPEs with higher levels of adaptive expertise faced the altered academic environment with greater success during the pandemic. The COVID-19 pandemic created situational constraints as it altered the familiar work environment into an unexpected situation that caused job stress [41]. Further, Venkatesh [41] reported that increased job stress could lead to lower job satisfaction, which could turn to lower job performance. However, the present finding of a positive relationship between adaptive expertise and perceived work performance suggests that although the hindrance stressors impede task performance, this does not have to be true for HPEs with good adaptive ability. Our study showed that HPEs with good adaptive ability seem more accustomed to altered academic environment during the pandemic using their problem-solving skills and capacity to move beyond conventional pedagogy. This adaptability may be attributed to the fact that adaptive expertise, characterized by efficiency and innovation in applying knowledge to new challenges, enables experts to navigate unfamiliar circumstances through enhanced problem-solving and experimentation when previous experience is not applicable [7]. Therefore, strategies to improve adaptive expertise among university teachers should be prioritized during staff development programmes at institutional levels. However, further explorations and research are necessary on the mechanisms of planning and development of such programs.

Adaptive expertise and experience

A significant relationship between age and experience noted in the present study implies a natural phenomenon that occurs in any population of the workforce as the experiences increase with age. A study conducted among Indonesian university teachers showed that experience significantly positively affects work performance as experience shapes performance [42]. Generally, it is reasonable to expect that ageing and work experiences can increase the amount of knowledge and, thus, expertise. Some have indicated that this should be true for routine expertise in the context of expert-novice differences, considering the domain-specific experience, as experience causes autonomous skill execution through practice [9, 43]. Therefore, increased work performance could be expected with augmented experience and ageing because experience blends knowledge and practice. However, our study did not find a relationship between work performance and age and experience. Further, there were no associations between adaptive expertise and HPEs' experience and age (Table 7). We speculate that it may be related to the circumstance that the present study investigated. Hatano & Inagaki [7] reported that adaptive expertise is particularly revealed in non-standard or unfamiliar situations like a pandemic. As the work performance was explored in the context of an unexpectedly altered academic environment during the pandemic, it seems that experience and age (maturity) are inadequate to be successful on such occasions. Further, it might even hinder being innovative.

Adaptive expertise is characterised by efficiency and innovation in applying knowledge to new situations and challenges in contrast to routine expertise [44]. Schwartz et al. [10] conceptualise that both adaptive and routine expertise comprise the same extent of domain knowledge and the ability to perform flawlessly in familiar situations. Adaptive experts engage in a more active process of knowledge-based problem-solving through experimentation when previous experience is unavailable, like in unaccustomed conditions [7]. Therefore, adaptive experts are much more likely to change their core competencies and expand and restructure their expertise, whereas the core competencies of routine experts develop throughout their lives with growing efficiency [17]. Also, adaptive experts are distinguished only in non-standard situations [7]. Therefore, our findings of the positive association between adaptive expertise score and the perceived work performance of university HPEs during the pandemic and the absence of any relations of adaptive expertise with experience and age are congruent with those views that adaptive experts are more successful than routine experts in a dynamically changing environment.

Consensus on how work experience influences adaptive expertise is a question. Ericsson [43] and Grunefeld [45] reviewed several research studies and indicated that a significant correlation was not always observed between the amount of professional experience or professional training and work performance. Furthermore, they reported a significant negative correlation between length of experience and objective performance, stating that performing tasks of highly experienced persons are not always superior to that of students using examples from the fields of computer programming and physics [43]. In addition, a study that explored the level of adaptive expertise among preschool teachers found that teachers with more teaching experience seemed less adaptive as they showed a fixed orientation to teaching [6]. Further, they explained that the teaching orientations could be associated with levels of adaptation of teachers and their personal practical theories. For example, teachers with more adaptability are open to new ways and perceived from practical observations. In contrast, less adaptive teachers can employ past workable experiences in new situations [6].

Expertise is not developed without experience. However, the development of adaptive expertise is related

to the extent to which an individual's experience has encompassed a variety of contexts, intensities and forms, learning activities that have substantiative variability from one another [11, 29, 43, 46]. Further, they suggested that experience with working on a variety of problems allows individuals to achieve high levels of abstraction in their knowledge representation, allowing them to apply their knowledge flexibly and deal with novel problems referring to a study conducted among business consultants and restaurant workers [47]. In other words, the experience could be helpful to training adaptive expertise when the events encourage reflection on experiences and errors, inviting critical dialogue which connects to the in-depth understanding of the knowledge and flexible knowledge application so that novel solutions are prompted.

In addition, Carbonell et al. [11] recorded that experience helps to develop adaptive expertise if the experience is involved in problem-solving after an extensive review. Further, they explained that the experience with meaningful insight focusing on in-depth reflection should be important in developing adaptive expertise. Therefore, our finding of a lack of relationship between adaptive expertise score and the experience of university HPEs, together with evidence from the literature, suggests that adaptive expertise is not autogenerated or acquired with seniority and experience automatically, but it is a mastery that should be developed deliberately. This highlights the importance of conducting continuous professional development programs to improve adaptive expertise among the staff, focusing on developing intuitions based on in-depth reflection irrespective of their age and experience.

Adaptive expertise and academic rank

Academic ranking is a faculty appointment system based on hierarchy [27]. It is necessary to reward academics through promotion and tenure. Although most universities have their own promotion policy, research indicates that the academic reward systems of most institutions are fundamentally designed to evaluate the professional activities of lecturers using several parameters such as peer-reviewed publications and their impact factor and citations, national or international reputation, research grants, awards and collaborations, patents, and teaching innovations [27, 48]. Similarly, HPEs of the University of Twente consider all these parameters in the academic reward system, while extraordinary talents can complete the track in a shorter period if they meet the requirements. In this context, it is plausible to think that high-achieving university HPEs ascend the academic career ladder faster than others.

A study conducted among employees of research and development (R&D) in six industries in South Korea has proposed that adaptive expertise enhances career adaptability, which helps employees achieve high career success [33]. Furthermore, it reported that personnel with high adaptive expertise are well equipped with self-regulation to carefully detect anomalies in their tasks and environment reflect the existing skills and make decisions in a dynamically changing environment [33]. Therefore, adaptive experts seek to adopt new perspectives and take risks to generate innovative solutions within the job domain rather than adhering to prior experiences and automated decision-making [33].

Adaptive behaviours to achieve career goals are a personal capacity to deal with unpredictable tasks [49]. High personal competence in self-regulation and environment exploration is closely associated with the achievement of career success [49]. Self-regulation strategies enable personnel to use available career opportunities, plan for the future, and deal with necessary intrapersonal, interpersonal, and environmental factors to accomplish career goals [50]. Lee [33] claimed that career adaptability is a critical path through which adaptive expertise leads to satisfactory career outcomes for innovators.

In this context, it can be argued that other dynamics, such as certain personality-related factors (e.g. self-regulatory mechanisms) of university teachers, can influence the level of adaptive expertise based on the present result of that the existence of a statistically significant relationship between adaptive expertise score and academic ranking of HPEs. Although the relation of personality factors to adaptive expertise is still unclear [11] some believe personality-related factors could be a dimension of it [51]. Doing an extensive review of concepts of adaptive expertise, several researchers [11, 51, 52] recorded that there were other elements in connection with adaptive expertise in addition to its known dimensions of domain-specific skills, innovation, and metacognition. Some of these additional constructs (elements) were described for the "Big Five model of personality traits" which includes (1) agreeableness, (2) conscientiousness, (3) extraversion, (6) emotional stability/neuroticism, and openness to experience [53]. However, Pulakos et al. [51] reported that three personality elements appeared to be most fruitful for predicting adaptive performance: openness to experience, emotional stability, and achievement motivation. Furthermore, they stated that achievement motivation and interest in learning new tasks and technologies were more significant in predicting adaptive performance. Hence it could be believed that personality traits drive the intrinsic characteristics to be adaptive. Initiating the process of adaptation, finding the best way of problem-solving and staying engaged till the end of the process are driven by personal characteristics or traits [54]. These traits may not be identical in every individual or profession.

Several studies have shown that certain parameters like research output (bibliometric measures) [27, 28] job satisfaction and academic productivity [55] vary in relation to academic ranking. For example, a positive relationship was recorded between academic ranking and the output of scientific publications using different indexes such as SINTA (National online database system in Indonesia) and h-index [27, 28]. To our understanding, there is no information about adaptive expertise and academic ranking among university teachers. Therefore, the present results of the positive relationship between adaptive expertise score and academic ranking of HPEs provide important information to the literature and considerations of it for improvement of the performance of university teachers. Although the present study could not identify specific personnel traits, our results encourage further empirical analysis in diverse national contexts to understand national cultural influences and identify characteristics of university teachers which contribute to being adaptive experts. Furthermore, important findings might be discovered by tracking their development in the career path and their thinking (reasoning process) about workaround when routines change and the need to generate new ideas and innovations.

Limitations

Caution is required when making generalisations from the present results due to a few limitations. Although the KMO value indicated an adequate sample size for statistical analysis, inadequate representations from different categories of HPEs and single-site studies limit the generalizability of the findings. Although statistically significant correlations were observed between adaptive expertise and both perceived work performance and academic ranks, these correlations ranged from weak to moderate. Regarding the methodology used in our study, another limitation arises from relying solely on questionnaire-based data collection. This reliance on self-reported data may not fully capture the nuances of how HPEs adapt their methodologies under varied circumstances. Although valuable, our current approach limits our understanding to quantitative assessments and might overlook the richer, qualitative insights that could be gleaned from direct interactions, such as interviews or focus group discussions. Therefore, to enhance the robustness and depth of future research, we recommend conducting a more comprehensive study that incorporates a broader sample from different faculties and universities. Additionally, integrating qualitative methods, such as interviews or focus group discussions, would provide a more detailed understanding of the adaptive strategies employed by HPEs. The present study calculated the perceived work performance using three questions, which cannot be considered a strong measurement of perceived work performance. Furthermore, it is only the perceived performance by the respondents, and real work output could not be established by other means because of the restrictions imposed by the COVID-19 pandemic.

Recommendations

Our study showed a relationship between adaptive expertise, academic rank and work performance for university HPEs. Therefore, it advises universities to develop professional programmes designed to educate and promote adaptive expertise among university teachers to increase their work performance and succeed in any disruptive work environment.

Ward et al. [54] stated that expertise could best be leveraged by examining performance in challenging, low-frequency, non-routine cases where adaptive skill or the ability to deal with the non-routine is paramount. Further, they suggested training models to advocate using learning opportunities on challenging and non-routine cases based on the expert's lived experiences. They are problem-focused, collaborative, and led by skilled facilitators [54]. Recently, Grunefeld [47] surmised that enhancing adaptive expertise should provide participants with: (1) the opportunity to acquire knowledge and skills relevant to the domain [13] (2) the opportunity to gain experience in dealing with change and novel tasks [13, 31], and (3) multiple opportunities for deliberate practice in the domain [45] reviewing the literature. Therefore, the curriculum and content delivery of staff development programs should emphasise these aspects in the development of adaptive expertise together with other pedagogical skills. However, there are unresolved issues in applying these models to tangible training objectives, course planning, designs and assessments, and CPD programs and await future work.

Conclusions

Adaptive expertise is crucial in any sector in an era of social, political, and technological changes and unexpected pandemics. Therefore, adaptive expertise in education platforms has gained particular interest. This study contends that the significant enhancements observed in perceived work performance among HPEs can be directly attributed to the activation of adaptive expertise, evidenced by a significant correlation (r - 0.41). Thus, our finding of a lack of relationships between adaptive expertise score and experience and age but significant relationships with work performance and academic ranking of university HPEs suggest adaptive expertise is not auto-generated or acquired with seniority and experience automatically, but it is a mastery that should be developed deliberately irrespective of the age and experience.

In this context, educational institutes should consider increasing awareness of adaptive expertise and improving

adaptive skills among educators (teachers) for successfully implementing curricula designed for developing adaptive expertise among students. The present study could fill a knowledge gap by discussing the adaptive skills of academic staff in relation to age, experience, academic ranking, and work performance during a restricted time like the COVID-19 pandemic and provide essential suggestions for staff development programs.

Supplementary Information

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Supplementary Material 1

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Author contributions
CJ conducted the study, analysed and interpreted the data and wrote the manuscript. MG conceived the study and was in charge of overall direction and planning and data collection. LN performed the analysis. All authors discussed the results and provided critical feedback and contributed to shape the manuscript. All authors read and approved the final manuscript.

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Data availability
One supplementary file is available. Raw data can be obtained by requesting from the corresponding author.

Declarations

Ethics approval and consent to participate
Ethical approval was obtained from the Ethical Review Committee of the Faculty of Behavioural Management Science (BMS) of the University of Twente, Netherlands. All methods were carried out in accordance with the Declaration of Helsinki. During data collection, all participants were provided with written information about the study via email, and informed consent was obtained. Anonymity of participants was preserved.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Abbreviations
CPD Continuous Professional Development.
HPEs Health Profession Educators.
KMO Kaiser-Meyer-Olkin.
UT University of Twente.

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