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What Difference Does Participation in Training Make?

Applying Latent Change Models in the Evaluation of Health Promotion Training Courses

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Abstract: To address societal change, adequate capacity-building measures are necessary, especially educational measures in health promotion (HP). The aims of this study are twofold: It explores on the one hand how HP competencies can be measured and quantified, and on the other hand how training courses in HP help to change them and which factors are associated with possible changes. Using a pre-post training design, 778 participants in an Austrian training programme for HP rated their competencies in this area using a self-assessment instrument. The applied latent change model showed an average increase in competencies, although participants benefited to different degrees in their perception. The inter-individual differences in (changes to) intra-individual competencies varied depending on individual and organisational factors and were related to the evaluation of the training. The results thus point to the relevance of the individual and the context, contributing to a better understanding of training-relevant mechanisms, processes and components. This model opens up new possibilities for research into effectiveness and transfer research. Its application can contribute to the creation of high-quality training measures and to developing the necessary professional competencies.

Key words: Health promotion; CompHP framework; training evaluation; latent difference scores

Welchen Unterschied macht Trainingsteilnahme? Anwendung latenter Veränderungsmodelle zur Evaluation von Bildungsangeboten in der Gesundheitsförderung

Zusammenfassung: Zur Bewältigung des gesellschaftlichen Wandels sind adäquate kapazitätsbildende Maßnahmen, vor allem Bildungsangebote in der Gesundheitsförderung (GF), notwen-

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dig. Die Ziele dieser Studie sind zweierlei: Sie fragte einerseits, wie GF-Kompetenzen gemessen bzw. quantifiziert werden können, und andererseits wie GF-Trainingskurse zu ihrer Veränderung beitragen und welche Faktoren mit möglichen Veränderungen im Zusammenhang stehen. Mittels Vorher-Nachher-Designs beurteilten 778 Teilnehmende eines österreichweiten Seminarprogramms für Gesundheitsförderung ihre diesbezüglichen Kompetenzen mit einem Selbstbewertungsinstrument. Das umgesetzte latente Veränderungsmodell belegte eine durchschnittliche Kompetenzsteigerung, wobei Teilnehmende ihrer Wahrnehmung nach unterschiedlich stark profitierten. Dabei waren die interindividuellen Unterschiede der intraindividuellen Kompetenz(-veränderung)en von individuellen und organisatorischen Faktoren abhängig und hingen mit der Trainingsbewertung zusammen. Die Ergebnisse weisen somit auf die Relevanz des Individuums und Kontexts hin und tragen zum besseren Verständnis von trainingsrelevanten Mechanismen, Prozessen und Komponenten bei. Das Modell eröffnet neue Möglichkeiten bei der Wirksamkeits- bzw. Transferforschung. Seine Anwendung kann zur Entwicklung von hochwertigen Trainingsmaßnahmen und zur notwendigen Kompetenzentwicklung des Fachpersonals beitragen.

Schlagwörter: Gesundheitsförderung; CompHP-Rahmenkonzept; Trainingsevaluation; latente Differenzwerte

1. Background

The Geneva Charter for Well-being emphasises the need to address the environmental, political, economic, digital and social determinants of health in depth (World Health Organization [WHO], 2021) in order to mitigate the risks to population health. HP is a key mechanism for overcoming these societal challenges and widespread inequalities, especially because "enabling people to increase control over their health and its determinants is at the core of health promotion" (Van den Broucke, 2020, p. 181). While the health sciences should contribute to our theoretical understanding of the most important challenges of the 21st century (Cross et al., 2021), practice-based HP must create or expand on corresponding capacities to overcome these challenges. "In health promotion, capacity building is the development of knowledge, skills, commitment, partnerships, structures, systems and leadership to enable effective health promotion actions" (Nutbeam & Muscat, 2021, pp. 1584–85). Capacity building (CB) helps individuals cope better with the challenges of rapidly changing environments or contexts and make better personal health decisions. CB also engages health education and HP professionals more effectively in evidence-based practices and encourages societies to improve programmatic efforts and policy initiatives to protect and promote population health (Stock, 2022).

Education is playing an increasingly important role in managing change (Bock-Schappelwein, 2024). The number of HP professionals has increased significantly in recent decades thanks to the growing number of educational programmes and agencies worldwide (Van den Broucke, 2021). Nevertheless, the current strategic plan of the International Union for Health Promotion and Education (IUHPE, 2021) emphasises the need to further improve the capacity of the HP workforce through professional education programmes and to train and upskill the existing labour force. However, a recent review only identified a few empirical studies on the implementation

of competency-based approaches and a lack of evaluation studies on their impact on practice, education and training (Battel-Kirk & Barry, 2019). To effectively address current and future public health challenges, therefore, research should focus on how CB health education and HP programmes can be evaluated to achieve effective and innovative teaching and learning (Stock, 2022).

While it is essential to help individual professionals develop their skills, that does not suffice. Competencies are the basis for professional performance (Biehl et al., 2021) but their development also requires organisational support and structures, namely educational institutions (Nutbeam & Muscat, 2021). High-quality training programmes are an effective means (Goldstein, 1997) to build the skills of HP professionals and improve their performance. They are generally aimed at changing (i. e. increasing) the competencies of HP professionals or others working in HP. In view of the current challenges, lifelong learning through continuing education and training plays a special role. However, training can only be considered effective if, in addition to improving competencies, what has been learnt is successfully transferred into practice (Ford et al., 2018; Tonhäuser & Büker, 2016). Individual research and intervention studies, meta-analyses in particular, have shown that training can be an effective vehicle for developing skills, knowledge, competences, and behaviour (Blume et al., 2010), including training for health and safety (Ricci et al., 2016), leadership or managers (Lacerenza et al., 2017; Tafvelin et al., 2019) or general training in organisations (Arthur et al., 2003). However, integrated models of training and evaluation research emphasise that such training output is not only dependent on individual characteristics (e. g. skills, motivation) but also on organisational contexts (e. g. training design, environment) and thus on the training process itself (Baldwin & Ford, 1988; Grossman & Salas, 2011; Hochholdinger et al., 2008).

As with every specialist discipline, the question arises for HP as to which competencies are necessary for its practice. To answer this question, the IUHPE developed the CompHP Core Competencies Framework for Health Promotion (Barry et al., 2012). It differentiates between 11 core competencies: fundamental skills relating to concepts and principles (knowledge base, ethical values), specific aspects of HP practice (e. g. enabling change, advocating for health) and skills for implementing HP (from assessment to evaluation/research). Overall, this framework not only offers a comprehensive set of competencies but also functions as a widely accepted and professional standard, such as in accreditation processes (Van den Broucke, 2021).

As far as questions of effectiveness are concerned, the literature points out that change processes, like changes in competencies from participating in training programmes, is – as afore mentioned – challenging but can be adequately represented with the help of latent structural models, especially latent change or difference score (LDS) models (Howardson et al., 2017). LDS models have several advantages over traditional methods for longitudinal designs (e. g. t-tests, ANOVA, or regression-based analyses). To mention the most important ones, they look at within-person change over time (individual trajectories) rather than just group-level trends. In addition, they can separate initial levels (baseline performances) from changes over time, which helps understand the impact of onset on subsequent change. As LDS models belong to the family of structural equation models, they do not need to assume perfect measurement because they control for measurement error and are, therefore, more accurate in

estimating change. Moreover, LDS models are more flexible because they allow for simultaneous consideration of predictors and outcomes of the change variable of interest or can examine bidirectional relationships between changes in different constructs over time (Geiser, 2021).

When LDS models are applied to multiple measurement points using a longitudinal design, it is possible to quantify differences in the competencies assessed before and after training (Lövdén et al., 2012; McArdle & Prindle, 2008). However, researching such change processes is methodologically challenging because several prerequisites must be met for LDS models (Schmiedek, 2021): Firstly, large samples are essential to ensure unbiased and robust estimates. This means that larger training programmes or many training courses are required. Secondly, although they are controlling for measurement error, a validated (reliable and valid) measurement instrument and model is necessary for the key training outcome variable (i. e. HP competencies), as is an adequate data structure (metric, normally distributed, intercorrelated measures). Thirdly, invariant measurements across groups and time points are indispensable for a clear interpretation and it must be ensured that the meaning of the instrument used does not change across the observation time points. Analyses of latent differences are already being used increasingly in the training literature (Könen & Auerswald, 2021). An internet search by the author did not identify such analyses for developing HP competencies. However, it would be beneficial if HP could learn from such applications or draw on proven methods to answer fundamental questions about capacity development.

By taking conceptual considerations and challenges, derived hypotheses and methodological requirements into account, the aims of this study are twofold: On the one hand it explores how HP competencies can be measured and quantified. On the other hand, it explores how training courses in HP help change them and which factors were associated with possible changes. Both are central questions for the evaluation of trainings in HP.

The article is structured as follows: In the methodology section, the measurement concept used is first specified and research hypotheses are derived. In addition, the study design is explained and finally the empirical data basis and the survey instrument are explained. The results are presented in accordance with the research hypotheses established and the analysis strategy derived from them. Finally, key content and methodological aspects of training and evaluation are discussed, and conclusions are drawn regarding capacity building in HP.

2. Methods

2.1 Concept Specification

Several self-assessment instruments have been developed based on the CompHP concept (e. g. Blackford et al., 2024; Lang, 2021). Lang's (2021) instrument was used in this study because the one-dimensional measurement structure of the competencies factor had already been verified using a sufficiently large sample in a confirmatory model. This study set out the implicit theoretical and methodological assumptions of

this survey instrument at various levels. The instrument can be used to assess relevant core competencies that are essential in the practice of HP (object level) in relation to the participants' own competencies (subject level) in continuing education and training (context level). With regard to the competencies, reference is made to the CompHP framework (Barry et al., 2012), which defined the characteristics of the concept or latent construct. Following this specification of the theoretical concept, a latent factor was assumed, which was measured using a multi-attribute instrument. Confirmatory bifactorial factor analysis revealed a strong general factor that included all 11 indicators. Several specific residual factors indicated the relevance of distinct competency domains: fundamental concepts and principles, aspects of competent practice, and implementation phases in HP.

For this study, it was necessary to measure these indicators at different points in time to ascertain how competencies change after participating in further training. In order to describe the change process with empirical data and to enable more in-depth validation, a longitudinal measurement and structural model was put into practice. Confirmatory factor and structural analyses (e. g. using LDS models) are suitable for investigating both the covariation and stability of inter-individual changes over time, i. e. they enable a structural and simultaneously dynamic (time-dependent) analysis (Geiser, 2021).

2.2 Research Hypotheses

To transfer the concept specification to a corresponding model, the following measurement or correspondence hypothesis was assumed for both single and multiple measurement points:

– H1. The more comprehensive the individual (self-rated) competencies in HP, the higher the assessment in different competency domains (*correspondence hypothesis*).

Because training is intended to strengthen the competencies of the trainees (Goldstein, 1997), it was assumed that participation in HP courses leads to an increase in individual competencies, although intra-individual differences can also be assumed:

– H2. The self-rated competencies of participants in HP trainings are rated higher after attending the training than before (*effectiveness hypothesis*).

In accordance with integrative approaches to training and transfer evaluation (Ford et al., 2018; Hochholdinger et al., 2008) a distinction was made between the conditions before training (input), during training (process) and learning effects after training (outputs). Reviews have shown that, in addition to the training offered (e. g. training design, methods, support; learning environment and objectives; practical relevance), both the individual characteristics of the participants (e. g. learning motivation, expectations, experiences) and the organisational characteristics of the programme (social support, structural and organisational learning circumstances) (Ford et al., 2018; Ton-

häuser & Büker, 2016) can have a significant influence on the success of the training (improved knowledge, competences, attitudes). In addition, if participating in training actually supports a gain in HP competencies, an association of relevant training outputs (perception and evaluation of the training) with a lasting effect or the transfer of what has been learnt (Ford et al., 2018) can be expected. It was therefore assumed that:

- H3a. The better the individual prerequisites of those attending further training, the higher the self-rated HP competencies before training (*individual hypothesis*).
- H3b. The more supportive the organisational conditions of the training, the higher the self-rated HP competencies after training (*service hypothesis*).
- H3c. The higher the self-rated HP competencies after training, the better the attitudes towards the training (*output hypothesis*).

2.3 Study design

Because a pre-post design enables direct measurement of changes, a longitudinal survey design with two time points and repeated measurements was used. This initially comprised a standardised survey of registered participants two weeks before the training course (PRE-training, t_1). At the end of the course (POST-training, t_2), participants were asked again using a second online survey (LimeSurvey v6.3) provided that they consented to data collection and utilisation in accordance with the General Data Protection Regulation.

2.4 Data basis

In its function as a national agency for HP, the Austrian Health Promotion Fund (Fonds Gesundes Österreich) offers further and continuing education programmes in the field of HP[2]. The target group is HP practitioners as well as decision makers, multipliers and experts. The population was made up of participants in the $N_j = 269$ training courses held between 2021 and 2023. The courses[3] were part of several programmes, with 33.1% of the courses taking place in the 'Education Network' general programme for all kinds of actors in HP, 21.9% in the specialised programme 'Workplace Health Promotion (WHP) Know-how' for internal company actors (e. g. project managers, managing directors, human resources managers, health officers, etc.) and 5.2% in the 'Mayoral Seminar Programme' for community-based actors (e. g. mayors, deputy mayors, local heads, heads of office). Four fifths (79.2%) of the courses were held face-to-face and 20.8% online. Just over half (56.9%) were in the category of professional training (e. g. "Strategies in HP and primary prevention", "Healthy leadership and sustainable project success") and 43.1% in the category of methodological training (e. g. "Focus groups in HP", "Evaluating HP projects"). Four fifths (79.9%) of the courses took place on two days, 11.5% on one day and 8.6% on three days, corre-

2 See https://fgoe.org/Fortbildungen_und_Veranstaltungen (7th Dec. 2024)
3 Subsequently also referred to as training.

sponding to an average duration of m = 13.9 hours (sd = 4.1). On average, 9.1 participants (sd = 3.3) registered for each course.

Out of all the events organised, 230[4] (85.5%) courses attended by 2,131 people (m = 9.3, sd = 3.3) were evaluated. In the pre-training survey, 67.0% of the participants responded to more than three quarters of the questions asked, which increased to 75.6% in the post-training survey. After matching pre-training with post-training data, panel data[5] with a sample size of 778 participants (35.5%) were available for the analysis comprising 79.0% women and 18.6% men (2.3% diverse or not specified); 34.2% under 40 years, 30.7% between 40 and 49 years and 33.4% 50 and above (1.7% n. a.); 33.8% from the public sector, 24.4% from the private sector, 29.2% from the non-profit sector and 7.5% from other sectors (5.1% n. a.).

2.5 Instruments and Operationalisation

A standardised survey instrument was used for the pre- and post-training questionnaire:

- At both measurement points, the instrument developed by Lang (2021) to measure self-assessed HP competencies was used, which was introduced with: "The practice of HP requires several key competencies. What level of knowledge do you currently have of HP with regard to the following core competencies?" Participants assessed 11 items on core competencies such as "advocating the improvement of health and well-being", "communicating HP appropriately for target groups" or "applying appropriate evaluation methods" using a bipolar response format (1 = *no knowledge* to 6 = *very high level of knowledge*).[6]

The pre-training survey included these additional aspects:

- Motivation for further training: Slightly adapted items from Rzejak et al. (2014) measured two facets, namely motivation for social interaction (e. g. "I generally take part in further training because I seek to exchange ideas with colleagues"; Cronbach's Alpha α = .866) and motivation for personal development (e. g. "… because I want to align my work with current knowledge"; α = .811) (1 = *strongly disagree* to 6 = *strongly agree*).
- Prior knowledge/experience: One item measured the number of HP training courses attended so far (0 = *none at all* to 5 = *five or more courses*).
- Socio-demographics: One item each measured gender (0 = *male*, 1 = *female*) and the age of the participants (1 = *under 29*, 2 = *30–39 years old* to 5 = *60 and above*).

4 Thirty-nine courses were not included due to technical problems with the online survey or a lack of feedback from participants.

5 Datasets were matched based on an individual and anonymous code participants generated for both surveys.

6 The measurement quality criteria are presented in the results section. The German-language instrument is provided in the appendix.

The post-training survey also recorded:

- Training satisfaction: Participants' satisfaction was measured for five aspects, which were satisfaction with the 'design', 'trainer', 'training conditions', 'cost-performance ratio' and 'overall service' (1 = *very dissatisfied* to 6 = *very satisfied*) (α = .963).
- Training benefits: Participants rated the extent to which their "expectations concerning suggestions for changes" and "the feasibility of putting them into practice" were fulfilled in the course (1 = *much worse* to 5 = *much better than expected*) (α = .853).
- Transfer intention: The intention to apply what had been learned after the course was assessed using two items: "Your intention to incorporate the information from this training course in the coming year is …" (1 = *very small* to 6 = *very large*) and "How likely or unlikely is it that you will apply the content or methods in the coming year?" (1 = *very unlikely* to 6 = *very likely*) (α = .906).

The following administrative data were available at training level:

- Programme: 0 = *Education Network*, 1 = *WHP Know-how/Mayoral Seminar Programme*.
- Training intensity: An additive index[7] was formed by combining information about the training format (1 = *online*, 2 = *face-to-face*) with its duration (1 = *one-day*, 2 = *two-day*, 3 = *three-day*).
- Training category: 1 = *professional training* (predominantly covering various topics of HP), 2 = *methodological training* (focusing on the methods and techniques of HP).

2.6 Statistical Analysis

To answer the research hypotheses, training effects at latent level were analysed using an LDS model (McArdle, 2009; McArdle & Prindle, 2008). The model took the self-rated HP competencies of participants before and after training as a latent factor into account. Following the results of Lang (2021), instead of using the 11 individual competencies (at item level) from the measurement instrument, the competencies were combined in three distinct domains by allocating the 11 items to item parcels (Little et al., 2022): The first item parcel summarised knowledge about fundamental concepts and principles (i. e. knowledge base, ethical values), the second summarised knowledge about competent practice (i. e. enabling change, advocating for health, mediating through partnership, communication and leadership) and the third summarised knowledge about relevant implementation phases in HP (i. e. assessment, planning, implementation and evaluation/research). For each item parcel, a mean composite

7 When creating the index, it was assumed that more intensive training courses are related to learning success (Richter et al., 2020). A representation of training intensity was achieved by combining the information about the number of days on which the training was executed (coded 1, 2, 3 days) and the training format. The online training lasted 4.8 hours/day on average (median: 4 hours/day) and face-to-face courses lasted 7.6 hours/day on average (median: 8 hours/day). Hence, face-to-face training coded with 2 was weighted higher than online training coded with 1.

score was calculated from the relevant individual items for both measurement points (i. e. item parcel par11, par12, par13 for time point t_1 and par21, par22, par23 for t_2).

Following Wickrama et al. (2022), the three item parcels were examined for their suitability for multivariate analysis using univariate and bivariate statistics. Before analysing the latent change, a longitudinal confirmatory factor analysis (LCFA) was conducted with the three item parcels as indicators for the latent variables before and after training. This was also used to evaluate the psychometric properties of the competencies measured on the two occasions. High measurement quality (reliability and validity) was indicated by Cronbach's α and McDonald's ω > .70 (Nunnally & Bernstein, 1994), standardised factor loadings λ > .50, explained item variances R^2 > .25 and average explained variance AVE > .40 (Bagozzi & Baumgartner, 1994).

A prerequisite for comparing the pre- and post-measurements of HP competencies is that they are identical over time and across groups. Following Little's (2013) recommendation, the measurement models were, therefore, examined at increasingly restrictive levels of measurement equivalence (ME) over the two time points (models M1a-c), i. e. in addition to configural (no restrictions at all) and metric ME (equal factor loadings) and scalar ME (equal factor loadings and intercepts) (Meredith & Horn, 2001). In addition, equivalence between genders (M2a-c) and age groups (M3a-c) was tested in multi-group comparisons. A non-significant Satorra-Bentler Chi-square difference test (p > .050) and a difference of CFI < .01 between two nested models indicated equivalent measures (Cheung & Rensvold, 2002; Little, 2013) and thus indicated an interpretable metric of the latent HP competency (Geiser, 2021).

In the case of scalar measurement equivalence, an LDS model (M4a) could be specified with two measurement points in time, with the difference variable representing the (true) change between self-assessed HP competencies before (PRE-training t_1) and after training (POST-training t_2), corrected for measurement errors. As usual in LDS models, this latent change in competencies ($DIFF_{t2 - t1}$) was specified by tracing the latent competencies measurement t_2 back to competencies t_1 and setting the non-standardised path to 1. In addition, the latent competencies measurement t_2 was traced back to the latent difference variable and the non-standardised path was also set to 1. Furthermore, the latent variables for the initial competency level and subsequent differences could freely covary with each other (McArdle, 2009). An additional (conditional) LDS model M4b tested concurrent and predictive validity with additional variables introduced into the model by examining whether the latent competency (or its change) covaried significantly with individual and organisational training variables.

All models with latent variables were evaluated using common model fit criteria (chi-square test and ratio between χ^2 and df, i. e. $\chi^2/df < 3.0$). The traditional cut-off criteria (Comparative Fit Index, CFI > .90, Standardised Root Mean Square Residual, SRMR and Root Mean Square Error of Approximation, RMSEA < .08) indicated an acceptable fit of the tested models to the data (Kline, 2011) and the more restrictive criteria of Hu and Bentler (1999) indicated a very good model fit (CFI > .95, SRMR and RMSEA < .060). Mplus 8 software (Muthén & Muthén, 2012) was used for the model calculations applying the robust maximum-likelihood estimation method.

3. Results

3.1 Suitable data basis for the longitudinal analysis

Table 1 shows the empirical correlation matrix of the item parcels for HP competencies at two measurement points (par11-par23), i. e. PRE-training t_1 and POST-training t_2. According to Little's (2013) guidelines, the underlying data were suitable for conducting the multivariate analysis because the correlation coefficients within a measurement point were higher (r = .62 to .84) than between the measurement points (r = .42 to .57, each p < .010), which indicates construct validity. The data thus provide evidence for the existence of a general competency factor for each measurement time point. These relationships are based on suitable indicators because they varied (sd = 1.03 to 1.20) considerably around their means (m = 3.77 to 4.40), were almost symmetrical and only slightly skewed (s^3 = -.35 to -.71) and were predominantly unimodal (s^4 = -.40 to .42).

Table 1: Correlation matrix and descriptive statistics among indicators

Time	Parcel level indicators	m	sd	s^3	s^4	par11	par12	par13	par21	par22	par23
PRE-training	par11 (t_1)	3.92	1.20	-.35	-.30	1					
	par12 (t_1)	3.77	1.11	-.35	-.16	*.74***	1				
	par13 (t_1)	3.77	1.20	-.31	-.40	*.62***	*.79***	1			
POST-training	par21 (t_2)	4.40	1.11	-.71	.32	*.57***	*.51***	*.44***	1		
	par22 (t_2)	4.34	1.03	-.68	.42	*.53***	*.56***	*.48***	*.81***	1	
	par23 (t_2)	4.36	1.11	-.69	.24	*.42***	*.49***	*.52***	*.70***	*.84***	1

Note: n ≥ 771, par parcel level indicators (par11 and par21 included knowledge of fundamental concepts and principles, par12 and par22 included knowledge about competent practice, par13 and par23 included knowledge about implementation phases), t_1 PRE-training, t_2 POST-training, m mean, sd standard deviation, s^3 skewness, s^4 kurtosis. Italic numbers indicate Pearson correlations. ** p < .010.
Source: Own calculations/representation.

3.2 Invariant measurements of HP competencies

The measurement model for the latent factor of HP competencies was tested confirmatively at the parcel level simultaneously using the longitudinal confirmatory factor analysis (LCFA) basic model M1a (no restrictions) for both measurement points. Factor loadings, intercepts and residuals, factor covariance and the three possible measurement error correlations of the same indicators over time were freely estimated (configural ME). For identification purposes, the first indicator for each point in time (i. e. par11 and par21) was fixed at 1. Cronbach's Alpha (α_{PRE} = .882, α_{POST} = .933) and McDonald's Omega (ω_{PRE} = .885, ω_{POST} = .915) as well as the average explained variance (AVE_{PRE} = .721, AVE_{POST} = .782) achieved good values and the model had a very good fit (Table 2).

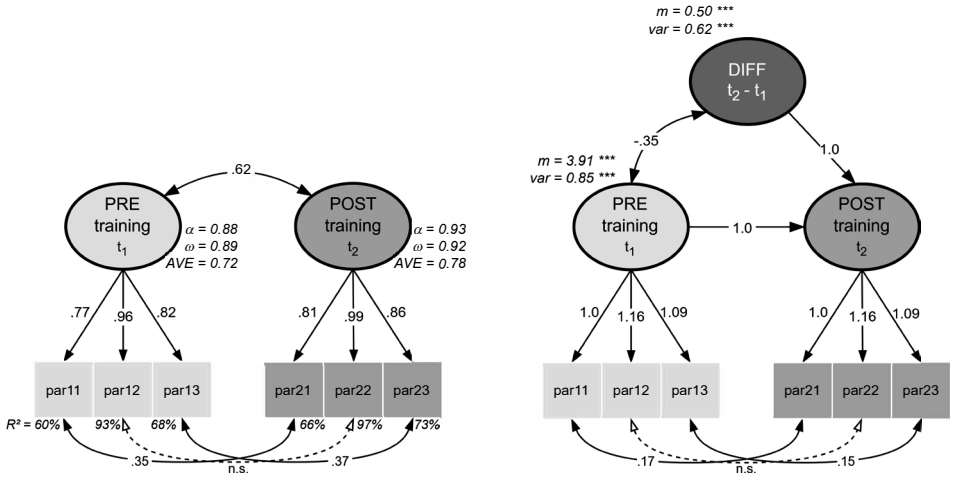
Furthermore, the substantial correlation between the pre- and post-measurements (r = .618, p < .001) indicated stability and construct validity. The restrictions intro-

Table 2: Model comparison

No.	Model description	χ^2	df	χ^2/df	p	S-B χ^2 test	RMSEA [90% CI]	p-close	CFI	ΔCFI	SRMR
1	*Parcel level LCFA*[1]										
a	Configural ME	14.485	5	2.90	.013	-	.049 [.021-.080]	.460	.996	-	.021
b	Metric ME	16.437	7	2.35	.021	1.952 (2) p = .377	.042 [.015-.068]	.662	.996	<.010	.025
c	Scalar ME	19.743	9	2.19	.020	5.258 (4) p = .262	.039 [.015-.063]	.750	.996	<.010	.027
2	*MGLCFA: Gender*[1,2]										
a	Configural ME	19.209	10	1.92	.038	-	.049 [.011-.082]	.468	.997	-	.024
b	Metric ME	23.284	14	1.66	.056	4.036 (4) p = .401	.042 [.000-.071]	.642	.996	<.010	.030
c	Scalar ME	27.419	18	1.51	.072	8.255 (8) p = .409	.037 [.000-.064]	.763	.996	<.010	.033
3	*MGLCFA: Age*[1,3]										
a	Configural ME	19.597	10	1.20	.033	-	.050 [.014-.083]	.452	.996	-	.023
b	Metric ME	21.618	14	1.54	.087	2.172 (4) p = .704	.038 [.000-.067]	.719	.997	<.010	.029
c	Scalar ME	34.531	18	1.92	.011	14.941 (8) p = .060	.049 [.023-.073]	.492	.994	<.010	.030
4	*Parcel level LDS*[1]										
a	Unconditional (baseline)[4]	19.743	9	2.19	.020	-	.039 [.015-.063]	.750	.996	-	.027
b	Conditional (incl. correlates)	452.764	301	1.50	.000	-	.025 [.021-.030]	1.000	.988	-	.023

Note: n = 778 with robust maximum-likelihood estimation method; [1] incl. three measurement error covariances of the same indicator across occasions, [2] gender was coded male and female, [3] age was coded ≤ 39 and 40 or more years, [4] model fit is equivalent with the scalar LCFA model M1c. LCFA longitudinal confirmatory factor analysis, MGLCFA multi-group longitudinal confirmatory factor analysis, LDS latent difference score model, ME measurement equivalence, χ^2 chi-square statistic, df degrees of freedom, p significance level (p-value), S-B χ^2 Satorra-Bentler chi-square difference test with degrees of freedom (in brackets) and p-value, RMSEA root mean square error of approximation [90% confidence interval], p-close probability of RMSEA ≤ .050, CFI comparative fit index, ΔCFI change in CFI, SRMR standardised root mean square residual.
Source: Own calculations/representation.

Figure 1a (left): Longitudinal confirmatory factor analysis (LCFA) of self-assessed HP competencies with pre-training and post-training measures.
Figure 1b (right): Latent difference score (LDS) model for modelling training-induced changes in HP competencies at the latent factor level.



Note: Circles represent latent factors (PRE-training t_1, POST-training competencies t_2 and the DIFFerence in competencies at t_2 minus t_1) while squares represent observed variables (item parcels) for two measurement occasions (par11-par13 for t_1 and par21-par23 for t_2). Directed arrows represent factor loadings or effects, double-headed arrows represent correlations between latent variables or error correlations between observed variables. Numbers in Figure 1a (left) show standardised results and numbers in Figure 1b (right) show unstandardised results, both with the robust maximum-likelihood estimation method after fixing for scalar measurement equivalence (ME) with equal factor loadings and intercepts across time points. All estimates are significant at $p \leq 0.001$ if not otherwise indicated (n. s. not significant). α Cronbach's alpha coefficient, ω McDonald's omega coefficient, AVE average variance explained, percentages (%) explained item variances (R^2); m latent mean, var latent variance. Sample size: n = 778. Model fit is equivalent for both models: $\chi^2 = 19.743$, d. f. = 9, $\chi^2/d.f. = 2.19$ (p = .020), RMSEA = .039, p-close = .750, CFI = .996, SRMR = .027.
Source: Own calculations/representation.

duced for metric and scalar ME (M1b-c) did not significantly worsen the model fit, which means that competencies were measured invariantly over time. The measurement was characterised by high factor loadings ($\lambda \geq .77$) and explained indicator variances ($R^2 \geq 60\%$) (Figure 1a). The confirmatory multi-group longitudinal factor analyses (MGLCFA) also showed that equivalent competencies measurements were obtained for gender (models M2a-c) and age groups (M3a-c). This indicates that the competencies measurement is consistent over time and across groups and that potential changes in competencies are true differences.

3.3 Average Increase in Competencies After Participating in Training

The LDS model M4a[8] was estimated with the following results (Figure 1b): The latent self-rated HP competencies of the participants before training had an unstandardised mean of 3.91 and those after training a mean of 4.41 ($p < .001$). The true change value ($DIFF_{t2 - t1}$) adjusted for measurement errors indicated a significant improvement

8 The LDS model M4 corresponds to the reformulated or reparameterised LCFA model M1c. Both models, therefore, have an identical model fit.

(training gain) in self-assessed competencies and that overall competency was on average .50 points higher than before training ($p < .001$). Furthermore, there was significant inter-individual variation in self-assessed competencies before training ($s^2_{t1} = .85$, $p < .001$) and in the latent difference/change value ($s^2_{t2 - t1} = .62$, $p < .001$) between the two points in time. In addition, the estimated negative covariance ($cov_{t1,t2 - t1} = -.346$, $p < .001$) between the pre-measurement and the latent difference showed that participants with high initial HP competencies had a smaller increase in their competencies than those with low initial competencies.

3.4 Training-Relevant Relationships With Competency (Improvement)

The significant differences in the mean level of competency before and after training may be related to other training-relevant factors. A conditional LDS model M4b was used to test whether individual preconditions were associated with the initial competency or whether the organisational training conditions were associated with the change in competencies. Again, to control for the statistical relationship, the competencies before training were correlated with the latent change variable.

Not gender ($r = .062$) but age ($r = .075$, both $p < .050$) had a significant but low correlation with competency levels before training, with the competencies of participants being assessed as higher with increasing age. A stronger social motivation ($r = .154$) and a development-oriented motivation ($r = .181$) for participating in further training were also positively and significantly associated with initial competencies ($p < .001$). Participants with a higher number of previously completed training courses (i. e. greater prior experience) also rated their own competencies as being significantly higher before attending the new course ($r = .341$). As with the previous model, pre-training competencies correlated negatively with the training-related competency gain (difference value) ($cov_{t1,t2 - t1} = -.475$, $p < .001$). Analogously, participants with more prior experience made less learning progress (a lower gain in competencies) than those with less prior experience ($r = -.196$).

In addition, factors at training level were associated with an increase in competencies: Participants in the specialised training programmes WHP Know-how and the Mayoral Seminar Programme ($r = .177$) and more intensive (i. e. multi-day face-to-face) training ($r = .128$, each $p < .001$) were associated with a higher average training benefit than participants who had attended the general programme (Education Network) or lower-intensity training (e. g. shorter online training). In contrast, the training category had no statistically significant correlation with training progress, i. e. participants in professional development training benefitted no more or no less from the course than those who took part in the methodological training. Finally, regarding potential training outcomes, a higher learning gain was positively associated with greater training satisfaction ($r = .126$), a stronger perception of training benefits ($r = .177$) and a more tangible intention to transfer ($r = .124$, each $p < .001$).

Table 2 illustrates the model fit (under Model 4b: conditional LDS model) and Table 3 shows the standardised correlations.

Table 3: Standardised correlations with pre-training competencies and post-training difference scores

Type	Variable	PRE-training competencies	Difference (POST-PRE competencies)
Controls	Gender (1 = female)[1]	+.062 n. s.	
	Age	+.075 *	
Individual factors	Social motivation	+.154 ***	
	Developmental motivation	+.181 ***	
	Prior training courses	+.341 ***	–.196 ***
	Pre-training competencies		–.475 ***
Contextual factors	Programme (1 = WHP/mayors)[1]		+.177 ***
	Training category (1 = method)[1]		–.014 n. s.
	Training intensity		+.128 ***
Output factors	Training satisfaction		+.126 **
	Training benefits		+.177 ***
	Training transfer intention		+.124 ***

Note: n = 778, [1] The information in brackets indicates the use of a dummy variable (coded 0 vs. 1). * p<.050, ** p < .010, *** p < .001, n. s. not significant.
Source: Own calculations/representation.

4. Discussion

Health literacy enables individuals to deal better with the challenges of changing living conditions and to make better health decisions, making it vital to build on HP capacities. Because education in HP plays an important role, the most frequently asked question is concerning the effectiveness of training (Könen & Auerswald, 2021). Hence, evaluation of further and continuing education programmes in HP is needed to ensure high-quality and effective training.

In (cognitive) training research, it has been emphasised that "programmatic intervention research should be aimed at the broader goal of answering a series of theoretically important empirical questions" (Willis & Schaie, 2009, p. 378). This paper, therefore, examined a large sample size of participants in Austrian HP training programmes, addressing relevant questions in terms of content and methodology to determine how self-assessments of HP competencies can be measured, how adequately modelled competencies change through training participation, which individual and/or organisational factors are related to changes in competencies and how changes are associated with training outputs. The results are summarised below and both training-specific and methodological points are discussed.

4.1 Discussion Points Specific to Training

It could be demonstrated empirically that training influences (self-assessed) competencies in HP. On average, there was a significant mean increase when comparing the self-rated competency levels before and after training. That is, training courses in HP

fostered competency changes, improved knowledge and skills. Thus, the effectiveness hypothesis (H2) could be confirmed with the available training data.

In training processes, compensation or magnification effects can often be observed (Lövdén et al., 2012): A compensation effect implies that trainees with lower initial competencies tend to benefit more from training while a magnification effect implies that trainees with higher initial competencies tend to benefit more. The significant negative correlation between self-assessed competencies before and after training indicated a compensation effect for the HP training courses examined. This result was additionally verified because participants with less prior experience (less training beforehand) were also able to benefit more from courses than participants with more prior experience.

The study also examined the question as to which variables for individual differences were associated with competencies (changes) through training. The significant variations in competencies before and after training prove that, as expected, there were inter-individual differences. This meant that not every participant had the same initial competency level and was thus not able to benefit equally (or benefited to different degrees) from the course. Gender had no influence and age only a marginal one, with older participants reporting higher competencies than younger ones, which is a plausible result. On the other hand, prior experience and higher motivation to undertake further training proved to be greatly relevant for higher competencies before training. Specifically, stronger social interaction and development-oriented training motives were associated with higher competency levels among participants. This shows that effectively implemented HP training integrates learning approaches that promote interaction between participants and between participants and teachers (Godley et al., 2021). Overall, hypothesis H3a could be confirmed using the examples of experience and motivation, namely that the prerequisites of participants in training for HP competencies are highly relevant for HP competence at training start.

If training courses really do strengthen competencies in HP, changes in perception and behaviour could also be assumed. According to behavioural theory (Ajzen, 1985), individual attitudes as an evaluative disposition towards attending further training are particularly important for ensuring transfer in training (Eagly & Chaiken, 1998). Following the tripartite attitude model by Rosenberg and Hovland (1960), attitudes can be expressed positively or negatively in affective, cognitive and behavioural terms as a result of training. Yang und Watson (2022) examined attitudinal influences on the transfer of training in a systematic review of empirical studies and this study also confirmed that increased competencies were positively related to attitudinal components, namely to higher training satisfaction (affective), higher training benefits (cognitive) and higher intention to transfer what was learned (behavioural). Thus, output hypothesis H3c was also confirmed.

The importance of the conditions of the training programme was also (mostly) confirmed (service hypothesis H3b) because it was found that the learning design of the training programme and the quality of the learning environment were important contextual features for increasing competencies. It was assumed that longer and more focused face-to-face training would lead to greater gains than shorter and more general online training. Training in specialised programmes (i. e. WHP Know-how and the Mayoral Seminar Programme) and more intensive training (longer in-person training)

were positively associated with a higher learning gain. The training category (professional vs. methodological training), on the other hand, was not related to a change in competencies. This is plausible because the CompHP framework is used to measure both professional and methodological aspects of HP. In addition, the relevance of organisational factors for courses can be indirectly inferred from the higher level of training satisfaction and usefulness (e. g. the role of trainers, content, methods and applicability). The greater intention to transfer also indicated how relevant successful training is for implementing and improving HP practice.

Overall, there is empirical evidence that specific mechanisms, processes or components of educational interventions are associated with the desired level of or increase in competencies. The results confirm that competencies in HP can be (further) developed through training and that both individual and organisational conditions influence the development of competencies. This confirms findings from general training research (Hochholdinger et al., 2008; Schmiedek, 2021) for the field of HP.

4.2 Methodological Discussion Points

The findings are based on the application of advanced and rigorous statistical evaluation methods from empirical social research, which made it possible to determine the effects of training on average changes between and within groups. The methodological requirements could be met by using a validated survey instrument (Lang, 2021), an extensive database and repeated measurement design (n = 778 pre- and post-training).

To show that attending HP courses leads to more competencies, it was first necessary to prove that the competencies were measured reliably and validly before and after training (Schmiedek, 2021). The latent factor of HP competencies was defined across several competency domains (parcel-level indicators) and the measurement model was analysed across two measurement points using longitudinal and confirmatory models. The factor loadings confirmed a strong relationship between the latent factor and the observed competencies, i. e. they were able to explain the relationship very well. Both the reliability (internal consistency, test-retest reliability) and validity (convergent and discriminant as parts of construct validity) of the measured competencies were demonstrated. The introduction of measurement restrictions also showed that the variability of the factors and factor loadings can be considered as invariant quantities (Little, 2013). The factor patterns were not influenced by training or time and there was measurement equivalence across sociodemographic groups (age, gender). This proof is crucial because the relationship between the instrument and the underlying latent variables can change over time, e. g. if an intervention lies between the measurement opportunities (i. e. training attendance) and the individuals change as a result (i. e. developmental transition through skill acquisition) (Widaman & Olivera-Aguilar, 2023). The existence of longitudinal factorial measurement invariance is, therefore, fundamental to the conclusion that observed changes over the observation period can be attributed to changes in the latent target variable (i. e. HP competencies) and not to the characteristics of the instrument (Millsap & Cham, 2012). Thus, the correspondence hypothesis H1 could also be confirmed.

Not only HP competencies before and after training could be measured reliably and validly but also training gains. Adding a latent change variable in the LDS model confirmed that the change in the shared competence factor was influenced by the training and was not influenced by other factors (e. g. gender or age). Because the difference variable in the LDS model is composed of the baseline value (competencies before training) plus the change value (difference in competencies after training minus those before training), it can express both an increase or decrease in HP competencies. The fact that participants gained competencies through training was also supported by the fact that the assessment of competencies was robust and rated equally across groups and points in time. However, the problem of causal interpretations must be emphasised at this point. Even though HP competencies were measured reliably and validly before and after the training and the training effect could be controlled for a number of relevant variables, alternative explanations, such as acquiring knowledge outside training courses, cannot be completely ruled out.

In addition, the LDS analysis provided evidence that there are inter-individual differences in changes to intra-individual HP competencies. The result showed that not all participants benefitted equally from the attended course or learned equally well, fast or as much. This is an important finding because it opens up the methodological question of associated factors to be further investigated. The analyses conducted with selected predictors or correlates of latent change variables were able to determine, for example, whether individual or situation-specific aspects are likely to lead to training success or training transfer. The conditional LDS model provided useful information about possible mechanisms that could moderate training outcomes, such as increasing or decreasing the average gain in competencies, although it cannot be a direct test for these mechanisms (Könen & Auerswald, 2021). Finally, the covariates considered here point to the possibility of interactions and demonstrate concurrent validity (previous experience, motivation) and predictive validity (transfer intention) of the competencies measured.

4.3 Limitations

Notwithstanding the methodological advantages, there are some limitations to the present study that need to be addressed: LDS models with two measurement points are able to exclude a number of possible sources of error that could distort the results in other models (Cribbie & Jamieson, 2000). Nevertheless, the pre-post design used here has its limitations, for example when it comes to proving causality or longer/more gradual changes. Because relatively little is known about longer training effects (Schmiedek, 2021), it is recommended to extend the study design with a third (follow-up) survey. This would provide additional insights into the sustainable and long-term effects of training in HP, such as the extent to which HP knowledge acquired in courses is put into practice, something which the current instrument does not capture. This would also take into account the requirement to consider training participation less as an event and more as a training process and episode (Ford et al., 2018). This would also contribute to the external validity and generalisability of training effects. Such distinctions should be further investigated in future studies.

As for statistical conclusion validity, the relationship between training and competencies gains should be demonstrated reliably. This guarantees that the observed changes in competencies cannot be attributed to sampling errors or other effects not controlled for (Schmiedek, 2021). In the present study, a large sample was used and the high reliability of the measurements was confirmed. However, there was no control group to further ensure internal validity and only some individual and contextual variables in training research could be controlled for in the LDS model. Future studies should consider other variables that were not measured here but could act as confounding factors.

Furthermore, only average changes in the overall group were examined here but these could hide an unknown mixture of trajectories expressed, for example, in different competency profiles (e.g. strong, moderate, weak changes). The concept of latent grouping also seems to make a lot of sense from a content point of view; therefore, future applications should take such latent mixture models (Little, 2013) into account when examining heterogeneous changes in the learning of HP competencies.

5. Conclusions

With regard to capacity building in HP, this study contributes to the broader evidence base by exemplifying what is needed to achieve this. Its impact on the practice of HP can be seen in several aspects: Firstly, the tool has proven to be reliable to map self-assessed core competencies in HP and to identify general competency deficits or gaps in competency areas. It can be used as part of further training programmes to evaluate the development of relevant knowledge and skills in this area. The instrument is particularly suitable for use in practice because it is an economical (short completion time) and, at the same time, reliable and valid tool.

On this basis, it is, secondly, possible to assess the role of further training in HP in the development of competencies, which is also essential for practice. This allows not only individual competencies but also differences in competencies to be recorded. The tool can be used to track individual progress but also how a group of participants has developed as a result of specific training. In practice, it makes it possible not only to assess whether a training programme works in general but additionally to understand which individual and situational characteristics contribute to training success and an increase in HP competencies. This provides a deeper understanding of the associations between gaining HP competencies and participating in further training.

Thirdly, in combination with advanced and sophisticated analysis methods, such as LDS models, more reliable and accurate results can be achieved. The models show how dynamic changes can be mapped and utilised to better understand the progression of HP competencies. This not only helps with the evaluation of the effectiveness of training courses, but also with the design of tailor-made training programmes. In this respect, the results of this study underline that when planning and implementing training in HP, the focus should be on the individual needs and requirements of the participants, the organisational framework conditions of the courses and the transfer-

ability and applicability of what has been learned, e. g. in the choice of learning and teaching approaches and in the adaptation of training methods to the needs.

Overall, the instrument and method used can help close the gap in the evaluation of training programmes, their impact on HP competencies and their subsequent development. Both can help ensure that CB programmes are effective and that HP practitioners are better equipped to meet current and future challenges and make more informed health decisions.

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Appendix: German CompHP measurement instrument

Für die Praxis der Gesundheitsförderung sind mehrere Schlüsselkompetenzen erforderlich. Über welchen Kenntnisstand der Gesundheitsförderung verfügen Sie derzeit hinsichtlich folgender Kernkompetenzen?

1	Grundlagenwissen der Gesundheitsförderung (Grundsätze, Konzepte, Theorien)	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
2	Die Berücksichtigung ethischer Werte (Gerechtigkeit, Selbstbestimmung, Freiwilligkeit)	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
3	Zielgruppen zum Aufbau von Kompetenzen befähigen	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
4	Für die Verbesserung von Gesundheit und Wohlbefinden eintreten	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
5	Gemeinsam mit Partnern die Wirksamkeit und Nachhaltigkeit verbessern	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
6	Gesundheitsförderung für Zielgruppen adäquat kommunizieren	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
7	Eine gemeinsame Vision und Strategie entwickeln	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
8	Bedarfe und Ressourcen erheben	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
9	Messbare Ziele formulieren	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
10	Aktivitäten und Maßnahmen entsprechend umsetzen	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand
11	Angemessene Evaluationsmethoden anwenden	1 = keine Kenntnisse … 6 = sehr hoher Kenntnisstand