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Improving coping with stressful teaching situations – an intervention study with physical education teacher education students

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Abstract

Introduction. To prepare physical education teacher education (PETE) students to handle stressful teaching situations, a stress lab was developed consisting of an e-learning unit (knowledge acquisition) and a practical unit (practicing skills). Aim of Study. The aim of this study is to verify whether participation in the stress lab enhances PETE students' perceived competences (knowledge and skills) in handling stressful teaching situations and whether participation in the e-learning unit before the practical unit can lead to more perceived competences. Material and Methods. Two intervention groups were formed, one group participated in both parts of the stress lab, the other group participated in the practical unit only. PETE students were surveyed before and after participation (perceived competences). Results. Results showed that participation improved PETE students' perceived competences. This effect occurred in particular when PETE students participated in the e-learning unit beforehand. After participating in the e-learning unit, PETE students perceived more competences than before. Conclusions. PETE students benefit from participating in the stress lab, therefore it should be integrated into university teaching in the future.

KEYWORDS: teacher education, teaching tool, learning outcomes, stressors.

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Introduction

Recent studies show that physical education (PE) teachers perceive stress on a daily basis [1]. This is problematic given that the consequences of stress have short-term (e.g., negative emotions) and long-term (e.g., burnout) effects on PE teachers' health [2]. Among others, sources of stress that PE teachers should be prepared for include discipline problems from pupils (e.g., pupils fighting) and a lack of facilities and equipment [3]. Previous studies suggest that teacher education programs are generally suitable for integrating stress-related content so that prospective (PE) teachers can be prepared for existing sources of stress in the future [4]. Despite this suggestion, no interventions exist to prepare physical education teacher education (PETE) students to handle sources of stress in specific teaching situations. Therefore, a stress lab was developed for university education programs to prepare PETE students for handling stressful teaching situations with a simulation training [5]. The present study aims to determine whether participation in the stress lab enhances perceived competences in PETE students in terms of coping with stressful teaching situations.

Theoretical background: stress and coping with sources of stress

The content of the stress lab concept is based on the transactional stress theory [6]. According to Lazarus and Folkman [6], stress is an overall process consisting of several subprocesses and variables. In their theory,

a source of stress is an event in which environmental or internal demands strain or exceed individuals' available coping strategies or resources. In more detail, stress develops within transactions between an individual and its environment depending on a two-fold appraisal process that contains a primary and a secondary appraisal. Within the primary appraisal, individuals rate the relevance of the situation regarding negative consequences and its significance for their subjective well-being. Within the secondary appraisal, individuals evaluate the coping options and resources available to handle the situation. An individual appraises a situation as stressful if the consequences of the situation are associated with a loss or are rated as harmful, threatening or challenging (primary appraisal), while at the same time rating the available coping strategies or other resources as inadequate or low (secondary appraisal). The consequence of this appraisal process is a negative emotional reaction [6]. Stress can be perceived on a physical (e.g., shivering), affective (e.g., fear) and cognitive level (e.g., negative thoughts). To handle stressful situations and/or negative emotional reactions in times of stress, coping strategies aim to eliminate or mitigate the source of stress (i.e., problem-focused coping) and/or to regulate the emotional reaction on a physical, affective and cognitive level (i.e., emotion-focused coping) within the stress process [6]. The goodness of fit hypothesis [7] postulates that coping strategies need to fit cognitive appraisal and situational factors, such as the controllability of the situation. Situations that are perceived as controllable require different strategies than situations that are perceived as uncontrollable [7]. There are various possibilities to adjust and improve the process of selecting suitable strategies in stressful situations [6].

Sources of stress for (prospective) PE teachers

Previous studies have identified PE teachers' perceived sources of stress that PETE students should be prepared for. According to a systematic review by von Haaren-Mack et al. [3], the most important sources of stress for PE teachers include pupils' discipline problems, the lack of facilities and equipment and an unrealistic curriculum [3]. However, a study by Pels et al. [8] revealed that there were differences between PE teachers' actual perception and PETE students' anticipations about sources of stress in the PE teaching profession. Results showed that PETE students anticipated the occurrence of discipline and motivational problems in pupils and inadequate facilities and equipment significantly more frequently than PE teachers. Concerning the actually perceived sources of stress of PETE students, research is limited. However, teacher education students, in general, perceived pupils' discipline problems as a source of stress during internships, among workload, lack of support and supervisor evaluation [4]. In summary, PETE students need to be prepared for different teaching-related sources of stress, particularly pupils' discipline problems [3].

Coping with stress in (prospective) PE teachers

According to Lazarus and Folkman [6], the way individuals are affected by sources of stress is related to their available coping strategies and resources. While research concerning coping in PE teachers and PETE students is limited, some studies concerning the frequency of coping strategies and the relationships between coping strategies and perceived stress have been reported. Regarding the frequency of using coping strategies, a comparison study by Schäfer et al. [9] showed that PE teachers used the problem-focused strategy of active coping more often than PETE students. PETE students used the emotion-focused strategy to focus on the positives more often than PE teachers [9], confirming results found for teachers in general [10]. Regarding the relationships between coping strategies on the one hand and (PE) teachers' and (PE) teacher education students' perceived stress on the other hand, studies indicate differences between emotion-focused and problem-focused coping. For example, Schäfer et al. [11] found that the problem-focused strategy of active coping as well as the emotion-focused strategy of focusing on the positives can reduce perceived acute stress in PETE students over time. However, the emotion-focused strategy of evasive coping did not [11]. In contrast, other studies identified a positive relationship between problem-focused strategies and stress, and a negative relationship between emotion-focused strategies and stress [12, 13]. These differing results can be explained by the goodness of fit hypothesis: coping strategies fit more or less according to the cognitive appraisal and situational factors (e.g., perceived controllability) of the individual situation [7]. Therefore, PETE students should learn and practice various coping strategies to handle different types of situations. To create an environment where PETE students can train coping competences (e.g., coping with teaching situations), simulation training has already been used as an educational approach for teachers in general.

Simulation training as an educational approach

Simulation training has recently become an established educational approach in teacher education programs

for training didactic skills [14-16]. In this context, simulation involves realistic but simplified virtual teaching situations, allowing teacher education students to explore teaching situations in a lab environment. This enables them to try out different decisions and actions without being directly confronted by pupils [14].

To date, no studies have been reported using simulation training in the education of PETE students, though several exist for teacher education in general [16]. Literature reviews [14, 15] showed that simulation trainings are mostly used in the education of prospective teachers to practice their didactic skills. Although the simulation trainings were not primarily aimed at handling stress, they can be regarded as problem-focused strategies (e.g., structuring a lesson). The simulations often demonstrated virtual (stressful) teaching situations (e.g., teaching math with avatar pupils [14, 15]). The results showed higher self-efficacy [17], greater confidence in their own ability to teach in general [18] and perceived improved classroom management skills [19] among teacher education students after participation. In addition, observing others taking part in the simulation also contributed to learning transfer [17, 18]. Participants indicated that their perceived competence (e.g., self-efficacy, confidence) to teach pupils was directly impacted by their perceived factual knowledge [17, 18]. However, none of the studies using simulation training have provided teacher education students with factual knowledge prior to the training. The literature offers no clear statement on whether factual knowledge should precede practical application [20]. Some argued for prioritizing practical exercises [21], while others saw factual knowledge foundational [22]. However, a review suggested that due to the lack of subject-related knowledge of teacher education students and the complexity of a simulation training, prior content preparation is essential [23].

Research gap and aim of study

In summary, there are several research gaps. First, despite the evidence of various sources of the stress PETE students need to be prepared for (e.g., pupils' discipline problems [8]), no interventions for PETE students address handling stressful teaching situations to date. Second, existing interventions for teachers in general so far focus on learning problem-focused strategies (e.g., didactic skills), while emotion-focused strategies (e.g., skills to focus on the positives) are largely neglected. However, given that depending on the situation both problem-focused and emotion-focused coping strategies are relevant to coping, it appears necessary to prepare PETE students for both. Finally, none of the studies using simulation training in the education of teachers in general have taught participants factual knowledge beforehand. Therefore, a stress lab was developed that consisted of an e-learning unit and a practical unit with a simulation training to teach PETE students competences such as knowledge and skills to cope with stressful teaching situations [5]. Preliminary studies showed that PETE students accept both units of the stress lab and that they reported positive outcomes in terms of knowledge and practical skills after participation [5]. However, due to the single post-measurement design, these preliminary studies have not yet been able to clarify whether PETE students can actually achieve learning success over time by participating in the stress lab. Based on the recommendations of de Bock and Rehfuess [24], an intervention study will therefore be conducted following the lab studies. The present study aims to determine whether participation in the stress lab enhances perceived competences in PETE students in terms of coping with stressful teaching situations. Two main research questions will be answered and the following related hypotheses will be tested:

(1) Does participation in an intervention containing a practical unit with a simulation training (i.e., the stress lab) enhance perceived coping competences (i.e., knowledge and practical skills) in PETE students in terms of coping with stressful teaching situations regardless of whether the participants take part only in the practical unit or also in the e-learning unit? (research question 1 (RQ1)); main effect of time (i.e., pre (t0, Figure 1) vs. post (t2, Figure 1)).

We assumed (hypothesis 1 (H1)) that participation in the stress lab would enhance perceived competences in PETE students in terms of coping with stressful teaching situations regardless of whether the participants only take part in the practical unit or also in the e-learning unit.

(2) Does the participation in the e-learning unit before participation in the practical unit with a simulation training lead to more perceived coping competences in PETE students than participation only in the practical unit? (research question 2 (RQ2)); interaction effect of time and group (i.e., different development from pre (t0, Figure 1) to post (t2, Figure 1) depending on the type of participation)).

We assumed (hypothesis 2 (H2)) that participation in the e-learning unit before the practical unit would lead to more perceived coping competences in PETE students in terms of coping with stressful teaching situations than participation only in the practical unit.

Material and Methods

Sample

A total of 71 PETE students (28 females and 43 males) aged 19-38 years (mean [*M*] = 21.80, standard deviation [*SD*] = 2.60) were included. PETE students were in their third or fourth term of the Bachelor's program in PE[1] at the local university. Of these participants, 87% had teaching experience, which was limited to coaching a sports team (25%) and internships at schools (62%), where they gained experience in the teaching profession by assisting or teaching with experienced teachers.

Design

The present study was designed as a field experiment (Figure 1). According to the protocol of cluster randomized trials [25], two intervention groups were formed to test the two parts of the intervention (between-subject factor), including one comparison group participating in only parts of the intervention and three measurement points were chosen to test the PETE students before and after participating in each part of the intervention (within-subject factor). Due to organizational reasons (e.g., limited number of PETE students), there was no comparison group without any intervention.

Two intervention groups were formed and each took part to a different level in the intervention called the stress lab. One intervention group took part in the whole stress lab consisting of an e-learning unit for knowledge acquisition and a practical unit for practicing skills (group 'e-learning + practical unit' [ELPU], $n = 29$). The other intervention group participated only in the practical unit (group 'practical unit' [PU], $n = 42$). The so-called 'stress lab' was developed by Hartmann et al. [5] based in terms of (a) content on the transactional stress theory [6] and (b) didactically on the concept of the cumulative acquisition of competences [26]. A cumulative acquisition of competences means that targeted competences are acquired systematically by gradually increasing the complexity of each competence. First, competence of a lower complexity (e.g., knowledge) is learned and is necessary for the acquisition of the next competence with a higher complexity (e.g., practical skills [26]). The e-learning unit was designed as a self-learning unit that provides PETE students with (a) content on stress-related knowledge [6] and empirical research on stress in PE teachers (e.g., [9]). It is situated on a professional digital learning platform and consists of three sections covering (1) the stress process, (2) PE-related sources of stress and (3) different types of resources and coping strategies. PETE students can click through the sections independently to read informative texts, obtain linked topics, literature or practical exercises, and quizzes [5]. In terms of (b) didactics, the e-learning unit is built sequentially, with each section preparing PETE students for the next section. Each section starts and ends with a short quiz to check for prior and acquired knowledge. In relation to the stress lab, the e-learning unit forms the knowledge base required for the acquisition of more complex competences, such as practical skills [26]. Accordingly, the e-learning unit is followed by the practical unit. The practical unit was designed as a presence unit for university teaching in which PETE students mainly work in small groups in order to discuss and exchange experiences in handling stressful situations and in order to observe and be observed by others while solving tasks. In terms of (a) content, the PETE students can acquire and practice skills in dealing with stressful situations on the basis of emotion-focused and problem-focused coping strategies [6] with the help of video simulation training. A script is provided explaining the structure and the various tasks. First, the PETE students are instructed to reflect on their own use of coping strategies. Then they get together in small groups of five to start the simulation training. The simulation training includes headphones, tablets via which the PETE students watch videos of real-life teaching situations (e.g., pupils misbehaving during a PE lesson). While watching the videos, the tasks in the script instruct the PETE students to perceive, appraise and handle one's own emotional reaction (physically, affectively and cognitively; e.g., 'Please assess how you feel right now') and to perceive, appraise and handle the stressful situation itself (e.g., 'Describe how you would act in this situation') while being observed by their group. After watching the videos, the tasks are discussed in small groups and PETE students can share their experiences in handling stressful situations. At the end of the practical unit, all small groups come together again for a joint reflection on the practical relevance of what has been learned (for more information see [5]). In terms of (b) didactics, not only does the practical unit build on the knowledge base acquired through participation in the e-learning unit, but the individual tasks in the script also build on each other and systematically increase in their complexity.

Three measurement points were chosen (t0, t1, t2; Figure 1) to measure the development of perceived competences in PETE students after participating in

[1] In Germany, PETE students (i.e., prospective PE teachers) have to graduate with a Bachelor's (normally 6 terms) and a Master's degree (normally 4 terms) in at least two subjects and education sciences.

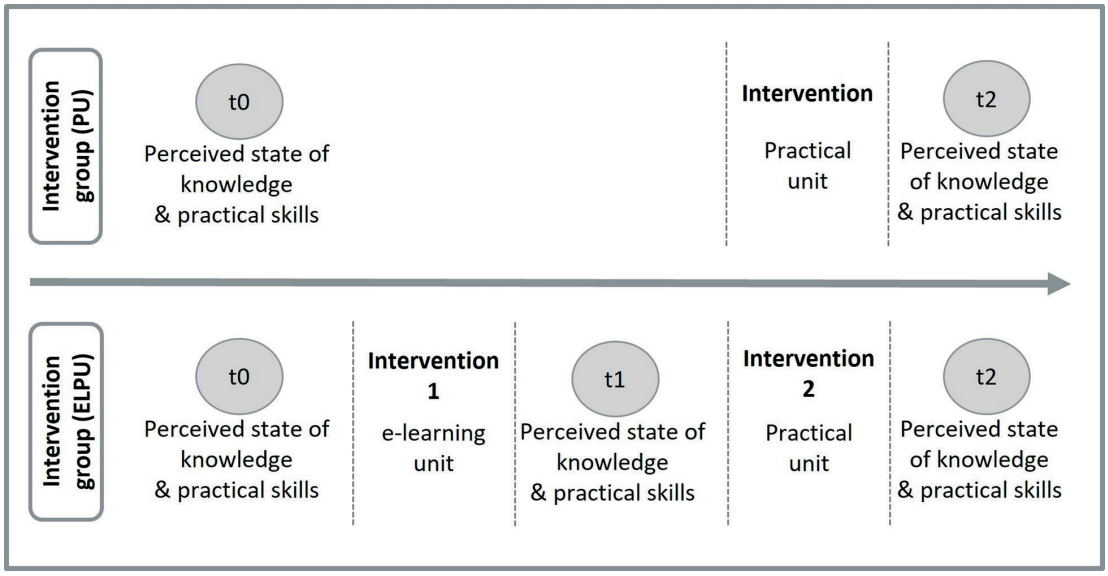


Figure 1. Study design

each part of the stress lab over time. Before participation (t0) and after participation (t2), PETE students of both intervention groups answered the same questionnaire about their perceived state of knowledge and practical skills. In addition, the ELPU group was surveyed after participating in the e-learning unit (t1) using the same questionnaire.

Measures

The questionnaire measuring stress-related competences was self-constructed by a focus group of PE teachers, PETE university lecturers, sports scientists and psychologists. This approach provides an opportunity to measure perceived competences of participants in terms of the learning aims and the contents of the two units of the stress lab. To ensure content validity, the items of the questionnaire were formulated with verbs that were selected based on the taxonomy levels of cumulative acquisition of competence (e.g., to measure 'knowledge', the verb 'describe' was used; [26]; see, e.g., [27]). Also, the items, therefore, consist of statements that relate to the learning aims and the content of both the e-learning unit ('perceived state of stress-related knowledge') and the practical unit ('perceived stress-related practical skills') and therefore based on the transactional stress theory [6]. Cronbach's alpha values confirm reliability of the items.

Perceived state of stress-related knowledge was measured by asking participants about 12 statements reflecting perceived factual knowledge about and comprehension of the content taught in the e-learning unit (hereinafter referred to as 'perceived knowledge'). Three subscales were based on the three sections of the e-learning unit: perceived knowledge about the stress process (four items; e.g., 'I can describe how stress arises'; t0: $\alpha = 0.73$, t1: $\alpha = 0.83$, t2: $\alpha = 0.82$), sources of stress (two items; e.g., 'I can describe the specific causes of stress in PE teachers'; t0: $\alpha = 0.64$, t1: $\alpha = 0.82$, t2: $\alpha = 0.79$) and resources and coping (six items; e.g., 'I can explain the function of resources in the development and management of stress'; t0: $\alpha = 0.85$, t1: $\alpha = 0.71$, t2: $\alpha = 0.87$). The items were to be answered on a five-point scale ranging from 1 (does not apply at all) to 5 (does apply completely).

Perceived stress-related practical skills were measured by asking participants about eight statements reflecting the content taught in the practical unit. Two subscales were based on the aim of coping strategies to eliminate or mitigate the emotional reaction within the stress process: skills concerning emotional reaction (four items; e.g., 'I can use strategies to manage my stress response (e.g., physical, emotional and cognitive response)'; t0: $\alpha = 0.72$, t1: $\alpha = 0.73$, t2: $\alpha = 0.83$) and the source of stress: skills concerning sources of stress (four items; e.g., 'I can use strategies to cope with stressful situations'; t0: $\alpha = 0.74$, t1: $\alpha = 0.65$, t2: $\alpha = 0.82$). The items were to be answered on a five-point scale ranging from 1 (does not apply at all) to 5 (does apply completely).

Procedure

After gaining permission from the local ethics committee, the study was conducted in a university seminar preparing PETE students for a practical semester

in two consecutive semesters (summer 2022 and winter 2022/2023). Four seminar groups (two per semester) were led by two lecturers, including the first author of the present paper. According to the protocol of cluster randomized trials [25], entire seminar groups were randomly assigned to one of two intervention groups (PU, ELPU). Following randomization, the distribution of internship experience – which could potentially be considered a confounding variable – was equally distributed between the two groups in absolute terms, but unequal in relative terms due to the unequal group sizes. However, since statistical testing showed that the students' previous experience with internships had no influence on the results, the internship experience was not taken into further account. The PETE students in the PU group participated in a 90-minute practical unit at the university. Participants were asked to complete an online questionnaire about their perceived state of knowledge and practical skills before (t0) and after (t2) participation in the practical unit. The participants were informed that the survey was anonymous and that there were no right or wrong answers to ensure that the participants could answer without feeling controlled [28]. PETE students in the ELPU group first completed the same online questionnaire as the PU group (t0), then accessed the e-learning unit via a provided link on the last page of the questionnaire. They then had a week to access the e-learning unit and work through the content independently. At the end of the third section, they got the link to the second questionnaire (t1). After confirming to have worked through and understood the content of all three units, they subsequently completed the second questionnaire (t1) with the same statements as at point t0. One week later, they participated in the practical unit and completed the same online questionnaire afterwards (t2).

Data analysis

Data were analyzed using IBM SPSS Statistics 27.0 (IBM, Armonk, NY, USA). Only the data from the participants who completed the questionnaire at both (PU group) or all three measurement times (ELPU group), respectively, were included in the analysis. First, an analysis of missing data regarding single item values in the questionnaire was performed, which showed that less than 5% of data were missing. Therefore, missing data were not replaced because any procedure to address missing data would yield similar results [29]. Second, descriptive analysis was run to report perceived competences at each measurement point. Following Pimentel [30], the mean values of the results were interpreted by categorizing them into intervals with equal distances, taking into account the underlying scale (perceived competences: very low = 1.00-1.79, low = 1.80-2.59, moderate = 2.60-3.39, high = 3.40-4.19, very high = 4.20-5.00; [30]). Third, to test both hypotheses, 2 × 2 analysis of variances (ANOVAs) with time (t0, t2) and group (PU, ELPU) were selected for all dependent variables with partial η^2 as effect size (small: $\eta^2 = 0.01$, medium: $\eta^2 = 0.06$, large: $\eta^2 = 0.14$; [31]) and t-tests for the post hoc interaction analysis with Cohen's *d* as effect size (small: $d < 0.2$, medium: $d = 0.5$, large: $d > 0.8$; [31]). In order to examine the extent to which an intervention that includes a practical unit can generally improve perceived coping competences in PETE students (RQ1/H1), we analyzed the main effect of time (i.e.; pre (t0) vs. post (t2)). In order to examine whether the participation in the e-learning unit before the practical unit leads to more perceived coping competences in PETE students than participation only in the practical unit (RQ2/H2), we analyzed the interaction effect of time and group (i.e.; different development from pre (t0) to post (t2) depending on the type of participation). Since Levene's tests revealed heteroscedasticity for most of the dependent variables, we decided to transform the variables by squaring them [32]. However, after computing the ANOVAs once with the transformed data and once with the original data, the results yielded no differences. Therefore, we decided to report the results of the main analysis with the untransformed data. As additional post hoc analyses, further t-tests were conducted to determine whether participation in the e-learning unit led to more perceived competences among the PETE students (i.e., pre- vs. post-participation in e-learning unit).

Results

Descriptive statistics

Table 1 presents descriptive statistics for perceived competences. Independent of the two experimental groups, participants reported a moderate level of perceived competences before participation (t0: $M = 3.18$, $SD = 0.55$) and a high level after participation in the practical unit (t2: $M = 3.68$, $SD = 0.60$). The ELPU group reported a high level of perceived competences after participation in the e-learning unit (t1: $M = 3.81$, $SD = 0.42$).

Hypothesis testing (H1 and H2)

Perceived state of stress-related knowledge

Stress process: Perceived state of knowledge about the stress process significantly increased over time across

both groups (Table 2), thus statistically supporting H1 that participation in the stress lab enhances perceived competences (i.e., knowledge and practical skills) in PETE students in terms of coping with stressful teaching situations. No main effect of group was found. However, there was a significant interaction effect of time and group (semi-disordinal interaction; Figure 2). In more detail, the result of a paired t-test showed that in the ELPU group, the state of knowledge of the stress process significantly increased over time ($t(28) = –5.13$, $p < 0.001$, $d = –1.21$). Descriptively, there was also an increase over time in the PU group, reflecting the main effect of time, but this increase was not significant ($t(41) = –1.31$, $p = 0.099$, $d = –0.17$). Results of a t-test revealed that the ELPU group showed significantly higher values at t2 than the PU group ($t(68.58) = –2.64$, $p = 0.010$, $d = –0.61$). No significant differences were found between the groups at t0 ($t(69) = 1.43$, $p = 0.156$, $d = 0.34$). These results statistically support H2 that participation in the e-learning unit before the practical unit leads to more perceived coping competences in PETE students in terms of coping with stressful teaching situations than participation only in the practical unit.

Sources of stress: Perceived state of knowledge about the sources of stress significantly increased over time across both groups, thus statistically supporting H1. No main effect of group was found. Moreover, a significant interaction effect of time and group was found (semi-disordinal interaction). More precisely, the result of a t-test revealed that state of knowledge significantly increased in the ELPU group over time ($t(28) = –4.16$, $p < 0.001$, $d = –1.03$). Descriptively, there was also an increase over time in the PU group, reflecting the main effect of time, but this increase was not significant ($t(41) = –0.88$, $p = 0.193$, $d = –0.17$). No significant differences were found between the groups at t0 ($t(69) = 1.83$, $p = 0.071$, $d = –0.17$) and at t2 ($t(69) = –1.88$, $p = 0.065$, $d = –0.46$). These results statistically support H2.

Resources and coping: Perceived state of knowledge about resources and coping significantly increased over time across both groups, thus statistically supporting H1. A significant main effect of group was found. In more detail, the ELPU group ($M = 3.26$, $SD = 0.40$) showed significantly higher values than the PU group ($M = 2.87$, $SD = 0.83$). The interaction effect of time and group was non-significant.

Table 1. Descriptive statistics of perceived competences

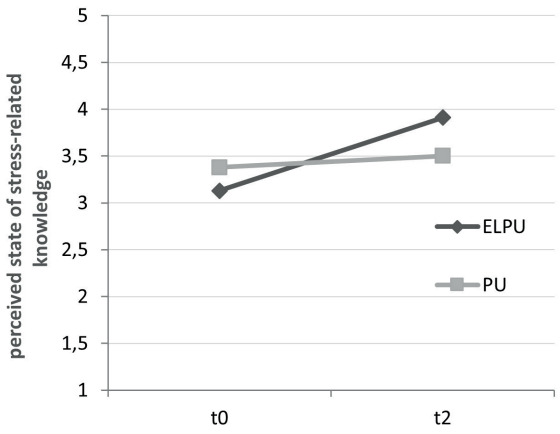
			t0					t1					t2				
			n	*M*	*SD*	*Min*	*Max*	*n*	*M*	*SD*	*Min*	*Max*	*n*	*M*	*SD*	*Min*	*Max*
Perceived state of knowledge	Stress process	PU	42	3.38	0.67	2.25	5.00						42	3.50	0.79	1.75	5.00
		ELPU	29	3.13	0.76	2.00	4.75	25	4.00	0.57	2.75	5.00	29	3.90	0.50	2.50	5.00
		total	71	3.27	0.71	2.00	5.00						71	3.67	0.71	1.75	5.00
	Sources of stress	PU	42	3.58	0.70	2.00	5.00						42	3.70	0.74	1.00	5.00
		ELPU	29	3.24	0.87	1.50	4.50	25	4.16	0.66	2.50	5.00	29	4.01	0.62	3.00	5.00
		total	71	3.44	0.79	1.50	5.00						71	3.83	0.71	1.00	5.00
	Resources and coping	PU	42	2.55	0.91	1.00	4.67						42	3.19	0.91	1.00	5.00
		ELPU	29	2.84	0.65	1.67	4.17	25	3.71	0.64	2.33	5.00	29	3.67	0.68	2.00	5.00
		total	71	2.67	0.82	1.00	4.67						71	3.39	0.85	1.00	5.00
Perceived practical skills	Skills concerning emotional reaction	PU	42	3.50	0.68	2.25	5.00						42	3.67	0.71	1.00	4.75
		ELPU	29	3.08	0.87	1.00	5.00	25	3.75	0.62	2.50	5.00	29	3.96	0.58	2.50	5.00
		total	71	3.33	0.79	1.00	5.00						71	3.79	0.67	1.00	5.00
	Skills concerning sources of stress	PU	42	3.54	0.65	2.00	5.00						42	3.66	0.69	1.00	4.75
		ELPU	29	3.13	0.83	1.00	4.75	25	3.81	0.55	2.75	5.00	29	4.03	0.47	3.00	5.00
		total	71	3.37	0.75	1.00	5.00						71	3.81	0.63	1.00	5.00

Note: PU – practical unit, ELPU – e-learning unit and practical unit
Scale ranging from 1 (does not apply at all) to 5 (does apply completely).

Table 2. Results of 2 (time: t0, t2) × 2 (group: PU, ELPU) ANOVAs for hypothesis testing

Perceived competences	DV	Effect	*df 1*	*df 2*	*F*	*p*	η^2
Perceived state of knowledge	Stress process	Time	1	69	27.99	<0.001	0.29
		Group	1	69	0.30	0.586	<0.01
		Time × group	1	69	14.61	<0.001	0.18
	Sources of stress	Time	1	69	15.75	<0.001	0.19
		Group	1	69	0.01	0.922	<0.01
		Time × group	1	69	8.48	0.005	0.11
	Resources and coping	Time	1	69	46.33	<0.001	0.40
		Group	1	69	5.50	0.022	0.07
		Time × group	1	69	0.80	0.373	0.01
Perceived practical skills	Skills concerning emotional reaction	Time	1	69	28.66	<0.001	0.29
		Group	1	69	0.23	0.630	<0.01
		Time × group	1	69	13.68	<0.001	0.17
	Skills concerning sources of stress	Time	1	69	32.77	<0.001	0.32
		Group	1	69	0.02	0.904	<0.01
		Time × group	1	69	18.80	<0.001	0.21

Note: PU – practical unit, ELPU – e-learning unit and practical unit, DV – dependent variable



PU – practical unit, ELPU – e-learning unit & practical unit

Figure 2. Stress process

Additional analysis: Additional t-tests were computed to check for differences in the perceived state of knowledge before and after the ELPU group participated in the e-learning unit. Results revealed that the state of knowledge significantly increased between t0 and t1 concerning the stress process ($t(24) = –6.74$, $p < 0.001$, $d = –1.45$), sources of stress ($t(24) = –6.50$, $p < 0.001$, $d = –1.15$) and resources and coping ($t(24) = –4.62$, $p < 0.001$, $d = –1.31$).

Perceived stress-related practical skills

Skills concerning emotional reaction: Perceived stress-related practical skills concerning the emotional reaction significantly increased over time across both groups (Table 2), statistically supporting H1. No effect of group was found. Moreover, a significant interaction effect of time and group was found (semi-disordinal interaction). More precisely, results of a t-test revealed that in the ELPU group perceived practical skills significantly increased over time ($t(28) = –5.19$, $p < 0.001$, $d = –1.19$). Descriptively, there was also an increase over time in the PU group, reflecting the main effect of time, but this increase was not significant ($t(41) = –1.44$, $p = 0.078$, $d = –0.23$). The ELPU group showed significantly lower values at t0 than the PU group ($t(69) = 2.32$, $p = 0.023$, $d = 0.55$). No significant differences were found between the groups at t2 ($t(69) = –1.81$, $p = 0.074$, $d = –0.45$). These results statistically support H2.

Skills concerning sources of stress: Perceived stress-related practical skills concerning the sources of stress significantly increased over time across both groups, statistically supporting H1. No effect of group was found. Analysis revealed a significant interaction effect of time and group (semi-disordinal interaction). More precisely, results of a t-test revealed that in the

ELPU group, perceived skills concerning sources of stress significantly increased over time ($t(28) = -5.12$, $p < 0.001$, $d = -1.33$). Descriptively, there was also an increase over time in the PU group, reflecting the main effect of time, but this increase was not significant ($t(41) = -1.44$, $p = 0.078$, $d = -0.19$). Compared to the PU group, the ELPU group showed significantly lower values at t0 ($t(69) = 2.31$, $p = 0.024$, $d = 0.55$) and significantly higher values at t2 ($t(69) = -2.53$, $p = 0.014$, $d = 0.63$). These results statistically support H2.

Additional analysis: Results of additional t-tests revealed that the perceived practical skills in the ELPU group significantly increased between t0 and t1 for skills concerning emotional reaction ($t(24) = -4.63$, $p < 0.001$, $d = -0.87$) and for skills concerning sources of stress ($t(24) = -4.60$, $p < 0.001$, $d = -0.97$).

Discussion

To date, there are no interventions for PETE students to handle stressful teaching situations, and the existing interventions for teachers, in general, had shortcomings in terms of content and didactics. Addressing these research gaps, the stress lab, consisting of one part for knowledge acquisition (e-learning unit) followed by a second part for practicing coping skills (practical unit), was developed for PETE students. The present study aims to verify whether participation in the stress lab enhances perceived competences (knowledge and skills) in PETE students in terms of coping with stressful teaching situations and whether participation in the e-learning unit before participation in the practical unit with a simulation training leads to more perceived coping competences in PETE students (ELPU group) than participation only in the practical unit (PU group). The results showed that: 1) participation in the stress lab improved PETE students' perceived competences (knowledge and skills) to handle stressful teaching situations; 2) this effect occurred in particular if the PETE students had participated in the e-learning unit beforehand; and 3) PETE students perceived more coping competences after participating in the e-learning unit than before.

1) As predicted by H1, participation in the stress lab improved PETE students perceived competences to handle stressful teaching situations in terms of knowledge and skills. This could be attributed to the way of learning (i.e., experiencing and reflecting stress during the learning process) and the content of the stimulus material (i.e., the use of videos with stressful teaching situations) used. In terms of the way of learning, the PETE students' perceived gain in competences could be because they were able to actively experience stressful teaching situations and practice handling them during participation in the stress lab. This experience of stressful teaching situations takes place on a physiological, emotional and cognitive level through pulse measurement and self-reflection guided through the tasks in the script. Similar approaches have been done in terms of students' learning of coping skills through practical experiences [16]. In addition, the social interaction in the stress lab through small group work with specific tasks in the script could have led to the PETE students' improvement of perceived competences. The small group work and the given tasks enabled PETE students to observe each other and exchange ideas in a small setting, which can help them to share thoughts within the group. This way of working promotes learning from each other, as also shown by Dalinger et al. [18] and Anton et al. [16]. Moreover, working in a small group motivates PETE students to work on their own coping competences, as they experience that the others have the same problems and challenges. The content of the stimulus material used could also explain why the PETE students perceived more coping competences after participating in the stress lab than before. The attractiveness of the stimulus material, as well as the closeness of the 'real-life' teaching situations to their future profession depicted, may have made the PETE students aware of the relevance of practicing coping competences. This is supported by a previous study that analyzed PETE students' satisfaction with this stimulus material and positive learning outcomes after working with the videos [5]. Furthermore, as previous studies have shown, simply observing future stressful teaching situations can help teacher education students gain more self-efficacy [17] and confidence in their own ability to teach [18].

2) As predicted by H2, participation in the e-learning unit before the practical unit with a simulation training led to more perceived coping competences in PETE students in terms of coping with stressful teaching situations (ELPU group) than participation only in the practical unit (PU group). From a didactic point of view, the difference between the groups could be due to the structure of the stress lab in accordance with the cumulative acquisition of competences. According to the cumulative acquisition of competence, aspired competences are acquired by systematically increasing the complexity of the required skills and linking learning contents with each other [26]. In line with previous recommendations for imparting prior

knowledge before practicing corresponding skills [22, 23], it can be concluded that the contents of the e-learning unit of the stress lab provided the necessary complexity of a basic understanding of stress required to successfully practice the desired practical skills in the practical unit. In more detail, the content provided in the e-learning unit made it easier for the PETE students of the ELPU group to act practically in the practical unit. For instance, the e-learning unit provided the PETE students with an in-depth understanding of how coping works (e.g., the function of coping), which they recalled in practical application in the simulated teaching situations and enabled them to select and apply suitable coping strategies (e.g., choosing an emotion-oriented strategy in a situation that is difficult for the teacher to control). Moreover, to this suitable recall, selection and application of coping strategies, it can also be assumed that these processes in turn reinforce and deepen the basic understanding provided in the e-learning unit. In addition to learning about the function of coping, the e-learning unit provided PETE students with knowledge about the wide range of coping (e.g., acceptance, positive rethinking, planning next steps or active coping), which possibly reinforced the variable selection and application of coping strategies in the practical unit and thus the development of practical skills. Similarly, this not only applies to coping strategies but also to the perception of one's own stress reaction and the appraisal of the situation. In summary, the ELPU group perceived a higher benefit regarding perceived competences than the PU group after participation. However, the results for the PU group that reflected the main effect of time, were not significant, which could be explained by the fact that the PU group had not received any prior information about coping before starting with the practical unit compared to the ELPU group.

3) A further notable result was that the PETE students in the ELPU group reported that they perceived more competences after participating in the e-learning unit than before. This result is plausible in terms of the perceived acquisition of knowledge on the one hand, but surprising in terms of the perceived acquisition of practical skills on the other. It appears understandable that the PETE students were able to perceive more knowledge after participating in the e-learning unit than before due to the focus of the content (e.g., knowledge based on transactional stress theory) and the type of learning [33]. However, it is surprising that the PETE students also perceived more practical skills after participating in the e-learning unit than before. As only a very small part of the e-learning unit consisted of suggestions for practical exercises (e.g., breathing exercises, guided meditation), it can be assumed that the PETE students overestimated their perceived practical skills after participating. This overconfidence bias [34] may have arisen because the PETE students were inclined to remain consistent in their answers (see consistency motif, [28]) in terms of competences gained in the e-learning unit and the practical unit. Therefore, previous studies have recommended the use of an external assessment (e.g., test of knowledge) in addition to the self-assessment [35].

Strengths and limitations

The present study has two major strengths. First, the study has high ecological validity as it was conducted in a regular seminar that prepares PETE students for an internship at a school and in which the intervention would later be actually implemented. Second, the study can be regarded as approximately internally valid, allowing causal conclusions to be drawn as it followed an experimental procedure with a cluster randomized trial including a comparison group participating only in parts of the intervention [25]. Despite these strengths, the study has some limitations. First, the ELPU group has a smaller sample size than the PU group due to the high dropout rate. The reason for the high dropout rate was the unreliable participation of the PETE students in the e-learning unit, which could not be controlled due to methodological (e.g., the link to the e-learning unit was sent by e-mail) and data protection (e.g. the tracking of participation in the e-learning unit) difficulties. Despite the slightly lower representativeness of the ELPU group due to the smaller sample size, the SDs of this group were not systematically higher than the PU group, indicating the reliability of the group statistics. Second, it was for technical (e.g., the settings of the digital learning platform) and data protection (e.g. the tracking of participation) reasons not possible to prove whether the PETE students that were not dropouts actually worked through the content of the e-learning unit. However, it was ensured that PETE students could only access the second questionnaire (t1) once they had clicked through the content of all three sections. Third, the questionnaire was self-constructed and although content validity was assumed, construct validity was not empirically checked beforehand. Fourth, the learning outcome was assessed using only self-assessment and no additional external assessment (e.g., knowledge test, stress-related behavior observation). Therefore, the results could be distorted by social desirability or overconfidence bias. Fifth, there was not a mere control group that received

no intervention at all, as the number of PETE students in the semester in question was limited and we wanted to ensure enough participants for both intervention groups. Furthermore, from a theoretical point of view, no change in students' perceived coping competences was expected without intervention.

Conclusions

In the present paper, an intervention study was conducted with the first teaching tool developed especially for PETE students that provides both knowledge and practical skills for handling stressful teaching situations. The aim of the present study was to determine whether participation in the stress lab enhances perceived competences in PETE students in terms of coping with stressful teaching situations. Considering the results of the lab studies [5] together with the present study, it can be concluded that the stress lab is suitable for teaching PETE students coping competences. Future research will be needed to investigate the extent to which PETE students succeed in transferring the competences in handling simulated teaching situations to dealing with real-life teaching situations. Moreover, replication studies are necessary that consider other universities and additional measures. Specifically in terms of measures, future research should integrate an external assessment alongside the self-assessment to make the competences that were actually acquired measurable (e.g., knowledge test, observation of behavior). Qualitative research could provide insights into what led to the result, that PETE students in the ELPU group perceived more coping competences than PETE students in the PU group. Several recommendations for practical implications can be made. First, the stress lab should be integrated into university teaching programs, which is supported by large effect sizes. Additionally, the participation in the e-learning unit before practicing coping skills should be mandatory for PETE students, as the large effect sizes have shown its meaningfulness for an acquisition of competences. This is to adequately prepare prospective (PE) teachers for handling existing sources of stress and protect them from burnout in later professional life. Second, the stress lab should be implemented in university teaching before the PETE students actually come into contact with real-life teaching situations (e.g., internships, pre-service phase). This is to ensure that they can practice what they have learned to help them effectively handle real-life teaching situations. However, this recommendation should not rule out the possibility of using the stress lab after the first contact with teaching situations. Third, although the stress lab was specifically developed for PETE students (e.g., real-life videos of PE lessons), it could also be adapted to prepare PETE students in other subjects (e.g., replacing the videos, context-specific changes in e-learning unit). In addition, the approach to combining stress-related knowledge with practical skills and gaining personal experience with the subject matter should be developed and tested for other university learning topics.

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Conflict of Interest

The authors declare no conflict of interest.

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