International Journal of Applied Positive Psychology (2024) 9:189–208
https://doi.org/10.1007/s41042-023-00120-7

RESEARCH PAPER

"Name Three Good Things About Yourself in Mathematics" – An Intervention to Reduce Pre-Service Teachers' Shame in Mathematics

Lars Jenßen[1]

Accepted: 16 August 2023 / Published online: 29 August 2023

Abstract

Shame is an unpleasant and activating emotion that affects learners' achievement, including in mathematics, and pre-service teachers' identity development. It is closely connected with the self. The current study investigated the efficacy of an intervention adapted from positive psychology aiming to reduce pre-service primary teachers' shame in mathematics. Accordingly, the *three good things* technique was adapted with respect to the self. The efficacy of the intervention was analyzed in comparison to a qualified control group and a control group receiving no intervention. Participants were allocated at random to the three groups. In total, $n = 176$ pre-service primary school teachers took part in the experiment for a duration of five weeks with exercises twice a week. Findings suggest small positive effects of the adapted intervention on shame reduction in mathematics and superior effects in comparison to both control groups.

Keywords Shame · Mathematics · Pre-service primary teachers · Positive psychology · Randomized controlled trial

Mathematics elicits a variety of emotions among learners (Hannula, 2019). This is also true for pre-service primary school teachers (Hodgen & Askew, 2007). There are several features of mathematics that can cause certain emotions with varying degrees of frequency and intensity (Goldin, 2014): The extent to which mathematics is valued for daily life affects the perception of mathematics as positive or negative. Instructional methods such as competitive games or calculating on the blackboard in front of others can trigger specific pleasant or unpleasant emotions. Goldin (2014) furthermore states that the prevalent right-or-wrong orientation

✉ Lars Jenßen
lars.jenssen@hu-berlin.de

[1] Department of Educational Studies, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany

of mathematics leads to evoking achievement emotions in learners which can be attributed to a subjective perception of success or failure. In addition, dysfunctional beliefs about mathematics, for example associating low mathematical skills with a lack of intelligence, might lead to unpleasant feelings about oneself in the face of continuous failure in mathematics.

When individuals experience difficulties in mathematics and subjectively attribute them to deficiency in terms of their general ability (e.g., *I am stupid*), they experience feelings of shame (Holm et al., 2017; Oades-Sese et al., 2014). However, this attribution of subjectively perceived failure to internal and stable aspects might not be the only factor facilitating the development of shame. According to the control-value theory (Pekrun, 2006), the extent to which an individual values mathematics also affects the degree to which shame is experienced. Individuals who value mathematics as more important (e.g., because mathematics achievement is important to them, mathematics is a fundamental part of their daily work as a mathematics teacher or someone of importance to them values mathematics highly) tend to experience more shame when failing in mathematics tasks than persons who ascribe less value to mathematics. Shame is affectively perceived as unpleasant and activating (Pekrun et al., 2018). Some authors suggest that shame is a *devastating emotion*, as shame reduces well-being (Turner et al., 2002). In a mild form, shame is associated with shyness in social situations, and in a more severe form, it is perceived as feelings of embarrassment or humiliation (Oades-Sese et al., 2014). Cognitive representations are retrospectively directed towards a negative outcome, for example, when one has failed to solve an (easy) mathematical problem (Lewis et al., 1992; Tulis & Ainley, 2011).

The current study focuses on pre-service primary teachers' shame when doing mathematics (e.g., when working on mathematical tasks). Pre-service primary teachers experience shame in mathematics more frequently and intensely than regarding other subjects such as physical education (Jenßen et al., 2021). The prevalence of shame among pre-service primary teachers often occurs due to a lack of learning opportunities in mathematics and a corresponding deficit in mathematical content knowledge (Bibby, 2002). Both aspects are a result of the specificity of teacher education, as primary teachers in most countries are trained as generalists, with mathematics-specific learning opportunities making up a smaller part of their training than for secondary teachers of mathematics (Cooke et al., 2019). Shame increases the more pre-service primary teachers compare their mathematical achievement to that of high-performing fellow students (Jenßen, 2021). Recent studies have shown that pre-service primary teachers report experiences with shame in mathematics classrooms while they were students at school (Jenßen et al., 2022). These experiences moderately affect their initial choice against studying mathematics as a subject at university (Jenßen et al., 2022). Additionally, there is a strong negative association between pre-service primary teachers' own experience of shame as learners of mathematics and their intention to teach mathematics later in school (Jenßen et al., 2023). Thus, shame might be a relevant emotional factor for prospective pre-service primary teachers' willingness to teach mathematics (which in turn is likely to affect their decision to study mathematics in the first place). This may be of relevance considering that

in some countries like Germany, there is a huge shortage of mathematics teachers even at primary schools.

In general, shame is closely linked to identity development (Lewis et al., 1989). This also applies to the identity development of pre-service primary teachers in mathematics (Hodgen & Askew, 2007). Like any other achievement emotion, shame is also involved in pre-service teachers' competence development (Cooke, 2015). In accordance with the control-value theory (Pekrun, 2006), it can be assumed that shame is negatively associated with mathematical achievement (Pekrun et al., 2011). In addition, it can be assumed that shame experienced by pre-service primary teachers during teacher education in math-related learning and achievement situations is positively related to shame they experience when teaching mathematics later in school (for mathematics anxiety: Olson and Stoehr, 2019). As Pekrun (2021, p. 316) summarizes, "emotions can profoundly influence teachers' thinking, motivation, and action in the classroom, as well as their health and professional development". For instance, persons experiencing shame tend to be less prosocial, meaning that they care less about others, and are less willing to help (Tignor & Colvin, 2017). Studies have shown that shy teachers were less supportive of their students and implemented fewer social learning strategies in the classroom (Deng et al., 2021). Thus, effects on pupils' achievement and emotions can be assumed (Frenzel, 2014).

1 Shame and Self-Concept

When individuals attribute failure to internal, stable, and uncontrollable factors, and also value the domain in which failures occur, they experience shame (Pekrun, 2006; Tracy & Robins, 2006). Shame "reflects the personal implication of the outcome of an event" (Turner et al., 2002, p.82). Thus, shame is referred to as a self-conscious emotion (Lewis, 2003). Perceived differences between the real and the ideal self can cause shame (Lewis, 2003). It is also assumed to be a negative emotional indicator of self-worth (Turner et al., 2002). This also applies to mathematics (Thompson & Dinnel, 2007). In particular, if a person expends a great deal of effort prior to experiencing failure (which is misinterpreted as an indicator of a lack of ability), shame and damage to self-worth are high (Turner et al., 2002). Individuals tend to avoid experiences of failure, which can be understood as being protective of the self-concept (Thompson et al., 2008). This vicious cycle of shame, self-worth damage, and avoidance is also assumed to apply to experiences in mathematics, especially when someone's self-concept is affected by one's mathematical achievements (Heyd-Metzuyanim, 2015). Specifically for pre-service primary teachers, studies have found that shame in mathematics is strongly related to a low ability self-concept (Jenßen, 2021).

2 Emotion Regulation of Shame

According to Gross (1998, p. 275), emotion regulation "refers the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions". The complex process of emotion

regulation comprises different stages with attentional deployment (e.g., focusing positive aspects of a situation) besides others (Gross, 1998, 2015).

Due to the strong linkage of shame to the self-concept, its regulation is regarded as challenging (Velotti et al., 2017). Nevertheless, the individual motivation to regulate shame is high (de Hooge et al., 2011). This is probably mainly due to the fact that after a failure, the focus of attention is directed to negative self-representations which are immediately activated (Tracy & Robins, 2004). These negative self-representations are experienced as painful and individuals do not perceive themselves as capable to handle shame-inducing situations in functional ways (Tracy & Robins, 2004). For example, they avoid shame-inducing situations or try to compensate for their subjectively perceived deficiency with apparent strengths such as perfectionism or aggression (Ashby et al., 2006; Bushman & Baumeister, 1998; Tangney et al., 1992). However, these regulation strategies do not lead to individuals becoming permanently resilient to shame experiences, what should be the goal of a functional emotion regulation (Brown, 2006; Turner & Schallert, 2001). Consequently, strategies related to cognitive change seem to be promising as they might have the potential to strengthen the control appraisal of an individual (Harley et al., 2019): Shameful narratives should be replaced with alternative functional narratives, such as a humorous view of one's perceived deficits (Yue, 2021) or esteem-related narratives (Holmstrom et al., 2021). In particular, moving away from social comparisons to intrapsychic comparisons can reduce the experience of shame (e.g., temporal comparison: Gürel et al., 2020). Overall, it must be noted that there is still a need for effective interventions to reduce shame specifically in mathematics (Amidon et al., 2020).

3 Positive Psychology Interventions

Various core assumptions of positive psychology have been applied to the educational context (Seligman et al., 2009), with the primary goal of using empirical evidence to develop interventions to strengthen individual resilience, character strength, and well-being. Pleasant emotions should be strengthened and unpleasant emotions should be regulated (Kristjánsson, 2012; Waters, 2011).

A variety of positive psychology interventions (known as *PPIs*) have been developed, the effectiveness of which has been meta-analytically examined many times, also with regard to reducing negative emotions (Carr et al., 2021; Davis et al., 2016; Dickens, 2017). From the perspective of emotion regulation, positive psychology interventions can be assigned to the different stages of the process of emotion regulation (Quoidbach et al., 2015). A common PPI is known as the *three good things* technique (Seligman et al., 2005), which involves systematically reflecting on three pleasant things experienced during a specific time interval, such as a day (attentional deployment). The conscious deployment of attention during this PPI promotes a positive perception and thus cognitive change, and strengthens the individual's resistance to unpleasant experiences (Seligman et al., 2005). Thus, focusing on positive aspects of a situation might lead not only to an increase of pleasant emotions but also to a reduction of unpleasant emotions. Training effects and increased effectiveness can be observed when this technique performed over

a longer period of time (Carr et al., 2021). This general PPI can be adapted to a specific domain (e.g., personal finance: Asebedo et al., 2021).

4 Developed Intervention

The intervention was designed based on positive psychology (Seligman et al., 2009). To minimize the risk of re-experiencing shame for the same negative aspect (de Hooge et al., 2011), it was not supposed to address shame directly, but instead increase resilience towards shame experiences on grounds of resource orientation (e.g., Brown, 2006). From an emotion regulation perspective, the intervention should facilitate individuals' attention to positive events and thus promote cognitive change regarding the individual's control over shame-inducing events (Harley et al., 2019). Furthermore, it was important that the intervention was economical, feasible, and continuable over a longer period of time. Therefore, the three good things technique was chosen as the foundation of the intervention (Seligman et al., 2005). However, this technique had to be adapted to accomplish the goal of reducing shame in mathematics. Specifically, the mathematics domain had to be addressed directly. Since shame can be understood as a self-conscious emotion, the focus had to be specifically on the self. In order to counterbalance global negative self-assessments in the context of shame, the focus should also address everyday experiences that are as concrete as possible. Thus, the following instructions (translated from German to English) were formulated for the adapted PPI:

> Name three good things you like about yourself in mathematics. For example, reflect on positive experiences in mathematics that you have personally accomplished in the past few days. Name as many different things as possible over the time for this exercise.

5 The Current Study

The present study aimed to investigate the efficacy of a developed intervention among pre-service primary teachers in an experimental setting (randomized controlled trial). The purpose of the intervention was to reduce their shame while doing mathematics. Intervention research on PPIs requires qualified control groups (Dickens, 2017). Only in this way, it can be ascertained that the PPI is effective - it has to be more effective than another intervention (Wood et al., 2010). Thus, the following research questions were posed:

The first question was whether participating in the PPI reduces pre-service primary teachers' shame in mathematics. The second question was whether the developed PPI was more effective in reducing shame compared to a control group in which participants did not participate in any intervention. The final question was whether the developed PPI is more effective in reducing shame in mathematics compared to a qualified control group (where participants received a different, simpler intervention).

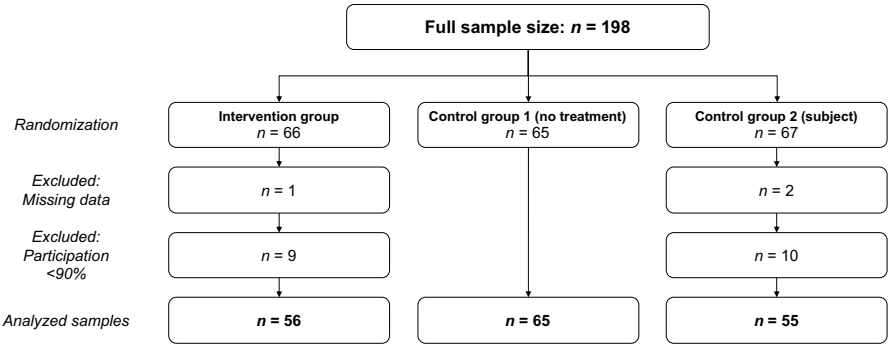

Fig. 1 Flow of participants through each stage of the study

6 Method

6.1 Participants

A total of 198 pre-service primary teachers[1] from a German university took part in the study. Some participants had to be excluded due to the study design (see Section 6.3 and Fig. 1), leaving a total of $n = 176$ pre-service primary teachers in the sample for analysis. Of these participants, 77.8% reported being women and 22.2% being men. The participants' mean age was $M = 25.64$ years ($SD = 6.75$; $min = 19$; $max = 52$). The majority (84.0%) were in their 5th semester of a bachelor's degree program in primary education ($min = 1$; $max = 15$). The participating pre-service primary teachers all attended an online lecture on the psychology of mathematics education, during which the study was conducted. Because the study was conducted at the beginning of the 5th semester, participants had previously learned about arithmetic and geometry from both a content-related and instructional perspective. They had not received instruction on emotions in mathematics as this was only part of the course where the intervention was applied. Participation in the study was voluntary and incentives were not provided.

6.2 Assessment

To assess pre-service primary teachers' shame in mathematics, the *Shame in Mathematics - Questionnaire* was used (SHAME-Q; Jenßen et al., 2023). The questionnaire captures shame in mathematics as a general trait and contains six items (e.g., "I am ashamed that I am not as good in math as I would like to be"). Items are rated on a five-point scale from 0 (=strongly disagree) to 4 (=strongly agree). Reliability of the SHAME-Q in the current application was McDonald's Omega = 0.87 at t1 (before the intervention)

[1] The term *pre-service teacher* refers to individuals who are still in their teacher education program and not yet in practice. In the present study, the students were still in the bachelor's program of their teacher training for the primary level (grades 1 to 6).

and McDonald's Omega = 0.89 for t2 (after the intervention). In the present study, it was decided to calculate McDonald's Omega as an estimation of reliability because it does not assume that the items load equally on the latent dimension (compared to Cronbach's Alpha, which assumes this restrictive condition). Previous studies on the *SHAME-Q* have shown that the loadings of the items differ (Jenßen, 2021). A comprehensive validation study indicated that the questionnaire exhibits sufficient construct representativeness, provides test scores that are empirically distinguishable from other negative achievement emotions in mathematics (anxiety), and allows for valid conclusions regarding content (Jenßen et al., 2023).

6.3 Procedure

The pre-service primary teachers attending the lecture were randomly assigned to three different conditions (see Fig. 1). Randomization was based on the principle that students attending the lecture were ranked according to their matriculation number and assigned to the three groups in turn (person-wise randomization). The first group received the developed PPI, the second group (control group 1) received no intervention, and the third group (control group 2) participated in a different intervention (qualified control group). Participants of control group 1 just attended the lecture as usual. The intervention for control group 2 - the qualified control group - was consistent with the three good things technique, but focused on the subject of mathematics rather than the self as it was the case in the developed intervention (instructions: "Name three good things about mathematics. Name as many different aspects as possible over the time of the exercise."). The experimental period was five weeks. At the beginning and end of the experiment, participants' shame was measured with the SHAME-Q (Fig. 2).

The intervention group and qualified control group were instructed to perform the respective exercise twice a week (Mondays and Thursdays) and document it via an online tool. Thus, participants in both groups took part in the respective exercise on maximally 10 times. Although the dosage of PPI interventions is considered a relevant explanatory factor for effect (Wellenzohn et al., 2016), it was set lower than the recommended daily exercise (Seligman et al., 2005). This was done for two reasons: First, to avoid overburdening participants who, unlike in therapeutic applications, did not choose to perform it on their own initiative and dropout could have otherwise been too high. Second, to allow the participants the possibility of concrete experiences with mathematics, which do not take place on a daily basis or at least are not consciously perceived on a daily basis.

Implementation fidelity was determined by checking participants' usage behavior regarding the online tool in terms of naming three things and participating twice a week. To ensure adherence, participants were instructed at the beginning of each week to perform the exercise and document it. The experiment was implemented by a psychologist who was familiar with the study design.

A total of three participants were excluded from the experiment due to missing values on the SHAME-Q. An additional 19 participants were excluded because they

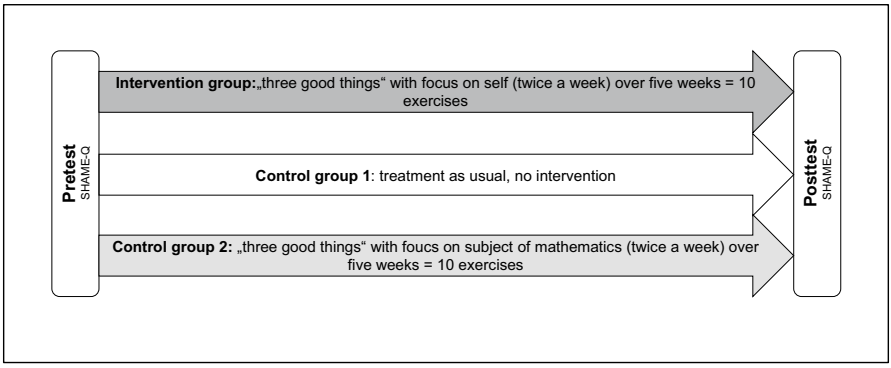

Fig. 2 Overview of the study design

completed the exercise fewer than nine times, as empirical findings suggest that efficacy is only achieved with frequent participation (Carr et al., 2021). This strict criterion was also chosen because the frequency of the intervention was lower than normally usual. The final sample size for each group is given in Fig. 1.

It is assumed that, despite the experimental design, the study had sufficient ecological validity because it took place in a setting familiar to the pre-service primary teachers. Since all pre-service teachers attended the same lecture, they knew that there were different groups. The intervention instructions were presented online and group-specifically to participants before each session. Participants were asked to not communicate with each other about the content of the interventions, however, the possibility that communication took place cannot be ruled out. In the informal feedback interview after the experiment was completed, students indicated that no communication took place. Participants were given detailed information about the content and objectives of the experiment after the posttest was conducted.

The study was conducted online because at the time of implementation there was a lockdown due to the *Sars-Cov2 pandemic*.

6.4 Data Analysis

Mean-based and variance analysis techniques were used to answer the research questions (Leppink, 2019). To investigate the efficacy of the developed PPI, a paired t-test was applied (Research Question 1). Research Questions 2 and 3 each involved comparing the intervention group with another group (Research Question 2: group without any treatment, Research Question 3: simple PPI focusing on the subject of mathematics). A mixed (between-within) ANOVA was conducted for these comparisons. The assumptions of these analysis techniques were checked a priori.

A power analysis (Keselman et al., 1998) revealed that small to medium effects could be detected with the available sample sizes, similar to the range of effect sizes for PPIs in previous work (Carr et al., 2021; Davis et al., 2016; Dickens, 2017). The

power analysis for the mixed ANOVA was used as the basis for the study design, as it is more complex and demanding than the paired t-test. Specifically, the a priori analysis for an effect size of 0.30 was conducted using the program G*Power 3.1 (Faul et al., 2007). The analysis revealed that there must be at least 40 participants per group. Confidence intervals (95%) were calculated for the determined effect sizes according to established standards (Steiger, 2004). All statistical analyses were performed with *IBM SPSS 25.0*.

In line with the recommendation regarding transparency made by Simmons et al. (2011), the following statements have been formulated: All information regarding how the sample size and data exclusions have been determined are given in the manuscript. Additionally, all manipulations and all measures in the study have been reported.

7 Results

7.1 Demographic Differences and Descriptive Results

First, correlations between shame scores (pretest) and the variables collected in the study were estimated. There were no significant correlations between shame and age ($r = .06$, $p = .41$), shame and semester ($r = .10$, $p = .19$) or shame and grade in arithmetic ($r = .09$, $p = .22$). *Arithmetic* is a core course during pre-service primary teachers' education in mathematics. The grade represents the exam grade of this course.

Second, differences among the three groups were analyzed (Table 1). A one-way ANOVA showed no statistically significant difference among the three groups on age, $F(2, 172) = 0.078$, $p = .93$. A chi-square test was used to compare gender and group membership. No expected cell frequencies were below 5. The results showed no significant association between gender and group membership, $\chi^2(2) = 2.81$, $p = .87$, Cramer's $V = 0.04$. There was a statistically significant difference among groups regarding semester of studies as determined by a one-way ANOVA ($F(2, 160) = 7.151$, $p = .001$). Post-hoc tests (Tukey) indicated that more students of higher

Table 1 Demographic variables for the three groups

Group	*n*	Age *M* (*SD*)	Gender categorical[1]	Semester *M* (*SD*)	Grade in arithmetic *M* (*SD*)
Intervention Group	56	25.70 (6.92)	78.6% women 21.4% men	5.00 (0.00)	7.50 (2.04)
Control Group 1 (no treatment)	65	25.39 (7.12)	80.0% women 20.0% men	4.56 (1.18)	7.76 (1.99)
Control Group 2 (subject)	55	25.87 (6.22)	76.4% women 23.6% men	5.44 (1.78)	7.31 (2.27)

[1] No participant indicated *diverse* or *other* as their gender. Grade in arithmetic ranged from 0 (= worst) to 15 (= best), *M* = mean, *S* = standard deviation

semesters were in the intervention group as well as control group 2 compared to control group 1. The difference was $\Delta_1 = 0.44$ semesters for intervention group and control group 1 and $\Delta_2 = 0.88$ semesters for control group 2 and control group 1. A one-way ANOVA showed no statistically significant difference among the three groups regarding grades in arithmetic, $F(2, 162) = 0.660$, $p = .52$.

On average, participants completed $M = 9.57$ exercises ($SD = 0.50$) in the intervention group and $M = 9.35$ ($SD = 0.52$) in control group 2. Descriptive results are presented in Table 2; Fig. 3.

7.2 Change in Intervention Group

Before testing for a significant change in shame scores from pre- to posttest in the intervention group, it was checked whether the assumptions of the paired t-test were met. There were no extreme outliers in the data (checked via box plots); only two slight outliers were found and were not excluded from further analyses (Note: analyses excluding these outliers yielded no differences in the results). The differences between pre- and posttest shame scores were not normally distributed, as assessed by the Shapiro-Wilk test (*Calc* $W = 0.93$, $df = 56$, $p = .002$). As the paired t-test still delivers robust results in the case of a non-normal distribution when the sample size is greater than 30 (Stone, 2010), no consequences were drawn for further analyses.

The paired t-test revealed that shame scores were significantly lower after the intervention, with $t(55) = 2.67$, $p = .01$. The effect size was small according to Cohen (1988), with Cohen's $d_z = 0.36$, CI95%[0.02;0.72].

7.3 Intervention Group in Comparison to Control Group 1 (No Treatment)

Again, it was first checked if the assumptions of a mixed ANOVA were met. There were no extreme outliers as analyzed by box plots. Only five slight outliers were found, which remained in the data for further analyses (Note: analyses excluding these outliers yielded no differences in the results). The error variances were homogeneous, as assessed by Levene's test ($p = .366$ for pretest and $p = .334$ for posttest). The covariances were also homogeneous, as assessed by Box's test ($p = .192$). Sphericity was given. As assessed by the Shapiro-Wilk test, shame scores were normally distributed for all groups ($p < .05$) except for the intervention group at pretest and control group 1 at posttest (see Appendix 1). Because the mixed ANOVA is robust against violations of the assumption of normally distributed dependent variables for each combination of the within- and between-subjects factor, no consequences were drawn for the main analyses (Glass et al., 1972).

The mixed ANOVA revealed a statistically significant interaction between time and group, with $F(1,119) = 9.530$, $p = .003$. The change in shame scores in the intervention group was greater than in control group 1. According to Cohen (1988), the effect size was medium, with partial $\eta^2 = 0.07$, CI95%[0.02;0.15].

Table 2 Shame scores at pretest and posttest and change in shame scores for the intervention group and control groups

Group	*n*	Pretest			Posttest			Change		
		M (*SD*)	CI95%	*Min* ; *Max*	*M* (*SD*)	CI95%	*Min* ; *Max*	*M (SD)*	*Min ; Max*	Effect size (Cohen's d_z with CI95%)
Intervention Group	56	9.30 (5.35)	7.87 ; 10.74	0 ; 24	8.23 (5.26)	6.82 ; 9.64	0 ; 22	-1.07 (3.01)	-10 ; 3	0.36 [0.08;0.72]
Control Group 1 (no treatment)	65	9.43 (5.82)	7.99 ; 10.87	0 ; 24	9.86 (5.92)	8.40 ; 11.33	0 ; 24	0.43 (2.34)	-4 ; 5	-0.18 [-0.43;0.06]
Control Group 2 (subject)	55	9.11 (4.61)	7.86 ; 10.35	0 ; 20	9.20 (4.44)	8.00 ; 10.40	1 ; 20	0.09 (2.34)	-5 ; 5	-0.04 [-0.30;0.23]

M = mean, *SD* = standard deviation, *CI95%* = 95% confidence interval, *Min* = minimum, *Max* = maximum

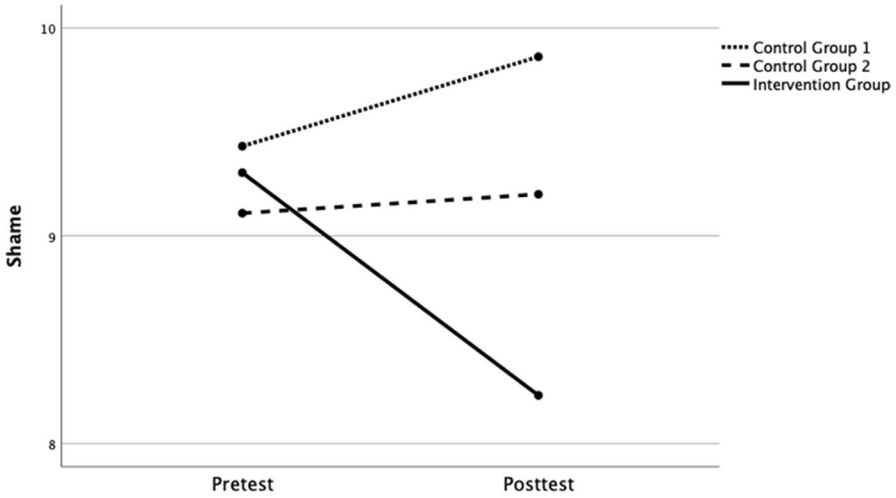

Fig. 3 Pre- and posttest scores in the three groups

7.4 Intervention Group in Comparison to Control Group 2 (Subject Focus)

The basic assumptions for the second mixed ANOVA were met. This was also the case for the prior mixed ANOVA. No extreme outliers were found, as analyzed by box plots. There were three slight outliers, but they remained in the dataset for further analysis (Note: analyses excluding these outliers yielded no differences in the results). Levene's test revealed homogeneity of error variances ($p = .389$ for pretest and $p = .436$ for posttest). Homogeneity of covariances, as assessed by Box's test ($p = .196$) and sphericity were given. Shame scores were not normally distributed for the intervention group at pretest, control group 2 at pretest, and control group 2 at posttest, but they were for intervention group at posttest, as assessed by the Shapiro-Wilk test (see Appendix 1). Again, no consequences were drawn for the main analyses due to the fact that mixed ANOVA is robust to violations of this assumption (Glass et al., 1972).

The mixed ANOVA for the intervention group vs. control group 2 also revealed a statistically significant interaction between time and group, with $F(1,109) = 5.158$, $p = .025$, partial $\eta^2 = 0.05$ (CI95%: 0.003;0.12) representing a small to medium effect (Cohen, 1988).

8 Discussion

The results suggest that the developed PPI is effective in terms of reducing shame in mathematics among pre-service primary teachers. The PPI was superior to both a group which did not receive any treatment and a qualified control group (regular PPI focusing on the subject of mathematics). The effect sizes were small to medium.

Since the developed PPI focusing on the self was more effective than two control groups, particularly the control group focusing only on the subject of mathematics, this evidence points to the importance the self has with regard to shame (Lewis, 2003; Tracy & Robins, 2004).

The effect size regarding change of the shame scores of the developed PPI was small. In terms of numbers alone, the practical significance of the effect size is difficult to interpret. The difference regarding the level of shame before and after the intervention is about one-third of a standard deviation. Following Lakens (2013), the effect should be interpreted against the background of otherwise standard effect sizes. The effect size of the developed PPI was smaller than what would have been expected from non-clinical studies with anxiety as the dependent variable (Carr et al., 2021). This could be due to the fact that shame, due to its complexity, is considered more challenging to regulate than other negative emotions (Velotti et al., 2017). Nevertheless, it must be noted that there is an effect that, even if it is small, can have practical significance in as far as the intervention can represent a first step in the regulation of shame. One advantage to be seen in the developed PPI could be that it intervenes very early in the emotion regulation process at the level of attentional deployment (Fried, 2011; Jacobs & Gross, 2014). This could be relieving for individuals, as they do not have to regulate the negative self-devaluations resulting from shame in the appraisal phase. These negative self-schemas are often activated automatically and are considered difficult to change (Tracy & Robins, 2004). To avoid this rapid activation, shame was not explicitly referred to in the PPI intervention instructions to refrain from focusing on prior shame experiences and potential re-shaming. Studies have found that shame regulation may be more effective when focusing on the self *in the context of others* (Leeming & Boyle, 2013). It would be conceivable to explicitly integrate such a focus into the instructions for the developed PPI. However, this could also have adverse or negative side effects, as social comparisons can trigger the experience of shame (in the case of *upward comparisons*), but also feelings of arrogance (in the case of *downward comparisons*) (Jenßen, 2021).

Throughout informal interviews that were conducted after the experiment was completed, participants reported that they developed a more positive view of themselves and mathematics, which they enjoyed. It is reasonable to assume that deliberately focusing on positive aspects may involve effort after an initial period, especially because participants were asked to name different things each time they completed the exercise. However, it can also be assumed that after a certain transition phase, a training effect occurs that promotes the efficacy of the PPI (Carr et al., 2021). The informal interviews did not suggest any adverse effects of the PPI.

The participants received frequent reminders to implement the intervention. If pre-service primary teachers were to perform the exercise by themselves in the future without external instructions, the PPI effects may be absent if compliance is low. Repeated instructions could be helpful for implementation.

However, findings suggest that it could possibly have effects, if the didactic implementation during teacher education fundamentally focused on positive aspects of the pre-service primary teachers' self. This could be an element part of a curriculum that aims to reduce unpleasant emotions (Geist, 2010).

A priori analyses showed that, except for the number of semesters, there were no differences between the groups with respect to relevant demographic characteristics. There was only a slight difference in the number of completed semesters. Since, at the university where the study was conducted, there are no courses regarding emotions in general, emotions in mathematics, or their regulation during pre-service teacher education, this difference should not have affected the treatment analyses.

Other traits of the pre-service teachers could be used to explain the reduction in shame, but these were not collected in the study. For example, it can be assumed that other emotional characteristics such as well-being (Velotti et al., 2017) or personality traits like general shame proneness (Cohen et al., 2011) are involved in the development of shame in mathematics. In addition, other constructs, for example self-esteem, may also be related to shame in mathematics (Velotti et al., 2017). Particularly in the educational context, it is conceivable that *values* in mathematics, especially social values, may have a significant influence on the level of shame experienced in mathematics (Pekrun, 2006). Even though these constructs were not the focus of the present study, they represent starting points for further intervention studies in order to investigate the complex set of conditions for the experience of shame.

9 Limitations

A limiting factor which could have influenced the results, could be that participants knew they were taking part in an experiment,. However, information about the content and causal pathways were only revealed after the experiment was completed. It should further be noted that the study had no follow-up measurement point. Thus, the stability of the effects is unknown and therefore it is questionable whether the PPI presented is only useful for short-term decreases or also for long-term decreases of pre-service primary teachers' shame in mathematics (Quoidbach et al., 2015). Moreover, a time series design would be fruitful in order to analyze at which phase of the PPI shame scores change.

The experiment was conducted during the *Sars-CoV-2 pandemic* when the pre-service primary teachers of this study only participated in digital learning and did not take any face-to-face courses. Thus, no direct social comparisons were possible, which can affect the experience of shame (Jenßen, 2021). However, this condition applied equally to all groups. Studies have shown that imagining others is sufficient to elicit shame (Smith et al., 2002). However, it must be noted that direct communication and performance feedback could be given via the video teleconferencing software used for digital instruction in all mathematics courses. This might have triggered social comparisons as well. For the participants, it was not an unfamiliar situation, as the mode of digital teaching had been implemented more than six months ago.

Another limiting factor is that the analyzed sample cannot be considered representative of pre-service primary teachers because it was recruited from only one university in Germany. Teacher education programs for primary teachers may differ across countries (Cooke et al., 2019), although they usually have comparable

proportions of learning opportunities in mathematics. Still, pre-service primary teachers' achievement in mathematics differs across countries (Blömeke et al., 2012). This, in turn, may be associated with differential emotional experiences in terms of control-value theory (Pekrun, 2006) and thus with differential effectiveness of the developed PPI.

Although the sample cannot be considered globally representative in terms of its selection, its size was sufficient to provide adequate statistical power in light of the effect revealed (0.99 for the mixed ANOVA regarding the intervention group and control group 2).

10 Conclusions and Future Research

In terms of time, the developed PPI is an economical and parsimonious procedure that seems to be effective in order to reduce pre-service primary teachers' shame in mathematics. However, in light of the limitations discussed, replications are needed.

The presented PPI could be integrated as a mandatory element of teacher education. Since possible long-term effects remain unclear, it would be more conceivable as a *kick-start intervention*, which is the case for most PPIs (Wood et al., 2010). This PPI could be particularly helpful at the beginning of a teacher education program, because pre-service primary teachers start university courses while they still hold on to impressions and emotional memories of mathematics they collected during their own years at school (Bekdemir, 2010). However, the efficacy of the application at the beginning of teacher education should be investigated in the future. Similarly, it would be interesting to examine whether the helpful experiences pre-service primary teachers gained during the PPI affect their subsequent regulatory strategies as in-service teachers (Taxer & Gross, 2018).

Shame is not a math-specific emotion, as it can play a significant role in learning across educational settings (Monroe, 2009). Future research could investigate whether the effects of the developed PPI can be generalized to other contexts. This may involve other populations of learners (e.g., students in school), teachers (e.g., shame when teaching mathematics as an *in-service* primary teacher), other emotions (e.g., pride or enjoyment), or other domains in which studies suggest that shame is an important conditional factor for learning processes (e.g., language education (Galmiche, 2018) or physical education (Hogue et al., 2018). In particular, the application of PPI in mathematics-related subjects, like physics, or for other self-conscious emotions, like guilt, may be able to achieve similar effects. The results of the study suggest that the developed PPI has an effect on reducing shame through the focused self-relation. Here, it would be interesting to examine if the intervention also reveals effects for other unpleasant emotions that may be less self-related (e.g., anxiety which may be more focused on a concrete object). Future studies also should investigate whether the PPI is not only effective in reducing pre-service primary teachers' shame when doing mathematics, but also if the PPI enhances their mathematics achievement or their motivation to teach mathematics later in school, as these factors are interrelated (Jenßen et al., 2023).

Appendix: Shapiro-Wilk Test Statistics

	Group	*Calc W*	*df*	*p*-Value
Pretest	Intervention Group	0.96	56	0.06
	Control Group 1	0.96	65	0.04
	Control Group 2	0.97	55	0.26
Posttest	Intervention Group	0.95	56	0.03
	Control Group 1	0.96	65	0.05
	Control Group 2	0.97	55	0.25

Funding Open Access funding enabled and organized by Projekt DEAL.

Data Availability The data that support the findings of this study are available on request from the corresponding author.

Declarations

Ethics Approval and Consent to Participate Each participant gave his or her consent to participate in written form. All participants were fully informed about method and aims of the study after the intervention had been carried out. All participants had 14 days to withdraw their participation and thus the release of their data for research purposes.

Conflict of Interest There are no conflicts of interest to disclose.

References

Amidon, J., Monroe, A., Rock, D., & Cook, C. (2020). Shame, shame, go away: Fostering productive struggle with mathematics. *Kappa Delta Pi Record, 56*(2), 64–69. https://doi.org/10.1080/00228958.2020.1729636

Asebedo, S. D., Seay, M. C., Little, T. D., Enete, S., & Gray, B. (2021). Three good things or three good financial things? Applying a positive psychology intervention to the personal finance domain. *The Journal of Positive Psychology, 16*(4), 481–491. https://doi.org/10.1080/17439760.2020.1752779

Ashby, J. S., Rice, K. G., & Martin, J. L. (2006). Perfectionism, shame, and depressive symptoms. *Journal of Counseling & Development, 84*, 148–156.

Bekdemir, M. (2010). The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students. *Educational Studies in Mathematics, 75*(3), 311–328. https://doi.org/10.1007/s10649-010-9260-7

Bibby, T. (2002). Shame: An emotional response to doing mathematics as an adult and a teacher. *British Educational Research Journal, 28*(5), 705–721. https://doi.org/10.1080/0141192022000015543

Blömeke, S., Suhl, U., Kaiser, G., & Döhrmann, M. (2012). Family background, entry selectivity and opportunities to learn: What matters in primary teacher education? An international comparison of fifteen countries. *Teaching and Teacher Education, 28*(1), 44–55. https://doi.org/10.1016/j.tate.2011.08.006

Brown, B. (2006). Shame resilience theory: A grounded theory study on women and shame. *Families in Society, 87*(1), 43–52. https://doi.org/10.1606/1044-3894.3483

Bushman, B. J., & Baumeister, R. J. (1998). Threatened egotism, narcissism, self-esteem, and direct and displaced aggression: Does self-love or self-hate lead to violence? *Journal of Personality and Social Psychology, 75*(1), 219–229.

Carr, A., Cullen, K., Keeney, C., Canning, C., Mooney, O., Chinseallaigh, E., & O'Dowd, A. (2021). Effectiveness of positive psychology interventions: A systematic review and meta-analysis. *The Journal of Positive Psychology, 16*(6), 749–769. https://doi.org/10.1080/17439760.2020.1818807

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd.). Lawrence Erlbaum Associates.

Cohen, T. R., Wolf, S. T., Panter, A. T., & Insko, C. A. (2011). Introducing the GASP scale: A new measure of guilt and shame proneness. *Journal of Personality and Social Psychology, 100*(5), 947–966. https://doi.org/10.1037/a0022641

Cooke, A. (2015). Considering pre-service teacher disposition towards mathematics. *Mathematics Teacher Education and Development, 17*, 1–11.

Cooke, A., Jenßen, L., & Norén, E. (2019). Mathematics initial teacher education programs in Sweden, Germany, and Australia. In G. Hine, S. Blackley, & A. Cooke (Eds.), *Mathematics Education Research: Impacting Practice (Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia)* (188–195). MERGA.

Davis, D. E., Choe, E., Meyers, J., Wade, N., Varjas, K., Gifford, A., Quinn, A., Hook, J. N., Van Tongeren, D. R., Griffin, B. J., & Worthington, E. L. (2016). Thankful for the little things: A meta-analysis of gratitude interventions. *Journal of Counseling Psychology, 63*(1), 20–31. https://doi.org/10.1037/cou0000107

de Hooge, I. E., Zeelenberg, M., & Breugelmans, S. M. (2011). A functionalist account of shame-induced behaviour. *Cognition and Emotion, 25*(5), 939–946. https://doi.org/10.1080/02699931.2010.516909

Deng, Q., Patwardhan, I., Rudasill, K., Trainin, G., Wessels, S., Torquati, J., & Coplan, R. J. (2021). Shy and outgoing preservice teachers and their responses to hypothetical problem behaviors in the classroom. *Educational Psychology, 41*(5), 658–673. https://doi.org/10.1080/01443410.2020.1718613

Dickens, L. R. (2017). Using gratitude to promote positive change: A series of meta-analyses investigating the effectiveness of gratitude interventions. *Basic and Applied Social Psychology, 39*(4), 193–208. https://doi.org/10.1080/01973533.2017.1323638

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biodemical sciences. *Behavior Research Methods, 39*, 175–191.

Frenzel, A. C. (2014). Teacher emotions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 494–519). Routledge.

Fried, L. (2011). Teaching teachers about emotion regulation in the classroom. *Australian Journal of Teacher Education*, *36*(3). https://doi.org/10.14221/ajte.2011v36n3.1

Galmiche, D. (2018). The role of shame in language learning. *Journal of Languages Texts and Society, 2*, 99–129.

Geist, E. (2010). The anti-anxiety curriculum: Combating math anxiety in the classroom. *Journal of Instructional Psychology, 37*(1), 24–31.

Glass, G. V., Peckham, P. D., & Sanders, J. R. (1972). Consequences of failure to meet assumptions underlying the fixed effects analyses of variance and covariance. *Review of Educational Research, 42*(3), 237–288. https://doi.org/10.3102/00346543042003237

Goldin, G. A. (2014). Perspectives on emotion in mathematical enagegment, learning, and problem solving. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 391–414). Routledge.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(3), 271–299. https://doi.org/10.1037/1089-2680.2.3.271

Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychological Inquiry, 26*(1), 1–26. https://doi.org/10.1080/1047840X.2014.940781

Gürel, Ç, Brummelman, E., Sedikides, C., & Overbeek, G. (2020). Better than my past self: Temporal comparison raises children's pride without triggering superiority goals. *Journal of Experimental Psychology: General, 149*(8), 1554–1566. https://doi.org/10.1037/xge0000733

Hannula, M. S. (2019). Young learners' mathematics-related affect: A commentary on concepts, methods, and developmental trends. *Educational Studies in Mathematics, 100*(3), 309–316. https://doi.org/10.1007/s10649-018-9865-9

Harley, J. M., Pekrun, R., Taxer, J. L., & Gross, J. J. (2019). Emotion regulation in achievement situations: An integrated model. *Educational Psychologist, 54*(2), 106–126. https://doi.org/10.1080/00461520.2019.1587297

Heyd-Metzuyanim, E. (2015). Vicious cycles of identifying and mathematizing: A case study of the development of mathematical failure. *Journal of the Learning Sciences, 24*(4), 504–549. https://doi.org/10.1080/10508406.2014.999270

Hodgen, J., & Askew, M. (2007). Emotion, identity and teacher learning: Becoming a primary mathematics teacher. *Oxford Review of Education, 33*(4), 469–487. https://doi.org/10.1080/03054980701451090

Hogue, C. M., Fry, M. D., & Iwasaki, S. (2018). The impact of the perceived motivational climate in physical education classes on adolescent greater life stress, coping appraisals, and experience of shame. *Sport Exercise and Performance Psychology, 8*(3), 273–289. https://doi.org/10.1037/spy0000153

Holm, M. E., Hannula, M. S., & Björn, P. M. (2017). Mathematics-related emotions among finnish adolescents across different performance levels. *Educational Psychology, 37*(2), 205–218. https://doi.org/10.1080/01443410.2016.1152354

Holmstrom, A. J., Shebib, S. J., Mazur, A. P., Mason, A. J., Zhang, L., Allard, A., & Boumis, J. K. (2021). Self-conscious emotions and esteem support: The effectiveness of esteem support in alleviating state shame and guilt. *Human Communication Research, 47*(2), 105–131. https://doi.org/10.1093/hcr/hqaa015

Jacobs, S. E., & Gross, J. J. (2014). Emotion regulation in education. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 183–201). Routledge.

Jenßen, L. (2021). What affects the arrogant, proud or ashamed pre-service teacher in mathematics? Effects of social comparison, gender and self-concept on self-conscious emotions. *Social Psychology of Education, 24*(5), 1105–1123. https://doi.org/10.1007/s11218-021-09655-6

Jenßen, L., Möller, R., & Roesken-Winter, B. (2021). *Shame: A significant emotion in preservice primary school teachers' mathematics education* [Paper presentation]. The 14th International Congress on Mathematical Education, Shanghai, China. https://www.researchgate.net/publication/339213977. Accessed 28 Aug 2023.

Jenßen, L., Möller, R., Eilerts, K., & Roesken-Winter, B. (2022). Pre-service primary teachers' shame experiences during their schooling time: Characteristics and effects on their subject-choices at university. *Educational Studies in Mathematics, 110*, 435–455. https://doi.org/10.1007/s10649-021-10141-1

Jenßen, L., Roesken-Winter, B., & Blömeke, S. (2023). Measuring pre-service primary teachers' shame in mathematics - a comprehensive validation study. *International Journal of Science and Mathematics Education, 21*, 463–488. https://doi.org/10.1007/s10763-022-10253-x

Keselman, H. J., Huberty, C. J., Cribbie, R. A., Lowman, L. L., Lix, L. M., Donahue, B., Petoskey, M. D., Olejnik, S., Kowalchuk, R. K., Keselman, J. C., & Levin, J. R. (1998). Statistical practices of educational researchers: An analysis of their ANOVA, MANOVA, and ANCOVA analyses. *Review of Educational Research, 68*(3), 350–386. https://doi.org/10.3102/00346543068003350

Kristjánsson, K. (2012). Positive psychology and positive education: Old wine in new bottles? *Educational Psychologist, 47*(2), 86–105. https://doi.org/10.1080/00461520.2011.610678

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2013.00863

Leeming, D., & Boyle, M. (2013). Managing shame: An interpersonal perspective. *British Journal of Social Psychology, 52*(1), 140–160. https://doi.org/10.1111/j.2044-8309.2011.02061.x

Leppink, J. (2019). *Statistical methods for experimental research in education and psychology*. Springer Nature Switzerland AG.

Lewis, M. (2003). The role of the self in shame. *Social Research, 70*(4), 1181–1204.

Lewis, M., Alessandri, S. M., & Sullivan, M. W. (1992). Differences in shame and pride as a function of children's gender and task difficulty. *Child Development, 63*(3), 630–638.
Lewis, M., Sullivan, M. W., Stanger, C., & Weiss, M. (1989). Self development and self-conscious emotions. *Child Development, 60*(1), 146–156. https://doi.org/10.1111/j.1467-8624.1989.tb02704.x
Monroe, A. (2009). Shame solutions: How shame impacts school-aged children and what teachers can do to help. *The Educational Forum, 73*(1), 58–66. https://doi.org/10.1080/00131720802539614
Oades-Sese, G. V., Matthews, T. A., & Lewis, M. (2014). Shame and pride and their effects on student achievement. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International Handbook of Emotions in Education* (pp. 246–264). Routledge.
Olson, A. M., & Stoehr, K. J. (2019). From numbers to narratives: Preservice teachers experiences' with mathematics anxiety and mathematics teaching anxiety. *School Science and Mathematics, 119*(2), 72–82. https://doi.org/10.1111/ssm.12320
Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review, 18*(4), 315–341. https://doi.org/10.1007/s10648-006-9029-9
Pekrun, R. (2021). Teachers need more than knowledge: Why motivation, emotion, and self-regulation are indispensable. *Educational Psychologist, 56*(4), 312–322. https://doi.org/10.1080/00461520.2021.1991356
Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The achievement emotions questionnaire (AEQ). *Contemporary Educational Psychology, 36*(1), 36–48. https://doi.org/10.1016/j.cedpsych.2010.10.002
Pekrun, R., Muis, K. R., Frenzel, A. C., & Goetz, T. (2018). *Emotions at school*. Routledge. https://doi.org/10.4324/9781315187822
Quoidbach, J., Mikolajczak, M., & Gross, J. J. (2015). Positive interventions: An emotion regulation perspective. *Psychological Bulletin, 141*(3), 655–693. https://doi.org/10.1037/a0038648
Seligman, M. E. P., Ernst, R. M., Gillham, J., Reivich, K., & Linkins, M. (2009). Positive education: Positive psychology and classroom interventions. *Oxford Review of Education, 35*(3), 293–311. https://doi.org/10.1080/03054980902934563
Seligman, M. E. P., Steen, T. A., Park, N., & Peterson, C. (2005). Positive psychology progress: Empirical validation of interventions. *American Psychologist, 60*(5), 410–421. https://doi.org/10.1037/0003-066X.60.5.410
Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science, 22*(11), 1359–1366.
Smith, R. H., Webster, J. M., Parrott, W. G., & Eyre, H. L. (2002). The role of public exposure in moral and nonmoral shame and guilt. *Journal of Personality and Social Psychology, 83*(1), 138–159. https://doi.org/10.1037/0022-3514.83.1.138
Steiger, J. H. (2004). Beyond the F test: Effect size confidence intervals and tests of close fit in the analysis of variance and contrast analysis. *Psychological Methods, 9*(2), 164–182. https://doi.org/10.1037/1082-989X.9.2.164
Stone, E. R. (2010). T test, paired samples. In N. J. Salkind (Ed.), *Encyclopedia of research design* (pp. 1560–1565). SAGE.
Tangney, J. P., Wagner, P., Fletcher, C., & Gramzow, R. (1992). Shamed into anger? The relation of shame and guilt to anger and self-reported aggression. *Journal of Personality and Social Psychology, 62*(4), 669–675. https://doi.org/10.1037/0022-3514.62.4.669
Taxer, J. L., & Gross, J. J. (2018). Emotion regulation in teachers: The why and how. *Teaching and Teacher Education, 74*, 180–189. https://doi.org/10.1016/j.tate.2018.05.008
Thompson, T., & Dinnel, D. L. (2007). Poor performance in mathematics: Is there a basis for a self-worth explanation for women? *Educational Psychology, 27*(3), 377–399. https://doi.org/10.1080/01443410601104197
Thompson, T., Sharp, J., & Alexander, J. (2008). Assessing the psychometric properties of a scenario-based measure of achievement guilt and shame. *Educational Psychology, 28*(4), 373–395. https://doi.org/10.1080/01443410701665873
Tignor, S. M., & Colvin, C. R. (2017). The interpersonal adaptiveness of dispositional guilt and shame: A meta-analytic investigation. *Journal of Personality, 85*(3), 341–363. https://doi.org/10.1111/jopy.12244
Tracy, J. L., & Robins, R. W. (2004). Putting the self into self-conscious emotions: A theoretical model. *Psychological Inquiry, 15*(2), 103–125. https://doi.org/10.1207/s15327965pli1502_01

Tracy, J. L., & Robins, R. W. (2006). Appraisal antecedents of shame and guilt: Support for a theoretical model. *Personality and Social Psychology Bulletin, 32*(10), 1339–1351. https://doi.org/10.1177/0146167206290212

Tulis, M., & Ainley, M. (2011). Interest, enjoyment and pride after failure experiences? Predictors of students' state-emotions after success and failure during learning in mathematics. *Educational Psychology, 31*(7), 779–807. https://doi.org/10.1080/01443410.2011.608524

Turner, J. E., Husman, J., & Schallert, D. L. (2002). The importance of students' goals in their emotional experience of academic failure: Investigating the precursors and consequences of shame. *Educational Psychologist, 37*(2), 79–89. https://doi.org/10.1207/S15326985EP3702_3

Turner, J. E., & Schallert, D. L. (2001). Expectancy-value relationships of shame reactions and shame resiliency. *Journal of Educational Psychology, 93*(2), 320–329.

Velotti, P., Garofalo, C., Bottazzi, F., & Caretti, V. (2017). Faces of shame: Implications for self-esteem, emotion regulation, aggression, and well-being. *Journal of Psychology, 151*(2), 171–184. https://doi.org/10.1080/00223980.2016.1248809

Waters, L. (2011). A review of school-based positive psychology interventions. *The Australian Educational and Developmental Psychologist, 28*(2), 75–90. https://doi.org/10.1375/aedp.28.2.75

Wellenzohn, S., Proyer, R. T., & Ruch, W. (2016). How do positive psychology interventions work? A short-term placebo-controlled humor-based study on the role of the time focus. *Personality and Individual Differences, 96*, 1–6.

Wood, A. M., Froh, J. J., & Geraghty, A. W. A. (2010). Gratitude and well-being: A review and theoretical integration. *Clinical Psychology Review, 30*(7), 890–905. https://doi.org/10.1016/j.cpr.2010.03.005

Yue, J. (2021). Speaking shame and laughing it off: Using humorous narrative to conquer the shame of anorectal illness. *Qualitative Health Research, 31*(5), 847–858. https://doi.org/10.1177/1049732320987832