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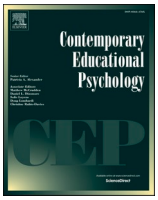

Revisiting the relation between academic buoyancy and coping: A network analysis

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ABSTRACT

Academic buoyancy, the capacity to respond to minor academic adversities, is expected to enable students to effectively deal with failure. Prior research, however, has shown negligible relations between buoyancy and coping, but only considered a limited set of coping strategies. In addition, academic buoyancy and effective coping are expected to positively relate to higher academic achievement. However, studies examining how coping could mediate relations from academic buoyancy to achievement are lacking. In the present study (N = 535 upper secondary students, mean age 16.4 years), we examined relations between students' buoyancy, coping with an examination failure, and academic achievement. We considered an extensive set of nine coping strategies (five adaptive, four maladaptive) and used a novel network analysis, alongside traditional analytic approaches (correlation, structural equation modelling). Buoyancy and coping were assessed with self-report, and achievement from an end-of-year examination. Buoyancy was positively related with adaptive, and negatively with maladaptive, coping strategies both in structural equation modeling and in the network analysis. In addition, structural equation modeling showed positive and negative indirect relations between buoyancy and achievement that were mediated by adaptive coping strategies. Our findings suggest that buoyancy interventions to enhance adaptive, and reduce maladaptive, coping strategies could be suitable ways to help students overcome examination failure.

1. Introduction

Setbacks, such as an examination not going well, will be experienced by the majority of students at some point during their schooling. How students respond to these critical educational junctures can determine their subsequent trajectory. Does the student seek assistance from teachers, or others, to determine the reason for their perceived underachievement and commit themselves to remedy the reason; do they carry on as before and hope it was a one-off situation; or do they feel despondent, confidence dented, and give up? Some responses to academic setbacks enable the person to 'bounce back' and continue on a trajectory to meeting one's educational potential. Other responses may set the person towards a cycle of chronic underachievement which may eventually lead to disengagement and alienation from school.

Some psychological characteristics could prime students to beneficial responses to academic setbacks. Academic buoyancy, defined as one's capacity to recover from minor educational adversity (Martin & Marsh, 2009), is one such attribute. Previous studies have highlighted the enabling benefits of academic buoyancy for continued engagement and persistence (e.g., Malmberg et al., 2013) and achievement (Putwain et al., 2022). The mechanisms by which academic buoyancy facilitates recovery from setbacks and adversities, however, have not been widely studied. Theoretically, one plausible set of mechanisms are the ways academically buoyant students cope with setbacks or adversity. That is, highly buoyant students would be expected to utilize adaptive coping strategies that drive a beneficial response to the setback.

However, to date only two studies have examined relations between academic buoyancy and coping, finding negligible to small relations (*r*s = -0.02 to 0.02 in Putwain et al., 2012; *r*s = -0.13 to 0.08 in Putwain et al., 2016). As these two studies only considered a limited range of

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coping strategies, the conclusion that academic buoyancy is unrelated to coping may be premature. Given the theoretical link between academic buoyancy and coping, and the paucity of studies examining the mechanisms by which buoyancy facilitates effective responses to setbacks, further studies are needed.

Accordingly, the present study examined relations between academic buoyancy and a more extensive repertoire of nine cognitive coping strategies used by upper secondary students. In addition to more traditional analytic approaches (bivariate correlations and structural equation modelling) to explore these relations, we used a relatively novel analytic approach, psychometric network analysis. Network analysis can establish the influence of indicators of a construct when considered alongside and in relation to indicators of other constructs (e.g., Aalbers et al., 2019; Heeren et al., 2018).

1.1. Academic buoyancy

Academic buoyancy is an asset-driven psychological attribute that refers to one's capacity to respond effectively to, or to bounce back from, academic setbacks and minor academic adversities (Martin & Marsh, 2008, 2009; Putwain et al., 2022). The setbacks and adversities that buoyancy assists recovery from are those typically experienced by the majority of students in their everyday academic life. These adversities include, among others, the pressures of taking examinations, dealing with multiple deadlines, difficulties in relationships with classmates and teachers, finding schoolwork difficult, and finding it difficult to get motivated. Studies have shown that academic buoyancy is associated with beneficial achievement-related beliefs (e.g., perceived importance of school), emotions (e.g., enjoyment), and behaviors (e.g., class participation) (e.g., Bostwick et al., 2022; Granziera et al., 2022), and relates positively to students' achievement (e.g., Putwain et al., 2022; Yun et al., 2018).

1.2. Coping with academic stress

According to transactional models of stress and coping (e.g., Hobfoll, 2011; Lazarus & Folkman, 1984), coping is triggered when the demands of a situation in which one's goals are at stake (e.g., preparing for a high-stakes examination) are appraised to tax or exceed one's personal resources. In addition to examinations, other academic stressors that might trigger coping include poor performance, challenging tasks, high workload, and deadlines (Skinner & Saxton, 2019). Coping processes are defined as the ways in which cognition, emotion, behaviour, and physiology, are regulated to manage a stressful situation (Skinner et al., 2003). Some coping strategies (or *families* comprising groups of related coping strategies), such as problem solving and help seeking, are typically adaptive in that they are beneficial for achievement-related motivation, engagement, and achievement (e.g., MacCann et al., 2013; Skinner et al., 2013, 2016). Other coping strategies, such as catastrophizing or avoidance, are typically maladaptive in that they are harmful for academic outcomes.

1.3. Academic buoyancy and coping with academic stress

Academic buoyancy and coping with academic stress are expected to be empirically related given their conceptual proximity. There is similarity in the setbacks and adversities that buoyancy is theorized to offer protection from (Martin & Marsh, 2009) and the academic stressors that might trigger coping strategies (Skinner & Saxton, 2019). Furthermore, there may also be close links between related measures. Specifically, one of the four items used in the Academic Buoyancy Scale (ABS: Martin & Marsh, 2008) explicitly references stress ("I don't let study stress get on top of me"). This might be another case of the jingle-jangle fallacies (Kelley, 1927) that are characteristic for the field of educational psychology (e.g., Marsh et al., 2019; Pekrun, 2019, 2023). That is, two different terms, namely academic buoyancy, and coping, are being used to describe the same process, namely coping.

Conceptually, this seems unlikely. In transactional models of academic coping (e.g., Skinner & Saxton, 2019), beliefs in one's capacity to respond to academic setbacks and adversity contribute to the appraisal processes that trigger coping. In such frameworks, academic buoyancy is theorized as an early-stage input into the coping process rather than representing a specific coping strategy. This is consistent with the conceptualization of buoyancy as a proactive attribute (Martin & Marsh, 2009). Highly buoyant students possess psychological strengths and assets that enable them to cope with setbacks and adversities in such a way as to prevent them from escalating into more serious problems. This would imply that highly buoyant students are able to use more effective forms of coping, such as problem-focused approaches (cf. Martin & Marsh, 2009) or proactive coping strategies (e.g., Schwarzer & Taubert, 2002).

Few studies, however, have empirically examined relations between academic buoyancy and coping. Putwain et al. (2012) found negligible correlations (rs = -0.02 to 0.02) between academic buoyancy and three coping strategies students used when preparing for high-stakes secondary school exit examinations: task-orientation and preparation, seeking social support, and avoidance. In another sample of students preparing for the same type of exam, Putwain et al. (2016) also reported small correlations between academic buoyancy and the aforementioned types of coping (rs = -0.13 to 0.08). On the one hand, these findings speak to academic buoyancy being distinct from, rather than a type of, coping strategy. On the other hand, it is a surprise that academic buoyancy did not relate more strongly to coping, given that it is conceptualized as a proactive attribute that is an input into the coping process.

From the findings of these two aforementioned studies, it might be inferred that academic buoyancy is unrelated to how students cope with academic setbacks and adversities. However, such a conclusion might be unwarranted for two reasons. First, these studies measured only three specific coping strategies (albeit among those expected to be the most prominently used when preparing for high-stakes examinations; Stöber, 2004). There are far more coping strategies than task preparation, seeking support, and avoidance. Skinner et al. (2003), for instance, identified ≈ 400 coping strategies, from 89 measures of coping, combined into 13 families of strategies. Academic buoyancy could show stronger relations with other coping strategies (or families of strategies) than task preparation, seeking support, and avoidance.

Second, Putwain et al., (2012,2016) collected data from participants during an eighteen-month course of study preparing for high-stakes secondary school exit examinations. It is plausible that as data were collected in advance of the exam situation, the level of adversity was not sufficiently high to trigger specific coping strategies. If data had been collected closer to the examinations (ethical issues notwithstanding), the heightened pressure may have been sufficient to trigger coping. Accordingly, in the present study we collected data after students had taken high-stakes secondary school exit examinations, and we instructed them to consider coping strategies used after one such examination that had not gone as well as expected. We reasoned that such an event would be sufficiently stressful to trigger the use of specific coping strategies.

In the present study, we considered nine different coping strategies as assessed in the Cognitive Emotional Regulation Questionnaire (CERQ; Garnefski et al., 2001, 2002). Five of them are considered adaptive (acceptance, positive refocusing, refocus on planning, positive reappraisal, and putting into perspective) and four maladaptive (self-blame, other-blame, rumination, and catastrophizing). As there may be a risk of inadvertently contributing to yet another jingle-jangle fallacy by using two terms, coping and ER, to refer to same construct, it is important, therefore, to clarify the conceptual relation between them. ER refers to cognitive and behavioural strategies that serve to manage emotions (Gross, 1998, 2015). When used in response to an emotional stressor, ER strategies can be considered as one type of coping process (Skinner & Zimmer-Gembeck, 2007). The CERQ, therefore, fulfils the need for a

measure to reflect a broad spectrum of possible coping strategies.

We chose the CERQ for three reasons. First, the CERQ specifically measures ER after a stressful event, thus making it a better measure of coping than other measures of ER. Second, the CERQ specifically measures cognitive channels of coping, thereby offering a greater conceptual alignment with academic buoyancy theorized as an early-stage input into the appraisal process. Third, the CERQ shows practical utility by measuring a range of coping strategies that students might plausibly use after a stressful event. The CERQ, therefore, offers an excellent balance between theoretical precision and practical utility.

1.4. Academic buoyancy, coping, and academic achievement

As a proactive attribute, academic buoyancy would enable students who effectively deal with academic adversity to show higher achievement than those who do not. For example, if an examination did not go as well as students had hoped, highly buoyant students would have the necessary psychological attributes and resources to achieve better on future exams than students who are less buoyant. Indeed, studies found positive relations between academic buoyancy and achievement. In some of these studies, this relation was direct (e.g., Putwain et al., 2015, 2022; Yun et al., 2018). In others, it was indirect and mediated by academic self-concept (e.g., Colmar et al., 2019) or perceived control (e.g., Collie et al., 2015). No studies, however, have examined whether coping could be a mediator in this relation.

Similarly, studies have shown students who use adaptive coping strategies when faced with academic pressures show higher achievement than those who do not. In studies of secondary school students (MacCann et al., 2012; Putwain et al., 2016) and undergraduate students (Gareau et al., 2019; MacCann et al., 2011), problem-focused coping (e.g., planning and engaging in self-study), an adaptive strategy, showed positive relations with achievement. In contrast, emotion-focused coping (e.g., focusing on regulating one's anxiety) or avoidance (e.g., watching television instead of studying), maladaptive strategies, showed negative or null relations with achievement.

Following Skinner and Saxton's (2019) transactional model of academic coping, academic buoyancy can be conceptualized as an early-stage input to the appraisal processes that trigger coping. Adaptive coping, in turn, leads to improved educational outcomes (including achievement, as noted above). Accordingly, there is a sound theoretical basis for testing whether relations between academic buoyancy achievement are mediated by coping strategies. As empirical evidence is lacking, the present study aimed to address this gap in the extant literature.

1.5. Psychometric network analysis: an innovative tool to examine relations between constructs

Psychometric network analysis is an approach to the study of how constructs, or the items that are used to measure constructs (referred to as nodes), are organized (e.g., Epskamp et al., 2012, 2018). It is a variable-centred approach that represents the global relations between indicators, based on partial correlations (referred to as edges), in graphical and numerical ways (Epskamp et al., 2017). Network analysis is well suited to examining potentially dense and complex patterns of relations between academic buoyancy and coping by considering all nodes simultaneously and holistically, while avoiding issues of multicollinearity that can occur when analyzing large numbers of related variables in a factor-analytic approach (Bar-Kalifa & Sened, 2020; Bringmann et al., 2016).

The formation of nodes into communities characterized by strong edges is conceptually similar to the identification of factors within factor analysis (Epskamp et al., 2017), but uses a different methodology. Whereas factor analysis assumes an underlying latent variable to account for shared variance between items, network analysis does not make strong assumptions of this type (Golino & Epskamp, 2017). In other words, whereas factor analysis defines constructs as reflective, network analysis is more liberal in defining the relation between communities and items.

Edges in a network analysis based on partial correlations, like in the present study, represent the unique relation between two nodes controlling for their relations with other nodes (Epskamp & Fried, 2018). Communities of nodes are based on these unique relations, meaning that they are defined controlling for relations with other nodes. In contrast, factor analysis typically aims to estimate factors independently from each other (although they are often correlated). The definition of edges in network analysis can assist the identification, through Expected Influence indices, of nodes that show strong, close, and multiple edges with other nodes (Borsboom et al., 2021; Robinaugh et al., 2016). In short, network analysis offers a granular node-level representation of data accounting for the system-wide influence of other nodes. Bivariate correlations and relations estimated from factor analysis and structural equation modelling offer a less granular representation of relations between variables (Christensen & Golino, 2021).

Specifically, network analysis complements methodologies based on factor analysis in three ways (Tang et al., 2022). First, network analysis provides a holistic understanding of a system of interconnected variables. That is, multiple edges, and expected influences, are considered simultaneously, and are conditioned by the presence of all nodes included within a network. Thus, in the present context network analysis may be particularly useful when considering multiple ways of coping that may overlap and are conceptualized alongside a cognate construct such as academic buoyancy. Second, the visual depiction of the network provided in network analysis can be instructive in moving beyond factor analysis by considering (a) whether groups of indicators cohere as "communities" (i.e., are located together and linked by strong relations), and (b), the spatial location of nodes (items) within the network (i.e., proximally located items/communities are more strongly related). In the graphical network, stronger partial correlations that link nodes are represented as thicker edges. Third, the identification of influential nodes within communities and networks can generate hypotheses about impactful targets for intervention (Borsboom et al., 2021). In the present study, we used Expected Influence (EI) indices to identify those nodes that show stronger and more numerous edges to others in the network (Robinaugh et al., 2016). Although nodes with stronger and more numerous edges with other nodes are denoted as "influential" in network analysis, this is not meant to imply causality. Edges can be directional or non-directional in nature, depending on the underpinning theory and the research design. Rather, influence is intended to refer to correlational characteristics of nodes within a network.

1.6. Aims of the present study

We aimed to examine relations between academic buoyancy and coping considering a broader repertoire of coping strategies than previous studies. The sample included students in the first year of upper secondary education in England (i.e., Year 12). The stressful event that we asked participants to consider, in relation to the various coping strategies, was a recent high-stakes examination that did not go as well as expected, such as the secondary school exit examinations six months previously (General Certificate of Secondary Examinations: GCSEs). We reasoned that this event, although specific, would be exactly the type of

adversity that academic buoyancy would assist with, hence appropriate to examine the relations between buoyancy, coping, and achievement.

Relations were examined using three complementary analytic approaches. First, we estimated latent bivariate correlations between academic buoyancy and the different coping strategies. We also included Year 12 achievement, prior achievement, and demographic variables. Second, we conducted a psychometric network analysis to consider the position and influence of academic buoyancy items, relative to coping items. Third, we examined predictive relations between academic buoyancy and Year 12 achievement using structural equation modeling (SEM). In this analysis, we considered mediation of effects of buoyancy on achievement by coping strategies controlling for gender and prior achievement.

Based on the conceptualization of academic buoyancy as an input to appraisals that trigger coping approaches, we offer the following hypotheses:

Hypothesis 1: Academic buoyancy relates positively to adaptive coping strategies (acceptance, positive refocusing, refocus on planning, positive reappraisal, and putting into perspective) and negatively to maladaptive coping strategies (self-blame, other-blame, rumination, and catastrophizing).

Hypothesis 2: Academic buoyancy nodes will show an influential position (i.e., strong expected influence and bridge expected influence) in the overall network of buoyancy and coping strategy items.

Hypothesis 3: Academic buoyancy and adaptive coping strategies relate positively to achievement. The relation between academic buoyancy and achievement is mediated by coping strategies.

2. Method

2.1. Participants and procedure

A convenience sample comprised 535 English students (138 male, 376 female, 3 other, 18 preferred not to say; mean age = 16.4 years, *SD* = 0.52) from three schools focusing on upper secondary academic education.[1] Participants were in the first year (Year 12) of two-year programs leading to the General Certificate of Education: Advanced Level examinations[2] taken at the end of Year 13. University entry in the UK is based on the grades obtained in these examinations. In the school year of data collection (2021–22), 52.4 % of secondary school students in England progressed to upper secondary academic education (Department for Education, 2022a). The remainder of students were in vocational, technical, or work-based forms of education.

Eighty participants were from black (15 %), 339 from white Caucasian (63.4 %), 62 from South Asian (11.6 %), 3 from Chinese (0.6 %), 27 from 'other' (5 %), and 25 from mixed heritage (4.6 %), backgrounds. There were 77 participants (14.4 %) eligible for free school meals (FSM), a proxy for low family income. In England, during the 2021–22 school year, 42 % of Year 12 students were from non-white backgrounds and 11.9 % were eligible for free school meals (Department for Education, 2022b), suggesting that the present sample was fairly representative in terms of background variables including ethnicity and economic disadvantage.

Self-report data were collected using an online survey platform at the mid-point in the school year. The study was approved by the institutional research ethics committee (17/EHC/001), and written permission was provided by the school principals and individual participants. Parental consent was not required for this age group in studies, like ours, deemed to be of 'low risk.' Participants could opt to complete the online survey only or provide additional consent for the research team to access end-of-year examination grades (439 participants gave permission to access their achievement data; see Supporting Information from the treatment of missing data). Grades were collected from college records using participants' unique college registration number to maintain anonymity. All data, materials, and analysis code, have been made publicly available at the Open Science Framework (https://doi.org/10.17605/OSF.IO/XVFSY). The study was not preregistered.

Table 1
Descriptive statistics for academic buoyancy, emotion regulation, and academic achievement.

	Scale Range	Mean	*SD*	ω	Skewness	Kurtosis
Academic Buoyancy	4 – 20	10.64	3.60	0.83	0.33	−0.48
Acceptance	4 – 20	11.62	3.59	0.71	0.25	−0.51
Positive Refocusing	4 – 20	8.95	3.73	0.87	0.67	−0.30
Refocus on Planning	4 – 20	11.64	3.59	0.77	0.07	−0.65
Positive Reappraisal	4 – 20	10.08	3.09	0.69	0.40	−0.28
Putting into Perspective	4 – 20	12.12	4.00	0.80	0.05	−0.74
Self-Blame	4 – 20	13.57	4.12	0.87	−0.16	−0.98
Other-Blame	4 – 20	5.28	1.96	0.79	2.06	5.28
Rumination	4 – 20	11.10	4.14	0.82	0.27	−0.73
Catastrophizing	4 – 20	9.02	3.90	0.78	0.74	−0.13
GCSE English Grade	1 – 9	6.39	1.18	—	0.08	−0.52
GCSE Mathematics Grade	1 – 9	6.70	1.31	—	0.06	−0.53
Year 12 Academic Achievement	1 – 7	4.04	1.47	—	−0.29	−0.75

2.2. Measures

We measured academic buoyancy using Martin and Marsh's (2008) 4-item Academic Buoyancy Scale (ABS; e.g., "I'm good at dealing with setbacks at college (e.g., a bad mark, negative feedback on my work)"). Participants responded to the items on a 5-point scale (1 = "Strongly disagree" to 5 = "Strongly agree"). There is extensive evidence for the unidimensional structure of this scale along with strong internal consistency and construct validity (e.g., Fong & Kim, 2019; Hoferichter et al., 2021). In the present study the internal consistency was good (ω = 0.83; see Table 1).

Coping was measured using Garnefski et al.'s (2002) Cognitive Emotion Regulation Questionnaire (CERQ). The CERQ comprises nine 4-item subscales, including acceptance (e.g., "I think that I have to accept the situation"), positive refocusing (e.g., "I think of nicer things that I have experienced"), refocus on planning (e.g., "I think about how to change the situation"), positive reappraisal (e.g., "I think I can learn something from the situation"), putting into perspective (e.g., "I tell myself there are worse things in life"), self-blame (e.g., "I think about the mistakes I have made in this matter"), other-blame (e.g., "I think about the mistakes others have made in this matter"), rumination (e.g., "I dwell on the feelings this situation has evoked in me"), and catastrophizing (e.g., "I continually think about how horrible the situation has been"). Participants responded to the items on a on a 5-point scale (1 = "Almost never" to 5 = "Almost always").

The CERQ is intended to measure strategies used after having experienced a stressful event. Such events could be educational or non-educational. To provide an educational context, participants were instructed to "Please think about a recent exam (maybe one of your GCSEs) that didn't go as well as you wanted it to. When this happened, what did you think? If this has never happened to you, please reply 'Almost Never' for all answers." Data collected by the CERQ has shown factorial validity for the nine subscales, test–retest reliability, and internal consistency (e.g., Garnefski & Kraaij, 2007). In the present study, internal consistencies were acceptable to good (ωs = 0.69 to 0.87; see Table 1).

Year 12 academic achievement was measured through end-of-year

[1] In the UK these schools are referred to as 6th form colleges (Years 12 and 13; age 16 to 19 years).

[2] Known colloquially as A Levels.

examinations taken under standardized conditions and graded on a seven-point scale (7 = the highest grade). In Year 12, students typically choose to study three subjects. The number of subjects offered varies from one school/college to another but is typically in the region of forty possible subject options in mathematics and sciences, humanities, art and design, social sciences, and languages. As participants may have chosen multiple subject options, we calculated a mean grade. Prior achievement was measured using grades from secondary school exit examinations (GCSEs[3]) taken at the end of Year 11 under standardized conditions. Achievement on these exams is graded on a nine-point scale (9 = the highest grade). We used GCSE grades from English and mathematics as these were compulsory subjects; hence all participants would have these grades which would not be the case with elective subjects.

2.3. Analytic strategy

2.3.1. Estimating latent bivariate correlations using a set-exploratory structural equation model

A detailed description of the analytic strategy, including the treatment of missing data (handled using Full-Information Maximum Likelihood estimation), can be found in the Supporting Information. The analysis proceeded in three phases. First, we estimated latent bivariate correlations between academic buoyancy, coping, Year 12 achievement, prior achievement, and demographic covariates (gender, FSM, and age), using a set-exploratory structural equation model (set-ESEM). Set-ESEM allows for items to load on non-target factors within, but not between, sets of theoretically related variables (Marsh et al., 2020; Morin et al., 2013). It can provide a better representation of complex model structures than confirmatory factor analysis (CFA), thereby improving model fit and reducing the likelihood of biased parameter estimates. In the present study, we used the buoyancy items as one set and the coping items as another set. We anticipated low-level cross-loading to non-target factors for the various coping strategies in the CERQ, hence the set-ESEM was preferred to a CFA.

2.3.2. Estimating a psychometric network analysis and expected influence indices

Second, we conducted a network analysis in R 4.2.1 using the "network tools" package version 1.5.0 (Jones, 2017). We used network analysis to establish how academic buoyancy and coping nodes cohered into distinct communities, and which nodes were particularly influential in the network and in bridging communities (Burger et al., 2023). A Gaussian graphical model based on regularized partial correlations between nodes was plotted using the Fruchterman and Reingold (1991) algorithm which places nodes with strongest edges closer to the center of the graph. The partial correlations were regularized using the Least Absolute Shrinkage and Selection Operator (LASSO), with the tuning parameter set to $\gamma = 0.5$ (Isvoranu & Epskamp, 2023). This involves shrinking small partial correlations to zero in order to remove possible spurious edges, and results in a sparser network than if not regularized. For comparative purposes, we also include the Gaussian graphical model based on non-regularized partial correlations (i.e., all partial correlations were included).

To assist in the identification of different communities, we used two complementary strategies. In one, we conducted an Exploratory Graph Analysis (Golino & Epskamp, 2017) to label nodes by their community. In the other, a spinglass algorithm was applied to the LASSO network using the igraph package in R (Version 1.4.1; Reichardt & Bornholdt, 2006). One-step Expected Influence (EI1s) and two-step Expected Influence Indices (EI2s) were used to estimate the number, strength, and distance, of nodes within the network (Robinaugh et al., 2016). As noted earlier, the term "influence" is not intended to imply directionality or causality. Rather, it is a way of describing the relations between nodes in terms of their number, strength, and distance. Bridge EIs show how one, or more, nodes may link different communities of nodes within a network.

2.3.3. Structural equation modeling to test mediation of the relation between buoyancy and achievement by coping strategies

Third, following on from the set-ESEM we used a structural equation model (SEM) to examine whether academic buoyancy predicted Year 12 achievement directly and indirectly, mediated by coping strategies, over and above the variance accounted for by prior achievement (see Fig. 3). Gender and prior achievement (math and English GSCE scores) were included as covariates, with estimated effects on buoyancy, the coping variables, and Year 12 achievement. The nine coping strategies were allowed to correlate. The set-ESEM used to estimate latent bivariate correlations, and the SEM, were conducted using M*plus* v8.8 (Muthén & Muthén, 2017). We used maximum likelihood estimation with robust standard errors (MLR) to account for potential non-normality of the variables (especially the biased distribution of the other-blame scores; Table 1).

Model fit was gauged using the root mean error of approximation (RMSEA), the standardized root mean residual (SRMR), the confirmatory fit index (CFI), and the Tucker-Lewis index (TLI). Simulation studies have shown that RMSEA ≈.05, SRMR ≈.06, and CFI and TLI ≈.95 is indicative of a good fit to data fit (Hu & Bentler, 1999). Many authors have cautioned, however, against an overly strict application of these thresholds for complex models and naturalistic data like ours (Heene et al., 2011; Lance et al., 2006).

3. Results

3.1. Descriptive statistics and latent bivariate correlations

Descriptive statistics for academic buoyancy, coping strategies, prior achievement, and Year 12 achievement are shown in Table 1. Other-blame had a positive leptokurtic distribution. For all other variables skewness and kurtosis were within ± 1. Latent bivariate correlations between academic buoyancy, coping, achievement, and socio-demographic variables (gender, FSM, and age) were estimated in a set-ESEM. All nine coping strategies were modelled as one set to account for cross-loading of items on cognate strategy factors (see Table S1 in the Supporting Information for all factor loadings). Gender (0 = female, 1 = male), FSM (0 = not eligible, 1 = eligible), age, and the achievement variables were included as manifest variables. This model showed a good fit to the data: $\chi^2(659) = 990.27$, $p < 0.001$, RMSEA = 0.031, SRMR = 0.025, CFI = 0.963, and TLI = 0.942. Supporting Hypothesis 1, buoyancy correlated with eight of the nine coping variables, including positive correlations with positive refocusing, refocus on planning, positive re-appraisal, and putting into perspective, and negative correlations with acceptance, self-blame, rumination, and catastrophizing (Table 2). Year 12 achievement was positively correlated with refocus on planning and rumination, and negatively correlated with acceptance and other-blame.

3.2. Psychometric network analysis

3.2.1. The graphical network

Graphical networks based on regularized and non-regularized partial correlations, with the spinglass algorithm applied, are shown in Fig. 1 (see Isvoranu & Epskamp, 2023). Nodes pertaining to buoyancy and coping are presented as differently colored circles. Positive and negative edges are depicted as green and red lines, respectively. Although we limited our interpretation to the regularized network, we included both to allow for a visual comparison of the networks with and without the LASSO applied to shrink small partial correlations to zero. Bootstrapped CIs showed that estimated edge weights were accurate (see Figure S1 in the Supporting Information).

[3] General certificate of Secondary Education (GCSE).

Table 2
Latent bivariate correlations between academic buoyancy, emotion regulation, academic achievement and demographic variables.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. AB	−0.20 (0.07)	0.25 (0.05)	0.17 (0.08)	0.52 (0.08)	0.22 (0.05)	−0.47 (0.05)	−0.10 (0.06)	−0.54 (0.05)	−0.58 (0.05)	0.08 (0.05)	−0.05 (0.05)	0.09 (0.05)	−0.31 (0.05)	−0.02 (0.05)	0.04 (0.05)
2. AC	—	0.12 (0.05)	−0.23 (0.05)	−0.18 (0.06)	0.16 (0.05)	0.30 (0.05)	0.22 (0.05)	0.18 (0.06)	0.28 (0.05)	−0.13 (0.05)	−0.09 (0.05)	−0.21 (0.05)	0.04 (0.05)	−0.04 (0.05)	−0.08 (0.05)
3. RF		—	0.31 (0.05)	0.31 (0.06)	0.50 (0.04)	−0.09 (0.04)	0.17 (0.05)	−0.01 (0.05)	−0.07 (0.06)	−0.07 (0.05)	0.02 (0.05)	−0.07 (0.05)	−0.11 (0.05)	−0.02 (0.05)	0.02 (0.05)
4. PL			—	0.37 (0.05)	0.25 (0.05)	0.10 (0.05)	−0.09 (0.05)	0.18 (0.06)	0.05 (0.06)	0.01 (0.05)	0.07 (0.06)	0.14 (0.06)	0.07 (0.08)	−0.04 (0.06)	0.01 (0.06)
5. RA				—	0.35 (0.06)	−0.09 (0.05)	−0.04 (0.05)	−0.10 (0.08)	−0.13 (0.05)	0.05 (0.06)	0.01 (0.07)	0.02 (0.07)	−0.21 (0.09)	−0.02 (0.06)	0.07 (0.07)
6. PS					—	0.03 (0.05)	0.07 (0.05)	−0.05 (0.05)	−0.22 (0.05)	0.05 (0.05)	0.09 (0.05)	0.08 (0.05)	−0.04 (0.05)	−0.03 (0.05)	0.08 (0.05)
7. SB						—	−0.05 (0.05)	0.49 (0.05)	0.40 (0.05)	−0.10 (0.05)	0.04 (0.05)	−0.07 (0.05)	0.02 (0.05)	0.01 (0.05)	−0.04 (0.05)
8. OB							—	0.09 (0.05)	0.24 (0.05)	−0.12 (0.05)	−0.16 (0.05)	−0.14 (0.05)	0.14 (0.05)	−0.06 (0.05)	−0.02 (0.05)
9. RM								—	0.60 (0.06)	0.04 (0.05)	0.12 (0.05)	0.07 (0.05)	0.24 (0.05)	0.05 (0.05)	−0.01 (0.05)
10. CT									—	−0.13 (0.05)	−0.05 (0.05)	−0.06 (0.05)	0.25 (0.06)	0.05 (0.06)	−0.09 (0.05)
11. G-E										—	0.43 (0.04)	0.44 (0.04)	0.02 (0.04)	−0.04 (0.04)	0.03 (0.04)
12. G-M											—	0.45 (0.04)	0.16 (0.04)	0.01 (0.05)	−0.09 (0.04)
13 ACH												—	0.14 (0.05)	−0.06 (0.05)	−0.02 (0.05)
14. Gender													—	0.09 (0.04)	0.11 (0.05)
15. FSM														—	−0.03 (0.04)
16. Age															—

Note. Standard errors in parentheses. AB = Academic Buoyancy, AC = Acceptance, RF = Positive Refocusing, PL = Refocus on Planning, RA = Positive Reappraisal, PS = Putting into Perspective, SB = Self-Blame, OB = Other-Blame, RM = Rumination, CT = Catastrophizing, G-E = GCSE English Grade, G-M = GCSE Mathematics Grade, ACH = Year 12 Achievement, and FSM = Free School Meals. Gender was coded 0 = male, 1 = female. FSM was coded as 0 = ineligible, 1 = eligible.

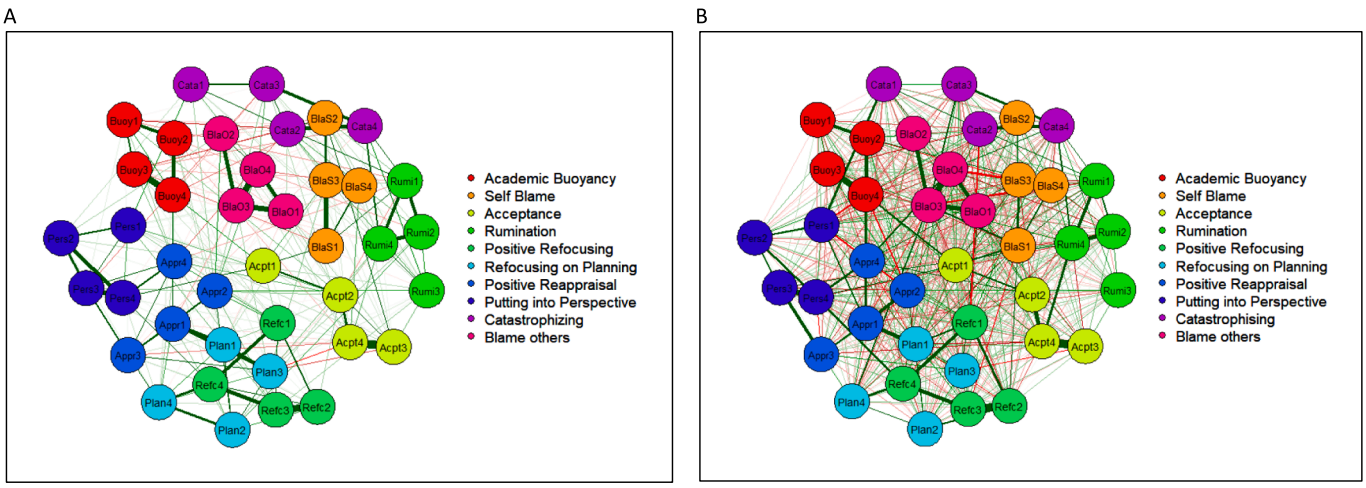

Fig. 1. *Graphical Network of Academic Buoyancy and Emotion Regulation Based on Regularized (Panel A) and Non-Regularized (Panel B) Partial Correlations between Nodes. Note.* Green and red edges represent positive and negative partial correlations, respectively and edge thickness corresponds to edge weight. Academic buoyancy items were labelled Buoy1 to Buoy4, self-blame items Blas1 to Blas4, acceptance items Acpt1 to Acpt4, rumination items Rumi1 to Rumi4, positive refocusing items Refc1 to Refc4, refocus on planning items Plan1 to Plan4, positive reappraisal items Appr1 to Appr4, putting into perspective items Pers1 to Pers4, catastrophizing items Cata1 to Cata4, and other-blame items BlaO1 to BlaO4. Edge weights ranged from –0.10 (Acpt4–Plan3) to 0.50 (Acpt3–Acpt4). Panel A shows the regularized network where small partial correlations were shrunk to zero. Panel B shows the non-regularized network resulting in a denser network with smaller, and potentially spurious, edges. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3
Strongest positive and negatives edges between buoyancy and different coping nodes.

Buoyancy node	Coping node
Positive edges	
Buoy4: I'm good at dealing with setbacks at school (e.g., negative feedback on my work, poor results)	**Appr1**: I think I can learn something from the situation
Buoy4: I'm good at dealing with setbacks at school (e.g., negative feedback on my work, poor results)	**Acpt1**: I think that I have to accept that this has happened
Buoy2: I think I'm good at dealing with schoolwork pressures	**Plan 1**: I think of what I can do best
Buoy1: I don't let study stress get on top of me	**Refc3**: I think of something nice instead of what has happened
Buoy3: I don't let a bad mark affect my confidence	**Pers3:** I think that it hasn't been too bad compared to other things
Negative edges	
Buoy4: I'm good at dealing with setbacks at school (e.g., negative feedback on my work, poor results)	**BlaS2**: I feel that I am the one who is responsible for what has happened
Buoy1: I don't let study stress get on top of me	**Cata2**: I keep thinking about how terrible it is what I have experienced
Buoy1: I don't let study stress get on top of me	**Rumi1**: I often think about how I feel about what I have experienced
Buoy2: I think I'm good at dealing with schoolwork pressures	**Acpt4**: I think that I must learn to live with it
Buoy2: I think I'm good at dealing with schoolwork pressures	**BlaO1**: I feel that others are to blame for it

Based on a visual inspection, academic buoyancy nodes were located at the top of the network to the left. In terms of position relative to adaptive coping items, buoyancy nodes were placed most closely to one putting into perspective node (Pers1: it could have been worse) and one positive reappraisal node (Appr4: looking for positive sides). In terms of maladaptive coping, buoyancy nodes were placed most closely to one catastrophizing node (Cata1: the situation is worse than what others have experienced) and one other-blame node (BlaO2: others are to blame). In short, academic buoyancy nodes were placed between maladaptive coping on one side, connected by negative edges, and adaptive coping on the other, connected by positive edges.

A database showing all 780 edge weights is included in the Supporting Information. In total 77 positive, and 43 negative, edges were estimated; the remaining edges were shrunk to zero. Positive edges were shown between academic buoyancy and positive reappraisal (Buoy1, 2, and 4, with Appr1, 3, and 4), acceptance (Buoy1 and 4 with Acpt1 and 2), refocusing on planning (Buoy2 and 4 with Plan1, 3, and 4), positive refocusing (Buoy3 with Refc1), and putting into perspective (Buoy3 with Pers3). Negative edges were shown between academic buoyancy and self-blame (Buoy2, 3, and 4, with BlaS1, 2, and 3), catastrophizing (Buoy1 to 4 with Cata2, 3, and 4), rumination (Buoy1 and 3 with Rumi1, 2, and 4), acceptance (Buoy2 with Acpt4), and other-blame (Buoy1 with BlaO1). The strongest positive and negative edges between buoyancy and each of the aforementioned coping strategies are shown in Table 3.

3.2.2. *Community detection*

The Exploratory Graph Analysis identified eight independent communities (see Figure S3 in the Supporting Information). Nodes for academic buoyancy, self-blame, other-blame, positive refocusing, putting into perspective, and acceptance, formed distinct communities. Nodes within communities were linked with positive edges. Catastrophizing and rumination formed a distinct community linked by positive edges. This is likely a result of their shared focus on repetitive thinking about a distressing event. Refocus on planning and positive reappraisal formed a

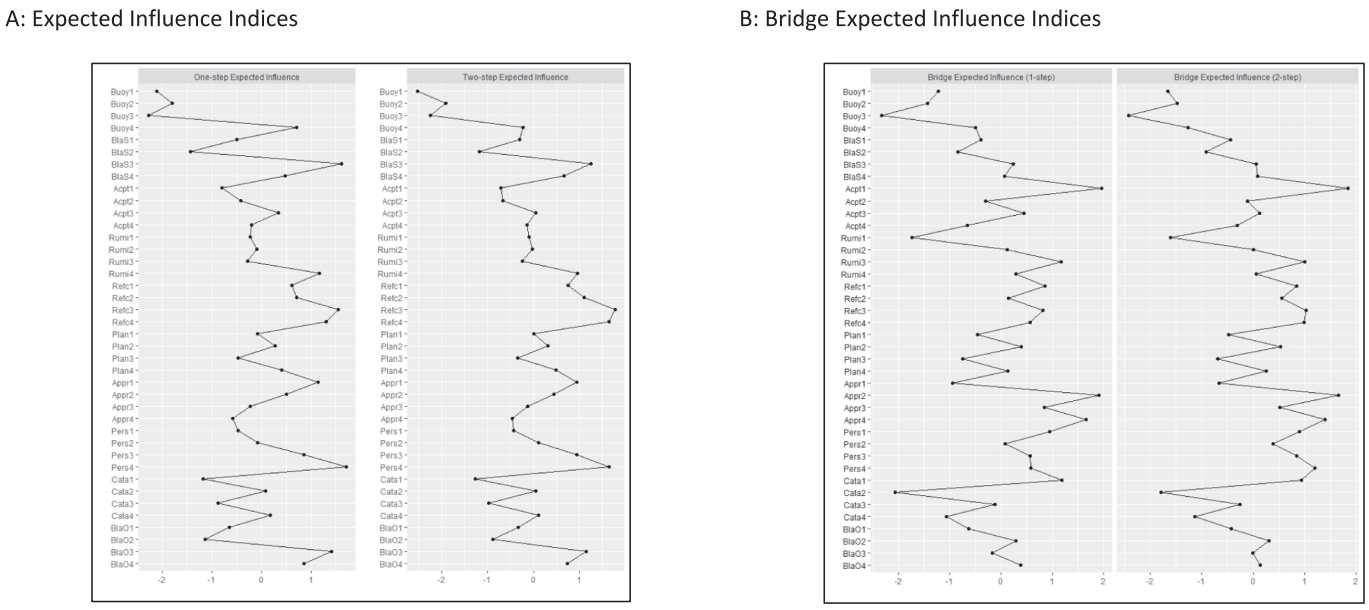

Fig. 2. *Indices for One- and Two-Step Expected Influence (Panel A) and Bridge Expected Influence (Panel B). Note*. Academic buoyancy items were labelled Buoy1 to Buoy4, self-blame items Blas1 to Blas4, acceptance items Acpt1 to Acpt4, rumination items Rumi1 to Rumi4, positive refocusing items Refc1 to Refc4, refocus on planning items Plan1 to Plan4, positive reappraisal items Appr1 to Appr4, putting into perspective items Pers1 to Pers4, catastrophizing items Cata1 to Cata4, and other-blame items BlaO1 to BlaO4. The expected influence estimates were relatively stable, with a centrality stability coefficient of 0.59, indicating that 59% of the data could be dropped to retain with 95% certainty a correlation of 0.7 with the original dataset (for further details, see Supporting Information).

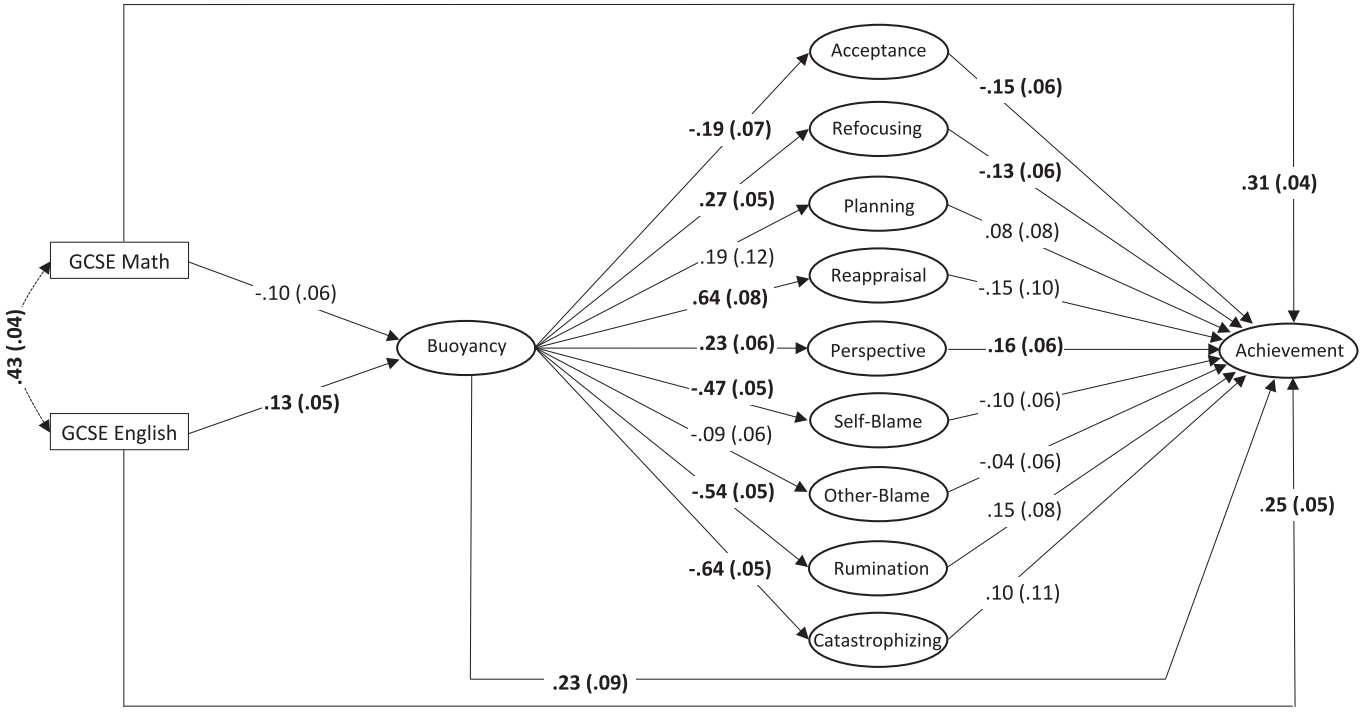

Fig. 3. *Structural Equation Model of Academic Buoyancy, Coping, and Academic Achievement Note*. **Bold** coefficients: $p < 0.05$. Straight lines indicate paths and the dotted line a correlation. Relations from GCSE English and mathematics to coping (see Table 3) and the coefficients for gender (see Table S2) are not displayed to avoid over-cluttering the Figure.

distinct community linked by positive edges. This likely reflects the close connection between the question of what can be done about the situation (planning) and what can be learned from the situation (appraisal). The communities identified in Exploratory Graph Analysis broadly corresponded to those in the LASSO network. In summary, nodes for the ten measures (academic buoyancy and coping) were distributed across eight communities. Six of the measures (academic buoyancy and five coping strategies) were represented as communities with corresponding target nodes. The remaining four coping strategies combined into two communities.

3.2.3. Expected influence

Expected influence indices (EIs) are shown in Fig. 2. A one-step expected influence index (EI1) is the sum of the edges (positive and negative) a node shares with all other nodes in the network. For a node with predominantly positive edges, the presence of a negative edge will diminish the positive EI1 value and vice versa. A two-step expected influence index (EI2) accounts for the secondary influence of a node through adjacent nodes, by including the EI1 index plus a weighted sum of the EI1 indices of the adjacent nodes. EI1 and EI2 indices were comparatively similar. This is likely a feature of the dense network with many direct edges minimizing the weight of additional indirect influences via neighboring nodes.

Strong negative EI1 and EI2 values were shown for buoyancy (Buoy1, 2 and 3), catastrophizing (Cata1), other-blame (BlaO2), and self-blame (BlaS2) nodes. These negative EIs reflect negative edges between buoyancy and maladaptive coping strategies. Buoy4 showed a strong positive EI1 value reflecting positive edges with Reap1and Acpt1. Nodes for self-blame (BlaS3), positive refocusing (Refc3 and Refc4), putting into perspective (Pers4), positive reappraisal (Appr4), and other-blame (BlaO3) also showed strong positive EIs. These positive EIs reflect the edges shared with other nodes within their respective communities. EIs were relatively stable (i.e., the interpretation remained similar across subsamples of the dataset; Epskamp et al., 2018) with a coefficient of 0.59, (i.e., 59 % of the data could be dropped to retain a correlation of 0.7 with the original dataset with 95 % certainty; see Figure S2 in the Supporting Information).

3.2.4. Bridge expected influence

Bridge EIs show how one or more nodes may link different communities of nodes within a network. The bridge EI1 index represents the summed edges of one node (positive and negative) to all other nodes that are part of different communities. The bridge EI2 index also includes the indirect influence of one node on those in other communities mediated via other nodes. Strong negative bridge EIs showed that the communities of academic buoyancy and catastrophizing/rumination were linked via Buoy3 (and to a lesser extent Buoy 2), Cata2, and Rumi1. The communities of positive reappraisal and academic buoyancy were bridged by Appr4. Moreover, Appr4 was the conduit from buoyancy to adaptive coping strategies via the direct and indirect positive edges Appr4 shared with putting in perspective, planning, and positive refocusing. Acpt1 also showed strong positive bridge EIs. This was the node that bridged academic buoyancy, adaptive coping strategies, and maladaptive coping strategies, all via positive edges. It is also notable that Acpt1 was positioned most centrally in the overall architecture of the network. In summary, Hypothesis 2 was supported. Academic buoyancy nodes shared edges with both adaptive and maladaptive coping strategies and, relative to other nodes, showed strong expected influence (including the three strongest negative EI1 and EI2 indices). Furthermore, academic buoyancy nodes bridged communities of catastrophizing/ rumination, positive reappraisal, and acceptance.

3.3. Structural equation modeling

3.3.1. Specifying and testing the structural equation model

A structural equation model was estimated to examine direct and indirect relations between academic buoyancy and Year 12 achievement, mediated by coping strategies, in a fully-forward model. We estimated paths from GCSE grades in English and mathematics (prior achievement) to buoyancy, coping strategies, and Year 12 achievement, paths from buoyancy to coping strategies and Year 12 achievement, and paths from coping strategies to Year 12 achievement (see Fig. 3). Gender was added as a covariate having effects on all other variables. We did not include FSM and age as they did not correlate substantively with buoyancy, coping, or achievement. Based on the set-ESEM measurement model, academic buoyancy and coping strategies were treated as latent variables. Gender, GSCE English, GSCE mathematics, and Year 12 achievement, were modeled as manifest variables. This model showed a good fit to the data: $\chi^2(599) = 915.82$, $p < 0.001$, RMSEA = 0.032, SRMR = 0.026, CFI = 0.964, and TLI = 0.943.

3.3.2. Key findings in the structural equation model

Academic buoyancy was positively related to positive refocusing, positive reappraisal, and putting into perspective, and negatively related to acceptance, rumination, catastrophizing, and self-blame. After controlling for the effects of prior achievement (GCSE English and mathematics), academic buoyancy had a direct positive predictive effect on Year 12 achievement. Putting into perspective also positively predicted Year 12 achievement. Acceptance and positive refocusing were negative predictors (see Table 4 and Figure for path coefficients; Tables S2 and S3

Table 4
Structural equation model: standardized path coefficients.

	GCSE English → buoyancy and coping	GCSE mathematics → buoyancy and coping	Buoyancy → coping	Buoyancy, coping, and GCSE → Year 12 achievement
Acceptance	−0.081 (0.055)	−0.067 (0.054)	−0.189 (0.071)**	−0.144 (0.061)*
Positive Refocusing	−0.126 (0.049)*	0.084 (0.048)	0.269 (0.055)***	−0.132 (0.062)*
Refocus on Planning	−0.041 (0.057)	0.090 (0.063)	0.180 (0.118)	0.083 (0.084)
Positive Reappraisal	−0.004 (0.055)	0.036 (0.063)	0.637 (0.078)***	−0.153 (0.102)
Putting into Perspective	−0.012 (0.050)	0.104 (0.053)*	0.227 (0.059)***	0.157 (0.060)*
Self-Blame	−0.086 (0.055)	0.055 (0.048)	−0.465 (0.047)***	−0.095 (0.062)
Other-Blame	−0.057 (0.055)	−0.138 (0.058)*	−0.084 (0.055)***	−0.039 (0.055)
Rumination	0.045 (0.044)	0.073 (0.048)	−0.544 (0.047)***	0.148 (0.079)
Catastrophizing	−0.053 (0.045)	−0.048 (0.047)	−0.630 (0.046)***	0.096 (0.107)
Academic Buoyancy	0.126 (0.052)*	−0.097 (0.056)	—	0.232 (0.092)*
GCSE English	—	—	—	0.253 (0.045)***
GCSE Mathematics	—	—	—	0.305 (0.043)***

Note. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$. Emotion regulation strategies were correlated (*r*s = -0.20 to 0.49). Correlations between coping strategies are reported in Table S2, and coefficients for gender are reported in Table S3 (see Supporting Materials).

in the Supporting Information show coefficients for gender and correlations between coping strategies).

3.3.3. Testing for indirect relations between academic buoyancy and year 12 achievement

To assess indirect relations from academic buoyancy to Year 12 achievement, mediated by coping, we estimated 95 % confidence intervals (CIs) for the point estimates of the standardized regression coefficients for the indirect effects. A statistically significant relation ($p < 0.05$) is shown by CIs that do not cross zero (MacKinnon et al., 2007). Supporting Hypothesis 3, positive indirect relations were shown for acceptance, $\beta = 0.027$, $SE = 0.015$, 95 % CIs [.003, 0.051], and putting into perspective, $\beta = 0.035$, $SE = 0.017$, 95 % CIs [.007, 0.063], as mediators. A negative indirect relation was shown for positive refocusing: $\beta = -0.035$, $SE = 0.019$, 95 % CIs [-0.005, −0.066].

4. Discussion

The aim of the present study was to reconsider relations between academic buoyancy and coping by using a broader repertoire of coping strategies than used in prior studies, and by linking both constructs to students' academic achievement. Supporting Hypothesis 1, latent bivariate correlations showed positive relations between academic buoyancy and positive refocusing, planning, putting into perspective, and positive reappraisal. Negative relations were shown with acceptance and other-blame. Providing support for Hypothesis 2, academic buoyancy nodes were influential in the network. That is, academic buoyancy showed multiple links to coping nodes, strong expected influence indices, and bridges to communities of catastrophizing, rumination, positive reappraisal, and acceptance. In addition, the network analysis showed academic buoyancy items to be located most closely to, and positioned between, adaptive coping strategies to one side (putting into perspective and positive reappraisal) and maladaptive coping strategies to the other (catastrophizing and other-blame). Finally, in line with Hypothesis 3, academic buoyancy positively predicted academic achievement controlling for prior achievement, in part mediated by coping.

4.1. Correlations between academic buoyancy and coping

We hypothesized (Hypothesis 1) that academic buoyancy would be positively related to adaptive coping, and negatively related to maladaptive coping, strategies. Latent bivariate correlations showed that academic buoyancy was indeed related to coping; positively to adaptive coping strategies (except for acceptance) and negatively to maladaptive coping strategies (except for other-blame). Hypothesis 1, therefore, was largely supported. It seems likely that the earlier studies by Putwain et al., (2012,2016) examined too narrow a range of coping strategies, and may have investigated these strategies in a study context that may not have been sufficiently adverse (i.e., too far from a high-stakes examination) to trigger coping. As such, these studies may have underestimated relations with academic buoyancy. As a proactive form of protection from academic adversity (Martin & Marsh, 2009) that provides early-stage inputs to coping processes (Skinner & Saxton, 2019), academic buoyancy would relate more strongly with *cognitive* ways of coping that represent early, appraisal-related stages in the coping process. The current findings indicate that highly buoyant students show adaptive ways of coping with academic setbacks and adversities, and refrain from using maladaptive ways of coping.

4.2. Network of academic buoyancy and coping strategies

Academic buoyancy was the intermediary between learning from the adversity or that the adversity could have been worse (i.e., positive reappraisal and putting in perspective), on the one hand, and ruminating that it was worse than the adversity experienced by others (i.e., rumination and catastrophizing), on the other hand. Lower academic buoyancy, and a ruminative catastrophic view of the adverse event, were associated with self-blame. Higher academic buoyancy was associated with greater positive reappraisal and putting in perspective. Furthermore, positive reappraisal was also a bridge to positive refocusing and refocusing on planning. Acceptance of the situation was positively related both to academic buoyancy and to communities of adaptive and maladaptive coping strategies. This finding further underlines the point that acceptance does not fall neatly into a dichotomy of adaptive versus maladaptive coping.

Hypothesis 2, that buoyancy would be influential within the network, was supported. Relations with putting into perspective, seeking positives, catastrophizing, and rumination were consistent with Martin et al.'s (2013) findings of negative relations between academic buoyancy and neuroticism. Persons with low neuroticism would catastrophize less, keep negative events in perspective, and seek positives (e.g., Bailen et al., 2019). As predicted by control-value theory (Pekrun, 2006, 2021), low agentic control (implied by low buoyancy) has been associated with increased risk for negative emotions and emotion disorders (e.g., Cheng et al., 2013; Gallagher et al., 2014; Pekrun & Loderer, 2020), and in school with negative academic emotions, lower motivation, and reduced achievement (e.g., Forsblom et al., 2022; Reeve, 2013; Reeve & Tseng, 2011). These findings are consistent with academic buoyancy offering proactive protection from academic adversity through maintaining motivation and engagement, and preventing negative emotions.

4.3. Acceptance: an adaptive or maladaptive strategy

Acceptance can be considered an adaptive coping strategy that involves adjusting to stressful events that have already happened (e.g., Carver et al., 1989). We therefore expected academic buoyancy to be positively related to acceptance. The zero-order bivariate correlation, however, was negative. Acceptance may imply a belief that one is unable to attain a different outcome in the future. In contrast, academic buoyancy is a belief that one can "bounce back" from minor adversities such as an exam that did not go well by changing one's behaviors (e.g., persistence or improving study skills), thus improving future outcomes. From this perspective, the negative zero-order bivariate correlation between academic buoyancy and acceptance is entirely consistent with the conceptualization of academic buoyancy as believing that a setback can be overcome.

In contrast, the psychometric network analysis showed positive and negative edges shared between academic buoyancy and acceptance. The negative edge was for an acceptance item that emphasized living with the adverse event, the positive edge for an acceptance item that emphasized accepting the adversity has happened. Notwithstanding that edges are based on partial correlations (and acceptance shared positive edges with both adaptive and maladaptive coping strategies), both nodes may imply a belief that setbacks can be overcome. Accepting that one must live with adversity implies a lack of agency to affect a more favorable outcome in the future. This is incongruent with the asset-driven nature of buoyancy, hence the negative edge. At the same time, accepting that a past adversity has occurred and can no longer be changed is an incentive to draw on buoyant resources (i.e., planning, persistence, and confidence) required to bounce back and do better in the future. This may be the reason why this node showed a positive edge with buoyancy. As such, one might conclude that acceptance does not fall neatly into a dichotomy of adaptive versus maladaptive coping.

4.4. Buoyancy shows direct and indirect relations with achievement

We hypothesized (Hypothesis 3) that buoyancy would show positive indirect relations with achievement, mediated by coping strategies. Acceptance and putting into perspective positively mediated positive relations between academic buoyancy and achievement. That is, more

highly buoyant students did not accept that future setbacks could not be overcome, put their past setbacks into perspective, and showed higher achievement in their end-of-year examinations. The findings linking adaptive coping strategies to higher academic achievement are consistent with previously reported findings (e.g., Gareau et al., 2019; MacCann et al., 2011, 2012; Putwain et al., 2016) and support the theorization of academic buoyancy as an input into the appraisals that trigger coping processes. Although the indirect regression coefficients were relatively small, it is important to note that prior achievement was controlled for, along with inter-relations between the various coping strategies included in the CERQ (see Collie et al., 2015).

The negative relation between positive refocusing and achievement, resulting in a negative indirect relation between academic buoyancy and achievement, ran counter to our hypothesizing. Although considered an adaptive strategy, the CERQ items for positive refocusing reflect an avoidance strategy that may provide a degree of short-term emotional relief but does not necessarily involve the cognitive or behavioural strategies required to overcome setbacks (Balmores-Paulino, 2018). When viewed as a form of avoidance coping, the negative relation with achievement is not surprising and consistent with the extant literature (e.g., Thomas et al., 2017). This finding raises the possibility that academic buoyancy may not only trigger coping strategies that are conducive to future achievement (i.e., overcoming setbacks) but also strategies that are advantageous in dealing with stress but that are not necessarily helpful for future achievement. On balance, we found partial support for Hypothesis 3.

The finding for positive refocusing raises the possibility that the small non-significant relations between academic buoyancy and achievement shown in some previous studies (e.g., Collie et al., 2015; Colmar et al., 2019) are the result of academic buoyancy triggering coping process with opposing positive and negative mediated effects on achievement, resulting in a small overall relation. Consistent with this interpretation were the findings of positive indirect relations between academic buoyancy and achievement mediated by control and academic self-concept in these studies. The direct relations we found between buoyancy and achievement could be accounted for by types of coping not included within the present study (e.g., behavioral strategies).

4.5. Academic buoyancy and academic coping: related but different

The present findings clearly document that in contrast to the findings from the earlier work by Putwain et al., (2012,2016), students' buoyancy and coping strategies are related. These relations raise an additional question over the extent to which academic buoyancy and coping strategies may be different terms applied to the same construct. Our findings suggest they are not, for two reasons. First, the range of bivariate correlations (*rs* = -0.58 to 0.52) indicates that academic buoyancy can be differentiated from coping strategies, especially given that the relations are estimated as latent correlations correcting for measurement error, thus representing the highest possible estimates. The relations would have been stronger if academic buoyancy was coping masquerading under a different name. Second, if academic buoyancy and coping were equivalent, no relations between buoyancy and achievement would be observed. When considering the possibility of jingle-jangle fallacies (e.g., Marsh et al., 2019; Pekrun, 2019), there appears to be little jangle here between academic buoyancy and coping strategies used in relation to an academic stressor. Our findings do imply, however, that an adverse event is required for academic buoyancy to trigger adaptive coping strategies.

4.6. Limitations and suggestions for future studies

Using a novel analytic approach (psychometric network analysis) alongside more traditional approaches (correlation and SEM), our study has shown that revisiting the relationship between academic buoyancy and coping was worthwhile. Nonetheless, there are five limitations we would like to highlight. First, participants reported ways of coping used in relation to one specific adversity, namely an examination that did not go as well as expected. Although a highly salient concern for students, and one that academic buoyancy would assist in dealing with, there are many other forms of academic adversity. Different coping strategies may be used in response to different adversities, and buoyancy may assist through different ways of coping for other adversities. In the present study, academic buoyancy was not strongly linked to all ways of coping, but it is possible that buoyancy could play a more influential role in a network of coping with other adversities. Accordingly, future studies should investigate academic buoyancy in relation to the ways of coping used for other adversities.

Second, the present study used an expanded repertoire of coping strategies compared to previous studies. There are, nonetheless, additional ways of coping that buoyancy may be related to (see Skinner & Saxton, 2019). Future studies could consider which, if any, additional ways of coping could be examined in relation to academic buoyancy. Furthermore, having established relations with cognitive coping strategies, studies could examine whether there are also relations with behavioural coping channels.

Third, the present research, like most academic buoyancy studies conducted to date, used a sample from a Western, Educated, Industrialized, Rich, Democratic (WEIRD) country. Only a few studies on buoyancy have been conducted using non-WEIRD samples (e.g., Chong et al., 2018; Datu & Yang, 2018). Although the findings of these studies confirm those using WEIRD samples, further studies are required to confirm the generalizability of academic buoyancy as a proactive psychological asset. Specifically in relation to coping strategies, it is likely that educational stressors, adversities, and challenges differ according to culture, educational system, and socio-demographics. Future studies should address how academic buoyancy is assistive in coping with the unique contexts provided in non-WEIRD countries.

Fourth, tests of statistical difference (e.g., the Bootstrapped Difference Test; Epskamp et al., 2018) can be useful in assisting the identification of edges that are particularly influential in a network. However, in the present study the density of the network, combined with the relatively high number of nodes, resulted in the estimation of 780 edges and a matrix for the Bootstrapped Difference Test with 608,400 cells (i.e., an exceedingly high number of possible statistical difference tests). Furthermore, the Bootstrapped Difference Test can be used for some centrality indices (i.e., closeness and betweenness) to assist the identification of influential nodes, but not for the expected influence indices we used in our analysis. As such, we focused on descriptive differences between the expected influences of nodes.

Fifth, although our test of how coping strategies mediated relations between academic buoyancy and achievement was robust in that prior achievement was controlled for, there was no temporal gap between the measurement of academic buoyancy and coping strategies. This limits the extent to which the directional relations between academic buoyancy and coping strategies can be established (Rucker et al., 2011). An additional, and related, issue is that academic buoyancy and coping strategies were both measured via self-report which may lead to single-source bias (e.g., Podsakoff et al., 2003). To reduce single-source bias future studies should consider multiple data sources, although this may be difficult to achieve with inherently private constructs like academic buoyancy and coping. Furthermore, temporal separation of academic buoyancy and coping would assist with a directional interpretation of findings.

4.7. Implications for intervention

According to the present findings, academic buoyancy related positively to students' adaptive ways of coping. Given that academic buoyancy is conceptualized as malleable, interventions to strengthen academic buoyancy could be highly beneficial for students experiencing challenges, adversities, or academic stressors. Few studies have

attempted to design interventions promoting academic buoyancy. Promising results (i.e., gains in academic buoyancy) have been shown for acceptance and commitment therapy (Puolakanaho et al., 2019), and for a multi-component intervention comprising nutritional psycho-education alongside activities to enhance gratitude, recognize and challenge biased thoughts, and mindfulness (Putwain et al., 2019).

The findings of the present study suggest building buoyancy to keep a sense of perspective, facilitate reappraisal, enhance agency, and reduce catastrophizing and rumination, could be additional promising foci for interventions in students following examination failure. Academic buoyancy interventions could directly build the academic skills required to prevent setbacks and use direct or vicarious experience of overcoming setbacks like examination failure to build competency. Whether skill-building or experiential, acceptance, and commitment interventions, as well as cognitive behavioral therapies, provide sufficiently flexible frameworks to include such foci.

Possible therapeutic strategies for a buoyancy intervention to reduce catastrophizing would be to challenge thoughts, such as "what I have experienced is the worst" (influential in the present network) through the use of graded questions and evidence-based thinking. Graded questions can prompt a reappraisal of a catastrophic situation as not being as bad as previously thought, and evidence-based thinking can be used to generate options for non-catastrophic outcomes. Therapeutic strategies for buoyancy to facilitate learning from the difficult situation, and enhance agentic change (also influential in the present network) could involve asking the person the "six-month question". This is to imagine oneself six months in the future, looking back to the present time, and thinking "if only I had done such and such my problem would be sorted." The person then needs to identify what 'such and such' might be as a useful strategy to employ in the present.

5. Conclusion

The present study showed that it was critically important to revisit relations between students' academic buoyancy and their coping with academic stressors. Whereas previous studies showed negligible to small relations between academic buoyancy and coping, and only used a narrow repertoire of coping strategies measured far in advance of a potentially adverse event. The present study included a broader range of nine coping strategies used specifically in relation to an adverse event that did already occur. The findings confirm that academic buoyancy is positively related to adaptive coping strategies (e.g., positive reappraisal) and negatively related to maladaptive strategies (e.g., catastrophizing). Importantly, the size of correlations indicates that academic buoyancy is not a case of two labels being applied to the same construct (the jangle part of the jingle-jangle fallacy). In addition, linkages between academic buoyancy and three coping strategies (acceptance, putting into perspective, and positive refocusing) extended to achievement, supporting the theorization of academic buoyancy as an input into the coping process. The use of network analysis highlights how this novel analytic approach can enhance understanding of educational psychological constructs. Moreover, the links from academic buoyancy to specific coping strategies (e.g., thinking the adverse situation could have been worse and looking for the positives from the adversity) provide foci for buoyancy interventions in students following academic adversity, setbacks, and challenges.

CRediT authorship contribution statement

David W. Putwain: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Martin Daumiller:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Tahrim Hussain:** Writing – review & editing, Writing – original draft, Methodology. **Reinhard Pekrun:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cedpsych.2024.102283.

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