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A PERMA-Informed Approach to Vocationally Contextualised Mathematics Teaching: A Mixed-Methods Action Research Study in Further Education

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DATA PROVENANCE AND DISTINCT CONTRIBUTION: This manuscript reports a PERMA-informed secondary theoretical and statistical re-analysis of the classroom dataset first reported by Offor (2026). The earlier article examined vocational contextualisation primarily through attitudes, motivation, engagement and Expectancy–Value Theory. The present paper asks a distinct question: how the same learner-level evidence can illuminate a PERMA-informed model of positive mathematics education. The dataset is therefore not represented as new. Essential study context, methods, participant-level data and findings are reported here so that this manuscript can be read and evaluated independently of the earlier publication.

This research was self-sponsored.

Abstract

This mixed-methods action-research paper develops a PERMA-informed interpretation of vocationally contextualised mathematics teaching for GCSE resit learners in Further Education (FE). Seventeen learners completed matched pre- and post-intervention questionnaires comprising 15 five-point Likert items grouped into behavioural engagement, perceived relevance, and emotional engagement/confidence. A five-week intervention embedded GCSE mathematics within vocational and real-world contexts. Quantitative re-analysis used paired-samples t-tests, Shapiro–Wilk diagnostics, exact Wilcoxon signed-rank sensitivity tests, 95% confidence intervals, Cohen's d_z, small-sample-corrected Hedges' g_z, rank-biserial correlations, bootstrap confidence intervals, Holm multiplicity adjustment and Cronbach's alpha. Qualitative responses were analysed thematically and mapped cautiously onto PERMA. Behavioural engagement increased from $M = 2.59$ to 3.67 (mean change=1.08, 95% CI [0.95, 1.21], $t(16) = 17.46$, $p < .001$, d_z=4.24). Perceived relevance increased from $M = 2.69$ to 3.78 (change=1.08, 95% CI [0.93, 1.24], $t(16) = 14.85$, $p < .001$, d_z=3.60). Emotional engagement/confidence increased from $M = 2.80$ to 3.49 (change=0.69, 95% CI [0.32, 1.07], $t(16) = 3.91$, $p = 0.001$, d_z=0.95); the exact Wilcoxon test corroborated this change. Qualitative themes also shifted positively: relevance 4/17→15/17, motivation/engagement 3/17→14/17, confidence/reduced anxiety 5/17→12/17, and understanding 6/17→13/17. The study does not claim that PERMA itself was experimentally tested; rather, PERMA provides an integrative lens linking positive emotion, engagement, relationships, meaning and accomplishment to vocational mathematics pedagogy.

Keywords: PERMA; positive education; vocational contextualisation; GCSE mathematics resit; Further Education; student engagement; mathematics confidence; action research; mixed methods
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1. Introduction

GCSE Mathematics resit learners in English Further Education form a substantial and heterogeneous population. Many arrive in post-16 settings after not achieving the standard GCSE pass threshold and must continue mathematics alongside vocational study. Recent research emphasises that these learners vary considerably in affect, participation and attainment, making it unhelpful to treat them as a single deficit group. A recurrent practitioner problem is nevertheless clear: previous difficulty, low confidence and a perceived lack of relevance can make compulsory mathematics psychologically distant from learners' vocational aspirations.

Vocational contextualisation attempts to reduce that distance by connecting mathematical ideas to authentic or recognisable applications. Its pedagogical promise is not that every GCSE problem should be converted into a trade scenario, but that context can make purpose visible, support sense-making and provide a bridge from experience to mathematical structure. This is especially pertinent in FE, where learners' developing occupational identities may offer meaningful entry points into ratio, measurement, percentage, proportional reasoning, statistics and other curriculum content.

The present paper introduces a positive-education interpretation of this process through Seligman's PERMA framework: Positive Emotion, Engagement, Relationships, Meaning and Accomplishment. PERMA has been used as a multidimensional account of student well-being, and empirical work by Kern and colleagues

demonstrates both its usefulness and the need for measurement caution: student well-being is multidimensional, and the five elements should not be assumed to collapse into a single score.

This study therefore asks a disciplined question: can the observed changes in engagement, relevance, confidence and learner voice be understood through a PERMA-informed model of vocational mathematics? The answer requires restraint. The original questionnaire was not a validated PERMA instrument and did not directly measure all five elements. Accordingly, PERMA is used here as an interpretive and design framework, while the original constructs remain the quantitative outcomes.

1.1 The post-16 GCSE mathematics resit problem

The study arose from a practical problem encountered during a PGCE Further Education placement in an English FE college. The participating learners were studying vocational programmes while also continuing GCSE Mathematics because they had not previously achieved the required Grade 4 threshold. In classroom interactions, mathematics was frequently experienced as compulsory, abstract and disconnected from vocational aspirations. Some learners explicitly questioned why mathematics was necessary for their chosen trade or occupational pathway. This problem is not unique to the study setting: post-16 mathematics policy in England requires many learners without the threshold qualification to continue mathematics, and the resit population includes learners with diverse histories of prior attainment, participation and affect toward mathematics.

The pedagogical problem was therefore not simply whether students could execute a mathematical procedure. It concerned whether they saw sufficient purpose in the mathematics to attend, persist, participate and tolerate the emotional risk of attempting work in a subject associated with previous difficulty. This made vocational contextualisation a plausible intervention: rather than changing the GCSE mathematical content itself, the teaching sought to change the context in which that content was encountered.

1.2 The original intervention and vocational contexts

The intervention lasted five weeks. Mathematics examples and tasks were deliberately recast in contexts recognisable from the learners' vocational programmes. The intention was to preserve the mathematical demand while changing the surface context and purpose of the task. Examples included:

- Bricklaying: brick types, wall height and length from brick courses, numbers of bricks, wall thickness, mortar mixing and material costs.
- Carpentry: timber types, staircase rise, stud-wall dimensions, frame dimensions, cutting lengths, joist spacing and timber costs.
- Media: video-view hours, editing sessions, photographs per location, filming set-ups, production costs and recording time.
- Sport: points in games, training sessions, laps, equipment used in drills, gym costs and fitness-training time.
- Plumbing: valve testing, pipe condition, flow-rate contexts, pipe identification and related measurement situations.
- Uniformed and Public Services: patrol distance, fitness-test points, training days, equipment issued, uniform costs and drill-training time.

The approach was consistent with situated and applied learning: mathematical ideas were positioned inside activity systems that were closer to learners' present courses and anticipated employment. The intervention was not a separate well-being programme and PERMA was not used to design the original questionnaire. The PERMA contribution of the present paper is therefore an explicit secondary theoretical interpretation of how the observed motivational, affective and meaning-related changes may be understood as conditions for flourishing in mathematics learning.

1.3 Why a PERMA-informed re-analysis is warranted

The original analysis was organised around engagement, relevance, emotional engagement/confidence and students' descriptions of their experience. Those constructs have conceptually meaningful intersections with PERMA: enjoyment and reduced anxiety bear on Positive Emotion; effort, attention and participation bear on Engagement; perceived vocational utility bears on Meaning; confidence, understanding and pride bear indirectly on Accomplishment; and classroom interaction may implicate Relationships. However, conceptual correspondence is not measurement equivalence. The present paper consequently uses the term PERMA-informed throughout. It does not retrospectively claim that a validated PERMA instrument was administered, and it treats Relationships as a particularly important unmeasured dimension.

1.4 Contribution and novelty of the present paper

The novelty of this manuscript lies neither in claiming a second intervention nor in presenting the same participants as a new sample. It lies in a substantially different analytical and theoretical treatment of the evidence. First, the learner-level domain scores are reconstructed directly from the 15 questionnaire items and subjected to a more extensive statistical analysis than in the original report, including confidence intervals, exact signed-rank sensitivity tests, Holm adjustment, small-sample effect-size correction, bootstrap confidence intervals and internal-consistency estimates. Second, the quantitative and qualitative strands are integrated explicitly through a PERMA-informed joint interpretation. Third, the paper distinguishes measured constructs from PERMA constructs, identifying where the evidence is strong, indirect or absent. This distinction is important because retrospective theoretical reframing can otherwise create the false impression that all five PERMA elements were measured prospectively.

The resulting contribution is therefore methodological as well as pedagogical: it demonstrates how practitioner action-research data can be re-examined rigorously through a positive-education lens without changing the historical design of the study. For FE mathematics, the paper proposes a testable mechanism in which vocational relevance strengthens meaning and utility, increased meaning supports engagement, successful participation creates accomplishment-related experiences, and these experiences may contribute to more positive emotion. Relationships are treated as a theoretically important but empirically under-measured condition rather than assigned an artificial score.

2. Theoretical Framework

2.1 PERMA and positive education

PERMA conceptualises well-being through five valued domains. Positive Emotion concerns favourable affective experience; Engagement concerns psychological involvement and absorption; Relationships concern supportive and satisfying social connections; Meaning concerns purpose and connection to something valued beyond the immediate task; and Accomplishment concerns mastery, achievement and progress. In education, these dimensions are potentially relevant because academic participation is simultaneously cognitive, affective and social.

2.2 Expectancy–Value Theory and Meaning

Expectancy–Value Theory (EVT) provides a particularly strong mechanism for the Meaning component. Learners are more likely to invest effort when they expect that success is possible and when the task has subjective value. Vocational examples can increase utility value by answering the question “Why do I need this mathematics?” In the present study, perceived relevance is therefore treated as the strongest measured proxy for vocational meaning, while acknowledging that PERMA meaning is broader than utility value.

2.3 Situated learning and contextualisation

Situated perspectives emphasise that learning is shaped by participation in meaningful activity. Contextualisation can make mathematical relationships visible through situations learners recognise, but good contextualisation must preserve mathematical integrity and support transfer. A learner who can calculate ratio in a mortar-mixing context must ultimately recognise the same multiplicative structure when the vocational surface is removed.

2.4 Proposed PERMA-informed pathway

The proposed mechanism is: vocational context → perceived meaning/utility → increased engagement → successful participation and understanding → confidence/positive emotion → further engagement. Relationships operate across this pathway through teacher support, peer interaction and psychological safety. This is a conceptual pathway, not a tested mediation model; $n = 17$ is insufficient for credible mediation modelling.

PERMA element	Evidence available in this study	Interpretive status
P – Positive Emotion	Emotional engagement/confidence items; qualitative references to enjoyment, pride and reduced nervousness	Partially measured
E – Engagement	Five behavioural-engagement items; motivation/engagement qualitative theme	Directly measured in part
R – Relationships	Classroom interaction practices, but no dedicated relationship scale	Theoretical/under-measured
M – Meaning	Five perceived-relevance items; relevance/practical-value qualitative theme	Strongly represented, but narrower than full PERMA meaning
A – Accomplishment	Confidence and understanding comments; no objective attainment test	Indirectly represented

2.5 Positive education, PERMA and the mathematics classroom

Positive education extends the concerns of education beyond academic attainment alone by asking how educational environments can support well-being, agency, participation and the development of personal resources alongside disciplinary learning. Seligman's (2011) PERMA model provides one influential account of flourishing through Positive Emotion, Engagement, Relationships, Meaning and Accomplishment. In a student population, Kern et al. (2015) demonstrated the value of treating these elements as distinguishable dimensions rather than assuming that well-being is a single undifferentiated construct. This multidimensionality is particularly relevant to mathematics education, where a learner may, for example, participate behaviourally while remaining anxious, perceive mathematics as useful while lacking confidence, or experience successful problem solving without a strong sense of belonging.

For the present study, PERMA is therefore not used as a replacement for mathematics-specific constructs. Instead, it provides an organising framework for considering how affective, motivational, social and purpose-related experiences may coexist with mathematical learning. Positive Emotion can be informed by enjoyment, pride and reduced nervousness; Engagement by attention, effort, persistence and participation; Meaning by perceived vocational and personal purpose; and Accomplishment by experiences of mastery, progress and competence. Relationships concern teacher support, peer interaction, trust and belonging, but this element requires direct social evidence and cannot be inferred merely from improved classroom scores. This distinction is central to the present re-analysis because the original questionnaire was designed around engagement, relevance and emotional engagement/confidence, not around a validated five-factor PERMA scale.

2.6 Mathematics engagement, affect and prior experience

Engagement in mathematics is multidimensional. Fredricks, Blumenfeld and Paris (2004) distinguish behavioural, emotional and cognitive aspects of engagement, showing why attendance or task completion alone cannot represent the quality of a learner's participation. For GCSE resit learners, this distinction matters because previous difficulty may shape both visible participation and less visible emotional responses to mathematics. Boli and Golding (2024) likewise emphasise heterogeneity among GCSE resit students in affect, participation and attainment. The practical implication is that post-16 resit learners should not be treated as a homogeneous low-attaining group: pedagogical responses need to attend to the learner's relationship with mathematics as well as to procedural knowledge.

Expectancy–Value Theory helps explain why relevance and confidence are especially important in this setting. Eccles and Wigfield (2002) argue that achievement-related choices and persistence depend partly on expectations of success and on the subjective value attached to a task. Vocational contextualisation can plausibly influence utility value by making the purpose of mathematics visible, while successful participation may strengthen expectancy-related beliefs. This does not mean that relevance automatically produces achievement. Rather, relevance may alter the motivational conditions under which learners are willing to invest effort, persist and attempt mathematically demanding tasks.

2.7 Mathematics within vocational and Further Education

The relationship between mathematics and vocational education in England has long been contested. Dalby and Noyes (2016) show that mathematics in post-16 vocational settings can be organised either in ways that isolate it from vocational experience or in ways that connect curriculum, pedagogy and occupational activity. Their case-study evidence indicates that more integrated approaches can positively affect students' engagement and attitudes. Related work on connecting mathematics teaching with vocational learning argues that merely placing a vocational label on an otherwise conventional exercise is insufficient; meaningful connection requires attention to the practices, values and contexts through which vocational learners encounter mathematics.

This issue is intensified by the status of GCSE Mathematics in Further Education. Noyes and Dalby (2017) document the complexity of mathematics provision across FE colleges, while Norris (2023) shows that vocational students may attribute substantial exchange value to GCSE as a qualification while questioning the usefulness of the mathematics they experience. The resulting tension is important for the present study: learners may understand that GCSE Mathematics matters institutionally or economically yet still experience classroom mathematics as disconnected from their chosen course. Vocational contextualisation attempts to address this pedagogical gap without reducing the mathematical demand of GCSE content.

2.8 Contextualisation, authenticity and transfer

Contextualised mathematics teaching is strongest when context functions as a bridge to mathematical structure rather than as decoration. Situated learning theory (Lave & Wenger, 1991) emphasises that knowledge develops through participation in socially and culturally organised activity. Dewey (1938) similarly foregrounds the role of experience in meaningful learning. In vocational education, authentic or recognisable situations can provide a reason for mathematical activity and can connect abstract relationships to tools, quantities, constraints and decisions encountered in occupational practice. Recent work continues to emphasise the importance of connecting mathematical content to vocational applications and the challenge for teachers of constructing tasks that are simultaneously authentic, mathematically valid and transferable (Acheampong, Adusei, & Sam, 2026).
A central caution, however, concerns transfer. Success with ratio in mortar mixing, percentage in production costs or measurement in carpentry is educationally valuable only if learners can progressively recognise the underlying mathematics beyond the original scenario. Effective contextualisation therefore requires movement between context and abstraction: the context establishes purpose and supports sense-making, while explicit mathematical discussion identifies invariant structures that can be reused elsewhere. This study interprets vocational context as a pedagogical entry point rather than as an alternative curriculum.

2.9 Synthesis and research gap

Taken together, the literature establishes four points. First, GCSE resit learners in FE are heterogeneous and their mathematical participation is shaped by affective and motivational histories as well as attainment. Second, vocational and general mathematics can become institutionally and pedagogically disconnected, creating a relevance problem for learners whose primary identities are developing through vocational programmes. Third, contextualisation can strengthen perceived purpose and engagement when it makes genuine connections to vocational activity while preserving mathematical structure. Fourth, PERMA offers a language for interpreting positive educational experience across emotion, engagement, relationships, meaning and accomplishment, but its constructs must not be claimed retrospectively as measured outcomes when a PERMA instrument was not administered.

The specific gap addressed by this paper lies at the intersection of these literatures. There is comparatively little work examining vocationally contextualised GCSE resit mathematics through an explicitly PERMA-informed positive-education lens while also retaining the original mathematics-specific outcomes and subjecting learner-level pre–post evidence to robust statistical sensitivity analysis. The present study addresses that gap through a transparent secondary re-analysis. It asks not whether the historical intervention was a PERMA intervention—it was not—but whether the observed changes can support a theoretically disciplined model for designing and prospectively testing more positive mathematics experiences in FE.

3. Research Questions

RQ1: To what extent did vocationally contextualised mathematics teaching change behavioural engagement?
RQ2: To what extent did it change perceived relevance of mathematics to learners' courses, careers and everyday life?

RQ3: To what extent did it change emotional engagement and confidence?
RQ4: How did learners describe their attitudes, motivation, confidence, understanding and experience after vocational contextualisation?
RQ5 (secondary PERMA question): How can the quantitative and qualitative findings be integrated within a PERMA-informed account without overstating what the original instrument measured?

4. Methodology

4.1 Design, setting and participants

The study used mixed-methods action research in an English FE college during a PGCE Further Education placement. The matched analytical sample comprised 17 GCSE Mathematics resit learners enrolled across vocational areas including Bricklaying, Carpentry, Plumbing, Sport, Uniformed/Public Services and Media. The intervention lasted approximately five weeks. The intact-class sample was purposive and practice-based rather than probability sampled.

4.1.1 Practitioner setting and sampling

The research was practitioner-led and conducted in one FE college during the researcher's teaching placement. The analytic sample comprises 17 learners for whom matched pre- and post-intervention questionnaire data were available. The sample is therefore a small, context-specific repeated-measures sample rather than a probability sample. This matters statistically: precision, generalisability and model complexity are constrained, but within-person change can still be examined directly because each learner acts as his or her own pre-intervention comparator.
Learners came from vocational areas including Bricklaying, Carpentry, Plumbing, Sport, Media, and Uniformed and Public Services. The study did not use a randomised control group. Accordingly, the statistical analyses estimate the magnitude and consistency of pre-post change during the intervention period; they do not by themselves identify the intervention as the sole causal mechanism.

4.2 Intervention

The intervention embedded mathematics within vocational and real-world situations while retaining GCSE objectives. Teaching also incorporated explicit modelling ("My Turn/Your Turn"), starters, question-level diagnostic analysis, mini-whiteboards, animations, interactive correction activities and targeted Grade 4 expectations. Because these practices were bundled, the design estimates change associated with the intervention package rather than isolating a pure contextualisation effect.

4.2.1 Pedagogical mechanism of the intervention

The intervention worked by embedding GCSE mathematical ideas in problems with recognisable vocational objects, quantities and decisions. For example, ratio and proportion could be encountered through mortar mixtures; measurement through wall, timber or pipe dimensions; arithmetic and proportional reasoning through material or production costs; and rate or quantity reasoning through sport, media or public-service scenarios. The pedagogical hypothesis was that authentic context would increase utility value and meaning, thereby making attention and effort more worthwhile and creating more opportunities for successful participation.
Contextualisation was combined with ordinary adaptive classroom practice rather than delivered as an isolated treatment package. Consequently, the intervention should be understood as a practitioner-developed pedagogical approach. The present analysis focuses on the common principle across lessons - making mathematics vocationally meaningful - rather than attributing change to any single classroom technique.

4.3 Quantitative instrument

Fifteen items used a five-point Likert response scale (1=Strongly Disagree to 5=Strongly Agree). Q1–Q5 measured behavioural engagement, Q6–Q10 perceived relevance, and Q11–Q15 emotional engagement/confidence. For each learner and domain, the composite score was the arithmetic mean of the five constituent items, retaining the original 1–5 metric.

4.3.1 Questionnaire items and scoring

Table 1. Original questionnaire domains and item content

Domain	Items	Content represented
Behavioural engagement	Q1-Q5	I pay attention during Maths lessons; I try my best to complete Maths tasks in class; I participate in Maths activities when asked; I stay focused during Maths lessons; I put effort into understanding Maths work.
Perceived relevance	Q6-Q10	I understand how Maths is used in real-life situations; Maths feels relevant to my course or future career; I can see the purpose of learning Maths; Maths feels more meaningful when linked to real-world examples; I believe Maths skills will be useful outside college.
Emotional engagement / confidence	Q11-Q15	Items assessed confidence, motivation, enjoyment, positive feelings about learning mathematics and emotional comfort/anxiety-related experience.

All closed items used a five-point response scale from 1 = Strongly Disagree to 5 = Strongly Agree. For learner i and domain d, the composite score was the arithmetic mean of the five constituent items. Thus each composite remained on the original 1–5 metric. Item-level and domain-level changes were defined explicitly as follows; positive values indicate movement in the hypothesised direction.

$$X_{id} = \frac{1}{m_d} \sum_{k \in d} X_{ik}$$

$$D_{ik} = Post_{ik} - Pre_{ik}$$

$$D_{id} = Post_{id} - Pre_{id}$$

The questionnaire was designed for the original action-research questions rather than as a validated PERMA profile. Consequently, the domain scores are analysed under their original construct labels. PERMA is applied only after the statistical and qualitative results have been established.

Table 2. Participant-level pre-intervention item scores and domain composites ($n = 17$)

Student	Q1	Q2	Q3	Q4	Q5	Behaviour Score	Q6	Q7	Q8	Q9	Q10	Relevance Score	Q11	Q12	Q13	Q14	Q15	Emotional Score
1	2	2	3	2	3	2.4	2	3	2	3	2	2.4	3	3	3	3	2	2.8
2	1	2	2	2	2	1.8	1	2	2	2	1	1.6	2	2	2	3	2	2.2
3	3	3	3	3	3	3.0	3	3	4	3	4	3.4	3	3	3	3	3	3.0
4	2	2	2	2	2	2.0	2	2	2	2	2	2.0	2	2	2	2	2	2.0
5	3	3	4	3	3	3.2	3	4	3	4	3	3.4	2	3	3	3	3	2.8
6	2	2	3	2	3	2.4	2	3	2	3	3	2.6	4	4	3	4	3	3.6
7	1	1	2	1	2	1.4	1	2	1	2	1	1.4	1	1	2	1	2	1.4
8	3	2	3	2	3	2.6	3	3	3	3	3	3.0	2	2	3	2	3	2.4
9	4	3	4	4	2	3.4	4	3	4	4	4	3.6	4	4	5	4	4	4.2
10	2	2	1	2	3	2.0	2	2	3	2	3	2.4	3	2	3	3	3	2.8
11	3	3	3	3	3	3.0	2	3	2	3	4	2.8	3	3	3	3	3	3.0
12	1	2	2	1	2	1.6	1	2	2	1	2	1.6	2	1	2	1	2	1.6
13	2	3	3	2	3	2.6	2	3	3	3	3	2.8	3	2	3	2	3	2.6
14	4	4	4	4	5	4.2	4	4	4	5	4	4.2	4	4	4	3	4	3.8
15	3	3	3	3	3	3.0	3	1	3	2	3	2.4	5	4	4	4	4	4.2
16	2	2	3	2	1	2.0	2	2	3	2	3	2.4	3	3	2	2	3	2.6
17	3	3	4	3	4	3.4	3	4	3	4	4	3.6	2	3	3	2	3	2.6

Note. Behaviour Score = mean(Q1-Q5); Relevance Score = mean(Q6-Q10); Emotional Score = mean(Q11-Q15). These participant-level values are reproduced here so that the present article is analytically self-contained.

Table 3. Participant-level post-intervention item scores and domain composites ($n = 17$)

Student	Q1	Q2	Q3	Q4	Q5	Behaviour Score	Q6	Q7	Q8	Q9	Q10	Relevance Score	Q11	Q12	Q13	Q14	Q15	Emotional Score
1	3	4	4	3	4	3.6	4	4	3	4	4	3.8	4	4	4	4	4	4.0
2	2	3	3	3	3	2.8	3	3	3	3	3	3.0	2	2	1	2	2	1.8
3	4	4	4	4	4	4.0	4	4	5	4	5	4.4	4	4	4	4	4	4.0
4	3	3	3	3	3	3.0	3	3	3	3	3	3.0	3	3	3	3	3	3.0
5	4	4	4	4	4	4.0	4	4	4	5	4	4.2	4	3	4	3	4	3.6
6	3	4	3	4	4	3.6	3	4	3	4	4	3.6	3	3	3	2	3	2.8
7	2	2	3	2	3	2.4	2	3	2	3	3	2.6	2	2	3	2	3	2.4
8	4	4	4	4	4	4.0	4	4	4	4	4	4.0	4	4	4	4	4	4.0
9	5	5	5	5	5	5.0	5	5	5	5	5	5.0	4	3	4	3	4	3.6
10	3	3	4	3	4	3.4	3	3	4	3	4	3.4	4	4	4	5	4	4.2
11	4	4	4	4	4	4.0	4	4	5	4	5	4.4	4	4	4	4	4	4.0
12	2	3	3	2	3	2.6	2	3	3	2	3	2.6	3	2	3	2	3	2.6
13	3	4	4	3	4	3.6	3	4	4	4	4	3.8	4	3	4	3	4	3.6
14	5	5	5	5	5	5.0	5	5	5	5	5	5.0	5	5	4	5	4	4.6
15	4	4	4	4	4	4.0	4	4	4	4	4	4.0	4	4	4	4	4	4.0
16	3	3	4	3	4	3.4	3	3	4	3	4	3.4	4	4	4	4	4	4.0
17	4	4	4	4	4	4.0	4	4	4	4	4	4.0	3	3	3	3	4	3.2

Data-quality check. For the present re-analysis, domain differences were recomputed directly from the item-derived composite scores rather than copied from the earlier difference-score column. This identified two transcription inconsistencies in the earlier emotional-difference column: Student 2 is 1.8 - 2.2 = -0.4 (not -0.3), and Student 6 is 2.8 - 3.6 = -0.8 (not -0.5). All inferential results in this paper use the recomputed values.

4.4 Analytical process: from item responses to integrated inference

The analytical process was conducted in a fixed sequence so that each inferential claim could be traced back to the participant-level questionnaire responses. First, the 17 pre-intervention and 17 post-intervention records were matched at learner level. The response matrices were checked for completeness and admissible values on the five-point scale. No missing item values were present in the reconstructed matrices. Second, each of the three domain scores was recomputed directly from its five constituent items: Behavioural Engagement from Q1–Q5, Perceived Relevance from Q6–Q10, and Emotional Engagement/Confidence from Q11–Q15. Using item-derived composites rather than previously copied summary columns provided an auditable basis for all subsequent calculations.

Third, for each learner and each domain, a paired difference was calculated as post-intervention composite minus pre-intervention composite. The sign, magnitude and distribution of these 17 difference scores were inspected before formal testing. This step was important because the inferential unit is the within-person change, not the difference between two unrelated group means. It also exposed two transcription inconsistencies in the earlier emotional/confidence difference column; the present analysis therefore uses the recomputed item-derived differences throughout.

Fourth, descriptive statistics were calculated for pre-intervention scores, post-intervention scores and paired changes. The analysis prioritised estimation as well as significance: mean change and its 95% confidence interval were reported to show the direction and plausible magnitude of change. Median and interquartile summaries of the paired differences were also examined to reduce dependence on the mean as the sole description of a small sample.

Fifth, the distributional assumption relevant to the paired-samples t-test was assessed on the difference scores using the Shapiro–Wilk diagnostic. Behavioural Engagement and Perceived Relevance differences were sufficiently compatible with normality for paired t inference. Emotional Engagement/Confidence differences showed evidence of non-normality. Because normality tests themselves have limited power in small samples, exact Wilcoxon signed-rank tests were additionally calculated for all three domains as sensitivity analyses.

Agreement between parametric and rank-based conclusions was treated as stronger evidence than reliance on either procedure alone.

Sixth, effect magnitude was quantified in complementary ways. Cohen's paired standardised mean change was calculated from the mean difference divided by the standard deviation of the paired differences; Hedges' small-sample correction was then applied. For the signed-rank analysis, rank-biserial correlation summarised the balance of positive and negative ranks. Raw mean change remained central because standardised effects can become unusually large when change scores are highly homogeneous. A 20,000-resample percentile bootstrap of the paired differences supplied an additional empirical interval for mean change without relying on a normal sampling approximation.

Seventh, internal consistency of each five-item domain was estimated separately at pre- and post-intervention using Cronbach's alpha. These estimates were used as descriptive checks on score coherence rather than as proof of unidimensionality or validity. Eighth, because three primary domain hypotheses were tested, Holm's sequential procedure adjusted the family of primary p-values to reduce inflation of Type I error.

Ninth, qualitative responses were analysed independently of the PERMA mapping. Responses were coded for recurring indications of relevance/practical value, motivation/engagement, confidence/reduced anxiety, and understanding through contextualisation. Pre–post theme frequencies and representative learner expressions were then compared. Only after these themes had been established were they considered in relation to PERMA. This ordering was intended to prevent the five PERMA categories from being imposed retrospectively on every response.

Finally, quantitative and qualitative strands were integrated through a convergence-oriented joint interpretation. A PERMA element was treated as strongly represented only where the original measured construct and learner voice provided conceptually appropriate evidence; partially represented where evidence was indirect; and under-measured where the original design lacked a dedicated measure. This is why Meaning and Engagement receive the strongest empirical interpretation, Positive Emotion and Accomplishment are treated more cautiously, and Relationships remains principally a theoretical proposition for future prospective measurement.

4.4.1 Estimands, assumptions and multiplicity

The principal estimand for each domain was the mean within-person change, $\Delta = \mathbf{mean(Post - Pre)}$. Normality was assessed on the change scores, not on the pre- and post-scores separately, because normality of the paired differences is the relevant assumption for a paired-samples t-test. Shapiro–Wilk tests were used as diagnostics given the small sample. Behavioural and relevance differences were sufficiently compatible with normality for paired t inference; emotional/confidence differences were non-normal, so the exact Wilcoxon signed-rank test was treated as an important sensitivity analysis.

$$\bar{D} = \frac{\sum_{i=1}^{n} D_i}{n}$$

$$s_D = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})^2}{\mathbf{n - 1}}}$$

For each domain, the analysis reports the pre and post means, mean change, 95% confidence interval for mean change, paired t statistic, exact Wilcoxon result, Cohen's d_z, Hedges' small-sample-corrected g_z, and rank-biserial correlation. A 20,000-resample non-parametric bootstrap of paired differences was used to provide an additional distribution-light interval for the mean change. Because three domain-level hypotheses were evaluated, Holm's sequential correction was applied to the three primary p-values to reduce familywise Type I error without the conservatism of a simple Bonferroni correction.

4.4.2 Reliability and interpretation of effect sizes

Internal consistency was estimated separately at pre- and post-intervention using Cronbach's alpha. Alpha values were high across the three five-item domains, but with $n = 17$ they should be regarded as descriptive rather than stable population estimates. High alpha also does not establish unidimensionality or construct validity. Cohen's d_z standardises mean paired change by the standard deviation of the difference scores; because very homogeneous change scores can produce very large d_z values, the paper reports raw change and confidence intervals alongside standardised effects.

4.4.3 Statistical tests, effect sizes and precision

For learner i, the paired change score was $D_i = Post_i - Pre_i$. Primary inference used the paired-samples statistic below, with $\mathrm{df} = \mathrm{n} - 1$. Normality was assessed on the paired differences using the Shapiro–Wilk diagnostic. Because assumption tests have low power in small samples and Likert composites can depart from normality, exact Wilcoxon signed-rank tests were computed as sensitivity analyses for every domain, not only where normality failed.

$$t = \frac{D}{\frac{s_D}{\sqrt{n}}}$$

$$95\%\ \mathrm{CI}:\ D \pm t_{\alpha/2,n-1}\frac{s_D}{\sqrt{n}}$$

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

Magnitude was quantified using Cohen's paired standardised mean change d_z. A small-sample correction J produced Hedges' g_z. For the signed-rank analysis, positive and negative rank sums were retained and rank-biserial correlation summarised their directional imbalance. Precision was reported using 95% t-based confidence intervals for mean change and 20,000-resample percentile bootstrap intervals. The three primary domain tests were additionally Holm-adjusted to control family-wise error. Internal consistency was examined with Cronbach's α at pre- and post-test, interpreted cautiously given $n = 17$.

$$d_z = \frac{D}{s_D}$$

$$J = 1 - \frac{3}{4\mathrm{df} - 1}, \quad g_z = Jd_z$$

$$W^+ = \sum R^+_i, \quad W^- = \sum R^-_i$$

$$r_{rb} = \frac{W^+ - W^-}{W^+ + W^-}$$

$$\alpha = \frac{k}{\mathrm{k} - 1}\left(1 - \frac{\sum_{j=1}^{k}{\sigma_j}^2}{{\sigma_T}^2}\right)$$

$$\alpha_j = \frac{\alpha}{\mathrm{m} - \mathrm{j} + 1}, \quad j = 1, \ldots, \mathrm{m}$$

$$\mathrm{Bootstrap}\ 95\%\ \mathrm{CI} = [\,Q_{0.025}, Q_{0.975}\,]$$

Here, D denotes the mean paired change and s_D the standard deviation of paired change scores. Other symbols are defined by their use in the equations above.

4.5 Qualitative analysis and integration

Open-ended responses were coded into four themes already present in the original action research: perceived relevance/practical value; motivation/engagement; confidence/reduced anxiety; and understanding through contextualisation. The present analysis maps these themes onto PERMA only after coding, avoiding retrospective invention of five PERMA scales. Quantitative and qualitative strands are integrated through convergence: numerical change indicates magnitude and consistency, while learner voice indicates how the change was experienced.

4.6 Ethics and data provenance

Participation was voluntary and questionnaire data were anonymised. The original participant information indicated that findings could later be published academically. For this secondary manuscript, the crucial additional issue is publication provenance: the dataset has already informed an earlier vocational-contextualisation article. A journal submission must therefore disclose that relationship and explain the distinct PERMA-informed theoretical and statistical contribution.

4.9 Data quality, reconstruction and audit trail

For the present re-analysis, domain scores were reconstructed from the participant-level item responses rather than copied uncritically from summary statistics. Each domain was calculated as the arithmetic mean of its five constituent items. Post–pre difference scores were then recomputed for every learner. This reconstruction identified two transcription discrepancies in the previously tabulated emotional/confidence difference column: for Students 2 and 6, the differences implied by the underlying domain scores are −0.4 and −0.8 respectively. The present manuscript uses the recomputed values. This correction does not reverse the substantive conclusion;

rather, it strengthens the audit trail by ensuring that inferential statistics are based on the item-derived composite scores.

No missing participant-level values were present in the reconstructed 17 × 15 pre-intervention and 17 × 15 post-intervention item matrices used for the domain analyses. Because the sample is small, inferential results are interpreted alongside raw changes, confidence intervals, exact rank-based tests and qualitative convergence rather than through statistical significance alone.

4.10 Ethical and interpretive safeguards

Participation was voluntary and questionnaire responses were anonymised. The participant information materials stated that findings might later be published academically. The present secondary analysis does not introduce a new intervention or new participant contact; it re-analyses the anonymised action-research evidence through an additional theoretical framework. Throughout the manuscript, claims are deliberately limited to the evidence collected: the study evaluates learner-reported engagement, relevance, emotional engagement/confidence and qualitative experience, not objective GCSE attainment or clinical well-being.

5. Results

5.1 Descriptive results and reliability

Domain	Pre M	Post M	Mean Δ	95% CI Δ	Median Δ	α pre	α post
Behavioural engagement	2.59	3.67	1.08	[0.95, 1.21]	1.00	0.92	0.96
Perceived relevance	2.69	3.78	1.08	[0.93, 1.24]	1.00	0.92	0.95
Emotional engagement/confidence	2.80	3.49	0.69	[0.32, 1.07]	1.00	0.94	0.95

Table 1. Descriptive change and internal-consistency estimates. The alpha coefficients are high, but with only 17 participants they should be treated as preliminary indicators of item covariance rather than definitive evidence of construct validity.

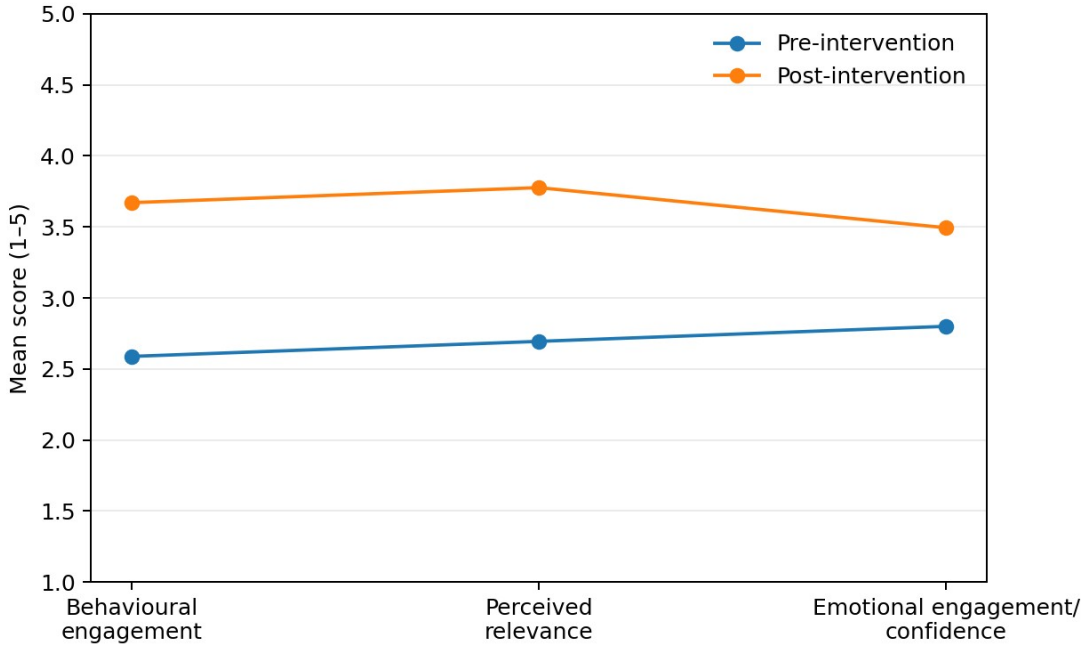


Figure 1. Pre- and post-intervention mean scores across the three measured domains.

5.1.1 Individual change patterns

Student	B pre	B post	ΔB	R pre	R post	ΔR	E pre	E post	ΔE
1	2.4	3.6	1.2	2.4	3.8	1.4	2.8	4.0	1.2
2	1.8	2.8	1.0	1.6	3.0	1.4	2.2	1.8	-0.4
3	3.0	4.0	1.0	3.4	4.4	1.0	3.0	4.0	1.0
4	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0
5	3.2	4.0	0.8	3.4	4.2	0.8	2.8	3.6	0.8
6	2.4	3.6	1.2	2.6	3.6	1.0	3.6	2.8	-0.8
7	1.4	2.4	1.0	1.4	2.6	1.2	1.4	2.4	1.0
8	2.6	4.0	1.4	3.0	4.0	1.0	2.4	4.0	1.6
9	3.4	5.0	1.6	3.6	5.0	1.4	4.2	3.6	-0.6
10	2.0	3.4	1.4	2.4	3.4	1.0	2.8	4.2	1.4
11	3.0	4.0	1.0	2.8	4.4	1.6	3.0	4.0	1.0
12	1.6	2.6	1.0	1.6	2.6	1.0	1.6	2.6	1.0
13	2.6	3.6	1.0	2.8	3.8	1.0	2.6	3.6	1.0
14	4.2	5.0	0.8	4.2	5.0	0.8	3.8	4.6	0.8
15	3.0	4.0	1.0	2.4	4.0	1.6	4.2	4.0	-0.2
16	2.0	3.4	1.4	2.4	3.4	1.0	2.6	4.0	1.4
17	3.4	4.0	0.6	3.6	4.0	0.4	2.6	3.2	0.6

Table 5. Participant-level domain scores and recomputed change scores

The individual pattern is striking. All 17 learners increased on behavioural engagement and all 17 increased on perceived relevance. Emotional engagement/confidence was more heterogeneous: 13 learners increased and four decreased. This heterogeneity explains why the emotional domain has a smaller standardised mean effect than the first two domains and why a rank-based sensitivity analysis is especially informative.

5.2 Inferential and sensitivity analyses

Domain	**SW p**	**t(16)**	**p**	**Holm p**	**W**	**Wilcoxon p**	d_z	g_z	**r_rb**	**Bootstrap 95% CI**
Behavioural engagement	0.120	17.46	<.001	<.001	0.0	<.001	4.24	4.02	1.00	[0.96, 1.20]
Perceived relevance	0.078	14.85	<.001	<.001	0.0	<.001	3.60	3.42	1.00	[0.94, 1.22]
Emotional engagement/confidence	0.007	3.91	0.001	0.001	13.0	0.001	0.95	0.90	0.83	[0.34, 1.01]

Table 2. Inferential tests, multiplicity adjustment, effect sizes and bootstrap sensitivity analysis.

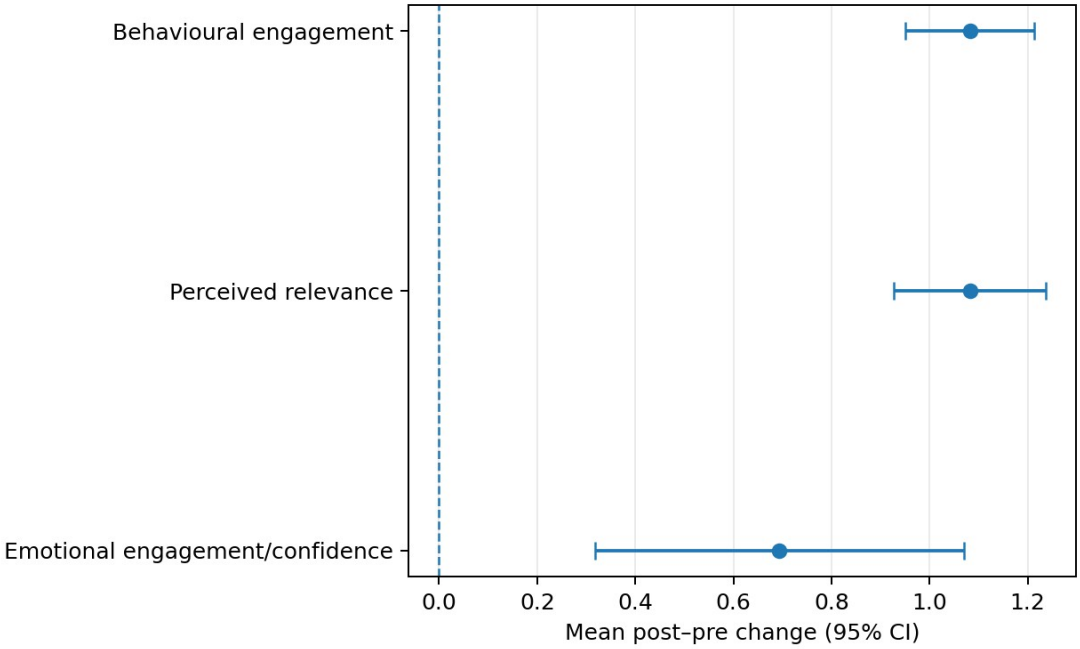


Figure 2. Mean post–pre changes with 95% confidence intervals.

5.3 Behavioural engagement

Behavioural engagement increased from $M = 2.59$ to $M = 3.67$, a mean increase of 1.08 points (95% CI [0.95, 1.21]). The paired-samples test gave $t(16) - 17.46$, $p < .001$, with $d_z - 4.24$ and small-sample-corrected $g_z = 4.02$. The exact Wilcoxon sensitivity test gave W=0.0, $p < .001$, with rank-biserial r=1.00. The 20,000-resample bootstrap interval for mean change was [0.96, 1.20].
The Shapiro–Wilk diagnostic was $p = 0.120$; no statistically detectable departure from normality was observed. The exact Wilcoxon result nevertheless provides a distribution-light robustness check.

5.4 Perceived relevance

Perceived relevance increased from $M = 2.69$ to $M = 3.78$, a mean increase of 1.08 points (95% CI [0.93, 1.24]). The paired-samples test gave $t(16) = 14.85$, $p < .001$, with $d_z = 3.60$ and small-sample-corrected $g_z = 3.42$. The exact Wilcoxon sensitivity test gave W=0.0, $p < .001$, with rank-biserial r=1.00. The 20,000-resample bootstrap interval for mean change was [0.94, 1.22].
The Shapiro–Wilk diagnostic was $p = 0.078$; no statistically detectable departure from normality was observed. The exact Wilcoxon result nevertheless provides a distribution-light robustness check.

5.5 Emotional engagement and confidence

Emotional engagement and confidence increased from $M = 2.80$ to $M = 3.49$, a mean increase of 0.69 points (95% CI [0.32, 1.07]). The paired-samples test gave $t(16) = 3.91$, $p = 0.001$, with $d_z = 0.95$ and small-sample-corrected $g_z = 0.90$. The exact Wilcoxon sensitivity test gave W=13.0, $p = 0.001$, with rank-biserial r=0.83. The 20,000-resample bootstrap interval for mean change was [0.34, 1.01].
The Shapiro–Wilk diagnostic for this domain was $p = 0.007$, indicating non-normality of difference scores. The agreement between the exact Wilcoxon result and the paired t result is therefore especially important: the conclusion of positive change does not depend on normality.

5.6 Qualitative change

Theme	Pre	Post	Count change	PERMA-informed interpretation
Relevance/practical value	4/17	15/17	+11	Meaning; utility value
Motivation/engagement	3/17	14/17	+11	Engagement; Positive Emotion
Confidence/reduced anxiety	5/17	12/17	+7	Positive Emotion; Accomplishment
Understanding through contextualisation	6/17	13/17	+7	Accomplishment; Meaning

The largest qualitative shifts concerned relevance and motivation/engagement. Post-intervention responses included “Useful for my course”, “Practical examples help”, “More motivated”, “I enjoy it”, “Proud”, “More confident”, “I can do it”, “Less nervous”, “Makes sense with examples” and “I understand more”. These brief statements converge strongly with the direction of the quantitative changes, while remaining too short to support claims about complex psychological processes beyond the coded themes.

5.6.1 Coding logic and student voice

Open responses were short, and a single response could contribute to more than one theme. Coding therefore focused on meaning units rather than treating the themes as mutually exclusive categories. Pre-intervention responses included expressions such as 'Hard', 'Stressful', 'Not confident', 'Makes me nervous' and 'Boring'. Post-intervention responses included 'Useful for my course', 'Practical examples help', 'More motivated', 'Proud', 'More confident', 'I can do it', 'Less nervous', 'Makes sense with examples', 'I understand more' and 'Clearer with real-world problems'. These brief statements are valuable because they show the direction and experiential character of the quantitative shifts without being treated as equivalent to a full interview dataset.

Theme	Pre-Intervention (n=17)	Post-Intervention (n=17)	Interpretation / Meaning
Relevance of Maths	4/17 “Don’t see why I need it” “Boring”	15/17 “Useful for my course” “Practical examples help” “Good when linked to real life”	Students increasingly recognise the value of maths for their course and career
Motivation & Engagement	3/17 “Boring” “Hard” “I struggle”	14/17 “More motivated” “I enjoy it” “Proud”	Engagement and willingness to participate improved; students show higher emotional and behavioural involvement.
Confidence & Reduced Anxiety	5/17 “Not confident” “Makes me nervous” “Stressful”	12/17 “More confident” “I can do it” “Less nervous”	Students’ self-efficacy increased; maths anxiety reduced, reflecting higher expectancy
Understanding through Contextualisation	6/17 “Confusing” “I don’t get it” “Too many numbers”	13/17 “Makes sense with examples” “I understand more” “Clearer with real-world problems”	Contextualised examples enhanced comprehension and practical understanding of concepts.

Table 7. Qualitative theme frequencies and illustrative responses before and after the intervention

Across themes, positive relevance-related responses increased from 4/17 to 15/17; motivation/engagement from 3/17 to 14/17; confidence/reduced anxiety from 5/17 to 12/17; and understanding through contextualisation from 6/17 to 13/17. These counts are descriptive indicators of thematic prevalence, not independent binomial outcomes, because themes could co-occur within the same learner response.

5.7 Mixed-methods joint display

Measured outcome	Quantitative finding	Qualitative convergence	PERMA interpretation
Behavioural engagement	Δ=1.08; d_z=4.24	Motivation/engagement 3→14	E: increased participation and investment
Perceived relevance	Δ=1.08; d_z=3.60	Relevance 4→15	M: vocational purpose/utility became visible
Emotional engagement/confidence	Δ=0.69; d_z=0.95	Confidence 5→12	P/A: more positive affect and perceived capability
No direct relationship scale	Not quantitatively measured	Interaction embedded in pedagogy	R: theoretically plausible but empirically under-measured
No attainment test	Not quantitatively measured	Understanding 6→13	A: subjective accomplishment, not objective attainment

5.8 What the results mean before applying PERMA

Taken on their own terms, before any PERMA interpretation is introduced, the results describe three related changes in the learners' experience of mathematics. First, learners reported substantially greater attention, effort, participation and focus. Second, they were much more likely to perceive mathematics as useful, purposeful and connected to vocational or real-world activity. Third, emotional engagement and confidence improved on average, although this change was less uniform than the first two domains. The qualitative data tell the same broad story in the learners' own short responses: mathematics became more useful, more understandable, less threatening and more worth engaging with.

This ordering matters. The statistical evidence does not require PERMA in order to be meaningful; it already supports a descriptive conclusion about within-person change during the five-week intervention. PERMA is added in the discussion as an explanatory and design lens. This protects the analysis from circularity: the original outcomes are first reported as originally measured, and only then considered in relation to Positive Emotion, Engagement, Relationships, Meaning and Accomplishment.

6. PERMA-Informed Discussion

6.1 Positive Emotion

The emotional/confidence domain and qualitative reports of reduced nervousness, enjoyment and pride provide the clearest evidence relevant to Positive Emotion. The mean increase was smaller than the engagement and relevance changes, and individual differences were more heterogeneous. This is pedagogically credible: learners may recognise usefulness and participate more readily before deep-seated mathematics anxiety fully changes.

6.2 Engagement

Behavioural engagement showed an exceptionally large and consistent shift. Every learner's composite behavioural score increased in the reconstructed dataset, producing a rank-biserial correlation of 1.00. Such consistency is noteworthy but should not be universalised. The intervention combined contextualisation with modelling, feedback, interactive tasks and explicit expectations, so the observed change belongs to the pedagogical package.

6.3 Relationships

Relationships are the weakest empirical part of the PERMA reframing. No dedicated items measured teacher support, peer belonging, trust or psychological safety. It would therefore be invalid to manufacture an R score. Relationships remain theoretically relevant because low-stakes questioning, mini-whiteboards, modelling and responsive feedback can change the interpersonal risk of making mathematical mistakes. Future work should measure this directly.

6.4 Meaning

Meaning is the strongest bridge between the original study and PERMA. Perceived relevance increased by more than one scale point and qualitative recognition of practical value increased from 4 to 15 learners. In this study, "meaning" is deliberately narrowed to educational and vocational purpose rather than the broader existential meaning used in well-being theory. EVT helps explain the mechanism: visible utility can increase the value attached to effort.

6.5 Accomplishment

Accomplishment is indicated indirectly by confidence, pride and reports of increased understanding. However, no objective attainment measure was collected. The correct claim is therefore that learners reported greater perceived capability and understanding—not that GCSE attainment improved. A future PERMA-informed trial should combine well-being/engagement outcomes with topic tests, mock examinations and delayed retention measures.

6.6 An integrated PERMA mechanism

Taken together, the data support a plausible pedagogical sequence rather than five independently tested PERMA effects. Vocational context first appears to alter the perceived meaning and utility of the mathematics. Increased meaning can make participation more worthwhile, which is consistent with the universal positive shifts in behavioural engagement. Participation in tasks that now make sense may create more opportunities for successful completion and understanding; these experiences can contribute to accomplishment-related appraisals such as pride and 'I can do it'. In turn, success and intelligibility may reduce anxiety and increase enjoyment or confidence, contributing to positive emotion. Relationships potentially condition every stage of this sequence through teacher support, peer participation and psychological safety, but the original instrument does not permit that pathway to be quantified.

This sequence is theoretically compatible with Expectancy-Value Theory and situated learning. PERMA adds value by broadening the interpretive question from 'Did engagement increase?' to 'What conditions of flourishing in mathematics may have been strengthened?' The answer from this dataset is strongest for meaning and engagement, substantial but indirect for positive emotion and accomplishment, and presently underdetermined for relationships.

6.7 Alternative explanations

Several rival explanations remain plausible. Changes may partly reflect familiarity with the questionnaire, maturation over the five-week period, the researcher's increasing familiarity with the class, general improvements in classroom routines, social desirability, or other concurrent teaching experiences. Regression to the mean is also possible where initial scores were low. The absence of a comparison group prevents these alternatives from being separated statistically from the contextualisation effect. The unusually large d_z values for behavioural engagement and relevance should therefore be interpreted as standardised within-sample change, not as transportable causal effect sizes for all FE resit learners.

7. Statistical Interpretation and Rigour

The extremely large paired standardised effects for behavioural engagement and relevance require careful reading. d_z standardises the mean change by the standard deviation of within-person change. When nearly all learners change in the same direction by similar amounts, s_D is small and d_z becomes very large. This does not mean that an intervention would produce a four-standard-deviation difference between independent FE populations. It means that change was unusually consistent within this small matched sample.
For that reason, the manuscript reports raw scale change, confidence intervals, corrected standardised effects and rank-based effects together. Raw change is especially interpretable: roughly +1.08 on a 1–5 scale for engagement and relevance, and +0.69 for emotional engagement/confidence. The inferential conclusion is also robust to analytic choice: exact Wilcoxon tests and bootstrap intervals agree with the paired tests, and Holm adjustment does not alter statistical significance.

Reliability estimates are high, but alpha is sample dependent and can be inflated by highly similar items. With $n = 17$, factor analysis would be inappropriate. A future study should validate the measurement model in a much larger sample before treating the domains as established psychometric scales.

8. Implications for FE Mathematics Practice

• Use vocational context as a bridge into mathematical structure, not as a replacement for GCSE abstraction.
• Make utility explicit: ask learners where the mathematics appears in their course, workplace or everyday decisions.
• Engineer small experiences of genuine success so that accomplishment is earned rather than created through lowered challenge.
• Use low-stakes participation routines to reduce the social cost of error and strengthen the relational conditions for engagement.
• Move deliberately from context → representation → symbolic mathematics → transfer to a different context or examination-style problem.
• Work with vocational colleagues to ensure contexts are authentic and mathematically accurate.
• Evaluate engagement and learning separately: a learner can feel more engaged without yet demonstrating improved attainment, and both outcomes matter.
• For future PERMA work, measure all five elements directly rather than retrospectively relabelling existing constructs.

9. Limitations

• The sample was small ($n = 17$), purposive and drawn from one practitioner setting.
• There was no control group, so maturation, novelty, teacher effects and other time-varying explanations cannot be excluded.
• The intervention was short, limiting conclusions about persistence and long-term transfer.
• Several pedagogical strategies changed simultaneously, preventing isolation of a contextualisation-only effect.
• The questionnaire was not a validated PERMA instrument; Relationships and Accomplishment were not directly measured as PERMA constructs.
• The qualitative responses were often brief and some verbal feedback was informal.
• The teacher was also the researcher, creating potential expectancy and social-desirability effects.
• No objective attainment outcome was included.
• The same underlying dataset has already supported an earlier publication, requiring explicit disclosure and a materially distinct secondary-analysis rationale.

10. Future Research: A Purpose-Built PERMA Mathematics Study

A stronger next study would prospectively design PERMA into both pedagogy and measurement. A multi-class or multi-college sample could use a comparison condition, validated PERMA/positive-education measures, mathematics-specific anxiety and self-efficacy scales, and curriculum-aligned attainment tests. Repeated measurements would permit longitudinal modelling. With adequate sample size, a multilevel model could account for learners nested within classes and teachers; mediation could then test whether increased vocational meaning predicts engagement, which predicts accomplishment and positive emotion. Preregistration of primary outcomes and an a priori analysis plan would substantially strengthen confirmatory inference.
For a two-group pre–post design, a practical analysis could use a mixed-effects model of the form:

$$Y_{ijt} = \beta_0 + \beta_1(Time_t) + \beta_2(Group_j) + \beta_3(\text{Time} \times \text{Group}) + u_j + v_{ij} + \varepsilon_{ijt}$$

Here, β_3 estimates the differential intervention change, u_j represents class/teacher variation and v_{ij} learner-level random intercepts. This would be a stronger causal design than relying on a single-group pre–post difference.

11. Conclusion

This study re-examined a five-week vocationally contextualised GCSE Mathematics intervention through a PERMA-informed positive-education lens while preserving the distinction between what the original research measured and what the later theoretical framework permits us to interpret. Across the 17 matched learners, behavioural engagement and perceived relevance increased consistently, while emotional engagement/confidence also improved overall despite greater individual variability. The inferential pattern was not dependent on a single statistical procedure: confidence intervals, paired-samples tests, exact signed-rank sensitivity analyses, multiplicity adjustment, corrected effect sizes and bootstrap intervals all pointed in the same

substantive direction. Qualitative evidence converged with the numerical findings through increased references to usefulness, motivation, confidence, reduced nervousness and understanding.

The principal theoretical contribution is not a claim that PERMA was experimentally tested. It is the proposal that vocational contextualisation may alter several conditions through which a learner experiences mathematics. By making mathematical activity visibly connected to a valued course, occupation or practical purpose, contextualisation can strengthen Meaning in the narrower sense of perceived utility and purpose. Greater purpose may support Engagement by giving learners a reason to attend, participate and persist. When participation leads to successful sense-making, learners may experience progress and competence that are relevant to Accomplishment; these experiences may in turn support more Positive Emotion and willingness to re-engage. Relationships may facilitate the entire sequence through teacher support, peer interaction and psychological safety, but the present study did not measure this element directly and therefore cannot estimate its contribution.

This interpretation adds an important qualification to deficit-oriented accounts of GCSE resit learners. The findings suggest that low participation in compulsory mathematics should not automatically be read as an absence of capacity or aspiration. For some learners, disengagement may also reflect the way mathematical activity is positioned in relation to their vocational identity, prior experience and anticipated future. A pedagogical response can therefore address not only what mathematics is taught but how its purpose is made visible. This does not diminish the importance of mathematical rigour. On the contrary, contextualisation is most defensible when it preserves the underlying concepts and deliberately supports movement from an authentic situation to general mathematical structure and then to new applications.

For FE practitioners, the study supports a design principle rather than a fixed recipe. Teachers can begin with the mathematical demands of the GCSE curriculum, identify authentic points of connection with learners' vocational programmes, make those connections explicit, and then progressively decontextualise so that learners recognise transferable mathematical relationships. Alongside this, classroom routines should create opportunities for visible progress, explanation, participation and low-risk error correction. Such practices may help mathematics become not merely a compulsory qualification but a subject in which learners can perceive purpose and experience growing capability.

For research, the present secondary analysis generates hypotheses that now require prospective testing. A purpose-built study should measure all five PERMA elements directly with validated instruments, retain mathematics-specific measures of anxiety, self-efficacy and engagement, include objective curriculum-aligned attainment outcomes, and recruit a substantially larger multi-class or multi-college sample. A comparison condition and repeated measurements would help separate intervention effects from maturation, novelty and teacher effects. With adequate statistical power, multilevel and mediation models could then test the proposed pathway from vocational meaning to engagement, accomplishment-related experience and positive emotion, while estimating the role of relationships rather than assuming it.

The study's small purposive sample, single setting, short duration and absence of a control group mean that causal and generalisable claims would be inappropriate. Nevertheless, the consistency of learner-level change, the agreement of parametric and non-parametric analyses, and the convergence of quantitative and qualitative evidence make the findings educationally informative. The value of the study lies in showing how vocational relevance, rigorous mathematics and positive educational experience can be considered together. Within those limits, a PERMA-informed perspective offers a promising framework for designing FE mathematics classrooms in which learners are supported not only to persist toward a qualification, but also to encounter mathematics as purposeful, participatory and capable of yielding genuine experiences of progress.

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Data provenance and prior publication statement

The anonymised classroom dataset analysed in this manuscript was previously reported by Offor (2026) in an article examining vocationally contextualised mathematics through attitudes, motivation, engagement and Expectancy–Value Theory. The present manuscript is a secondary re-analysis of that dataset with a distinct PERMA-informed theoretical purpose and an expanded statistical treatment. The dataset is not presented as newly collected. Study context, instrument information and participant-level data are included here to permit independent evaluation of the present analysis.

References

Offor, P. U. (2026). An exploration of FE GCSE students' attitudes and motivation towards mathematics lessons: A vocationally contextualised approach. Journal of Education and Practice, 17(9), 1–32. https://doi.org/10.7176/JEP/17-9-01

Boli, D., & Golding, J. (2024). Mathematics GCSE resit students: heterogeneous patterns of affect, participation and attainment. Proceedings of the British Society for Research into Learning Mathematics.

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

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE.

Dewey, J. (1938). Experience and education. Macmillan.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. Annual Review of Psychology, 53, 109–132.

Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5th ed.). SAGE.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. Review of Educational Research, 74(1), 59–109.

Kern, M. L., Waters, L. E., Adler, A., & White, M. A. (2015). A multidimensional approach to measuring well-being in students: Application of the PERMA framework. The Journal of Positive Psychology, 10(3), 262–271. https://doi.org/10.1080/17439760.2014.936962

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge University Press.

Noyes, A., & Dalby, D. (2017). Mathematics in Further Education Colleges (MiFEC): Final report. University of Nottingham.

O'Leary, Z. (2021). The essential guide to doing your research project (4th ed.). SAGE.

Seligman, M. E. P. (2011). Flourish. Free Press.

Acheampong, P. A., Adusei, M. S., & Sam, L. N. (2026). Enhancing mathematics teachers' contextualization of mathematics content in welding and fabrication courses using ChatGPT and Meta AI. Discover Education, 5, 830. https://doi.org/10.1007/s44217-026-02067-8

Dalby, D., & Noyes, A. (2016). Locating mathematics within post-16 vocational education in England. Journal of Vocational Education & Training, 68(1), 70–86. https://doi.org/10.1080/13636820.2015.1110828

Norris, J. (2023). The positioning of GCSE and Functional Skills in Further Education: How do vocational students make sense of post-16 mathematics pathways? Research in Mathematics Education, 25(1), 43–61. https://doi.org/10.1080/14794802.2021.2010239

Appendix A. Statistical Formulae

Domain composite: $X_t - \frac{X_{i1} + \cdots + X_{i5}}{5}$

Paired change: $D_i = Post_i - Pre_i$

Mean change: $D = \frac{\sum D_i}{n}$

Paired t: $t = \frac{D}{\frac{s_D}{\sqrt{n}}}$

Cohen's paired effect: $d_z = \frac{D}{s_D}$

Small – sample correction: $J = 1 - \frac{3}{4n - 9}; \quad g_z = Jd_z$

$$\text{Rank} - \text{biserial effect: } r_{rb} = \frac{W^{+} - W^{-}}{W^{'} + W}$$

Appendix B. Questionnaire Used in the Original Action Research

Response scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree.
Q1. I pay attention during Maths lessons.
Q2. I try my best to complete Maths tasks in class.
Q3. I participate in Maths activities when asked.
Q4. I stay focused during Maths lessons.
Q5. I put effort into understanding Maths work.
Q6. I understand how Maths is used in real-life situations.
Q7. Maths feels relevant to my course or future career.
Q8. I can see the purpose of learning Maths.
Q9. Maths feels more meaningful when linked to real-world examples.
Q10. I believe Maths skills will be useful outside college.
Q11. I feel confident in Maths lessons.
Q12. I feel motivated to learn Maths.
Q13. I enjoy Maths lessons.
Q14. I feel positive about learning Maths at college.
Q15. I feel comfortable attempting Maths work even when it is challenging.
Open-ended item: How has your experience of learning Maths changed, if at all, after the recent lessons?

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