

Teaching Strategies and Training Outcomes in Men's Artistic Gymnastics among Students of Shandong Sports University

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ABSTRACT

Men's artistic gymnastics requires instruction that addresses technical development, confidence, training discipline, and safety-related practices. Understanding how students experience these instructional approaches can inform the evaluation of university training programs. This study examined differences in teaching strategies and perceived training outcomes across respondent characteristics and the associations between these variables at Shandong Sports University. A quantitative descriptive-correlational design was used with 285 male students selected through proportional stratified random sampling. Data were collected using a researcher-made, expert-reviewed questionnaire comprising ten five-item subscales. A pilot test with 30 students yielded Cronbach's alpha coefficients ranging from .82 to .85. The five teaching strategies were demonstration and modeling, progressive skill drills, technology-assisted visual feedback, safety spotting and conditioning, and feedback and correction. One-way analysis of variance and Pearson correlation were used, with a supplementary Holm adjustment across 25 correlations. Teaching strategy and perceived-outcome scores differed across age, skill-level, and weekly-training groups at the unadjusted .05 level. Training experience showed a more selective pattern of differences. Technology-assisted visual feedback was positively associated with all five perceived outcomes. Safety spotting and conditioning showed its strongest association with perceived skill acquisition, while feedback and correction had the strongest observed relationship with training discipline ($r = .750$). Twenty correlations remained significant following the supplementary Holm adjustment. The findings support further evaluation of differentiated technology-assisted, feedback-rich, and safety-oriented instruction. The cross-sectional design, shared self-report measurement, and limited evidence concerning construct validity and statistical assumptions constrain interpretation. These associations do not establish instructional effects or reductions in actual injury incidence.

Keywords: men's artistic gymnastics, teaching strategies, perceived training outcomes, technology-assisted visual feedback, differentiated instruction

INTRODUCTION

Men's artistic gymnastics is one of the most technically demanding sports because successful performance depends on the coordinated development of strength, flexibility, balance, spatial orientation, timing, body control, and precise interaction with six apparatuses: floor exercise, pommel horse, still rings, vault, parallel bars, and horizontal bar. Unlike many physical activities in which participation can be modified easily, gymnastics requires carefully sequenced instruction because errors in body position, timing, or progression may affect both performance quality and safety. Contemporary gymnastics research therefore increasingly views coaching as a pedagogical process in which biomechanics, motor learning, physical preparation, feedback, and injury prevention must operate together (Farana et al., 2023; Magill & Anderson, 2023).

Within sports universities, the quality of instruction is especially important because students are expected not only to participate but also to develop increasingly complex technical competencies. Teaching must therefore move beyond repetitive practice and provide learning conditions that are responsive to readiness and proficiency. Models-based and learner-centered approaches in physical education emphasize that instruction should be adapted to learner characteristics, the nature of the task, and the intended outcome rather than delivered uniformly to all students (Casey & MacPhail, 2021; Fernández-Río et al., 2023). This principle is

highly relevant to men's artistic gymnastics, where beginners, intermediate performers, advanced gymnasts, and competitive athletes differ substantially in movement repertoire, physical preparation, risk exposure, and feedback needs.

The present study examined five teaching strategies that represent major instructional functions in gymnastics. Demonstration and modeling provide learners with observable representations of correct movement patterns and are consistent with Bandura's (1977) social learning perspective. Progressive skill drills organize practice from fundamental to more complex tasks and are supported by schema and motor-learning principles emphasizing repeated, varied, and appropriately structured practice (Schmidt, 1975; Schmidt & Lee, 2019). Safety spotting and conditioning provide the physical preparation and controlled learning environment needed for demanding skills, while feedback and correction help athletes recognize errors, regulate effort, and refine subsequent attempts (Starzak et al., 2022; Panadero et al., 2022).

Technology-assisted visual feedback has become increasingly relevant because gymnastics movements are often too rapid and complex for athletes to evaluate accurately while performing. Video replay, slow-motion analysis, side-by-side comparison, and visual annotation allow performers to review body alignment, apparatus contact, rotation, flight, landing, and timing after an attempt. Systematic reviews and recent gymnastics research indicate that video-based feedback can support motor learning, reflection, motivation, and self-monitoring when it supplements rather than replaces direct coaching and physical practice (Möding et al., 2022; Bouzid et al., 2025; Martín-Rodríguez & Madrigal-Cerezo, 2025).

The five training outcomes examined in the study—skill acquisition, performance confidence, training discipline, safety awareness, and perceived injury-prevention practices—were selected because gymnastics development is multidimensional. Technical mastery alone does not fully represent successful training. Confidence is associated with perceived competence and performance under pressure (Lochbaum et al., 2022), while disciplined participation requires self-regulation, sustained attention, goal-directed behavior, and adherence to training expectations. Safety awareness and injury-prevention practices are equally important because the technical and physical demands of gymnastics can expose athletes to substantial risk when preparation, supervision, equipment use, or progression is inadequate.

The theoretical basis of the study also recognizes that these outcomes can be explained through complementary perspectives. Social Learning Theory explains how modeling and reinforcement can shape performance-related beliefs and behavior (Bandura, 1977). Schema Theory explains how repeated and varied practice contributes to generalized motor programs that can be adapted to changing movement demands (Schmidt, 1975; Schmidt & Lee, 2019). Self-Determination Theory adds a motivational perspective by proposing that autonomy, competence, and relatedness influence persistence, engagement, and quality of participation (Deci & Ryan, 2000; Ryan & Deci, 2020). Together, these perspectives suggest that no single instructional strategy should be expected to account for every training outcome.

A context-specific research gap motivated this investigation. Gymnastics literature has developed extensively in biomechanics, motor control, injury mechanisms, and elite preparation, but fewer studies have examined how students' experiences of teaching strategies relate to a broad set of perceived training outcomes in a specialized Chinese sports-university setting. This study examined profile-related differences in instructional experiences and perceived training outcomes and the associations between these variables among male students at Shandong Sports University.

This article focuses on three inferential research questions: whether teaching-strategy utilization differs across age, skill level, years of gymnastics training, and weekly training hours; whether perceived training outcomes differ across the same groups; and whether teaching strategies are associated with perceived training outcomes. The analyses were exploratory. The original significance level was .05, with an additional adjustment for the family of 25 correlations.

METHODOLOGY

Research design

The study employed a quantitative descriptive-correlational design to examine differences in students' reported experiences of gymnastics instruction and their perceived training outcomes. The design also allowed assessment of associations between the five teaching strategies and five outcome dimensions. The observational survey design did not involve random assignment or manipulation of instructional practices.

Participants and sampling

The study population comprised male students actively participating in men's artistic gymnastics training at Shandong Sports University. University and department records identified approximately 1,000 eligible male student-athletes. Proportional stratified random sampling by year level and academic program was used, and 285 respondents were included in the analyses.

The sample included 25 students aged 17 or below, 54 aged 18–19, 135 aged 20–21, and 71 aged 22 or above. Skill levels comprised 27 beginners, 33 intermediate, 199 advanced, and 26 elite/competitive students. Training experience comprised 2 students with less than one year, 3 with 1–2 years, 189 with 3–4 years, and 91 with at least five years. Weekly training hours comprised 2 students training fewer than 5 hours, 68 training 5–9 hours, 125 training 10–14 hours, and 90 training at least 15 hours. Each profile classification included all 285 respondents.

Sample-size planning used a 5% margin of error, and the achieved sample comprised 285 students. The sample was predominantly advanced in skill level and experienced in gymnastics training. The unequal group sizes, including categories containing only two or three students, are relevant to the interpretation of group comparisons.

Research instrument

Data were collected using a researcher-made questionnaire developed from the study objectives and relevant theoretical and empirical literature. Part I recorded age, skill level, years of gymnastics training, and weekly training hours. Part II assessed demonstration and modeling, progressive skill drills, technology-assisted visual feedback, safety spotting and conditioning, and feedback and correction. Part III assessed perceived skill acquisition, performance confidence, training discipline, safety awareness, and perceived injury-prevention practices. Each of the ten subscales comprised five items. Teaching-strategy responses ranged from 1 (not at all) to 4 (great extent), while outcome responses ranged from 1 (very low level) to 4 (very high level). Perceived injury-prevention practices concerned warm-up, equipment use, skill progression, reporting pain, and safe landing, falling, and spotting. The outcome measures reflected students' perceptions rather than independently assessed performance or documented injury incidence.

Validity, reliability, and data collection

Experts in physical education and sports, research methodology, and educational measurement reviewed the questionnaire for relevance, clarity, appropriateness, and adequacy. The instrument was pilot-tested with 30 students whose characteristics were similar to those of the target respondents and who were excluded from the main study. Cronbach's alpha coefficients ranged from .82 to .85 across the ten five-item subscales, indicating good internal consistency in the pilot sample. These estimates describe pilot-sample internal consistency and do not establish the questionnaire's factor structure or reliability in the main sample.

Formal institutional permissions and informed consent preceded questionnaire administration. Responses were treated confidentially, and completed questionnaires were checked, coded, and tabulated for analysis. Supporting documentation concerning instrument review and data-collection procedures was submitted to the university as part of the study requirements.

Statistical treatment

One-way analysis of variance (ANOVA) was used to examine differences in each of the ten questionnaire dimensions across four classifications: age, skill level, years of gymnastics training, and weekly training hours. Each classification contained four groups and 285 respondents, yielding 3 between-group and 281 within-group degrees of freedom. For the present summary-based analysis, ANOVA p-values were calculated from the rounded F-statistics using the $F(3, 281)$ distribution. Eta squared was derived as $\eta^2 = 3F/(3F + 281)$; in an ordinary one-factor ANOVA, this equals partial eta squared. These p-values and effect-size estimates are approximations based on the available summary statistics, rather than a reanalysis of individual responses.

Pearson product-moment correlations were used to examine the 25 associations between teaching-strategy and perceived-outcome dimensions. The original correlation coefficients and nominal p-values are presented alongside a supplementary Holm adjustment. Two-sided p-values for this adjustment were calculated from rounded r-values and $N = 285$ using $t = r\sqrt{(N - 2)/(1 - r^2)}$, with 283 degrees of freedom. Holm's procedure was then applied jointly across all 25 correlations at a familywise significance level of .05. The adjusted p-values are approximate because the calculation used rounded coefficients.

The 40 omnibus ANOVA tests were interpreted as exploratory and were evaluated at an unadjusted significance level of .05. Significant omnibus tests indicate that at least one group mean differs, but do not identify specific pairwise differences or their direction. Interpretation was therefore limited to omnibus patterns; group-specific means, standard deviations, and post hoc estimates were unavailable for the present analysis.

Diagnostic evidence concerning residual normality, homogeneity of variance, linearity, and influential observations was unavailable for this analysis. Consequently, robustness to violations of ANOVA and Pearson assumptions could not be assessed. Potential dependence among students sharing a coach or training class was also not evaluated. These considerations are particularly relevant to the smallest profile groups.

RESULTS

Differences in teaching strategies according to respondent profile

Teaching-strategy scores differed across age groups at the unadjusted .05 level. Safety spotting and conditioning produced the largest F-value, followed by demonstration and modeling and technology-assisted visual feedback. These findings indicate variation in perceived instructional experiences across age categories. Because age may overlap with experience and skill level, the results do not isolate an independent effect of age.

Table 1: Differences in teaching strategies by age

Dimension	F	df between	df within	p	η^2
Demonstration and modeling	155.088	3	281	< .001	.623
Progressive skill drills	60.368	3	281	< .001	.392
Technology-assisted visual feedback	101.045	3	281	< .001	.519
Safety spotting and conditioning	190.056	3	281	< .001	.670
Feedback and correction	6.190	3	281	< .001	.062

Note. $N = 285$. p -values and η^2 were calculated from rounded F -statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p -values are unadjusted. $\eta^2 = \text{eta squared}$.

As shown in Table 1, safety spotting and conditioning had the largest age-group difference, $F(3, 281) = 190.056$, $p < .001$, $\eta^2 = .670$. Demonstration and modeling, technology-assisted visual feedback, and progressive skill drills also differed across age groups. Feedback and correction had the smallest effect-size estimate, $F(3, 281) = 6.190$, $p < .001$, $\eta^2 = .062$. The large estimate for safety spotting and conditioning describes variation in self-reported scores associated with age-group membership; it does not establish the direction or practical importance of particular group differences.

These patterns are compatible with developmentally responsive instruction. Farana et al. (2023) emphasize the interaction of coaching, biomechanics, and motor-control demands in gymnastics, while Casey and MacPhail (2021) stress adaptation to learner characteristics. Age-related variation may reflect differences in task difficulty, preparation, or supervision needs. These explanations remain hypotheses because the present analysis did not separate age from related learner characteristics.

Skill level also significantly differentiated all five teaching strategies. Progressive skill drills produced the largest F -value across skill-level groups, which is pedagogically coherent because progression should change as athletes move from fundamental movement patterns toward more advanced and competitive skills. The pattern is compatible with learner-centered and progressive teaching principles in which task difficulty, feedback, and support are adjusted to readiness rather than delivered uniformly (Casey & MacPhail, 2021; Magill & Anderson, 2023).

Table 2: Differences in teaching strategies by skill level

Dimension	F	df between	df within	p	η^2
Demonstration and modeling	4.375	3	281	.005	.045
Progressive skill drills	146.751	3	281	< .001	.610
Technology-assisted visual feedback	58.648	3	281	< .001	.385
Safety spotting and conditioning	94.164	3	281	< .001	.501
Feedback and correction	78.312	3	281	< .001	.455

Note. $N = 285$. p -values and η^2 were calculated from rounded F -statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p -values are unadjusted. $\eta^2 = \text{eta squared}$.

All five teaching strategies differed across skill levels. Progressive skill drills showed the largest effect-size estimate, $F(3, 281) = 146.751$, $p < .001$, $\eta^2 = .610$. Safety spotting and conditioning, feedback and correction, and technology-assisted visual feedback also showed significant differences. Demonstration and modeling had the smallest estimate, $F(3, 281) = 4.375$, $p = .005$, $\eta^2 = .045$. The omnibus results do not establish which proficiency groups differed or whether scores increased progressively with skill level.

The pattern is compatible with motor-learning principles emphasizing organized practice, variation, and feedback (Schmidt & Lee, 2019). Research on structured learning approaches also identifies opportunities to support gymnastics skill development (Khataybeh et al., 2024). Together, these perspectives provide a

rationale for evaluating how progression, feedback, visual analysis, and spotting are adapted to athlete readiness, without prescribing particular group differences from the present omnibus tests.

Years of gymnastics training showed a selective pattern of differences. Progressive skill drills, technology-assisted visual feedback, and feedback and correction differed across experience groups, whereas demonstration and modeling and safety spotting and conditioning did not reach the .05 threshold. The pattern suggests that experience-group membership is associated with some aspects of perceived instruction more strongly than others.

Table 3: Differences in teaching strategies by years of gymnastics training

Dimension	F	df between	df within	p	η^2
Demonstration and modeling	0.778	3	281	.507	.008
Progressive skill drills	3.236	3	281	.023	.033
Technology-assisted visual feedback	3.589	3	281	.014	.037
Safety spotting and conditioning	1.406	3	281	.241	.015
Feedback and correction	5.993	3	281	< .001	.060

Note. $N = 285$. p -values and η^2 were calculated from rounded F -statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p -values are unadjusted. $\eta^2 = \text{eta squared}$.

Progressive skill drills differed across training-experience groups, $F(3, 281) = 3.236$, $p = .023$, $\eta^2 = .033$, as did technology-assisted visual feedback, $F(3, 281) = 3.589$, $p = .014$, $\eta^2 = .037$, and feedback and correction, $F(3, 281) = 5.993$, $p < .001$, $\eta^2 = .060$. Demonstration and modeling, $F(3, 281) = 0.778$, $p = .507$, and safety spotting and conditioning, $F(3, 281) = 1.406$, $p = .241$, were not statistically significant. These results concern differences among experience categories and do not demonstrate change within athletes over time.

Non-significant findings do not establish equivalence across groups. Demonstration and safety support remain relevant instructional considerations when athletes encounter unfamiliar or demanding skills. The observed differences in drills, visual feedback, and correction are compatible with adaptive approaches to feedback and practice (Treschman et al., 2024), although the present design cannot determine whether coaching practices changed as athletes accumulated experience.

All five teaching-strategy scores differed across weekly-training groups at the unadjusted .05 level. Technology-assisted visual feedback showed the largest effect-size estimate. The findings suggest variation in perceived instructional environments across training-hour categories, without establishing that additional training time produces better instruction.

Table 4: Differences in teaching strategies by weekly training hours

Dimension	F	df between	df within	p	η^2
Demonstration and modeling	17.965	3	281	< .001	.161

Progressive skill drills	4.902	3	281	.002	.050
Technology-assisted visual feedback	27.328	3	281	< .001	.226
Safety spotting and conditioning	14.854	3	281	< .001	.137
Feedback and correction	2.659	3	281	.049	.028

Note. $N = 285$. p -values and η^2 were calculated from rounded F -statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p -values are unadjusted. $\eta^2 = \text{eta squared}$.

Technology-assisted visual feedback had the largest weekly-training association, $F(3, 281) = 27.328$, $p < .001$, $\eta^2 = .226$. Demonstration and modeling and safety spotting and conditioning also differed across groups. Progressive skill drills showed a smaller difference, $F(3, 281) = 4.902$, $p = .002$, $\eta^2 = .050$, while feedback and correction was close to the nominal threshold, $F(3, 281) = 2.659$, $p = .049$, $\eta^2 = .028$. The latter finding warrants particular caution within the family of exploratory ANOVAs.

Greater training exposure may provide more opportunities for video review, repeated demonstrations, individualized correction, and advanced physical preparation. However, training volume should not be equated automatically with instructional quality. Magill and Anderson (2023) emphasize that motor learning depends on the quality and organization of practice, not simply repetition. Thus, coaches should use additional training time to improve sequencing, feedback, reflection, and recovery rather than merely increase workload.

Differences in perceived training outcomes according to respondent profile

All five perceived training outcomes differed across age groups at the unadjusted .05 level. Perceived injury-prevention practices and skill acquisition produced the largest F -values. The pattern indicates variation in students' self-assessments across age categories and is compatible with differences in developmental and training contexts.

Table 5: Differences in perceived training outcomes by age

Dimension	F	df between	df within	p	η^2
Skill acquisition	80.925	3	281	< .001	.464
Performance confidence	30.743	3	281	< .001	.247
Training discipline	22.759	3	281	< .001	.195
Safety awareness	33.690	3	281	< .001	.265
Perceived injury-prevention practices	99.173	3	281	< .001	.514

Note. $N = 285$. p -values and η^2 were calculated from rounded F -statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p -values are unadjusted. $\eta^2 = \text{eta squared}$.

Perceived injury-prevention practices had the largest age-group effect-size estimate, $F(3, 281) = 99.173$, $p < .001$, $\eta^2 = .514$, followed by perceived skill acquisition, $F(3, 281) = 80.925$, $p < .001$, $\eta^2 = .464$. Safety

awareness, performance confidence, and training discipline also differed across age groups. These results describe perceived outcomes rather than independently measured technical proficiency or injury rates.

The large F-values for perceived injury-prevention practices and skill acquisition identify differences in self-reported scores, but do not reveal their direction or establish practical importance. Motor learning is shaped by learner, task, and environmental conditions (Wulf & Lewthwaite, 2021). Age-responsive instruction may therefore warrant consideration, although these data cannot identify the groups requiring particular adjustments or demonstrate that instruction reduces actual injuries.

All five perceived outcomes differed across skill levels. Training discipline had the largest effect-size estimate, followed by performance confidence and skill acquisition. Variation in task demands and training expectations provides possible context for these associations, but the analysis does not establish their direction or underlying mechanisms.

Table 6: Differences in perceived training outcomes by skill level

Dimension	F	df between	df within	p	η^2
Skill acquisition	65.019	3	281	< .001	.410
Performance confidence	69.220	3	281	< .001	.425
Training discipline	82.582	3	281	< .001	.469
Safety awareness	47.894	3	281	< .001	.338
Perceived injury-prevention practices	48.348	3	281	< .001	.340

Note. N = 285. p-values and η^2 were calculated from rounded F-statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p-values are unadjusted. η^2 = eta squared.

Training discipline showed the largest skill-level association, $F(3, 281) = 82.582$, $p < .001$, $\eta^2 = .469$, followed by performance confidence, $\eta^2 = .425$, and perceived skill acquisition, $\eta^2 = .410$. Perceived injury-prevention practices and safety awareness also differed across skill-level groups. The findings indicate variation across technical, psychological, behavioral, and safety-related self-assessments.

As athletes progress, expectations related to attention, effort regulation, training adherence, and independent responsibility typically increase. Lochbaum et al. (2022) identify confidence as an important performance-related construct, while Self-Determination Theory suggests that perceived competence can influence motivation and persistence (Ryan & Deci, 2020). The findings therefore support differentiated training that includes not only more complex skills but also stage-appropriate confidence building, behavior regulation, and safety education.

Training experience was associated with differences in perceived skill acquisition, performance confidence, and safety awareness. Training discipline and perceived injury-prevention practices did not reach the .05 threshold in the summary-based analysis. Performance confidence showed the largest effect-size estimate within this classification.

Table 7: Differences in perceived training outcomes by years of gymnastics training

Dimension	F	df between	df within	p	η^2
Skill acquisition	4.837	3	281	.003	.049
Performance confidence	10.117	3	281	< .001	.097
Training discipline	2.152	3	281	.094	.022
Safety awareness	7.057	3	281	< .001	.070
Perceived injury-prevention practices	2.431	3	281	.065	.025

Note. N = 285. p-values and η^2 were calculated from rounded F-statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p-values are unadjusted. η^2 = eta squared.

Perceived skill acquisition differed across experience groups, $F(3, 281) = 4.837$, $p = .003$, $\eta^2 = .049$, as did performance confidence, $F(3, 281) = 10.117$, $p < .001$, $\eta^2 = .097$, and safety awareness, $F(3, 281) = 7.057$, $p < .001$, $\eta^2 = .070$. Training discipline, $F(3, 281) = 2.152$, $p = .094$, and perceived injury-prevention practices, $F(3, 281) = 2.431$, $p = .065$, were not statistically significant. Estimates involving the two smallest experience groups are particularly sensitive to individual responses.

The non-significant discipline result does not establish that training experience is unrelated to self-regulation. It does, however, provide no evidence of an omnibus difference at the stated threshold. Goal setting, monitoring, and evaluative feedback remain relevant to self-regulated learning (Panadero et al., 2022), and their roles warrant direct investigation rather than inference from time spent in the sport.

All five perceived outcomes differed across weekly-training groups at the unadjusted .05 level. Perceived skill acquisition had the largest effect-size estimate, while perceived injury-prevention practices had the smallest. This pattern is compatible with associations between training exposure and students' self-assessments, but increased hours alone cannot be treated as a causal mechanism. Practice quality, feedback, and recovery remain relevant considerations (Wulf & Lewthwaite, 2021).

Table 8: Differences in perceived training outcomes by weekly training hours

Dimension	F	df between	df within	p	η^2
Skill acquisition	82.177	3	281	< .001	.467
Performance confidence	41.857	3	281	< .001	.309
Training discipline	7.838	3	281	< .001	.077
Safety awareness	25.121	3	281	< .001	.211
Perceived injury-prevention practices	2.724	3	281	.045	.028

Note. $N = 285$. p -values and η^2 were calculated from rounded F -statistics for an ordinary one-way ANOVA with four groups and are approximate. All omnibus p -values are unadjusted. $\eta^2 = \text{eta squared}$.

Perceived skill acquisition showed the largest weekly-training association, $F(3, 281) = 82.177$, $p < .001$, $\eta^2 = .467$, followed by performance confidence, $\eta^2 = .309$, and safety awareness, $\eta^2 = .211$. Training discipline also differed across groups, $\eta^2 = .077$. Perceived injury-prevention practices was close to the nominal threshold, $F(3, 281) = 2.724$, $p = .045$, $\eta^2 = .028$. The small effect-size estimate and multiple exploratory comparisons limit strong practical conclusions from this latter result.

At the same time, the self-reported nature of perceived injury-prevention practices precludes concluding that additional training hours automatically produce safer practice. Effective practice must remain appropriately structured, progressively challenging, and supported by recovery and safety procedures (Wulf & Lewthwaite, 2021; Magill & Anderson, 2023). Training volume should therefore be managed together with instructional quality, athlete readiness, and preventive practices.

Relationships between teaching strategies and perceived training outcomes

The correlations varied in direction and magnitude across teaching strategies and perceived outcomes. Demonstration and modeling was positively associated with performance confidence and negatively associated with safety awareness and perceived injury-prevention practices. Its associations with perceived skill acquisition and training discipline were not significant. The negative relationships may reflect task difficulty, athlete readiness, or other unmeasured factors; the cross-sectional design does not establish their explanation.

Table 9: Relationships between demonstration and modeling and perceived training outcomes

Perceived outcome	r	N	p	Holm p
Skill acquisition	-0.051	285	.390	1.000
Performance confidence	0.186	285	.002	.010
Training discipline	0.008	285	.889	1.000
Safety awareness	-0.219	285	< .001	.002
Perceived injury-prevention practices	-0.553	285	< .001	< .001

Note. $N = 285$. r = Pearson correlation coefficient. p denotes the original nominal p -value. Holm p is an approximate two-sided adjustment across all 25 correlations, calculated from rounded r -values with $df = 283$. The familywise significance level is .05.

Demonstration and modeling showed a mixed pattern of relationships. It was positively associated with performance confidence ($r = .186$, $p = .002$), but it was not significantly related to skill acquisition ($r = -.051$, $p = .390$) or training discipline ($r = .008$, $p = .889$). Significant negative associations were observed with safety awareness ($r = -.219$, $p < .001$) and perceived injury-prevention practices ($r = -.553$, $p < .001$), the latter representing a moderate relationship.

The positive confidence relationship is compatible with Bandura's (1977) observational-learning framework because a clear model can reduce uncertainty about how a movement should be performed. However, observation alone does not guarantee physical mastery; repeated, organized practice remains necessary (Magill & Anderson, 2023). The negative safety correlations should not be interpreted causally. A plausible

explanation is that coaches demonstrate more frequently when athletes are attempting difficult or riskier movements. Task difficulty, reverse direction of association, confounding, and response patterns were not tested. The coefficient does not show that demonstrations cause injury. Instructional practice may nevertheless model not only the target technique but also safe landing, falling, spotting, and apparatus use.

Progressive skill drills was positively associated with perceived skill acquisition, performance confidence, training discipline, and safety awareness. Its strongest positive association was with performance confidence ($r = .486$), while perceived injury-prevention practices showed a weak negative association ($r = -.200$). These relationships are compatible with the relevance of structured practice to perceived learning outcomes, while instructional approaches continue to incorporate conditioning, supervision, and recovery (Magill & Anderson, 2023; Aliriad, 2023).

Table 10: Relationships between progressive skill drills and perceived training outcomes

Perceived outcome	r	N	p	Holm p
Skill acquisition	0.219	285	< .001	.002
Performance confidence	0.486	285	< .001	< .001
Training discipline	0.210	285	< .001	.003
Safety awareness	0.363	285	< .001	< .001
Perceived injury-prevention practices	-0.200	285	.001	.005

Note. N = 285. r = Pearson correlation coefficient. p denotes the original nominal p-value. Holm p is an approximate two-sided adjustment across all 25 correlations, calculated from rounded r-values with $df = 283$. The familywise significance level is .05.

Progressive skill drills were significantly related to all five outcomes. Positive associations were found with skill acquisition ($r = .219$), performance confidence ($r = .486$), training discipline ($r = .210$), and safety awareness ($r = .363$). The strongest positive relationship was with performance confidence. Perceived injury-prevention practices showed a weak negative relationship ($r = -.200$, $p = .001$).

The positive associations are compatible with Schema Theory, which emphasizes repeated and varied practice in motor learning (Schmidt, 1975; Schmidt & Lee, 2019). The confidence relationship may also reflect perceived mastery, although that mechanism was not tested. The negative correlation with perceived injury-prevention practices does not demonstrate that progressive drills increase injury risk. Independent measures of practice, skill difficulty, and injury exposure would help distinguish possible explanations.

Technology-assisted visual feedback demonstrated the most consistently positive pattern in the study. It was significantly and positively related to all five training outcomes, with the strongest associations found for safety awareness ($r = .577$) and training discipline ($r = .557$), followed by perceived injury-prevention practices, performance confidence, and skill acquisition. Video replay, slow-motion review, visual annotation, and movement analysis can make body position, timing, apparatus contact, and landing mechanics observable after performance, supporting reflection and self-monitoring. The result is consistent with research emphasizing the value of video feedback in motor learning and motivation (Bouzzid et al., 2025; Martín-Rodríguez & Madrigal-Cerezo, 2025).

Table 11: Relationships between technology-assisted visual feedback and perceived training outcomes

Perceived outcome	r	N	p	Holm p
Skill acquisition	0.334	285	< .001	< .001
Performance confidence	0.386	285	< .001	< .001
Training discipline	0.557	285	< .001	< .001
Safety awareness	0.577	285	< .001	< .001
Perceived injury-prevention practices	0.503	285	< .001	< .001

Note. N = 285. r = Pearson correlation coefficient. p denotes the original nominal p-value. Holm p is an approximate two-sided adjustment across all 25 correlations, calculated from rounded r-values with df = 283. The familywise significance level is .05.

Technology-assisted visual feedback produced the most consistently positive pattern in the correlation analysis. It was significantly related to skill acquisition ($r = .334$), performance confidence ($r = .386$), training discipline ($r = .557$), safety awareness ($r = .577$), and perceived injury-prevention practices ($r = .503$), all at $p < .001$. The strongest relationships were with safety awareness and training discipline.

This association supports further evaluation of video-based learning in gymnastics. Mödinger et al. (2022) report that video-based visual feedback can enhance motor learning in physical education, while Bouzid et al. (2025) found benefits of video feedback for motor skill and motivation in gymnastics-related learning. Visual review makes otherwise inaccessible movement information observable and can support reflection, error detection, and self-monitoring. Technology should nevertheless remain a supplement to expert coaching, progressive physical practice, and safety supervision.

Safety spotting and conditioning was positively associated with perceived skill acquisition, performance confidence, safety awareness, and perceived injury-prevention practices. Its strongest association was with skill acquisition ($r = .525$), while the correlation with training discipline was not significant. The pattern is compatible with an instructional role for physical preparation and supervised practice, but it does not demonstrate improved performance or protection from actual injuries.

Table 12: Relationships between safety spotting and conditioning and perceived training outcomes

Perceived outcome	r	N	p	Holm p
Skill acquisition	0.525	285	< .001	< .001
Performance confidence	0.359	285	< .001	< .001
Training discipline	-0.049	285	.408	1.000
Safety awareness	0.188	285	.001	.010
Perceived injury-prevention practices	0.371	285	< .001	< .001

Note. $N = 285$. r = Pearson correlation coefficient. p denotes the original nominal p -value. Holm p is an approximate two-sided adjustment across all 25 correlations, calculated from rounded r -values with $df = 283$. The familywise significance level is .05.

Safety spotting and conditioning had significant positive relationships with skill acquisition ($r = .525$), performance confidence ($r = .359$), safety awareness ($r = .188$), and perceived injury-prevention practices ($r = .371$). Its strongest association was with skill acquisition. The relationship with training discipline was not significant ($r = -.049$, $p = .408$).

The moderate association with skill acquisition suggests that safety-oriented physical preparation can also serve an instructional function. Appropriate spotting allows students to attempt unfamiliar skills in a controlled environment, while conditioning develops the physical capacities needed for successful execution. At the same time, the non-significant correlation does not demonstrate the absence of an association with discipline. Behavioral expectations, monitoring, and feedback must be addressed through complementary strategies.

Feedback and correction showed significant positive relationships with performance confidence, training discipline, and safety awareness. The strongest association in the entire correlation matrix was between feedback and correction and training discipline ($r = .750$). Feedback and correction was not significantly related to perceived skill acquisition or perceived injury-prevention practices. These findings are compatible with a possible role in self-monitoring and behavioral regulation but do not establish that feedback causes these outcomes. Physical practice, progression, conditioning, spotting, and safety procedures remain complementary instructional considerations (Starzak et al., 2022).

Table 13: Relationships between feedback and correction and perceived training outcomes

Perceived outcome	r	N	p	Holm p
Skill acquisition	-0.060	285	.315	1.000
Performance confidence	0.400	285	< .001	< .001
Training discipline	0.750	285	< .001	< .001
Safety awareness	0.569	285	< .001	< .001
Perceived injury-prevention practices	0.043	285	.469	1.000

Note. $N = 285$. r = Pearson correlation coefficient. p denotes the original nominal p -value. Holm p is an approximate two-sided adjustment across all 25 correlations, calculated from rounded r -values with $df = 283$. The familywise significance level is .05.

Feedback and correction showed significant positive relationships with performance confidence ($r = .400$), training discipline ($r = .750$), and safety awareness ($r = .569$). The association with training discipline was the strongest correlation observed in the entire matrix. Feedback and correction was not significantly related to skill acquisition ($r = -.060$, $p = .315$) or perceived injury-prevention practices ($r = .043$, $p = .469$).

The strong feedback–discipline association is compatible with a role for feedback in self-monitoring and behavioral regulation. Starzak et al. (2022) discuss verbal feedback in gymnastics motor learning, while Panadero et al. (2022) connect feedback and evaluative judgment with self-regulated learning. Shared respondent perceptions or overlap in item content may also contribute to the observed relationship. The non-

significant association with perceived skill acquisition does not establish that corrective feedback is ineffective.

Taken together, the correlations suggest different patterns of association across perceived outcomes. The direction and magnitude of relationships varied across teaching strategies. Technology-assisted visual feedback had the broadest positive association pattern; safety spotting and conditioning was particularly related to skill acquisition; progressive drills were most strongly related to confidence; and feedback and correction was strongly related to training discipline. The findings therefore motivate further evaluation of coordinated use of strategies based on the outcome being developed rather than reliance on one instructional technique.

DISCUSSION

The profile-related patterns are compatible with learner-centered pedagogy. Casey and MacPhail (2021) and Fernández-Río et al. (2023) emphasize responsiveness to learner needs, while gymnastics-specific research identifies potential benefits of structured and cooperative learning (Khataybeh et al., 2024). These perspectives support evaluation of instructional approaches that consider readiness, experience, and intended outcomes. The present omnibus comparisons do not establish which specific groups would benefit from particular adjustments.

Recent empirical literature also supports the strong role of feedback and technology. Video-based visual feedback enables learners to observe performance information that is difficult to perceive during rapid movement and has been associated with improved motor-learning processes (Möding et al., 2022; Bouzid et al., 2025). Verbal and corrective feedback can support error recognition and refinement of gymnastics skills (Starzak et al., 2022), while broader work on evaluative judgment links feedback with self-regulation (Panadero et al., 2022). These studies provide possible theoretical context for the observed relationships of technology-assisted visual feedback with all five outcomes and of feedback and correction with training discipline.

Across the inferential findings, the literature suggests that men's artistic gymnastics instruction is best understood as an integrated learning system. Bandura's (1977) Social Learning Theory helps explain why demonstration can contribute to confidence, whereas Schema Theory explains why progressive and varied practice is necessary for physical mastery (Schmidt, 1975; Schmidt & Lee, 2019). Self-Determination Theory complements these perspectives by emphasizing competence, autonomy, and meaningful feedback as foundations of motivation and persistence (Deci & Ryan, 2000; Ryan & Deci, 2020). The mixed correlations in the present study are therefore theoretically coherent: different strategies may perform different instructional functions, but the present correlations do not establish those mechanisms.

Several limitations qualify the findings. Teaching strategies and perceived outcomes were measured using the same questionnaire and respondents, creating susceptibility to common-method bias through response styles, social desirability, recall, and overlapping content. The pilot coefficients provide evidence of internal consistency, but factor-validity evidence and main-sample reliability estimates were unavailable for this analysis. Similarly, the absence of group means, standard deviations, post hoc comparisons, and assumption diagnostics limits assessment of the direction, practical importance, and robustness of group differences. Very small profile groups may yield unstable estimates. The summary-based calculations are approximate, and the unadjusted ANOVA family remains vulnerable to inflated Type I error. The single-institution sample and incomplete information on sampling implementation and nonresponse further limit generalizability.

CONCLUSION

Teaching-strategy and perceived-outcome scores differed across age, skill-level, and weekly-training groups at the nominal .05 level. Training experience showed a more selective pattern: three teaching-strategy dimensions and three perceived outcomes differed across groups. The omnibus findings identify variation in reported experiences, but do not determine its direction, specific pairwise sources, or causal explanation.

Technology-assisted visual feedback was the only strategy positively associated with all five perceived outcomes. Safety spotting and conditioning showed its strongest association with perceived skill acquisition, progressive skill drills with performance confidence, and feedback and correction with training discipline ($r = .750$). Twenty of the 25 associations remained significant in the supplementary Holm analysis. These patterns identify priorities for further investigation rather than establish the effectiveness of particular strategies.

The findings and cited literature provide a rationale for evaluating an integrated instructional model. Demonstration can clarify movement and support confidence, but observation must be followed by physical practice. Progressive drills can support mastery and confidence, but they should be paired with conditioning, spotting, recovery, and safety procedures. Technology can strengthen reflection and self-monitoring, but it should supplement direct coaching. Feedback can reinforce discipline and safety awareness, but corrective information must be converted into action through guided practice. The proposed instructional approach is differentiated, progressive, technology-assisted, feedback-rich, and safety-based.

The study provides exploratory evidence concerning students' perceptions of gymnastics instruction and training outcomes. The cross-sectional design does not establish temporal order or causation, and the injury-related measure describes perceived preventive practices rather than documented injury incidence. Conclusions about instructional effectiveness require evidence from independent performance measures and longitudinal or intervention research.

RECOMMENDATIONS

- Coaches may use the findings to review how demonstrations, skill progressions, feedback, conditioning, and safety support are matched to individual readiness. The omnibus results alone do not justify assigning specific interventions to particular profile groups.
- Technology-assisted visual feedback may be integrated with direct coaching and physical practice through video recording, slow-motion replay, visual annotation, and guided athlete self-review. Its contribution should be evaluated using independent measures of learning and performance.
- Progressive skill training should be paired with skill-specific conditioning, spotting, safe landing and falling practices, equipment checks, hazard recognition, and adequate recovery so that technical progression and safety development occur together.
- Training discipline may be supported through clear expectations, goal setting, monitoring, training logs, and timely feedback. The observed feedback–discipline association provides a rationale for evaluating these practices rather than assuming a causal effect.
- The Department of Gymnastics may establish minimum instructional standards for demonstration, progression, feedback, technology-assisted analysis, safety procedures, and physical preparation, while allowing coaches to individualize their application.
- Future research should evaluate the questionnaire's factor structure and internal consistency in larger samples, include adequately represented profile groups, and report group-level descriptive statistics, assumption diagnostics, effect-size uncertainty, and adjusted pairwise comparisons. Longitudinal, experimental, quasi-experimental, or mixed-method designs combining self-reports with independent performance assessments and prospectively recorded injuries and training exposure would strengthen evidence concerning instructional effects.

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