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Provider versus recipient: Peer feedback roles effect on task performance, perceptions of learning, trust, and epistemic emotions☆

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ABSTRACT

When participating in peer feedback, students typically act as either providers or recipients. While existing research indicates these roles may influence learning in different ways, evidence on their specific effects remains scarce. This study investigated the impact of peer feedback roles on task performance, perceptions of learning and trust, and emotions. Using a repeated-measures quasi-experimental design, 95 undergraduate Physical Education students completed a task, were randomly assigned to the provider or recipient role, and then completed a second task. The results showed no significant differences between roles in improvements in task performance or perceived learning, although both roles significantly improved over time. Role assignment also did not affect trust in oneself or peers, nor the intensity of epistemic emotions. Overall, these findings suggest that, in the short term, taking the role of provider or recipient leads to similar learning outcomes.

1. Introduction

Peer feedback is a learning activity in which individuals or small groups exchange, reflect on, and act upon feedback regarding their performance on a specific learning task. Its primary goal is to achieve shared and individual learning objectives, whether implicit or explicit (Alqassab et al., 2018a). Peer feedback falls under the broader category of peer assessment and focuses on the exchange of qualitative comments (e.g., Alqassab et al., 2019). During the peer feedback process students can take on two distinct roles: providers or recipients of feedback (Reinholz, 2016). As providers, students leverage their knowledge and skills to review, clarify, and correct their peers' work (Kim, 2009). As recipients, they receive feedback from their peers, which they can use to enhance their task performance, develop self-regulated learning strategies, and strengthen critical thinking skills, among other benefits (Tsivitanidou & Constantinou, 2016).

With the aim of understanding student learning through provision and reception of peer feedback, extensive research has focused on its impact on learning outcomes, like task performance, as supported by numerous reviews and meta-analyses (Double et al., 2020; Li et al., 2020). Moreover, researchers have investigated how peer feedback influences other relevant outcomes, such as students' perceptions and emotions (Panadero et al., 2023). The influence of peer feedback on perceptions, such as perceived learning (e.g., Nicol et al., 2014) or perceptions of trust (e.g., Cheng et al., 2023), is particularly pertinent, given its connection to student motivation and engagement in learning activities (Bandura, 1978). Similarly, emotions play a crucial role in students engagement and academic success (Pekrun & Linnenbrink-Garcia, 2012). Accordingly, studies have shown that peer feedback, can significantly influence students' emotions, both through

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the provision (Alqassab et al., 2019) and reception of peer feedback (Cheng et al., 2014).

However, research on the effects of peer feedback on the above-mentioned variables has often either examined both roles, provider and recipient, without distinguishing between them (e.g., Cho & MacArthur, 2011; Gielen et al., 2010) or focused exclusively on only one role (e.g., Alqassab et al., 2019; Berndt et al., 2018; Strijbos et al., 2010). Recently, an increasing number of correlational studies have begun to explore both roles simultaneously, focusing especially on the quality and quantity of the feedback provided or received (Wu & Schunn, 2020, 2023; Zong et al., 2021). Going even further, a more reduced group of studies have explored both roles and compared them in terms of learning outcomes (e.g., Huisman et al., 2018; Ion et al., 2019; Lundstrom & Baker, 2009). This effort is particularly relevant, as it helps to identify how students learn differently from peer feedback provision versus feedback reception, which ultimately, allows for the identification of role-specific needs through direct contrast between the two roles (e.g., Ion et al., 2019). However, disentangling the effects of providing and receiving feedback remains challenging, and many studies do not fully isolate the unique contributions of each role (Double et al., 2020). As a result, a significant gap remains in advancing the comparison between peer feedback roles, despite the progress made by the studies mentioned above. The following section reviews prior research comparing the effect of peer feedback roles on key learning outcomes and highlights the specific gap this study addresses.

1.1. Peer feedback roles and task performance

The effect of peer feedback and task performance has been a central focus of research. Reviews (Panadero et al., 2018; van Zundert et al., 2010) and meta-analyses (Double et al., 2020; Yan et al., 2022) show that peer feedback can positively impact task performance. It has been suggested that the two roles might not impact equally on task performance, as students activate distinct cognitive processes (Aben et al., 2024; Bauer et al., 2023). Along these lines, it has been pointed out that the recipient role might be more passive as students might not know what to do with the feedback received from the provider, hindering its impact on task performance (Gielen & De Wever, 2015). However, this is still an open question since most of the studies typically examine the overall impact of peer feedback on task performance without distinguishing between the differential effects of the two roles, providers and recipients (Double et al., 2020). Moreover, the scarce empirical evidence comparing the effects of providing and receiving feedback on task performance yields mixed findings.

Few (quasi-)experimental studies comparing both roles exist. This includes: Crinon and Marin (2010), Lundstrom and Baker (2009), Huisman et al. (2018), and Zamorano et al. (2025). On one hand, Crinon and Marin (2010) and Lundstrom and Baker (2009) found that students who provided peer-feedback on a writing task outperformed those who only received peer-feedback. On the other hand, Huisman et al. (2018) and Zamorano et al. (2025) found no significant differences between roles on improvement in task performance. In Huisman et al.'s (2018) classroom-integrated intervention students who acted as feedback providers or recipients equally showed significant gains. The study by Zamorano et al. (2025) was conducted in a single-session laboratory setting and revealed no significant gains in task performance. While these results may appear balanced, differences in study designs, tasks, and contexts likely contribute to these divergent findings. In particular, Zamorano et al.'s (2025) laboratory-based study isolated the roles under highly controlled conditions. Therefore, further classroom-based interventions, similar to those by Crinon and Marin (2010) and Lundstrom and Baker (2009), are needed to examine whether the effects observed in laboratory settings replicate in authentic learning environments. Such efforts would provide a clearer understanding of how provider and recipient roles differentially affect task performance across contexts. Yet, focusing solely on performance outcomes overlooks the inherently social and multifaceted nature of peer feedback. As highlighted by Panadero et al. (2023), its effectiveness is also shaped by personal and interpersonal factors, particularly students' perceptions, which play a critical role in how feedback is received and acted upon.

1.2. Peer feedback roles and perceptions

In educational contexts perception refer to students' beliefs and attitudes about their learning experiences. They have received extensive attention in the broader education field since they have the potential to influence motivation and engagement in learning activities, which, in turn, affects learning outcomes (Bandura, 1978). In the peer feedback field, there has been growing recognition of how peer feedback shapes students' perceptions, which have become one of the most extensively studied outcomes of peer feedback (Alqassab et al., 2023). This attention is well deserved, since peer feedback shapes students' perceptions, which at the same time influence their engagement in later learning activities and future peer feedback cycles (Panadero et al., 2023). Some of the perception that can shape the peer feedback process are perceptions of learning or trust in oneself and in peers as providers of peer feedback (Senden & Coertjens, 2024). Although research has explored the effects of providing and receiving peer feedback on student perceptions, recent studies suggest that these roles may have distinct influences on them (Ion et al., 2019; Martin & Sippel, 2021; Mulder et al., 2014). These efforts are valuable because they help identify differences between feedback roles that may need to be addressed. For instance, students may perceive higher learning or greater trust in one role than in the other, potentially leading to disengagement with the less preferred role, despite its learning potential. The following section reviews the evidence related to these differences.

1.2.1. Perceptions of learning from peer feedback

Perception of learning is one dimension that researchers have been particularly interested in, especially regarding how different peer feedback roles influence it. This focus is important because perceptions influence engagement, and if students generally perceive more learning in one role, targeted support may be needed for the less preferred role, given that both roles can enhance learning. So far, some evidence has suggested that students often perceive greater learning gains when providing rather than receiving peer feedback (Ion et al., 2019; Martin & Sippel, 2021; Mulder et al., 2014). Meanwhile, other studies argue that students perceive similar learning benefits from both roles (Cao et al., 2019; Ertmer et al., 2007; Nicol et al., 2014, Zamorano et al., 2025).

However, despite the extensive attention perceived learning has received regarding role effects, the majority of these studies rely on student testimonies and lack a (quasi-)experimental design. Two notable exceptions form the above-mentioned studies comparing students perceptions as providers and recipients, addressed this limitation by using a quasi-experimental design to assess both the significance and magnitude of this difference (Martin & Sippel, 2021; Zamorano et al., 2025). Martin and Sippel (2021) compared three student groups: a control group, a recipient group, and a provider group. Both providers and recipients showed significant differences in perceived learning at the post-test, with providers exhibiting a significantly greater perceptions of learning (medium effect size). Nonetheless, their analysis did not directly compare the magnitude of change between the groups, making it unclear whether the provider group's improvement overtime was larger or smaller than the others. Meanwhile, Zamorano et al. (2025) was able to compare roles directly by conducting a laboratory-based study in which students participated in both with-in a single session, which enabled a controlled comparison. They found no significant difference in students' perceptions of learning between the two roles. However, the laboratory setting may have limited the generalizability to authentic classroom peer feedback as students worked individually in the laboratory with standardized feedback and peer solutions. This may not fully represent how students experience peer feedback in real

classroom setting like Martin and Sippel (2021). Accordingly, given the limited number of (quasi-)experimental studies and the limitations and mixed findings of the existing research, more studies, particularly classroom-based ones such as Martin and Sippel (2021), are needed to confirm differences in perceived learning.

1.2.2. Perceptions of trust as providers and recipients

Peer feedback can also influence students perceived trust both in themselves and in their peers as competent providers of peer feedback (Panadero et al., 2023; Senden & Coertjens, 2024). Previous research has examined trust separately either from the perspective of providers and the recipients (Rotsaert et al., 2017; van Gennip et al., 2010) as well as how prior trust in peer feedback affects future engagement and outcomes (Carlsson Hauff & Nilsson, 2022). However, few studies have directly investigated how adopting the role of either provider or recipient shapes students' trust in themselves and in their peers as providers of feedback. Trust can directly influence students' willingness to engage in the peer feedback and consequently influence learning outcomes like task performance (Carless, 2012; Cheng & Tsai, 2012). Consequently, understanding if and how trust is shaped differently by the specific role can help provide more targeted support for that role if indeed needed. Under that premise, in a qualitative study, Zhan (2024) highlighted students' particularly distrust toward their peers' competence as providers. Following this results, with the aim of testing the significance and size of this effect, Zamorano et al. (2025) directly measured the effect of role on students' trust, on an experimental design, finding no significant difference between providers and recipients. While both studies are valuable, they are insufficient to determine whether peer feedback roles have an effect on students' perceived trust, especially if considering exploratory nature of Zhan (2024) and the laboratory setting of Zamorano et al. (2025), which while controlled might not reflect the reality of a classroom environment. Thus, whether peer feedback roles have a significant effect on students' perceptions of trust remains an open question. Addressing this gap calls for research in classroom settings that can robustly isolate the effect of roles on perceived trust. Beyond perceived learning and trust, which have begun to receive growing attention in studies comparing provider and recipient roles, other intrapersonal factors equally central to learning from peer feedback remain underexplored, like emotions.

1.3. Peer feedback roles and emotions

According to Pekrun (2024), epistemic emotions, emotions emerging from cognitive conflicts and challenges within learning tasks, play a crucial role in shaping students' engagement and the amount of effort students invest in a learning task. In peer feedback settings, these emotions become particularly relevant because the provision and reception of feedback involve different cognitive processes (Aben et al., 2019; Bauer et al., 2023) which may, in turn, lead to different emotional experiences (Panadero et al., 2023). For example, stronger feelings of confusion when receiving feedback may stem from an incongruity between students' perceptions and their peers' comments, which can lead to abandoning the task due to a lack of control (Alqassab et al., 2019). In contrast, confusion during feedback provision may arise from difficulties in understanding the peer's task, resulting in vague or incomplete feedback. These dual dynamics also extend to frustration, curiosity and other epistemic emotions (Pekrun, 2024; Pekrun & Stephens, 2011). Some studies have tentatively explored this "emotional duality": Bharuthram and van Heerden (2023) conducted a qualitative study that catalogued providers and recipients emotions (e.g., joy, annoyance) and grouped them into broad positive versus negative categories. Although both roles exhibited a similar emotional response, the study's design could not show how intensely each emotion was experienced, nor whether these intensities differed by role. Accordingly, further evidence is needed as understanding these role-specific emotional patterns would deepen our knowledge of how students process peer feedback. Our focus is to explore whether there are epistemic emotions (e.g., curiosity, enjoyment, confusion) that are more prominently elicited depending on the role, provider and recipient. Such insights have practical implications for instructional design, highlighting the importance of preparing students to manage both the emotional and cognitive demands associated with each role.

1.4. Aim, research questions (RQ) and hypotheses

Our aim is to examine the effects of peer feedback roles (providing or receiving) on changes in (RQ1) task performance, (RQ2) students' perceptions of learning and trust, and (RQ3) epistemic emotions. Our research questions (RQ) and hypotheses (H) are as follows:

RQ1. What is the effect of peer feedback roles on changes in task performance?

H1. Based on prior research showing no significant performance differences between roles (Huisman et al., 2018; Zamorano et al., 2025), we hypothesize that providers and recipients will show similar improvements in task performance.

RQ2. What is the effect of peer feedback roles on students' changes in perceptions of learning (RQ2.1) and trust (RQ2.2)?

H2. Based on results of Zamorano et al. (2025) which found no significant role-based differences in either perceived learning or trust therefore we hypothesize that changes in both perception will not differ significantly between students who provide feedback and those who receive peer feedback.

RQ3. What is the effect of peer feedback roles on the intensity of epistemic emotions?

H3. Due to the lack of previous empirical evidence, we did not formulate a hypothesis for this research question, making it an exploratory investigation.

2. Method

2.1. Sample

During the second semester of the academic year, 167 third- and fourth-year Sport Sciences and Physical Education students from a Spanish public university voluntarily participated in this study. They completed initial control measures: previous task related knowledge and previous peer feedback and rubric self-efficacy. Then, they enrolled in a three-week intervention with three measurement points (control measure, pre-test, and post-test). Following guidelines to ensure data quality Acock (2005), participants with more than 10 % missing data per variable at any time point were excluded, resulting in a final sample of 95 students. For the remaining participants (n = 95) with incomplete responses, we applied a 10 % threshold for missing data per variable, following Acock (2005). If missing data fell below this threshold, we tested for the Missing Completely at Random (MCAR) assumption. As the assumption was met, we applied Expectation-Maximization (EM) imputation, as recommended by Acock (2005).

After this process, we retained 95 participants with complete data across all measurement points. The final sample consisted of 30 female and 65 male students ($M_{age} = 21.53$; $SD_{age} = 1.84$). Students from each year group were simultaneously divided into pre-configured groups: Third-year students were enrolled in "*Pedagogy of Physical Education*" ($n_{3^{o}year} = 52$; $n_{3^{o}year\text{-}A} = 30$, $n_{3^{o}year\text{-}B} = 22$) and fourth-year students were enrolled in "*Leisure and Outdoor Activities*" ($n_{4^{o}year} = 43$; $n_{4^{o}year\text{-}A} = 22$, $n_{4^{o}year\text{-}B} = 21$). To assess statistical power, we conducted a sensitivity power analysis to determine the minimum effect size detectable given a fixed sample size, desired statistical power, and alpha level (Lakens, 2022b). As for the Generalized Linear Mixed Model (GLMM) analyses, power estimation remains complex due to the lack of openly available raw datasets with similar structures (Kumle et al., 2021). Consequently, we used G*Power to conduct sensitivity analyses for the three research questions. For RQ1 and RQ2, we ran repeated-measures ANOVAs

(within-subjects and within-between interactions) with 80 % power and an $\alpha = .05$. The results indicated that our analyses were sensitive enough to detect small-to-medium effect sizes for within-subjects ($d = .370$) and interaction effects ($d = .290$). For RQ3, we conducted a sensitivity analysis for a one-way between-subjects ANOVA with the same parameters (80 % power, $\alpha = .05$), which revealed that our analysis was sensitive to medium effect sizes ($d = .580$).

2.2. Design

We employed a between-subjects experimental design with repeated measures to examine how peer feedback roles influence changes in task performance, perceptions of learning, and trust. Epistemic emotions were measured only at post-test, after either providing or receiving peer feedback, as we did not examine the effect of roles over time. The study included 95 participants who had complete data across all measurement points (see Fig. 1). Following the control and pre-test phase, participants assigned by they pre-configured university groupings, to one of two conditions: peer feedback providers ($N = 51$; $n_{s°year\text{-}A} = 30$, $n_{s°year\text{-}B} = 21$) or recipients ($N = 44$; $n_{s°year\text{-}B} = 22$, $n_{s°year\text{-}A} = 22$). The study was approved by the Deusto University Research Ethics Committee (Reference: ETK-19/23–24). Prior to participation, all students provided informed consent.

2.3. Materials

2.3.1. Task performance task: orienteering map analysis task

Task performance was measured using scores from two writing tasks that students completed in class: one before acting as providers or recipients, depending on their assigned condition, and one after (Task 1 and Task 2, Appendix A). The task assessed students' ability to orient themselves and interpret map information according to the rules of the orienteering sport discipline. For the task, students were given a topographic map with a marked trajectory (see Appendix A). To successfully complete the task, students had to make a written report of the trajectory marked on the map and include five key elements: geographic space description, map symbol interpretation, land use analysis, contour line interpretation, and three-dimensional landscape analysis. The geographic space description required students to identify terrain features such as valleys, hills, and plains, along with significant landmarks like rivers, roads, and forests, to establish orientation. Map symbol interpretation involved identifying key elements along the route, including trail intersections, elevation markers, water bodies, and vegetation types. Land use analysis required students to distinguish between residential, industrial, agricultural, and conservation areas and explain how this influenced navigation. Contour line interpretation focused on assessing elevation and slope variations, recognizing how inclines, descents, or flat areas affected the route. Finally, three-dimensional landscape analysis involved integrating an understanding of terrain features and contour lines to identify elevation changes, ridgelines, depressions, and natural obstacles that could impact navigation. These five elements ensured a comprehensive spatial analysis, guiding students in applying topographic and navigational skills effectively.

2.3.2. Rubric

A rubric developed by the first and fourth authors was used to score the orienteering map analysis task. The rubric consisted of five criteria, rated on a scale from 0 (lowest) to 4 (highest) (see Appendix B). To score students orienteering map analysis tasks and ensure reliability, the first author and a research assistant independently scored 15 % of randomly selected student responses. Cohen's Kappa (κ) was used to assess inter-rater reliability (McHugh, 2012). If the agreement did not meet the acceptable threshold ($\kappa > .80$), discrepancies were discussed and resolved, and the process was repeated with another randomly selected 15 % of responses. This procedure continued until the inter-rater agreement reached an acceptable level. After three rounds, a final Kappa coefficient of $\kappa = .896$ was achieved.

The rubric had another use beyond ensuring construct validity when scoring the task (Jonsson & Svingby, 2007). Since the intervention was embedded in a real classroom context, students had access to the same rubric throughout the completion of the task and the peer feedback activity. Specifically, the rubric aimed to help students understand performance expectations and use these criteria as a reference point during the provision or reception of feedback. The rubric provided to the students did not include scores but rather proficiency criteria (from inadequate to excellent). Given the central role of the rubric in guiding students' engagement with the task and peer feedback, we also measured students' prior self-efficacy in rubric use as a control measure.

2.4. Instruments

2.4.1. Prior knowledge test

Prior knowledge was assessed as a control measure (Cho & MacArthur, 2010) using a multiple-choice test designed by the fourth author, who is a subject matter expert. The test consisted of 11 multiple-choice questions, each with only one correct answer, with a resulting score from 0 to 11. This assessment measured students' pre-existing knowledge of map interpretation and decoding within the context of orienteering. The prior knowledge test can be found in Appendix C. The reliability assessed using McDonald's omega, was $\omega = .418$, which is modest; however, given the test's design to sample a broad range of subskills with a limited number of items, together with the absence of baseline group differences and its expected behavior as a covariate in the GLMM, we consider it an adequate control measure.

2.4.2. Questionnaires

The internal structure of the not validated but previously used scales Peer Feedback Provision Questionnaire and Feedback Receiving Questionnaire was assessed using confirmatory factor analysis (CFA) (Bandalos & Finney, 2019; Sun, 2005). Adjustments were made to ensure construct alignment. A detailed description of this process provided in Supplementary Material 1. We now present the final scale structure, the number of items, and their respective reliability measures, assessed using McDonald's Omega (Ω) (Mcneish, 2017).

Peer Feedback and rubric use self-Efficacy (Ad-Hoc). As a control measure, students completed three items assessing their prior perceived self-efficacy in providing peer feedback (e.g., *"How capable do you feel of giving and receiving feedback from a classmate?"*) and another three items for using rubrics (e.g., *"How capable do you feel of using a rubric when completing a class assignment?"*), as both tasks were integral to later stages of the study. Responses were rated on a five-point Likert scale, ranging from 1 ("None") to 5 ("Excellent"), capturing their perceived self-efficacy before engaging in these activities.

The Peer Feedback Provision Questionnaire (PFPQ; Alqassab et al. (2018b, 2019) and Peer Feedback Receiving Questionnaire (PFRQ; Zamorano et al. (2025). We employed this previously used instrument (Alqassab et al., 2018b, 2019) to measure changes in students' perceptions of learning and trust as feedback providers or recipients. The scales were adapted to allow us to measure these two constructs separately for each role, enabling direct comparisons, as most existing instruments typically combine both roles within the same measures. The consists of 31 items organized into two sub-scales, each rated on a 7-point Likert scale (1 = "Strongly disagree" to 7 = "Strongly agree"). The sub-scales include: Learning from Peer Feedback (LR/PF (17 items) *"Providing/receiving peer feedback motivates me to modify my own work"*) and Trust[5] in Peer Feedback (TR/PF (14 items), *"I believe that I have the*

[5] In the original scale, the authors labelled this subscale as confidence in peer feedback. The label trust was adopted in this study because the items align with the wording of items in other studies measuring trust in peer feedback.

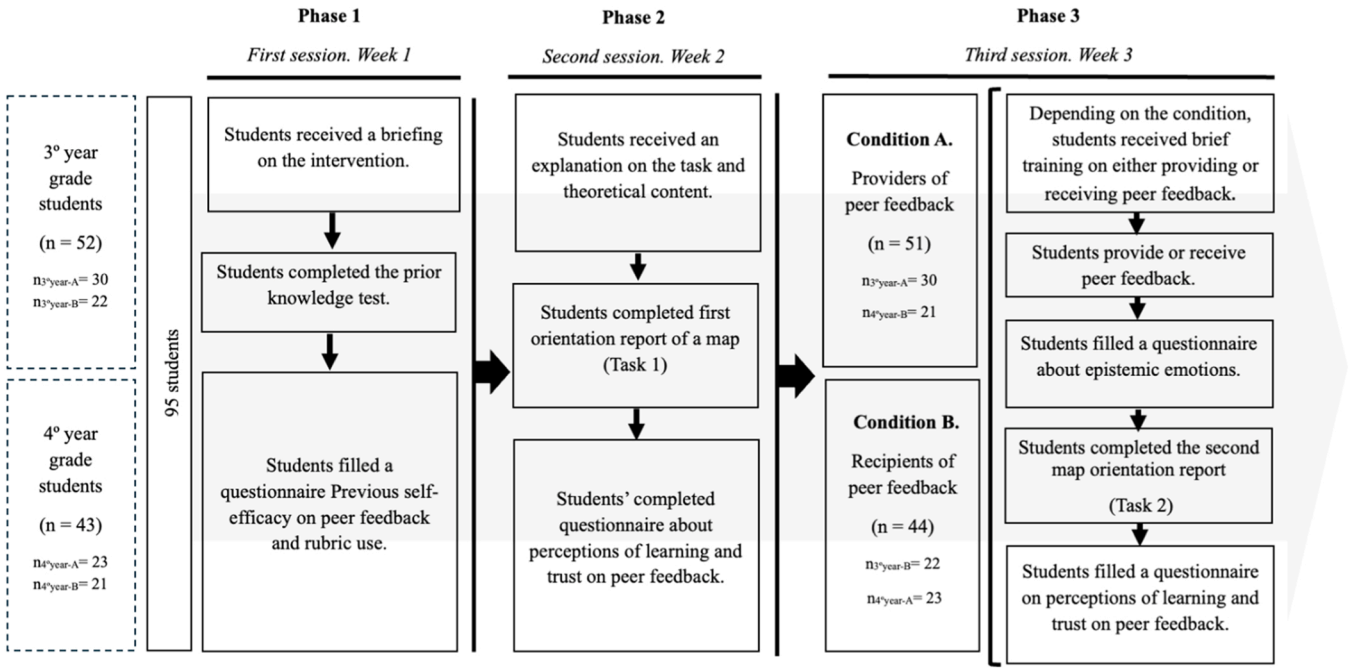

Fig. 1. Detailed illustration of the study procedure.

competence to provide/receive peer feedback."). All sub-scales demonstrated high reliability, with Learning from Peer Feedback (Ω =.948) and Trust in Peer Feedback (Ω =.945) indicating that the scales as a whole showed strong reliability.

Epistemically-Related Emotion Scales (EES) (Pekrun et al., 2017**).** We used this instrument to measure the effect of roles on the intensity of epistemic emotions. The short scale by Pekrun et al. (2017) has two elements, the seven epistemic emotions, each represented by a single-word item, *Surprise, Curiosity, Enjoyment, Confusion, Anxiety, Frustration, and Boredom* and the intensity the experience this emotions. Participants rated the intensity of each emotion on a five-point Likert scale, ranging from 1 ("Not at all") to 5 ("Very strong"). Trevors et al. (2017) groups them in two subscales: Positive (Curiosity, Enjoyment) and Negative (Confusion, Frustration, Anxious, Bored, Surprise). We calculated the mean of Positive and Negative while also analyzed each emotion independently.

2.5. Procedure

Participants were enrolled in a curricular activity as part of two different courses within the Sports Sciences degree, both lectured by the same teacher, the fourth author. Third-year students were enrolled in "Pedagogy of Physical Education" who were divided into two pre-configured groups ($n_{3ºyear}$ = 52; $n_{3ºyear\text{-}A}$ = 30, $n_{3ºyear\text{-}B}$ = 22). Fourth-year students were enrolled in "Leisure and Outdoor Activities" with the same division ($n_{4ºyear}$ = 43; $n_{4ºyear\text{-}A}$ = 22, $n_{4ºyear\text{-}B}$ = 21). The experimental procedure was identical for both year groups. Participation in the study activities was mandatory as they were part of the curriculum of both subjects and counted toward classroom attendance; however, participation in the study itself was voluntary.

The intervention spanned three weeks (from the second to the fourth week of February 2024) and consisted of three structured sessions, one per week, each lasting two hours.

In Session 1, students attended a regular class session, where they received a briefing on the intervention, provided informed consent, and completed baseline self-report measures. These included a prior knowledge test, an ad-hoc scale on self-efficacy in peer feedback and rubric use.

In Session 2, students received theoretical and practical training on map interpretation and decoding in orienteering sports, which provided the foundational knowledge necessary for subsequent tasks. Then, they completed the first orienteering map analysis task (Task 1, see Fig. 1) and when finished students filled the Peer Feedback Reception/Provision Questionnaire (PFPQ/ PFPQ).

In Session 3, students were assigned to two conditions based on their enact classes: providers (N = 51; $n_{3ºyear\text{-}A}$ = 30, $n_{4ºyear\text{-}B}$ = 21) or recipients (N = 44; $n_{3ºyear\text{-}B}$ = 22, $n_{4ºyear\text{-}A}$ = 22) of peer feedback. Peer feedback providers, who attended class one day before the recipients, attended class and received a training on feedback provision of half an hour (Ocampo et al., 2024), then provided feedback on the Task 1 responses of two peers. To assign students to their recipients, prior knowledge test scores were used to categorize them into low and high-performance levels. Each student provided feedback to one peer from the high level and one from the medium level on prior task knowledge. Immediately after providing peer feedback, students completed the Epistemic-Related Emotion Scale (EES). Following this, students completed the second orienteering map analysis task (Task 2, see Fig. 1). Finally, they filled out the Peer Feedback Provision or Reception Questionnaire (PFPQ/PFRQ) depending on their condition. The following day, the procedure was repeated with the recipient condition. However, in this session, students (1) received training on feedback reception, which included general strategies for engaging with peer feedback, such as how to interpret feedback critically, manage conflicting information, and reflect on its usefulness, and (2) received the feedback provided by their peers. On both conditions, throughout the completion the two orienteering map analysis task and the feedback provision or reception participants had access to the rubric, later used to score the task (see Appendix C). For more information on the peer feedback instructional design, see Supplementary Material 2.

2.6. Data analysis

2.6.1. Data screening

To assess the distribution of the data, we examined standardized skewness and kurtosis, the Shapiro-Wilk test of normality, and univariate outliers. Following Tabachnick and Fidell's (2013) criteria of ±3 for extreme skewness and kurtosis, several variables showed substantial departures from normality. For instance, post-measurements of

perceived learning and trust both exceeded ±3 in skewness ($sk = -6.93$ and $sk = -4.33$, respectively), while post-measurements of perceived learning also exceeded ±3 in kurtosis ($k = 8.19$). Moreover, the Shapiro-Wilk test indicated that most variables significantly deviated from a normal distribution ($p < .05$), confirming non-normality. Outlier analysis based on z-scores (Field, 2009) identified one participant with consistently low scores ($z < -3$) on perceived learning from peer feedback. After verifying the original entries, the data were retained as they fell within an acceptable range of deviation for inclusion in the analysis.

2.6.2. Plan of analysis

For our RQ1 and RQ2, we examined the impact of peer feedback role (provider or recipient) on students' changes in task performance and perceptions of learning and trust using GLMMs. These models are well-suited for analyzing non-normal data (Bolker et al., 2009) while also allowing for the testing of both fixed effects and random effects. Fixed effects represent the variables of primary interest in the study, while random effects accounts for individual differences across repeated observations within participants (Brown, 2021). We began by fitting a maximal model with random intercepts for both year level and individual variation and progressively simplified it until the model converged (Singmann & Kellen, 2019). Given the positive skew observed in task performance and perception scores, we applied a Gamma distribution with a logarithmic link function (Garson, 2014). To assess model fit, likelihood ratio tests were used to compare the full model (including predictors) with a nested model (excluding predictors), determining whether peer feedback role significantly influenced the dependent variables (Brown, 2021). We report both fixed and random effects along with the results of these likelihood ratio tests (Meteyard & Davies, 2020) and Cohen's d as a standardized effect size (Lakens, 2022a). Since epistemic emotions were measured only at post-test, we performed Mann–Whitney U tests for all emotion variables, including both grouped (positive/negative affect) and discrete emotion measures. Although the range of year levels in our sample was relatively small, from the third to fourth year of their graduate program, we included it as a random effect in the GLMM to account for the nested data structure and potential differences in peer feedback outcomes reported in previous research (Li et al., 2016; Sanchez et al., 2017; Zhang et al., 2020). All analyses were performed in R version 4.2.2. GLMM models were run with the lme4 package (v. 1.1–32; Bates et al., 2015).

3. Results

3.1. Preliminary analysis

Due to the pre-structured group assignments for each condition, we first ensured that participants in both conditions (provider and recipient) did not differ at baseline. To do so, we examined three variables: (1) self-efficacy regarding peer feedback, (2) self-efficacy with rubrics, and (3) prior knowledge. We performed Kruskal-Wallis tests to compare peer feedback providers and recipients on these measures. The groups did not differ significantly on self-efficacy for peer feedback, ($H\ (94) = 0.001$, $p = .976$) or prior knowledge ($H\ (94) = 1.10$, $p = .294$). However, they did differ on self-efficacy for rubric use ($H\ (94) = 8.16$, $p = .004$). Therefore, we included self-efficacy for rubric use as a covariate in the subsequent task performance analyses to control for this baseline imbalance.

Prior to examining the coefficients, all models for the three research questions were initially tested both with and without the nested structure of year level for the GLMM. Likelihood ratio tests and changes in the Akaike Information Criterion (AIC) were examined for GLMMs (Bolker et al., 2009; Bono et al., 2021). Results showed that model fit did not improve or even worsened across all models when year level was included. Therefore, the final models presented did not include year level as it did not contribute significantly to explaining the data. A detailed report of the entire analysis procedure, including the contrast between models and detailed results, is available in Supplementary Material 3.

3.2. RQ1. Peer feedback roles effect on task performance

According to a GLMM that included peer feedback role and time as fixed factors, self-efficacy with rubrics as a covariate, and a random intercept for participants, role (provider or recipient) did not have a significant effect on improvement of task performance (Std.$\beta = -0.01$, $p = .555$). However, students' task performance significantly improved from Time 1 ($M = 2.08$, $SD = 0.55$) to Time 2 ($M = 2.37$, $SD = 0.45$) (Std.$\beta = 0.12$, $\chi^2(4) = 3.10$, $p = .006$) with a medium effect size of $d = .557$ (see Table 1 Fig. 2). This suggests that, in our sample, regardless of the roles students played their task performance significantly improve over time. Variance at the subject level was not estimated, indicating minimal between-subject differences in baseline values, but was retained to account for repeated measures.

3.3. RQ2.1 Peer feedback roles effect on students' perceptions of learning

According to a GLMM that included peer feedback role and time as fixed factors and a random intercept for participants, role (provider or recipient) did not have a significant effect on the improvement of perceived learning (Std.$\beta = 0.00$, $p = 1.00$). However, students perceived learning significantly increased from Time 1 ($M = 5.46$, $SD = 0.82$) to Time 2 ($M = 5.76$, $SD = 0.75$) (Std.$\beta = 0.03$, $\chi^2(3) = 2.63$, $p = .027$), with a medium effect size of $d = .381$ (see Table 2 Fig. 3). This suggests that, regardless of the roles students played, their perceived learning significantly improved over time. Overall, perceived learning was already high at pre-test and increased for both roles: for providers ($M_{pre} = 5.56$, $SD_{pre} = 0.79$; $M_{post} = 5.87$, $SD_{post} = 0.87$) and for recipients ($M_{pre} = 5.38$, $SD_{pre} = 0.70$; $M_{post} = 5.68$, $SD_{post} = 0.77$). Variance at the subject level was not estimated, indicating minimal between-subject differences in baseline values, but was retained to account for repeated measures.

3.4. RQ2.2 Peer feedback roles effect on students' perceptions of trust

According to a GLMM that included peer feedback role and time as fixed factors and a random intercept for participants, role (provider or recipient) did not have a significant effect on changes of perceived trust over time (Std.$\beta = -0.00$, $p = 1.00$). This is reinforced by the fact that our model including predictors did not provide a better fit than the null model (see Table 3 Fig. 4). These findings indicate that perceived trust remained stable across both time points, regardless of students' roles in

Table 1
GLMM Model Predicting Task Performance as a Function of Peer Feedback Role.

	Fixed Effects			
	Std.β	95 % CI	*t*	*p*
Predictors				
Intercept	1.34	0.45–0.95	5.552	.000
Role	-0.01	-0.56–0.04	-.235	1.00
Time	0.12	0.02–0.11	3.105	.006***
Self-efficacy Rubric	0.03	-0.02–0.06	.736	1.00
Interaction				
Role x Time	0.04	-0.01–0.06	1.102	.555
	Random effects			
	Variance	*SD*		
Subject (Intercept)	-	-		
	Model fit: Likelihood-ratio test.			
	X^2	*df*	*p*	
"Nested model" vs. model	10.42	5	.006	

Note. Model equation: Task performance ~ as factor(ROLE) * as factor(Time Point) + Self efficacy on rubric use + (1|Subject). Significant codes: ***$p < .001$. *p* values are corrected with Bonferroni. Coding: Recipient (1); Provider (2)

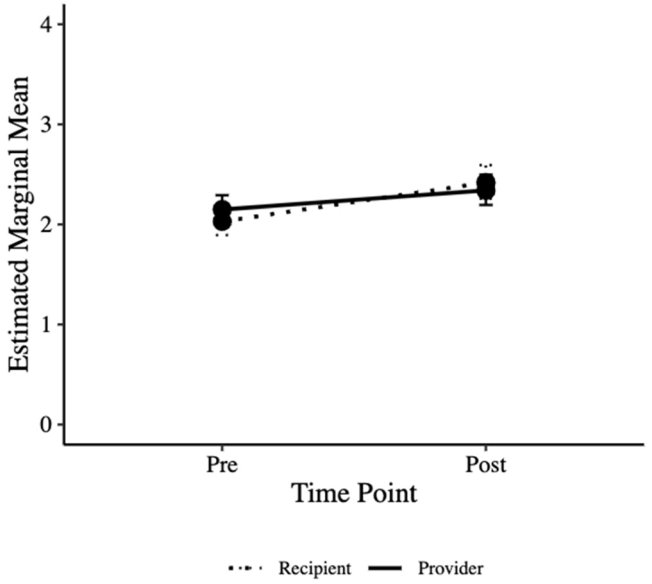

Fig. 2. *Pre and post task performance marginal means by peer feedback role, Note.* Error bars are standard errors of means.

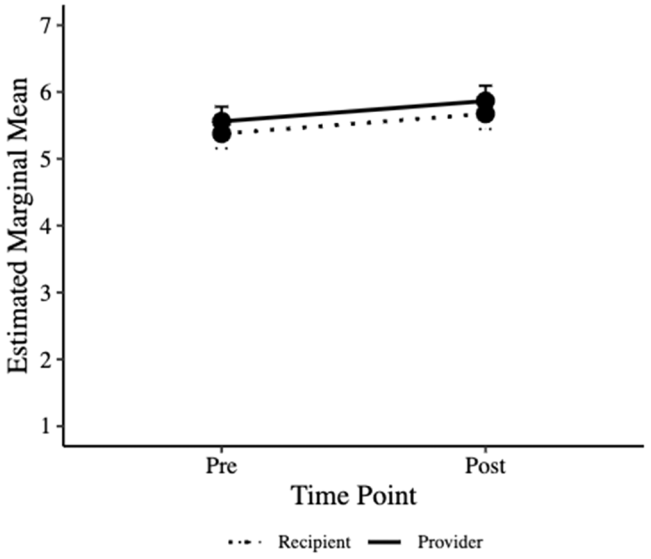

Fig. 3. *Pre and post perceived learning marginal means by peer feedback role, Note.* Error bars are standard errors of means.

Table 2
GLMM Model Predicting Perceived Learning as a Function of Peer Feedback Role.

	Fixed Effects			
	Std.β	95 % CI	*t*	*p*
Predictors				
Intercept	2.15	1.70–1.74	169.7	.000
Role	0.02	-0.03–0.00	-1.64	.307
Time	0.03	0.00–0.04	2.63	.027*
Interaction				
Role x Time	0.00	-0.01–0.02	0.02	1.00
	Random effects			
	Variance	*SD*		
Subject (Intercept)	-	-		
	Model fit: Likelihood-ratio test.			
	X^2	*df*	*p*	
"Nested model" vs. model	8.07	3	.045	

Note. Model equation: *Perceived Learning* ~ as factor(ROLE) * as factor(Time Point) + (1|Subject) *Significant codes: *$p < .05$. *p* values are corrected with Bonferroni. Coding: Recipient (1); Provider (2)

Table 3
GLMM Model Predicting Perceived Trust as a Function of Peer Feedback Role.

	Fixed Effects			
	Std.β	95 % CI	*t*	*p*
Predictors				
Intercept	1.69	1.63–1.69	123.3	.000
Role	- 0.01	- 0.03–0.01	-0.88	1.00
Time	0.01	0.00–0.04	1.26	.617
Interaction				
Role x Time	- 0.00	- 0.02–0.02	-0.19	1.00
	Random effects			
	Variance	SD		
Subject (Intercept)	-	-		
	Model fit: Likelihood-ratio test.			
	X^2	*df*	*p*	
"Nested model" vs. model	2.09	3	.554	

Note. Model equation: *Perceived trust*~ as factor(ROLE) * as factor(Time Point) + (1|Subject). *p* values are corrected with Bonferroni. Coding: Recipient (1); Provider (2)

peer feedback. Whether acting as a provider or recipient, students' trust perceptions of themselves as providers or their peers did not significantly change over time. However, overall, perceived trust was already high for both roles on both time-points: for providers ($M_{pre} = 5.24$, $SD_{pre} = 0.96$; $M_{post} = 5.45$, $SD_{post} = 1.18$) and for recipients ($M_{pre} = 5.14$, $SD_{pre} = 0.81$; $M_{post} = 5.29$, $SD_{post} = 0.91$).Variance at the subject level was not estimated, indicating minimal between-subject differences in baseline values, but was retained to account for repeated measures.

3.5. RQ3. Peer feedback roles effect on epistemic emotions

Exploratory Mann–Whitney U analyses of post-test epistemic emotion intensity, with p-values adjusted via Bonferroni correction to account for multiple comparisons revealed no significant differences between providers and recipients, whether examining individual epistemic emotions or the aggregated positive and negative groupings from Trevors et al. (2017) (see Table 4 Fig. 5).

4. Discussion

This study examined the effect of peer feedback roles (provider or recipient) on task performance, perceptions of learning and trust, and epistemic emotions.

4.1. Effect of peer feedback roles on task performance (RQ1)

Our results showed no significant impact of peer feedback role on task performance improvement, supporting H1. Contrary to the findings of Lundstrom and Baker (2009) and Crinon and Marin (2010), we did not observe higher task performance among students in the provider role compared to those in the recipient role. Instead, our findings align with Huisman et al. (2018) and Zamorano et al. (2025), both of which also found no significant effect of peer feedback roles on task performance.

However, our results are more closely aligned with Huisman et al. (2018) than with Zamorano et al. (2025), as we observed a significant improvement in task performance over time, regardless of students' assigned roles, a trend absent in Zamorano et al. (2025). One possible explanation for our findings if contrasting with Lundstrom and Baker (2009) and Crinon and Marin (2010), is the availability of assessment criteria along the process. Prior research, operating under the premise

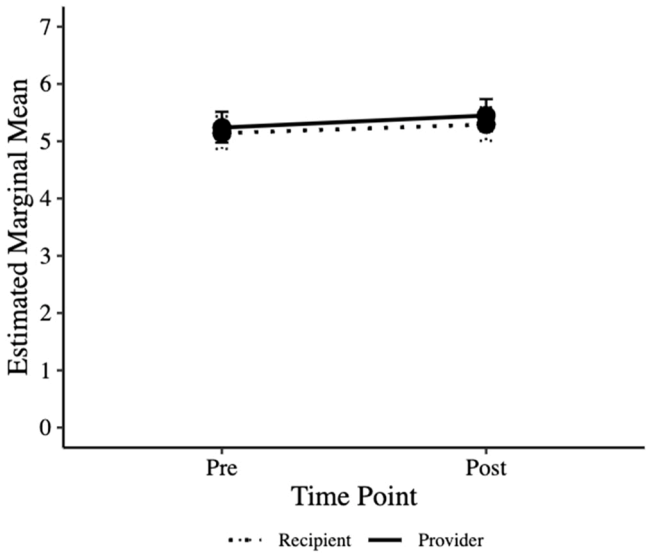

Fig. 4. *Pre and post perceived trust marginal means by peer feedback role, Note.* Error bars are standard errors of means.

Table 4
Mann-Whitney U Test comparing epistemic emotions intensity between roles.

Epistemic Emotions	*H*	*p*
Positive	1093.5	.831
Curiosity	1102	.137
Surprise	1359	.067
Negative	923	.875
Confusion	861.5	.788
Frustration	954.5	.067
Enjoyment	1087	.266
Anxiety	984	.186
Boredom	989.5	.297

Note. Positive refers to the mean of curiosity and enjoyment. *Negative* refers to the mean of confusion, frustration, surprise, anxiety, and boredom. Coding: Recipient (1); Provider (2)

that recipients did not interact with or reflect on the assessment criteria, has found that providing clear criteria and opportunities for engagement, such as using them to request feedback or assess work, improves the task performance of recipients compared to those who do not have such opportunities (Gielen & De Wever, 2015; Voet et al., 2018). In both our study and Huisman et al. (2018), students had access to the criteria throughout the process as both providers and recipients. In contrast, Lundstrom and Baker (2009) nor Crinon and Marin (2010) either did not provide content-specific criteria or did not report whether the criteria were accessible during the task. This pattern suggests that when the assessment criteria are not made available, the differences between peer feedback providers and recipients may become more pronounced. As Gielen et al. (2010) argue, recipients are typically less active and have fewer opportunities to engage with the assessment criteria, underscoring the importance of scaffolding. Their findings indicate that recipients who received such support achieved higher performance compared to those who did not. Consequently, in situations where criteria are absent, providers are likely to benefit more from engaging with the task, whereas making the criteria accessible to both roles can help reduce these disparities. These findings aligned with those of Huisman et al. (2018) and Zamorano et al. (2025), may also suggest that engaging in each peer feedback role once, either as a provider or recipient, does not lead to significant differences in task performance. Meanwhile, long-term interventions with repeated engagement in a specific role, such as in Lundstrom and Baker's (2009) study, where students provided feedback four times, may amplify the effects and differences between roles, as their findings suggest. However, this interpretation contrasts with Crinon and Marin (2010) which also found role-based differences despite students engaging in only a single feedback interaction per role.

To further clarify these dynamics, future research should explore whether sustained engagement in specific peer feedback roles over longer interventions leads to differential effects on task performance and examine how varying levels of accessibility to assessment criteria may shape these effects.

4.2. Effect of peer feedback roles on students' perceptions of learning and trust (RQ2)

Regarding **RQ2.1**, our findings indicate that peer feedback roles did not significantly influence changes in students' perceptions of learning over time (H2.1 was confirmed). However, students' perceptions of learning significantly improved over time, regardless of the role students engaged. This result contrasts with previous studies that found providing feedback led to greater perceived learning compared to recipient (Ion et al., 2019; Martin & Sippel, 2021; Mulder et al., 2014). In contrast, our findings align with those qualitative studies of Nicol et al. (2014), Cao et al. (2019), Ertmer et al. (2007) who reported that students perceived similar learning gains from both providing and receiving feedback. Specifically, our results align with Zamorano et al. (2025) which found no significant differences between provider and recipient. Zamorano et al. (2025) was conducted in a laboratory setting, which raised questions about the generalizability of its findings. The present study extends these results to a classroom context, reinforcing the absence of role differences in perceived learning. While this claim contrasts with the significant differences between roles found by Martin and Sippel (2021), their analysis did not accounted for change over time and only reported post-test differences, which may limit their interpretation. Taken together, based on evidence from the previous study that rigorously measured the effects of peer feedback roles (Zamorano et al., 2025), it can be argued that although students may report differences in perceived learning these differences might be small. Interestingly, among the outcomes examined, perceived learning has received the most attention regarding role effects, yet robust evidence accounting for the statistical significance of these differences remains limited. While the present study contributes to this line of research, it also highlights the need for further (quasi-)experimental studies to clarify the impact of feedback roles on perceived learning.

Similarly, regarding **RQ2.2**, our analysis of trust revealed no significant effect of roles on changes on perceived trust in themselves as providers and trust in peers as providers (H2.2 was confirmed). Actually, perceived trust was relatively high in all time points for both provider ($M_{pre} = 5.24$, $SD_{pre} = 0.96$; $M_{post} = 5.45$, $SD_{post} = 1.18$) and recipients ($M_{pre} = 5.14$, $SD_{pre} = 0.81$; $M_{post} = 5.29$, $SD_{post} = 0.91$). Our results aligned with the study by Zamorano et al. (2025), who also found no significant impact of roles on perceived trust in a laboratory setting. The present classroom-based results align with these findings suggesting that the absence of role differences in trust is consistent across contexts. However, while we did not find a significance effect on trust, this does not reject Zhan (2024) qualitative results who highlighted students' concerns about the accuracy and fairness of peer feedback received from peers. In our study, even if recipient could perceive less trust than the providers these differences were not large enough to be detected with our sample. One explanation for our findings might be that design choices of peer feedback impact trust (Senden & Coertjens, 2024). For instance, previous studies have suggested that providing more guidance has a positive impact on trust, as it helps students navigate the peer feedback process (Cheng et al., 2023; Ching & Hsu, 2016). In our study, students received prior training and had continuous access to the rubric throughout the process. The guidance and the rubric may have helped reinforce trust in both themselves and their peers as providers across roles by increasing their familiarity with the criteria, thereby reducing uncertainty and perceptions of unfairness

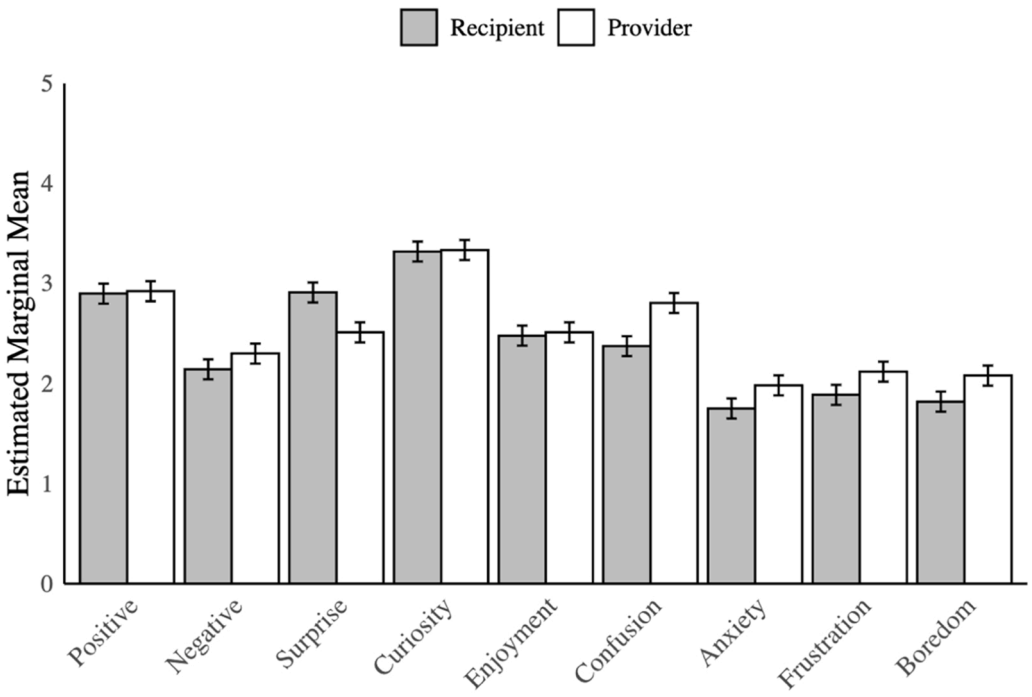

Fig. 5. *Estimated marginal means of intensity of epistemic emotions per role.*, *Note.* Error bars are standard errors of means.

in the results and maintaining perceived trust high after acting as either provider and recipient. While, training, could be a possible explanation, other peer feedback design decision like anonymity, could have influenced (Su, 2023). Future research should further examine this interplay between perceived trust, roles and peer feedback design elements to further examine how specific design choices influence students' trust and engagement in peer feedback processes, for both roles.

4.3. Effect of peer feedback roles on students' emotion (RQ3)

Regarding our final, exploratory research question, we found no statistically significant differences in emotional responses between students who provided PF and those who received it. This analysis was motivated by the theoretical assumption, grounded in prior literature emphasizing the different socio-cognitive processes during provision and reception. (Aben et al., 2019; Bauer et al., 2023). Which prompted us to hypothesize provider and recipients could present different emotional profiles. The exploratory effort was guided from the epistemic emotion framework from the control value theory (CVT) which guided the emotions to explore (comfort, curiosity, boredom…etc) (Pekrun, 2014). Our findings did not support our exploratory assumption. They align with those of Bharuthram and van Heerden (2023), who conducted a qualitative study documenting emotions such as joy, anxiety, and annoyance and grouped under positive and negative among feedback providers and recipients, categorized emotions broadly and found similar emotional experiences. Together, despite differences in cognitive and social processes between providers and recipients, the intensity of epistemic emotions does not appear to differ significantly between roles. Therefore, making strong claims, such as one role consistently eliciting more frustration would be overly explanatory. A more nuanced interpretation of these results can be informed by the CVT (Pekrun, 2024; Pekrun & Stephens, 2011). According to this framework, emotions are shaped by students' perceived control over the task (e.g., self-efficacy and task difficulty) and the value and information related to achievement. In peer feedback contexts, both the feedback received from peers and the task completed by peers can influence how students position their own performance within the activity. Variations in these two elements, the control (via self-efficacy and difficulty of the task) and the content of the feedback provided or received, may therefore moderate the emotional responses observed in each role. While some efforts have been made under the CVT framework in the context of peer feedback, these studies have examined the roles independently (e.g., Alqassab et al., 2019), leaving room for correlational, theory-informed research that can address both roles.

4.4. Limitations and future lines of research

First, our short intervention window, three weeks with one peer feedback activity, may not fully capture the long-term or cumulative effects of peer feedback roles. Consequently, it remains to be explored whether role differences in cognitive outcomes or intrapersonal factors require a more extended period of practice and observation to become evident, warranting further investigation. Longitudinal studies could provide richer insights into the dynamic nature of students' emotional states in both feedback provision and reception roles. Additionally, the analysis of epistemic emotions may have been based on a broad explanatory hypothesis, namely, that emotions vary between roles. Future research aiming to explore the interplay between emotions and peer feedback roles simultaneously could benefit from using theory-informed correlational designs to examine how different elements interact as potential moderators. Relevant studies on motivation and self-efficacy provide useful examples for adopting such an approach (Keller et al., 2025; Li et al., 2025).

Second, while our study offers valuable insights, the wide confidence intervals and limited examination of emotions and perceptions call for larger samples in future research. We also acknowledge the absence of a counterbalanced design, which may have introduced practice effects. Although our procedure strengthens comparability and is sufficient for the present study, results should still be interpreted with caution. Additionally, the exclusion of participants who did not complete all measurements may have influenced the composition of the sample.

Lastly, the effect of roles on different peer feedback outcomes may be influenced by specific peer feedback design elements (e.g., scaffolding, anonymity). However, Alqassab et al. (2023) identified 21 design elements but also noted that peer assessment research is not as diverse in its implementation, with recurring instructional design elements forming

distinct patterns. They identified five main design patterns. As Senden and Coertjens (2024) recommend, given these recurring patterns, rather than investigating each of the 21 design elements separately, future research should explore how the effects of roles vary across these five key settings, offering a broader understanding of their impact on peer feedback processes and outcomes.

4.5. Practical implications

Our results indicate that both roles were similar in terms of learning outcomes (task performance, perceptions of learning, trust and epistemic emotions). This suggests that teachers do not need to prioritize or balance peer feedback roles to compensate for differential benefits. Instead, instructional attention should shift toward maximizing learning opportunities within both roles.

To enhance task performance and perceptions of learning during both feedback provision and feedback reception, we offer a suggestion based on a constrast of our results with prior literature. Although this was not tested directly in the present study, a pattern emerged when contrasting findings across studies: studies that did not provide assessment criteria while performing peer feedback tended to report differences between roles, whereas studies in which students were provided with criteria during peer feedback did not observe such differences. This pattern suggests that when students become familiar with evaluation criteria learning opportunities across both roles may become more balanced. Teachers may therefore consider providing students with explicit criteria, such as rubrics, as a practical strategy, as was done in the present study.

Similarly, trust and epistemic emotions were comparable across peer feedback roles. This means that extensive role-specific training to manage intrapersonal dynamics is unnecessary. However, while extensive role-specific training may be unnecessary and the trust levels were relatively high in this study, trust levels could still be improved . While there is still limited research on how training influences trust (e.g., Senden et al., 2023), instructional design should still explicitly consider strategies to foster trust across roles. Therefore, a unified approach that supports students across both roles is recommended and timely.

5. Conclusion

Peer feedback is a powerful instructional activity that typically involves two main roles: providing and receiving feedback. Although many studies have examined these roles separately or without distinguishing between them, there is growing recognition some suggesting that they have a distinct effect on outcomes. Our study has investigated whether these roles differentially affect key outcomes, such as task performance, perceptions of learning, trust, and epistemic emotions. In our study, we found no significant differences between these roles in terms of their impact on task performance, perceived learning, perceived trust, or epistemic emotions. Taken together, while roles might lead students to engage in different cognitive processes, their short-term impact on learning outcomes are similar. While peer feedback design elements like the presence of criteria during the peer feedback or prior training could potentially regulate these differences, further research is needed.

CRediT authorship contribution statement

Zamorano Sande David: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ernesto Panadero:** Supervision, Methodology, Funding acquisition, Conceptualization. **Maryam Alqassab:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Gómez Varela Joaquín:** Resources, Investigation.

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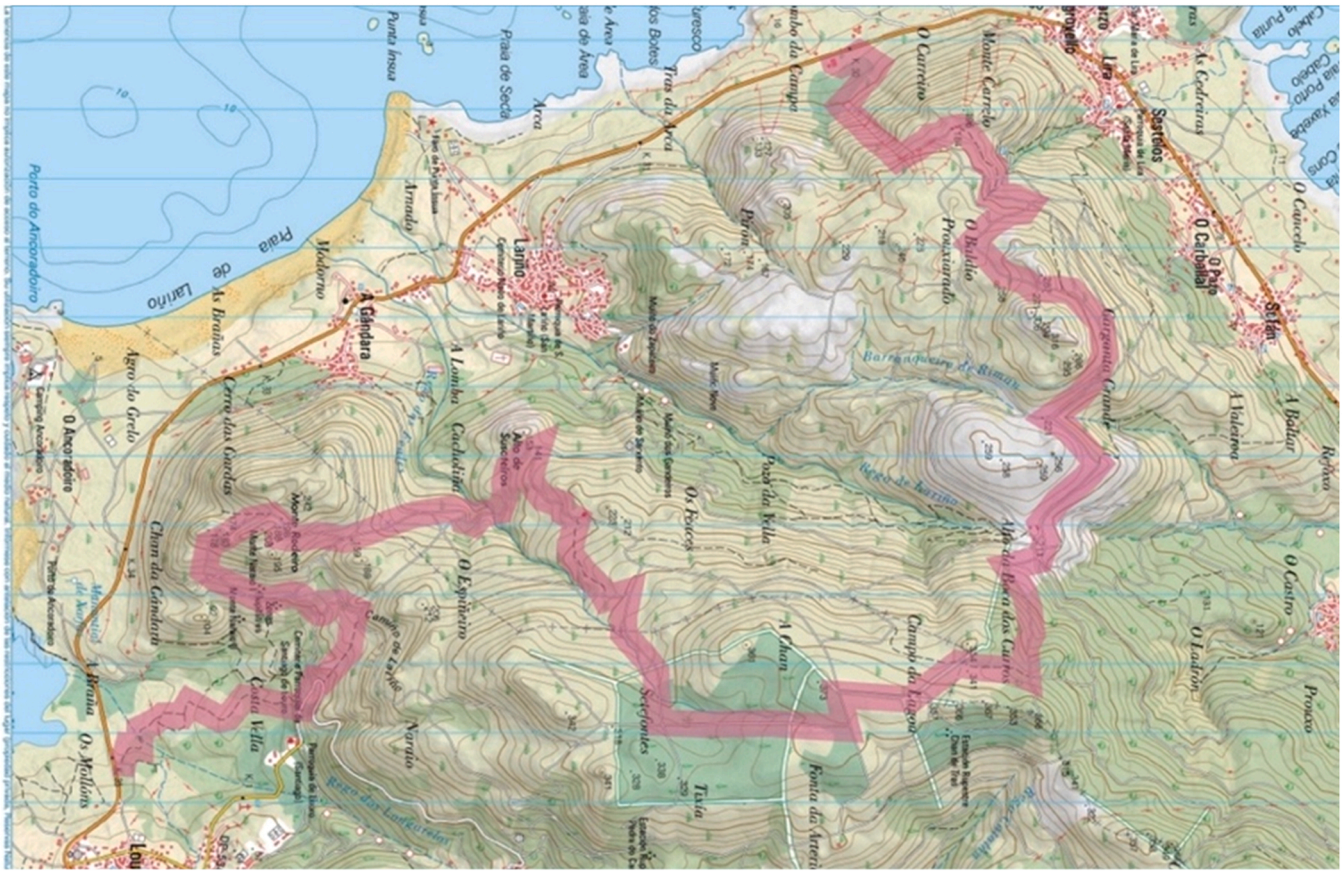
Appendix A. Orienteering map analysis task

Task 1

Below, you can observe a route that starts in the south, near "Louro," and ends in the north, near "O Carreriro." Write a description of the route through an interpretation of the following points:

1. General interpretation of the topographic environment of the itinerary.
2. Interpretation of the itinerary based on:
   - **Symbology**: The symbols that appear along the route and are associated with some real-world element. You can find their meanings in your notes.
   - **Land use**: The characteristics of the land (e.g., crops, natural vegetation, areas without vegetation). You can find details on the different types of land use in your notes.
   - **Slope**: The inclination of the terrain along the route (e.g., starts with a steep incline, remains flat, then increases, etc.). This information is provided by the contour lines.
   - **Landforms**: Due to changes in slope, various landforms are created along the route (e.g., slopes, valleys, ravines, hills). This information is also provided by the contour lines.

Remember. You can use the rubric to complete this description, following the structure indicated in the instructions. You have approximately 20–25 min.

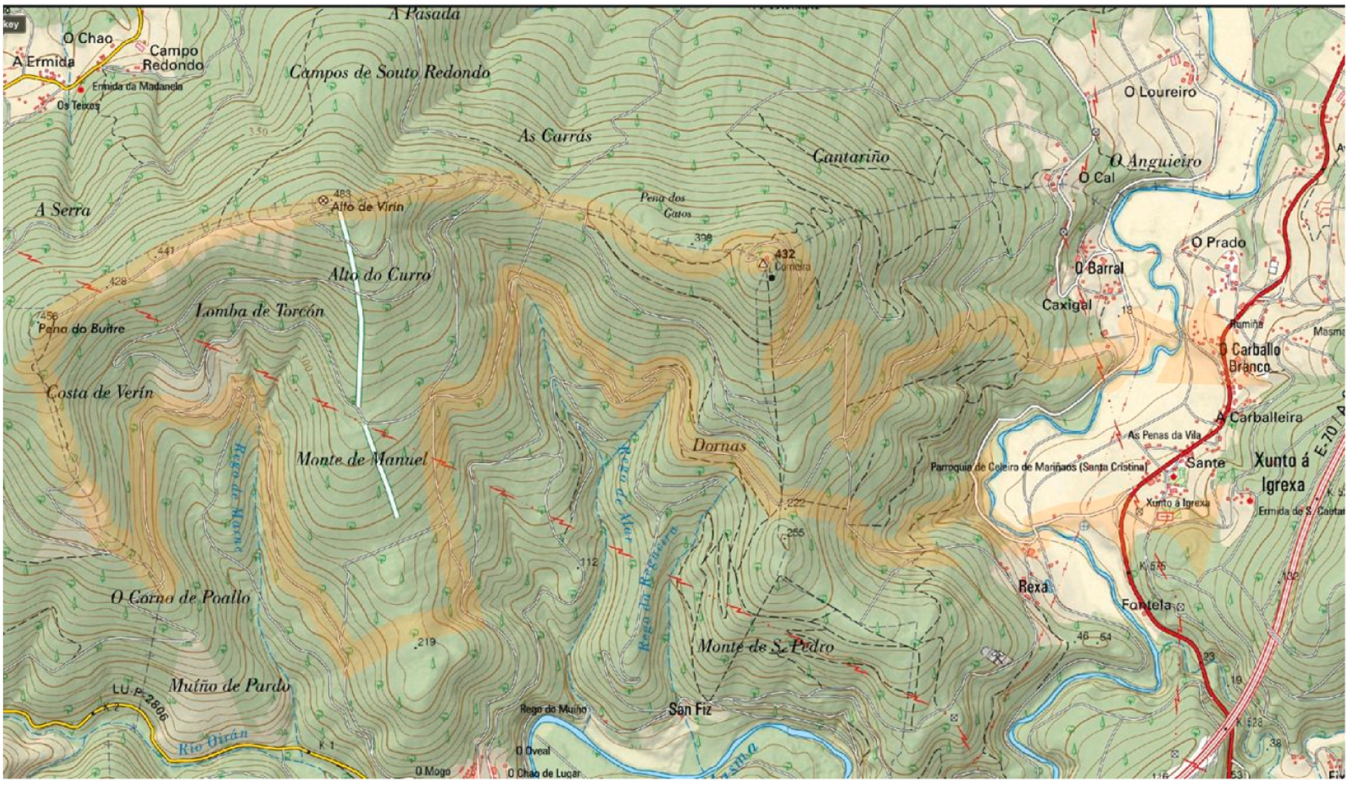


Task 2

Below, you can observe a route that starts near "Carballo," and ends, near "Sante." Write a description of the route through an interpretation of the following points:

1. General interpretation of the topographic environment of the itinerary.
2. Interpretation of the itinerary based on:
   - **Symbology**: The symbols that appear along the route and are associated with some real-world element. You can find their meanings in your notes.
   - **Land use**: The characteristics of the land (e.g., crops, natural vegetation, areas without vegetation). You can find details on the different types of land use in your notes.
   - **Slope**: The inclination of the terrain along the route (e.g., starts with a steep incline, remains flat, then increases, etc.). This information is provided by the contour lines.
   - **Landforms**: Due to changes in slope, various landforms are created along the route (e.g., slopes, valleys, ravines, hills). This information is also provided by the contour lines.

Remember. You can use the rubric to complete this description, following the structure indicated in the instructions. You have approximately 20–25 min.



Appendix B. Rubric used to rate cover letter analysis (Task 1 and 2)

Criteria		4	3	2	1
General interpretation	Synthesis that provides a general description of the space represented on the map, considering terrain forms, significant elements, and land uses as references for orienting oneself along the route.	Provide a detailed and comprehensive description of the area, integrating terrain forms, significant elements, and land uses for effective orientation.	Provide an accurate description with some relevant details of the terrain and significant elements.	Provide a general description with omissions or inaccuracies.	Provide a poor description or none.
Map Symbols and Legend	Decoding and interpretation of the symbology belonging to the groups of symbols included in the map's legend. Detail their meanings and identify them in relation to the various elements found along the route and its annexes.	Identify and precisely explain the meaning of all the symbology in the context of the route, making clear connections to the terrain elements.	Correctly identify most of the symbols and their meanings, with some explanations of the context of the route.	Recognize some important symbols and offer a basic interpretation of their meaning.	Struggle to identify and explain the map's symbology.
Land Use and Geographic Features	Decoding of the land uses through which the marked route passes on the map.	Analyze and thoroughly describe the land uses along the route and their implications. Describe them throughout the entire route, indicating how they change along the way.	Correctly identify land uses with an adequate description of their distribution along some sections of the route.	Identify land uses but with general or inaccurate options. When describing land uses, the student fails to integrate them into the landscape analysis.	Show little understanding of the land uses on the map and fail to mention them.
Contour Lines and Elevation	Decoding and interpretation of the contour lines and their significance regarding the terrain slopes along the marked route on the map.	Interpret the contour lines with an advanced understanding of the slopes and represent them in the context of the specific terrain of the route.	Identify and describe the terrain slopes with precision.	Understand the concept of contour lines but have difficulty applying it to represent slopes.	Do not correctly interpret contour lines or their significance regarding slopes.
Map Decoding and Spatial Analysis	Decoding and interpretation of the contour lines and their significance regarding the terrain forms that the indicated route crosses on the map.	Demonstrate a detailed understanding of how contour lines describe terrain forms and apply this knowledge to the analysis of the route.	Correctly identify the terrain forms indicated by the contour lines, including some details.	Recognize the relationship between contour lines and terrain forms, but with a superficial interpretation.	Have difficulty relating contour lines to terrain forms.

Appendix C. Previous-knowledge task

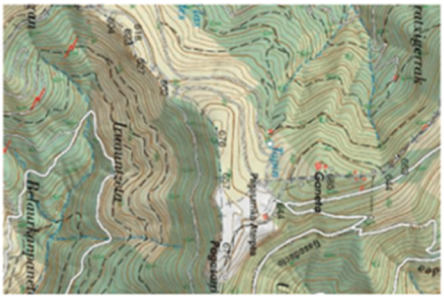
This is a placement test conducted before delivering the content that will be covered in the upcoming sessions. It does not count toward your grade. However, we kindly ask you to answer as honestly as possible according to your level, not at random.

1. **What does it mean to orient a map in the context of navigation?**

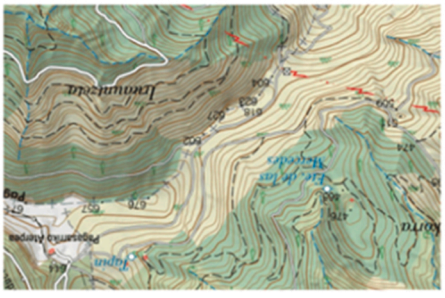
a) To position it so that the compass points to the South.
b) To position it so that the landscape matches the map.
c) To turn it until the map's legend is at the top.
d) To always keep it in a vertical position.

2. **Which of the maps (A, B, and C) is oriented with respect to the image below?**

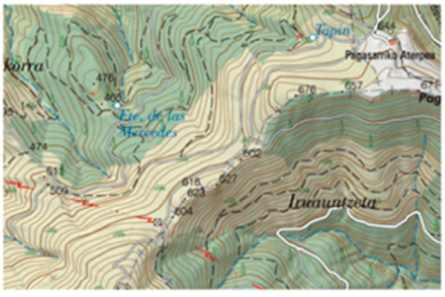
A



B



C



3. **How are orientation maps typically aligned in relation to the cardinal directions?**

a) North at the top, South at the bottom, East on the right, and West on the left.
b) North at the bottom, South at the top, East on the right, and West on the left.
c) East at the top, West at the bottom, North on the right, and South on the left.
d) South at the top, North at the bottom, West on the right, and East on the left.

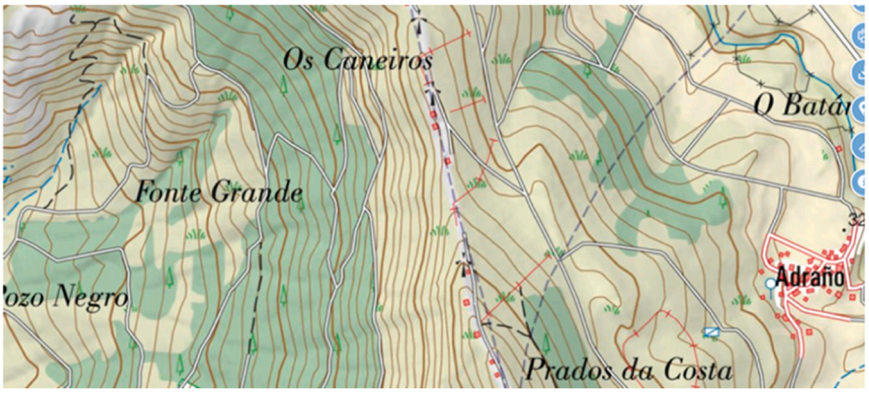
4. **What does a 1:10,000 scale indicate on a foot orientation map?**

a) 1 cm on the map represents 10,000 cm in reality.
b) 1 cm on the map represents 1000 cm in reality.
c) 10 cm on the map represents 1000 cm in reality.
d) 10 cm on the map represents 10,000 cm in reality.

5. **On a 1:25,000 scale map, if a distance of 5 centimeters is measured, what is the corresponding distance in the real world?**

a) 2 kilometers
b) 1.25 kilometers
c) 0.25 kilometers
d) 5 kilometers

6. **If you need to go from "Fonte Grande" to "Ardaño" in a straight line, you will…**



a) Go uphill
b) Go uphill and downhill
c) Go downhill
d) Encounter no elevation change

7. **What is the main function of contour lines on an orientation map?**
   a) To mark the location of control points
   b) To indicate the distance between two points on a route
   c) To represent the altitude and terrain relief
   d) To show the direction of North on the map
8. **How are contour lines represented on orientation maps?**
   a) With a dashed line in brown
   b) With a continuous line in green
   c) With a dashed line in blue
   d) With a continuous line in brown
9. **What does the contour interval indicate on an orientation map?**
   a) The difference in height between two consecutive contour lines
   b) The distance between two control points in a competition
   c) The total distance of a course in a competition
   d) The maximum height reached during a race
10. **What are examples of linear features in orientation?**
    a) Buildings, isolated trees, forest clearings
    b) Roads, paths, trails, power lines
    c) Cliffs, hills, streams, valleys
    d) All of the above
11. **What elements are represented in BLACK on an orientation map?**
    a) Areas without vegetation
    b) Ground details like pits and cliffs
    c) Man-made features and rocks
    d) Dense vegetation and impassable forest

Appendix D. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.stueduc.2026.101560.

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