
**DESIGN OF AN EDUCATIONAL GAME AND ITS USE IN A TEAM GAME
TOURNAMENT AS A STRATEGY TO ENGAGE STUDENTS IN REVIEWING
STEREOCHEMISTRY CONCEPTS**

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Stereochemistry Race – Portuguese

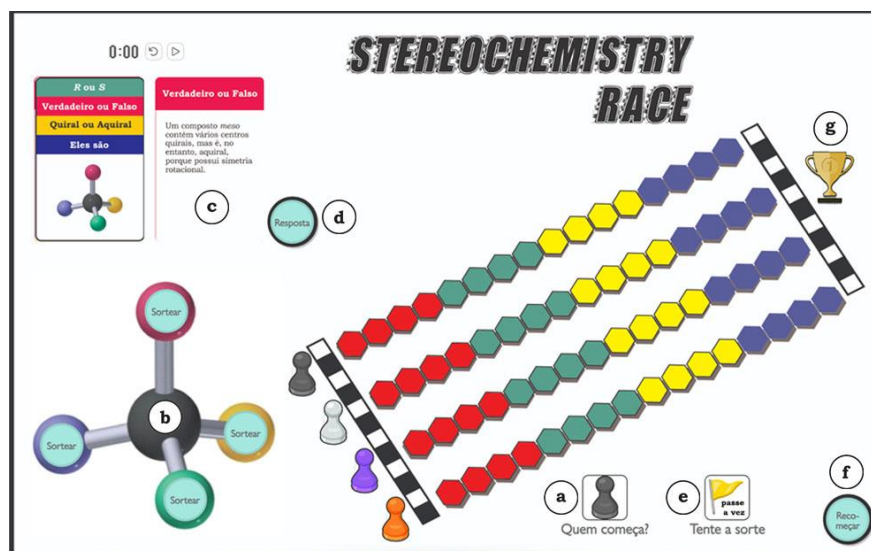


Figure 1S. Stereochemistry Race - Portuguese

Regras

O jogo pode ser jogado por 2 a 4 jogadores.

Cada jogador deverá escolher uma peça da cor que preferir.

Cada jogador deverá percorrer sua própria trilha, a qual é composta de 16 casas, sendo 4 casas com 4 cores distintas, com tarefas específicas:

- Vermelha: o jogador deverá classificar uma afirmação como sendo verdadeira ou falsa.
- Verde: o jogador deverá determinar a configuração absoluta (*R* ou *S*) de um centro assimétrico indicado por um asterisco em uma molécula.
- Amarelo: o jogador deverá classificar uma molécula como quiral ou aquiral.
- Azul: o jogador deverá classificar um par de compostos como iguais, isômeros constitucionais, enantiômeros ou diastereoisômeros.

Para percorrer a trilha, o jogador deverá executar corretamente os comandos acima até chegar ao final da trilha. Aquele que percorrer toda sua trilha primeiro torna-se o campeão.

Como jogar

- 1) Inicialmente, um dos jogadores deve clicar no dado “Quem começa” (Figura 1 a) para determinar quem será o primeiro jogar (Figura 1 b). Então, os demais seguirão a ordem das peças no tabuleiro, considerando-se o sentido de cima para baixo a partir da peça sorteada.
- 2) A trilha inicia-se com vermelho, logo os jogadores deverão clicar botão “Sortear” localizado no átomo vermelho (Figura 1 b) enquanto suas peças estiverem posicionadas em uma casa vermelha. No decorrer da

partida, o jogador deverá clicar no botão “Sortear” localizado no átomo com a mesma coloração da casa onde sua peça está localizada.

- 3) Ao clicar em qualquer botão “Sortear”, uma carta será movida do deck para o lado direito (Figura 1 c).
- 4) O jogador, então, deve responder verbalmente ao comando da carta. Dica: para aumentar o tamanho da carta, o jogador deve manter o dedo pressionado sobre carta em smartphones ou tablets. Em computadores, posicione o cursor sobre a carta. Porém, em todos os casos, o jogador não deve clicar na carta para evitar virá-la e revelar a resposta.
- 5) Para checar se a resposta dada é a correta, o jogador deve clicar no botão “Resposta” (Figura 1 d), virando a carta e revelando a resposta correta.
- 6) Se o jogador errou, ele não move sua peça e passa a vez ao próximo jogador.
- 7) Se o jogador acertou a resposta, ele tem duas opções:
 - a. Avançar sua peça uma posição na trilha ou
 - b. Tentar a sorte clicando no dado “Tente a sorte” (Figura 1 e) com faces. Há três opções nas faces do dado: passe a vez (3 faces); turbo (1 face) e box (1 face). Se a face sorteada for “passe a vez”, o jogador avança sua peça uma posição e já passa a vez ao próximo jogador. Se a face sorteada for a “turbo”, ele avança sua peça duas posições e passa a vez ao próximo jogador. Se a face sorteada for a “box”, ele avança sua peça uma posição e passa a vez ao próximo jogador, mas fica sem jogar na próxima rodada.
- 8) O jogo segue está dinâmica até que o primeiro jogador atinja a área onde está o troféu, tornando-se o campeão.

Stereochemistry Race – French

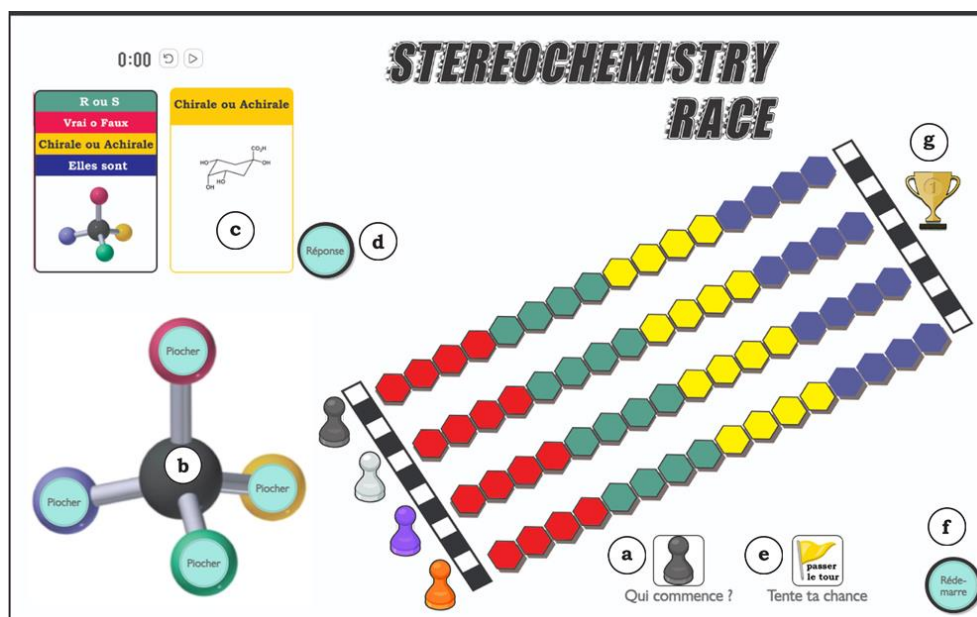


Figure 2S. Stereochemistry Race - French

Règles du jeu

Le jeu peut être joué de 2 à 4 joueurs.

Chaque joueur doit choisir le pion coloré de son choix.

Chaque joueur doit suivre son parcours, composé de 16 cases, quatre cases avec quatre couleurs différentes, avec des rôles spécifiques :

- Rouge : le joueur doit indiquer si l'affirmation est vraie ou fausse.
- Vert : le joueur doit déterminer la configuration absolue (*R* ou *S*) d'un centre asymétrique indiqué par un astérisque dans une molécule.
- Jaune : le joueur doit désigner une molécule comme chirale ou achirale.
- Bleu : le joueur doit classer les composés comme identiques, isomères de constitution, énantiomères ou diastéréoisomères.

Pour avancer, le joueur doit répondre correctement jusqu'à atteindre la fin du parcours.

Celui qui termine le parcours en premier devient le champion.

Comment jouer ?

- 1) Initialement, l'un des joueurs doit cliquer sur le dé "Qui commence" (Figure 1 a) pour déterminer qui jouera en premier (Figure 1 b). Ensuite, les autres suivront l'ordre des pions sur le plateau, en considérant la direction de haut en bas à partir du pion tiré.

- 2) Le piste commence avec la couleur rouge, donc les joueurs doivent cliquer sur le bouton " Piocher " situé sur l'atome rouge (Figure 1 b) tandis que leurs pions sont positionnés sur une case rouge. Pendant le jeu, le joueur doit cliquer sur le bouton " Piocher " sur l'atome de la même couleur que la case où se trouve son pion.
- 3) En cliquant sur n'importe quel bouton " Piocher ", une carte sera déplacée du paquet vers le côté droit (Figure 1 c). Astuce : pour agrandir la carte, le joueur doit maintenir son doigt sur la carte sur les smartphones ou les tablettes. Sur les ordinateurs, positionnez le curseur sur la carte. Cependant, dans tous les cas, le joueur ne doit pas cliquer sur la carte pour éviter de la retourner et de révéler la réponse.
- 4) Le joueur doit ensuite répondre verbalement à la commande sur la carte.
- 5) Pour vérifier si la réponse donnée est correcte, le joueur doit cliquer sur le bouton " Réponse " (Figure 1 d), ce qui retourne la carte et révèle la réponse correcte.
- 6) Si le joueur se trompe, il ne déplace pas sa pièce et passe le tour au joueur suivant.
- 7) Si le joueur a la bonne réponse, il a deux options :
 - A. Avancer son pion d'une case sur la piste ou
 - B. Tenter sa chance en cliquant sur le dé " Tente ta chance " (Figure 1 e) avec des faces. Il y a trois options sur les faces du dé : passer le tour (3 faces), turbo (1 face) et case (1 face). Si la face tirée est " passer le tour ", le joueur avance son pion d'une case et passe le tour au joueur suivant. Si la face tirée est " turbo ", il avance sa pièce de deux cases et passe le tour au joueur suivant. Si la face tirée est " case ", il avance sa pièce d'une case et passe le tour au joueur suivant mais ne joue pas au prochain tour.
- 8) Le jeu continue sur cette dynamique jusqu'à ce que le premier joueur atteignant la ligne d'arrivée, où se trouve le trophée, devienne le champion.

Stereochemistry Race – Italian

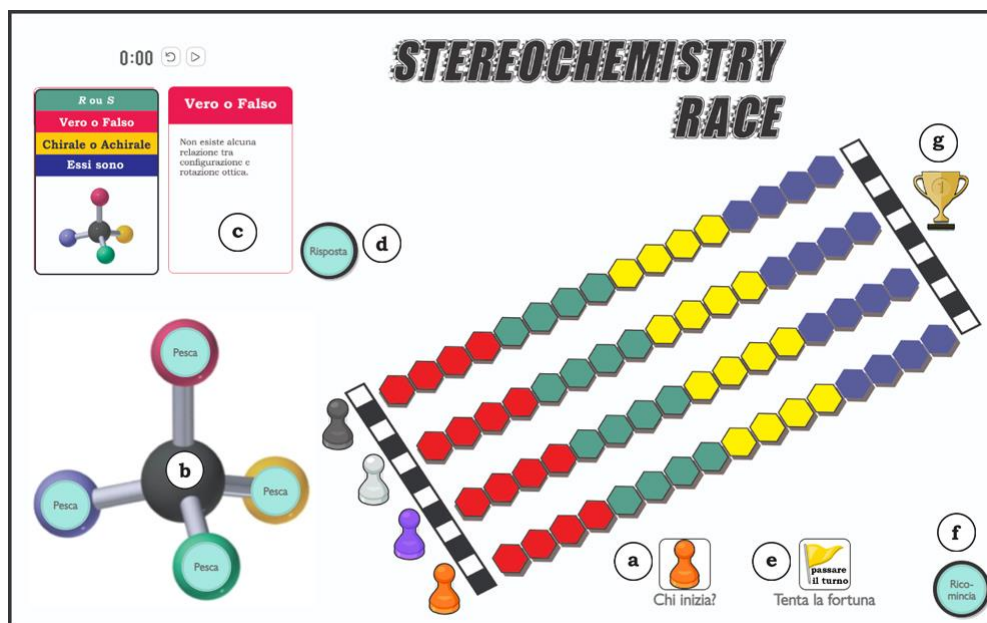


Figure 3S. Stereochemistry Race - Italian

Regole

Sono possibili da 2 a 4 giocatori.

Ogni giocatore sceglie il colore del proprio segnalino.

Ogni giocatore deve seguire il proprio percorso, composto da 16 caselle, 4 per ciascun colore che corrisponde ad una diversa tipologia di domanda:

- Rosso: il giocatore deve rispondere ad una domanda vero o falso
- Verde: il giocatore deve determinare la configurazione assoluta del carbonio stereogenico indicato con un asterisco nella molecola assegnata
- Giallo: il giocatore deve indicare se la molecola assegnata sia chirale o achirale
- Blu: il giocatore deve stabilire se le due molecole assegnate sono tra di loro lo stesso composto, enantiomeri, diastereoisomeri o isomeri costituzionali

Il giocatore che per primo completa l'intero percorso vince la gara

Come giocare

- 1) All'inizio uno dei giocatori preme il tasto "Chi inizia?" (Figura 1, **a**) per sorteggiare chi comincerà per primo. L'ordine di gioco seguirà quindi la posizione dei segnalini a partire da quello sorteggiato, proseguendo dall'alto al basso.

- 2) Il percorso comincia con le caselle di color rosso, quindi i giocatori devono premere il tasto “Pesca” in corrispondenza dell’atomo rosso del carbonio tetraedrico (Figura 1, **b**). Durante il gioco i giocatori devono sempre pescare una carta del colore della casella su cui si trovano.
- 3) Selezionando il tasto “Pesca” una carta si sposterà dal mazzo a fianco dello stesso (Figura 1, **c**). E’ possibile ingrandire la carta passando con il cursore del mouse sulla stessa (per chi usa un computer) oppure tenendo il dito sulla stessa (per chi usa smartphone e tablet), tuttavia non bisogna fare click sulla carta perché questo automaticamente rivelerebbe la risposta.
- 4) Il giocatore deve rispondere verbalmente al quesito presente sulla carta sorteggiata.
- 5) Premendo il pulsante “Risposta” (Figura 1, **d**) viene rivelata la risposta corretta al quesito.
- 6) Se il giocatore ha fornito la risposta sbagliata il suo segnalino rimane fermo nella posizione originale.
- 7) Se il giocatore ha fornito la risposta corretta ha due opzioni:
 - A. Può far avanzare il suo segnalino di una posizione sul percorso
 - B. Può tentare la fortuna con il tasto corrispondente (Figura 1, **e**). In questo caso si possono verificare tre situazioni: con “passa il turno” il giocatore avanza il suo segnalino di una posizione e passa il turno al giocatore successivo, con “box” il giocatore avanza il suo segnalino di una posizione ma salta il turno successivo, con “turbo” il giocatore avanza il suo segnalino di due caselle. Anche in questi ultimi due casi il turno viene quindi passato al giocatore successivo.
- 8) Il gioco prosegue con questa modalità fino a quando un giocatore non raggiunge il traguardo.

EVALUATION OF THE GAME AND TOURNAMENT- STUDENTS' OPINIONS

Student confidentiality and security of student data

To protect student confidentiality and improve data security, the students did not have their names linked to any collected data.

Survey: Composition of the classes

In April 2024, the sixteen Brazilian Pharmacy undergraduate students comprised three males and thirteen females, whose average age was 20.9 years.

In May 2024, the twelve Brazilian high school students comprised four males and eight females, whose average age was 16.6.

In May 2024, the fifty-seven Italian undergraduate students (from Natural Science and Biotechnology) comprised sixteen males and forty-one females, whose average age was 19.8.

Survey: Evaluation of the game and TGT

Sixteen Pharmacy undergraduate students from the Federal University of Ceará in Brazil played the game face-to-face in the classroom, participating in the TGT in April 2024. All of them were enrolled in an Introductory Organic Chemistry Course. Before that, all learners attended four presential lectures (8 hours) covering the content related to the stereochemistry of organic compounds.

The twelve high school 12th-grade students from Colégio Maximus in Fortaleza, Brazil, played the game face-to-face in the classroom, participating in the TGT in May 2024. Before that, the high school students attended three presential lectures (6 hours) covering the content related to the stereochemistry of organic compounds.

The fifty-seven Italian undergraduate students (from Natural Science and Biotechnology courses) from the Università degli Studi di Genova followed precisely the same procedures as Brazilian students.

The teachers invited all Brazilian and Italian students to answer the questions in an electronic form (Table 1S) divided into 3 sections and to evaluate the game (Tables 2S-4S) and the TGT (Tables 5S-7S). Additionally, the students rated the game and the tournament (assigning a score from 0 to 10) as a teaching strategy to review topics related to the stereochemistry of organic compounds.

Table 1S. E-form questions to evaluate the Stereochemistry Race game and Tournament

1) What is your gender?					
2) What is your age?					
Section 1 - Perceptions of the Stereochemistry Race Game by Survey Statement	AT	A	M	D	DT
GS1) The game layout is visually attractive.	☐	☐	☐	☐	☐
GS2) The graphic elements are of good quality and well-defined.	☐	☐	☐	☐	☐
GS3) The game rules are clear, and the game is easy to play.	☐	☐	☐	☐	☐
GS4) The game is fun.	☐	☐	☐	☐	☐
GS5) The content of the letters adequately covers the content on Stereochemistry covered in the classroom.	☐	☐	☐	☐	☐
GS6) The content of the letters contributes to the review of Stereochemistry.	☐	☐	☐	☐	☐
GS7) The game promotes memorization and learning of stereochemistry.	☐	☐	☐	☐	☐
GS8) Luck is not a determining factor in defining the champion of the match.	☐	☐	☐	☐	☐
GS9) The game is an innovative educational tool that helps students review and learn content related to Stereochemistry.	☐	☐	☐	☐	☐
GS10) The game is an alternative educational tool to traditional exercise-solving classes.	☐	☐	☐	☐	☐
GS11) What are the positive aspects (if any) of the game?					
GS12) What are the negative aspects (if any) of the game?					
GS13) Rate the game with a score from 0 to 10 as an educational tool that helps students review stereochemistry					
Section 2 - Perceptions of the Tournament by Survey Statement	AT	A	M	D	DT
TS1) The tournament is an educational strategy that motivates students to study more.	☐	☐	☐	☐	☐
TS2) Students studied to participate in the tournament.	☐	☐	☐	☐	☐
TS3) Students consider holding the tournament exciting and promoting stereochemistry learning.	☐	☐	☐	☐	☐
TS4) The two-round format of the tournament was well accepted by students and promoted interaction between them.	☐	☐	☐	☐	☐
TS5) Participation in the tournament contributes to learning stereochemistry.	☐	☐	☐	☐	☐
TS6) Students used the game between the two days of the tournament to prepare for the final stage.	☐	☐	☐	☐	☐
TS7) The prize is a motivating factor for students to study to participate in the tournament.	☐	☐	☐	☐	☐
TS8) Students prefer to participate in the tournament instead of a traditional problem-solving class.	☐	☐	☐	☐	☐
TS9) What are the positive aspects (if any) of the game/tournament?					
TS10) What are the negative aspects (if any) of the repechage tournament?					
TS11) Rate the tournament on a scale from 0 to 10 as an educational strategy that helps students review stereochemistry.					
Section 3 - User Engagement Scale – Short Format	AT	A	M	D	DT
FA-S.1 I lost myself in this tournament.	☐	☐	☐	☐	☐
FA-S.2 The time I spent in the tournament just slipped away.	☐	☐	☐	☐	☐
FA-S.3 I was absorbed in this tournament.	☐	☐	☐	☐	☐
PU-S.1 I felt frustrated while using this tournament.	☐	☐	☐	☐	☐
PU-S.2 I found this tournament confusing to use.	☐	☐	☐	☐	☐
PU-S.3 Participating in this tournament was taxing.	☐	☐	☐	☐	☐
AE-S.1 This tournament was attractive.	☐	☐	☐	☐	☐
AE-S.2 This tournament was aesthetically appealing.	☐	☐	☐	☐	☐
AE-S.3 This tournament appealed to my senses.	☐	☐	☐	☐	☐
RW-S.1 Participating in the tournament was worthwhile.	☐	☐	☐	☐	☐
RW-S.2 My experience was rewarding.	☐	☐	☐	☐	☐
RW-S.3 I felt interested in this tournament	☐	☐	☐	☐	☐

Table 2S. Brazilian Pharmacy undergraduate students' perceptions of the game by survey statement (in May 2024) – percentage distribution of Likert categories of each class

Statement	Brazilian Pharmacy undergraduate students agreement* (N = 14)				
	AT	A	M	D	DT
GS1) The game layout is visually attractive.	50.0	42.9	7.1	0.0	0.0
GS2) The graphic elements are of good quality and well-defined.	50.0	28.6	7.1	14.3	0.0
GS3) The game rules are clear, and the game is easy to play.	50.0	42.9	7.1	0.0	0.0
GS4) The game is fun.	35.7	50.0	14.3	0.0	0.0
GS5) The content of the letters adequately covers the content on Stereochemistry covered in the classroom.	50.0	35.7	7.1	0.0	7.1
GS6) The content of the letters contributes to the review of Stereochemistry.	42.9	50.0	0.0	7.1	0.0
GS7) The game promotes memorization and learning of stereochemistry.	85.7	0.0	7.1	7.1	0.0
GS8) Luck is not a determining factor in defining the champion of the match.	28.6	0.0	42.9	14.3	14.3
GS9) The game is an innovative educational tool that helps students review and learn content related to Stereochemistry.	50.0	50.0	0.0	0.0	0.0
GS10) The game is an alternative educational tool to traditional exercise-solving classes.	42.9	50.0	7.1	0.0	0.0

*AT: agree totally; A; agree; M: maybe; D: disagree; DT: disagree totally.

Table 3S. Brazilian High School students' perceptions of the game by survey statement (in May 2024) – percentage distribution of Likert categories of each class

Statement	Brazilian High School students agreement* (N = 12)				
	AT	A	MB	D	DT
GS1) The game layout is visually attractive.	75.0	25.0	0.0	0.0	0.0
GS2) The graphic elements are of good quality and well-defined.	50.0	50.0	0.0	0.0	0.0
GS3) The game rules are clear, and the game is easy to play.	50.0	50.0	0.0	0.0	0.0
GS4) The game is fun.	75.0	25.0	0.0	0.0	0.0
GS5) The content of the letters adequately covers the content on Stereochemistry covered in the classroom.	75.0	25.0	0.0	0.0	0.0
GS6) The content of the letters contributes to the review of Stereochemistry.	83.3	16.7	0.0	0.0	0.0
GS7) The game promotes memorization and learning of stereochemistry.	100.0	0.0	0.0	0.0	0.0
GS8) Luck is not a determining factor in defining the champion of the match.	58.3	0.0	41.7	0.0	0.0
GS9) The game is an innovative educational tool that helps students review and learn content related to Stereochemistry.	91.7	8.3	0.0	0.0	0.0
GS10) The game is an alternative educational tool to traditional exercise-solving classes.	91.7	8.3	0.0	0.0	0.0

*AT: agree totally; A; agree; M: maybe; D: disagree; DT: disagree totally.

Table 4S. Italian undergraduate students' perceptions of the game by survey statement (in May 2024) – percentage distribution of Likert categories of each class

Statement	Italian students agreement* (N = 57**)				
	AT	A	MB	D	DT
GS1) The game layout is visually attractive.	26.3	66.7	7.0	0.0	0.0
GS2) The graphic elements are of good quality and well-defined.	14.0	70.2	12.3	3.5	0.0
GS3) The game rules are clear, and the game is easy to play.	61.4	38.6	0.0	0.0	0.0
GS4) The game is fun.	57.9	40.4	1.8	0.0	0.0
GS5) The content of the letters adequately covers the content on Stereochemistry covered in the classroom.	24.6	71.9	1.8	0.0	0.0
GS6) The content of the letters contributes to the review of Stereochemistry.	61.4	38.6	0.0	0.0	0.0
GS7) The game promotes memorization and learning of stereochemistry.	43.9	54.4	1.8	0.0	0.0
GS8) Luck is not a determining factor in defining the champion of the match.	5.3	19.3	18.5	36.8	22.8
GS9) The game is an innovative educational tool that helps students review and learn content related to Stereochemistry.	54.4	45.6	0.0	0.0	0.0
GS10) The game is an alternative educational tool to traditional exercise-solving classes.	57.9	33.3	8.8	0.0	0.0

*AT: agree totally; A: agree; M: maybe; D: disagree; DT: disagree totally. **16 1st-year Natural Science undergraduate students and 41 1st-year Biotechnology students.

Table 5S. Brazilian Pharmacy undergraduate students' perceptions of the tournament by survey statement (in May 2024) – percentage distribution of Likert categories of each class

Statement	Brazilian Pharmacy undergraduate students agreement* (N = 14)				
	AT	A	MB	D	DT
TS1) The tournament is an educational strategy that motivates students to study more.	49.9	35.7	21.4	0.0	0.0
TS2) Students studied to participate in the tournament.	57.1	28.6	14.3	0.0	0.0
TS3) Students consider holding the tournament exciting and promoting stereochemistry learning.	57.1	35.7	0.0	7.1	0.0
TS4) The two-round format of the tournament was well accepted by students and promoted interaction between them.	57.1	28.6	7.1	7.1	0.0
TS5) Participation in the tournament contributes to learning stereochemistry.	50.0	42.9	0.0	7.1	0.0
TS6) Students used the game between the two days of the tournament to prepare for the final stage.	50.0	28.6	14.3	7.1	0.0
TS7) The prize is a motivating factor for students to study to participate in the tournament.	78.6	21.4	0.0	0.0	0.0
TS8) Students prefer to participate in the tournament instead of a traditional problem-solving class.	28.6	21.4	42.9	7.1	0.0

*AT: agree totally; A: agree; M: maybe; D: disagree; DT: disagree totally.

Table 6S. Brazilian High School students' perceptions of the tournament by survey statement (in May 2024) – percentage distribution of Likert categories of each class

Statement	Brazilian High School students agreement* (N = 12)				
	AT	A	MB	D	DT
TS1) The tournament is an educational strategy that motivates students to study more.	50.0	41.7	0.0	8.3	0.0
TS2) Students studied to participate in the tournament.	16.7	50.0	33.3	0.0	0.0
TS3) Students consider holding the tournament exciting and promoting stereochemistry learning.	58.3	25.0	16.7	0.0	0.0
TS4) The two-round format of the tournament was well accepted by students and promoted interaction between them.	41.7	50.0	8.3	0.0	0.0
TS5) Participation in the tournament contributes to learning stereochemistry.	66.7	25.0	8.3	0.0	0.0
TS6) Students used the game between the two days of the tournament to prepare for the final stage.	16.7	50.0	33.3	0.0	0.0
TS7) The prize is a motivating factor for students to study to participate in the tournament.	83.3	16.7	0.0	0.0	0.0
TS8) Students prefer to participate in the tournament instead of a traditional problem-solving class.	83.3	8.3	8.3	0.0	0.0

*AT: agree totally; A; agree; M: maybe; D: disagree; DT: disagree totally.

Table 7S. Italian Chemistry undergraduate students' perceptions of tournament by survey statement (in May 2024) – percentage distribution of Likert categories of each class

Statement	Italian undergraduate students agreement* (N = 57**)				
	AT	A	MB	D	DT
TS1) The tournament is an educational strategy that motivates students to study more.	42.9	35.7	21.4	0.0	0.0
TS2) Students studied to participate in the tournament.	57.1	28.6	14.3	0.0	0.0
TS3) Students consider holding the tournament exciting and promoting stereochemistry learning.	57.1	35.7	0.0	7.1	0.0
TS4) The two-round format of the tournament was well accepted by students and promoted interaction between them.	57.1	28.6	7.1	7.1	0.0
TS5) Participation in the tournament contributes to learning stereochemistry.	50.0	42.9	0.0	7.1	0.0
TS6) Students used the game between the two days of the tournament to prepare for the final stage.	50.0	28.6	14.3	7.1	0.0
TS7) The prize is a motivating factor for students to study to participate in the tournament.	78.6	21.4	0.0	0.0	0.0
TS8) Students prefer to participate in the tournament instead of a traditional problem-solving class.	28.6	21.4	42.9	7.1	0.0

*AT: agree totally; A; agree; M: maybe; D: disagree; DT: disagree totally. **16 1st-year Natural Science undergraduate students and 41 1st-year Biotechnology students

USER ENGAGEMENT

We also invited all Brazilian and Italian students to complete a specific electronic form replicating the layout of the UES-SF (User Engagement Scale – Short Format)¹, as shown in section 3 of Table 1S, regarding the tournament. Table 8S presents all the respective data obtained from the 83 participating students who completed the form.

Table 8S. Brazilian and Italian students' answers to the UES-SF form about the Tournament experience

	FA-S.1	FA-S.2	FA-S.3	PU-S.1	PU-S.2	PU-S.3	AE-S.1	AE-S.2	AE-S.3	RW-S.1	RW-S.2	RW-S.3
p1	3	2	4	3	2	3	4	5	4	4	3	4
p2	3	3	3	3	2	2	4	4	4	4	3	4
p3	5	5	5	2	2	2	5	5	5	5	5	5
p4	4	4	4	2	2	2	4	4	4	4	4	4
p5	4	4	4	3	2	2	4	4	4	4	4	4
p6	4	5	5	2	1	1	5	5	5	5	5	5
p7	4	4	4	3	4	2	3	4	4	4	4	4
p8	4	2	2	5	2	4	2	4	1	2	2	2
p9	4	5	5	3	2	2	5	5	5	5	4	5
p10	3	5	3	1	1	1	5	5	5	5	5	5
p11	5	4	5	1	1	1	4	4	4	5	5	5
p12	5	4	5	2	1	2	5	5	4	4	4	5
p13	5	5	5	1	2	2	5	5	5	5	5	5
p14	5	4	5	1	1	1	5	5	5	5	5	5
p15	4	4	4	1	2	3	5	5	5	5	5	5
p16	5	5	4	1	2	3	5	5	5	5	4	5
p17	5	5	5	5	5	5	5	5	5	5	5	5
p18	4	4	5	1	2	1	5	5	5	5	5	5
p19	4	5	5	3	2	3	4	4	3	4	4	4
p20	4	5	4	3	1	1	4	4	5	5	4	5
p21	4	3	4	2	2	1	1	4	4	4	4	4
p22	4	5	5	2	2	2	2	4	4	4	4	4
p23	5	4	4	2	2	2	4	4	4	5	5	5
p24	5	5	5	1	1	1	5	4	5	5	5	5
p25	5	5	5	1	1	1	5	5	5	5	5	5
p26	5	5	5	2	1	2	4	4	5	5	4	5

	FA-S.1	FA-S.2	FA-S.3	PU-S.1	PU-S.2	PU-S.3	AE-S.1	AE-S.2	AE-S.3	RW-S.1	RW-S.2	RW-S.3
p27	4	5	5	1	2	2	5	5	5	5	5	5
p28	4	5	4	2	2	2	3	4	4	5	4	4
p29	4	4	4	2	2	3	4	3	4	4	4	4
p30	5	4	4	1	2	2	4	4	4	5	4	4
p31	4	4	4	4	2	2	4	4	4	4	4	4
p32	4	5	4	1	1	1	4	5	5	5	5	5
p33	4	5	5	1	1	1	5	5	5	5	5	5
p34	2	5	4	1	2	1	4	5	5	5	5	5
p35	5	5	5	1	1	1	5	5	5	5	5	5
p36	5	4	4	2	3	2	4	4	4	4	4	4
p37	4	4	4	2	2	2	3	3	5	5	4	4
p38	5	5	5	1	1	1	5	5	5	5	5	5
p39	4	4	4	1	1	1	4	4	4	4	4	4
p40	5	5	5	2	2	2	4	5	5	5	5	5
p41	5	4	4	3	3	3	5	5	3	5	5	5
p42	5	5	5	1	1	1	4	4	4	5	5	5
p43	4	4	4	2	2	2	4	4	4	4	4	4
p44	4	4	5	1	2	1	4	4	4	4	4	4
p45	3	3	4	2	2	2	3	2	4	4	4	4
p46	5	5	5	5	4	1	5	4	5	5	4	2
p47	4	5	4	1	1	1	4	5	5	5	4	5
p48	5	4	4	2	2	1	4	4	4	5	4	5
p49	4	4	4	1	2	2	4	4	4	4	4	4
p50	3	4	3	5	4	4	3	2	3	4	3	3
p51	4	4	4	1	2	2	4	4	4	5	4	4
p52	4	4	4	1	2	1	4	4	4	4	4	4
p53	5	4	5	1	1	1	5	4	5	5	5	4
p54	4	4	4	1	2	1	4	4	4	4	4	4
p55	4	5	3	2	2	1	3	4	4	4	4	4
p56	4	5	4	1	1	1	4	4	4	4	4	5
p57	4	5	4	2	2	1	3	4	4	5	5	5
p58	4	4	4	2	2	2	4	4	4	4	4	5

	FA-S.1	FA-S.2	FA-S.3	PU-S.1	PU-S.2	PU-S.3	AE-S.1	AE-S.2	AE-S.3	RW-S.1	RW-S.2	RW-S.3
p59	4	5	5	2	2	2	4	3	4	5	4	4
p60	3	4	4	2	2	1	3	4	4	4	2	4
p61	4	4	4	2	2	2	3	4	4	4	4	4
p62	4	4	4	1	1	1	3	4	4	5	5	5
p63	5	5	5	1	3	1	5	5	5	5	5	5
p64	5	5	5	2	1	1	5	4	5	5	3	5
p65	4	4	4	2	2	2	5	4	4	4	4	4
p66	5	5	5	1	2	2	4	4	4	4	4	4
p67	4	4	4	1	2	1	4	4	4	4	4	4
p68	4	5	4	3	1	1	4	4	4	5	4	5
p69	4	4	4	2	2	2	4	4	4	4	4	4
p70	5	5	5	3	2	2	5	4	5	5	5	4
p71	4	5	4	2	2	1	5	5	5	5	5	5
p72	4	5	5	2	2	1	5	4	5	5	5	5
p73	4	3	4	3	3	3	3	3	3	3	3	3
p74	3	3	3	3	3	3	3	3	3	3	3	3
p75	4	4	4	2	1	2	4	5	4	5	4	4
p76	4	4	4	2	2	2	4	3	4	4	4	4
p77	4	4	4	1	1	1	4	4	4	4	4	4
p78	5	5	4	1	2	1	4	4	5	5	4	5
p79	4	4	4	1	1	2	4	4	4	4	4	4
p80	4	5	5	1	2	2	5	5	4	5	5	5
p81	5	4	5	1	1	1	2	5	5	5	5	5
p82	4	4	4	2	2	2	2	4	4	4	4	4
p83	3	4	3	2	4	2	5	4	5	5	4	4

FA: focused attention; PU: perceived usability; AE: aesthetic appeal; RW: reward.

Figures 4S and 5S, respectively, show the average UES-SF scores obtained from the twelve statements and the average UES-SF scores stratified by domain and trial arm.

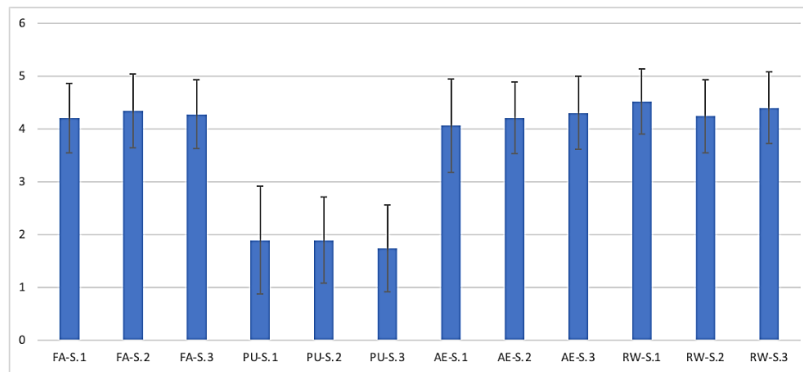


Figure 4S. Average UES-SF scores obtained from Brazilian students

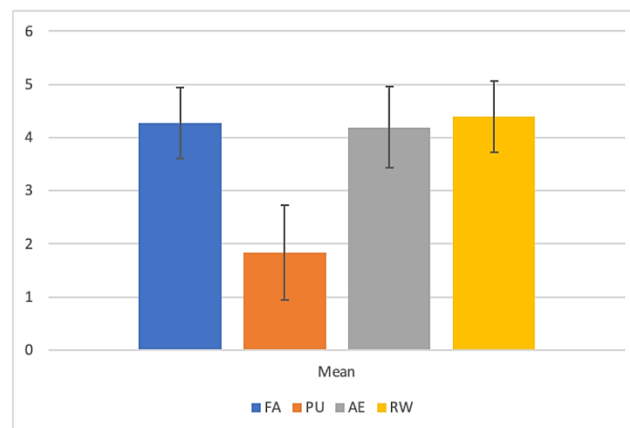


Figure 5S. Average UES-SF scores, stratified by domain and trial arm (mean and standard deviation shown), obtained from Brazilian students. FA: focused attention, PU: perceived usability, AE: aesthetic appeal, RW: reward¹

SCORING THE UES-SF

Considering the data shown in Table 8S:

- Reverse code the following items: PU-S1, PU-S2, PU-S3.¹
- If participants have completed the UES more than once as part of the same experiment, calculate separate scores for each iteration. This will enable the researcher to compare engagement within participants and between tasks/iterations.
- Scores for each of the four subscales can be calculated by adding the values of responses for the three items contained in each subscale and dividing by three. For example, “Aesthetic Appeal” would be calculated by adding AE-S1, AE-S2, and AE-S3 and dividing by three.
- An overall engagement score can be calculated by adding all of the items together and dividing by twelve.

REFERENCES

1. O’Brien, H. L.; Cairns, P.; Hall, M.; *Int. J. Hum. Comput. Stud.* **2018**, *112*, 28. [[Crossref](#)]

