

Game Modality Preferences and Learning Expectations in Multiplatform Game-Based Philosophy of Science Learning: Implications for Instructional Design

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ABSTRACT

Background: Understanding students' game modality preferences is critical for optimising game-based learning (GBL) design, yet most GBL research in higher education measures engagement and learning outcomes without systematically documenting what types of games students prefer and why. Purpose: This study investigates the game modality preferences and learning expectations of 78 pre-service science teachers (2024 cohort) at Universitas Negeri Makassar following participation in a multiplatform GBL intervention in the Philosophy of Science course. Method: A survey instrument with six structured and open-ended items assessed: (1) overall preferred game modality; (2) preferred offline games; (3) preferred psychomotor games; (4) preferred digital platforms; (5) preferred learning sequence; and (6) expected learning outcomes from games. An additional open-ended item collected student-generated game suggestions. Frequency analysis was conducted for all items; cross-class comparisons were performed for overall modality preference; and qualitative content analysis was applied to open-ended suggestions. Results: Offline games were the single most preferred modality (42.3%), followed by a combination of all three modalities (38.5%). Among offline games, the Ontology-Epistemology-Axiology Concept Puzzle (60.3%) and Socratic Discussion Cards (57.7%) were most preferred. Quizizz dominated digital platform preferences (78.2%). Embodied concept enactment (50.0%) and Standing Debate (44.9%) led psychomotor preferences. Critical thinking enhancement was the most expected learning outcome (78.2%). Qualitative analysis identified six thematic categories of student-generated suggestions, with debate-based games most frequently proposed (31.3%). Notable cross-class variation was observed in overall modality preference. Conclusion: Findings challenge the assumption that digital games are universally preferred by Gen-Z learners, and reveal a student body that prioritises argumentative, collaborative, and critically stimulating game formats over entertainment-oriented or recall-based ones. Implications for multiplatform GBL design in Philosophy of Science and analogous abstract higher education courses are discussed.

KEYWORDS

Game-Based Learning; Game Modality Preference; Philosophy of Science; Multiplatform Learning; Pre-Service Science Teachers; Instructional Design; Offline Games; Digital Games

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A. Introduction

Game-based learning (GBL) has achieved broad theoretical and empirical support as a strategy for enhancing student engagement, motivation, and learning outcomes in higher education ([Plass et al., 2015](#); [Wouters et al., 2013](#); [Veldkamp et al., 2020](#)). However, a persistent limitation in the GBL literature is its predominant focus on a single game type — typically digital games or gamified platforms — to the relative neglect of offline games, psychomotor game activities, and multiplatform designs that deliberately integrate all three modality types. [Bayeck \(2020\)](#) identified this representational imbalance in a multidisciplinary review spanning over two decades of board game

research, noting that analogue and physically embodied game formats are significantly underrepresented relative to their digital counterparts. Similarly, [Sousa et al. \(2023\)](#), in a systematic review of 151 studies on analogue game-based learning, found that offline and tabletop game formats accounted for a disproportionately small share of higher education GBL research despite demonstrating robust learning effects. This modality narrowness in research design partially reflects an implicit assumption seldom empirically tested that digital games are universally preferred by contemporary university students, particularly those belonging to Generation Z — a demographic often characterised in educational technology discourse as inherently digitally native and therefore assumed to prefer digital learning modalities (Prensky, 2001; Kirschner & De Bruyckere, 2017). However, Kirschner and De Bruyckere (2017) critically challenged this characterisation, arguing that the concept of the ‘digital native’ is a myth unsupported by empirical evidence, and that assumptions linking generational cohort to uniform digital learning preferences risk distorting instructional design decisions.

A complementary gap in the GBL literature concerns students' game preferences as a design input. Most GBL studies measure the effects of predetermined game designs on engagement or achievement, without first systematically investigating what types of games students prefer, how they rank different game modalities relative to each other, and what outcomes they expect games to facilitate. Understanding student game preferences is not merely a matter of consumer satisfaction; it has direct theoretical implications for motivational alignment between game design and student learning goals ([Ryan & Deci, 2000](#); [Hamari et al., 2016](#)), and practical implications for the sustainability and scalability of GBL interventions in resource-constrained educational settings.

Philosophy of Science presents a particularly challenging — and instructive — context for investigating game modality preferences. Unlike domain-specific science content, Philosophy of Science requires engagement with abstract concepts (ontology, epistemology, axiology) that resist direct operationalisation into points-badges-leaderboards mechanics, and that demand argumentation, perspective-taking, and collaborative conceptual synthesis ([Lipman, 2003](#); [Erduran & Dagher, 2014](#)). The question of which game modalities pre-service science teachers prefer for learning such content and for what reasons — has direct implications not only for Philosophy of Science course design, but also for the broader challenge of designing GBL for abstract, philosophically oriented subject matter.

This article presents a survey-based investigation of game modality preferences and learning expectations among 78 pre-service science teachers who participated in a multiplatform GBL intervention in the Philosophy of Science course at Universitas Negeri Makassar, Indonesia. The multiplatform intervention intentionally incorporated three game modality categories: offline games (concept puzzles, discussion card games, boardgames), psychomotor games (standing debates, gallery walks, embodied concept enactment, scientific trial drama), and digital platforms (Quizizz, Wordwall, Kahoot!, Padlet, digital escape room). Participants thus had direct, experiential exposure to all three modality types before completing the preference survey — making their responses informative comparative evaluations rather than speculative preferences.

The study addresses four research questions: (RQ1) Which game modality do pre-service science teachers prefer for Philosophy of Science learning, and do preferences differ across class sections? (RQ2) Which specific game formats are preferred within each modality category? (RQ3) In what sequence do students prefer to encounter different game modalities? (RQ4) What learning outcomes do students expect from game-based Philosophy of Science learning, and what additional game types do they suggest?

Literature Review

1. Game Modalities in Educational Contexts

Educational games can be categorised along several dimensions: medium (digital vs. analogue), activity type (cognitive, physical/embodied, social), and design mechanics (competitive, cooperative, narrative, puzzle-based). Research on offline analogue games — including boardgames, card-based discussion games, and concept puzzles — highlights their distinctive affordances for deep information processing, collaborative sense-making, and social engagement that are not fully replicated by digital interfaces ([Bayeck, 2020](#); [Sousa et al., 2023](#)). The tactile and interpersonal dimensions of analogue games may be particularly well-suited to subject matter that requires argumentation and collaborative construction of meaning, as is the case in Philosophy of Science.

Digital game platforms such as Quizizz and Kahoot! contribute competitive motivation, immediate formative feedback, and accessibility for large cohorts ([Sitompul et al., 2023](#); [Janković & Lambić, 2022](#)). Comparative research consistently shows that students tend to prefer Quizizz over Kahoot! due to its greater variety of question types, self-paced functionality, and detailed performance reporting ([Sitompul et al., 2023](#); [Basuki & Hidayati, 2019](#)). Psychomotor games — including embodied learning, role play, and drama simulation — engage the body as a site of meaning-making, drawing on enactive cognition theories that posit a constitutive role for bodily action in concept formation ([Wilson, 2002](#); [Shapiro, 2019](#)). Despite their recognised pedagogical value, psychomotor game formats are significantly underrepresented in higher education GBL research.

2. Student Preferences as a GBL Design Input

Self-determination theory ([Ryan & Deci, 2000](#)) provides a theoretical foundation for treating student preferences as a meaningful design input: when instructional activities are congruent with students' intrinsic motivational orientations, engagement and learning outcomes are enhanced. In the context of GBL, [Hamari et al. \(2016\)](#) demonstrated that perceived challenge and goal clarity — dimensions of game design that can be tailored to student preferences — were the strongest predictors of engagement and learning. [Dichev and Dicheva \(2017\)](#) similarly noted that 'one-size-fits-all' gamification approaches consistently underperform relative to designs that account for student motivational profiles. Despite this theoretical grounding, few GBL studies in higher education have systematically documented student preferences across multiple game modalities as a basis for design recommendations.

3. Game-Based Learning for Philosophy and Abstract Concepts

The application of GBL to abstract, philosophically oriented content in higher education remains a frontier area of research. [Lipman's \(2003\)](#) 'community of inquiry' approach to philosophy education emphasises dialogical argumentation as the primary vehicle for philosophical concept formation — a finding that aligns with the dominance of debate-based game preferences reported in the present study. Recent work on escape rooms ([Veldkamp et al., 2020](#)), boardgames ([Bayeck, 2020](#)), and discussion card games ([Sousa et al., 2023](#)) in higher education suggests that analogue game formats are well-positioned to scaffold the argumentation, perspective-taking, and collaborative reasoning central to philosophical inquiry. However, empirical evidence on student preferences for specific game formats within Philosophy of Science or analogous abstract courses remains scarce.

B. Method

1. Participants and Context

Participants were 78 pre-service science teachers (2024 cohort) from three parallel class sections (Class A: n=31; Class B: n=16; Class C: n=31) enrolled in the Philosophy of Science course

at Universitas Negeri Makassar, Indonesia, during the 2025/2026 academic year. Prior to completing the preference survey, all participants had experienced all three game modality categories across multiple course sessions: offline games (Concept Puzzle O-E-A, Socratic Discussion Cards, Ontology Word Battle, Philosopher's Journey Boardgame, Role Play Scientist vs. Philosopher), psychomotor games (Standing Debate, Gallery Walk, Embodied Concept Enactment — Realism vs. Idealism, Scientific Trial Drama Simulation, Physical Timeline Construction), and digital platforms (Quizizz, Wordwall, Kahoot!, Padlet, Digital Escape Room, Mentimeter). This experiential exposure ensures that preference ratings reflect comparative evaluation rather than uninformed anticipation.

2. Instrument

Game preference and learning expectation data were collected through a six-item structured section appended to the Student Engagement Instrument. Items are presented in Table 1.

TABLE 1. Game Preference and Learning Expectation Survey Items

Item	Question	Format	Options/Notes
1	In general, which type of game-based learning do you prefer most?	Single select	Offline games; Psychomotor games; Digital games; Combination of all three modalities
2	Which offline games do you consider most suitable for learning Philosophy of Science?	Multiple select (≥ 1)	5 options: O-E-A Concept Puzzle; Socratic Discussion Cards; Ontology Word Battle; Philosopher's Journey Boardgame; Role Play
3	Which psychomotor games are most interesting to you?	Multiple select (≥ 1)	5 options: Embodied Movement; Standing Debate; Gallery Walk; Physical Timeline; Trial Drama
4	Which digital platforms or games do you prefer most for learning?	Multiple select (≥ 1)	6 options: Quizizz; Wordwall; Padlet; Kahoot!; Escape Room; Mentimeter
5	If you could choose only one, your preferred sequence for learning Philosophy of Science is...	Ranked ordering	6 ordering combinations of Offline, Psychomotor, and Digital modalities
6	What aspects do you expect from Philosophy of Science learning games?	Multiple select (≥ 1)	6 options: Critical thinking; Enjoyment; Abstract concepts; Teamwork; Argumentation; Professional relevance
7 (open)	Write the type of game or learning activity that you would like to try in the Philosophy of Science course:	Open-ended text	Free response; n = 67 valid

Note. Items were administered in Bahasa Indonesia and are translated into English for manuscript presentation. Items 2-4 and 6 are multiple-selection; percentages are based on N = 78. Item 5 yields ranked sequence data.

3. Data Analysis

Frequency and percentage distributions were computed for all structured items (Items 1–6). For multi-selection items, percentages were calculated relative to total participants (N = 78), allowing values to exceed 100% in aggregate. Cross-class comparisons for Item 1 (overall modality preference) were conducted using frequency distributions; due to the small sample size of Class B (n = 16), inferential testing was not performed. The preferred learning sequence (Item 5) was analysed using frequency of each ordering combination. Open-ended suggestions (Item 7) were analysed using qualitative content analysis (Hsieh & Shannon, 2005), with themes identified inductively and representative excerpts selected to illustrate each category.

C. Results and Discussion

1. Results

a. Overall Game Modality Preference (Item 1)

Table 2 presents overall game modality preferences for the full sample and disaggregated by class section. Across all 78 participants, offline games were the single most frequently selected modality ($n = 33$; 42.3%), followed by a preference for a combination of all three modalities ($n = 30$; 38.5%), psychomotor games ($n = 10$; 12.8%), and digital games ($n = 5$; 6.4%). Together, preferences for offline-inclusive options — including offline alone (42.3%) and the combination (38.5%) — represented 80.8% of all selections, while digital games as the exclusive preference represented only 6.4%.

Notable cross-class variation was observed. Class A showed the highest preference for the combined modality ($n = 13$; 41.9%), suggesting a more pluralistic orientation. Class C showed the strongest exclusive preference for offline games ($n = 17$; 54.8%), nearly double the offline preference rate of Class A ($n = 9$; 29.0%). Digital games were minimally preferred in all three classes (1–3 students per class), consistently the least selected option.

TABLE 2. Overall Game Modality Preference by Class Section (Item 1; $N = 78$)

Modality	Class A ($n=31$)	n	%	Class B ($n=16$)	n	%	Class C ($n=31$)	n	%	Total n	%
Offline games	9		29.0%	7		43.8%	17		54.8%	33	42.3%
Combination of all three modalities	13		41.9%	6		37.5%	11		35.5%	30	38.5%
Psychomotor games	6		19.4%	2		12.5%	2		6.5%	10	12.8%
Digital games	3		9.7%	1		6.2%	1		3.2%	5	6.4%

Note. Each participant selected one option only.

b. Preferred Offline Game Formats (Item 2)

Among the five offline game formats experienced in the course, the Concept Puzzle (Ontology-Epistemology-Axiology) was the most preferred ($n = 47$; 60.3%), followed by Socratic Discussion Cards ($n = 45$; 57.7%), Ontology Word Battle ($n = 36$; 46.2%), the Philosopher's Journey Boardgame ($n = 33$; 42.3%), and Role Play: Scientist vs. Philosopher ($n = 19$; 24.4%). The dominance of the Concept Puzzle and Socratic Discussion Cards — both formats that require active conceptual manipulation and structured argumentation — is consistent with the finding that critical thinking enhancement was the most expected learning outcome (see Section 4.5). The full distribution is presented in Table 3.

TABLE 3. Preferred Offline Game Formats (Item 2; $N = 78$; Multiple Selection Allowed)

Game Format	n	%	Primary Cognitive Demand
Ontology-Epistemology-Axiology Concept Puzzle	47	60.3%	Conceptual matching & categorisation
Socratic Discussion Cards (debating the nature of science)	45	57.7%	Argumentation & dialectical reasoning
Word Game (Ontology Word Battle)	36	46.2%	Vocabulary & definitional recall
'Philosopher's Journey' Boardgame (exploring schools of philosophy)	33	42.3%	Sequential reasoning & strategic thinking
Role Play: Scientist vs. Philosopher	19	24.4%	Perspective-taking & narrative argumentation

Note. Percentages calculated relative to N = 78; totals exceed 100% as multiple selections were permitted.

c. Preferred Psychomotor Game Formats (Item 3)

Among the five psychomotor game formats, Embodied Concept Enactment - bodily movement to express realism vs. idealism — was most preferred (n = 39; 50.0%), followed by Standing Debate (n = 35; 44.9%) and Gallery Walk with argumentation stickers (n = 35; 44.9%). The Physical Timeline construction (n = 24; 30.8%) and Scientific Trial Drama simulation (n = 21; 26.9%) were less frequently selected, suggesting that embodied and immediate-interaction formats are preferred over more elaborate narrative or sequential physical formats. Results are presented in Table 4.

TABLE 4. Preferred Psychomotor Game Formats (Item 3; N = 78; Multiple Selection Allowed)

Game Format	n	%	Modality Type
Bodily movement to express realism vs. idealism	39	50.0%	Embodied/enactive concept expression
Standing Debate on scientific values	35	44.9%	Verbal-physical argumentation
Gallery Walk with argument stickers on posters	35	44.9%	Movement + written argumentation
Physically arranging a timeline of Philosophy of Science figures	24	30.8%	Sequential physical construction
Simulation drama: 'Scientific Theory Trial'	21	26.9%	Role play + narrative drama

d. Preferred Digital Platforms (Item 4)

Quizizz dominated digital platform preferences substantially (n = 61; 78.2%), followed by Wordwall (n = 40; 51.3%), Padlet (n = 28; 35.9%), Kahoot! (n = 26; 33.3%), Digital Escape Room (n = 16; 20.5%), and Mentimeter (n = 9; 11.5%). The gap between Quizizz (78.2%) and Kahoot! (33.3%) — despite both being competitive quiz platforms with broadly similar mechanics — is notable and consistent with prior research indicating student preferences for Quizizz's greater question variety, self-paced functionality, and detailed score reporting (Sitompul et al., 2023). Results are presented in Table 5.

TABLE 5. Preferred Digital Platforms (Item 4; N = 78; Multiple Selection Allowed)

Platform	n	%	Primary Function
Quizizz - competitive team quiz	61	78.2%	Competitive team quiz with leaderboard and immediate feedback
Wordwall - vocabulary and concept games	40	51.3%	Vocabulary and concept-matching game formats
Padlet - digital idea collaboration	28	35.9%	Asynchronous collaborative knowledge board
Kahoot! - real-time quiz	26	33.3%	Real-time competitive quiz with avatar mechanics
Digital escape room themed around Philosophy of Science	16	20.5%	Narrative puzzle-solving challenge (philosophy-themed)
Mentimeter - polling and word cloud	9	11.5%	Real-time polling and anonymous word cloud display

e. *Preferred Learning Sequence (Item 5)*

When asked to rank their preferred order for encountering the three game modalities in a course session, the Offline > Psychomotor > Digital sequence was most frequently selected (n = 26; 33.3%), followed by Digital > Offline > Psychomotor (n = 23; 29.5%) and Offline > Digital > Psychomotor (n = 15; 19.2%). The full distribution is presented in Table 6.

TABLE 6. Preferred Learning Sequence of Game Modalities (Item 5; N = 78)

Preferred Sequence	n	%	Implied Learning Trajectory
Offline > Psychomotor > Digital	26	33.3%	Conceptual groundwork → embodied action → digital consolidation
Digital > Offline > Psychomotor	23	29.5%	Digital activation → conceptual deepening → embodied application
Offline > Digital > Psychomotor	15	19.2%	Conceptual foundation → digital reinforcement → embodied expression
Psychomotor > Digital > Offline	5	6.4%	Embodied introduction → digital consolidation → analogue elaboration
Digital > Psychomotor > Offline	5	6.4%	Digital activation → embodied engagement → analogue synthesis
Psychomotor > Offline > Digital	4	5.1%	Embodied introduction → analogue conceptualisation → digital assessment

Note. Each participant selected one ordering combination only.

f. *Expected Learning Outcomes from Game-Based Learning (Item 6)*

Table 7 presents the distribution of expected learning outcomes. Enhancing critical thinking skills was the most frequently expected outcome (n = 61; 78.2%), substantially ahead of all other options. This was followed by making learning enjoyable and not boring (n = 56; 71.8%), facilitating understanding of abstract concepts (n = 52; 66.7%), encouraging teamwork (n = 49; 62.8%), training argumentation skills (n = 48; 61.5%), and relevance to the science teaching profession (n = 42; 53.8%). The top three expected outcomes — critical thinking, enjoyment, and abstract concept understanding — directly correspond to the three core pedagogical challenges of Philosophy of Science teaching: cognitive depth, motivational engagement, and conceptual accessibility.

TABLE 7. Expected Learning Outcomes from Game-Based Philosophy of Science Learning (Item 6; N = 78; Multiple Selection Allowed)

Expected Outcome	n	%	Relationship to Course Goals
Enhancing critical thinking skills	61	78.2%	Core competency of philosophical inquiry
Making learning enjoyable and not boring	56	71.8%	Motivational accessibility of abstract content
Facilitating understanding of abstract concepts	52	66.7%	Ontology/epistemology/axiology accessibility
Encouraging teamwork	49	62.8%	Collaborative argumentation in philosophy
Training argumentation skills	48	61.5%	Core skill of philosophical discourse
Relevance to the science teaching profession	42	53.8%	Pre-service teacher professional identity

g. *Student-Generated Game Suggestions (Item 7)*

Sixty-seven participants provided valid open-ended game suggestions. Qualitative content analysis yielded six thematic categories, presented in Table 8 with representative excerpts. The most frequently proposed theme was debate-based games (n = 21; 31.3%), encompassing standing debate, carousel debate, pro-con debate on contemporary science issues, and three-position philosophical debate. Quiz and interactive games were the second most common category (n = 18; 26.9%), followed by guessing and problem-solving games (n = 17; 25.4%), simulation and role-play (n = 10; 14.9%), case study activities (n = 10; 14.9%), and escape room or mystery formats (n = 4; 6.0%).

TABLE 8. Thematic Categories of Student-Generated Game Suggestions (Item 7; n = 67 valid responses)

Theme	Description & Examples from Responses	n	%
Debate-based games	Role debate (Realism vs. Idealism vs. Constructivism), Debate Carousel Game, pro-con debate on contemporary science issues (genetic engineering, climate change), philosophical paradigm debate	21	31.3%
Quiz & interactive games	Interactive philosophy quizzes, O-E-A quiz competition, true-or-false games, team-based rapid-response questions, scientist-guessing quizzes	18	26.9%
Guessing & problem-solving	Picture guessing, word guessing, concept guessing, The Black Box Mystery simulation, philosophy word-chain game	17	25.4%
Case study activities	Case studies of scientific development, 'What if' cases in the history of science, analysis of contemporary philosophical problems	10	14.9%
Simulation & role-play	Peer-review simulation, scientific journal simulation, role-play of philosophical figures (Karl Popper, Aristotle, Thomas Kuhn), science ethics dilemma drama	10	14.9%
Escape room & mystery formats	Digital escape room themed around O-E-A philosophy, closed-concept puzzles	4	6.0%

Note. Themes are not mutually exclusive. Percentages relative to n = 67 valid responses.

Representative excerpts illustrating the range of suggestion sophistication are presented below:

"Black Box Simulation: An activity in which students must determine the contents of a closed box without opening it, using indirect experiments. This is very useful for simulating the epistemology of science - the limits of observation and how scientists build models from limited data."

— Participant, Class C

"Role debate: Realism vs. Idealism vs. Constructivism. Students are divided into three groups, each defending an ontological position on the case: 'Do genes really exist, or are they merely mental constructions of scientists?'"

— Participant, Class A

"I would like to try a Debate Carousel Game, a rotating debate among groups to train critical thinking and argumentation in Philosophy of Science issues."

— Participant, Class C

"Science Ethics Dilemma: A real-case discussion to examine the intersection between scientific knowledge and moral values - for example, the ethics of genetic engineering or scientists' decisions in situations involving conflicts of interest."

— Participant, Class A

2. Discussion

a. *The Offline Paradox: Challenging Digital Ubiquity Assumptions*

The finding that offline games were the single most preferred modality (42.3%), with digital games exclusively preferred by only 6.4% of participants, represents the most theoretically significant result of this study. It directly challenges the prevailing assumption in educational technology discourse that contemporary university students — and particularly Generation Z learners who have grown up with digital devices — universally prefer digital learning environments over analogue ones. Our findings suggest that this assumption, while plausible in general digital consumption contexts, does not straightforwardly transfer to the domain of game-based learning for abstract, philosophically oriented content.

The dominance of offline preferences may reflect several interacting factors. First, the specific offline games used in this course — particularly the Concept Puzzle and Socratic Discussion Cards — were cognitively well-matched to the content: they required argumentation, conceptual manipulation, and collaborative sense-making in ways that align with the dialogical epistemology of philosophical inquiry ([Lipman, 2003](#)). Students' preference for these formats may thus reflect recognition that the game's cognitive demands match the content's intellectual requirements. Second, offline games afford richer interpersonal interaction — eye contact, tone of voice, physical co-presence — which may be particularly valued in the context of learning Philosophy of Science, a subject that relies fundamentally on the quality of argumentative discourse. This finding is consistent with [Bayeck's \(2020\)](#) analysis of boardgame affordances and with [Sousa et al.'s \(2023\)](#) systematic review of analogue educational games.

b. *Within-Modality Preferences: Argumentation as the Common Thread*

Across all three game modality categories, the most preferred formats share a common structural feature: they require argumentation or active conceptual engagement rather than passive recall or recognition. Within offline games, the Concept Puzzle (60.3%) and Socratic Discussion Cards (57.7%) — both requiring active conceptual manipulation and structured debate — outperformed the more passive or sequential Boardgame (42.3%) and Role Play (24.4%). Within psychomotor games, Embodied Concept Enactment (50.0%) and Standing Debate (44.9%) — both formats in which students must actively articulate and defend a philosophical position — outperformed the more constructive or narrative Drama Simulation (26.9%). Within digital platforms, Quizizz's dominance (78.2%) over Kahoot! (33.3%) and Mentimeter (11.5%) may reflect Quizizz's greater variety of question types and its team-based competitive structure, which more closely approximates the argumentative dynamics valued by participants.

This cross-modality pattern — preference for argumentation-demanding formats — is directly coherent with the learning expectation data: critical thinking (78.2%) and argumentation training (61.5%) were the most expected outcomes of game-based Philosophy of Science learning. The data thus reveal not a superficial entertainment preference but a metacognitively aware preference for games that deliver the intellectual challenges students know they need. This is an important finding for instructional designers: student preferences in this context are pedagogically informative, not merely hedonically expressive.

c. *Learning Sequence Preferences: Two Dominant Models*

The distribution of preferred learning sequences reveals two distinct pedagogical models among participants. The majority preference for Offline > Psychomotor > Digital (33.3%) reflects an 'analogue-to-digital escalation' model, in which conceptual groundwork is laid through tactile, interpersonal game formats, then physically enacted through embodied activities, and finally

consolidated or assessed through digital platforms. This sequence mirrors established instructional design principles of concrete-to-abstract progression ([Bruner, 1966](#)) and the enactive-iconic-symbolic learning sequence ([Ainsworth, 2006](#)).

The second most common preference, Digital > Offline > Psychomotor (29.5%), reflects an 'activation-deepening' model, in which a digital quiz or interactive platform is used to activate prior knowledge and create a motivational entry point, followed by deeper conceptual engagement through offline games, and consolidated through embodied expression. This sequence is consistent with flipped classroom and pre-class digital activation designs. The coexistence of these two dominant models in roughly equal proportions (33.3% vs. 29.5%) suggests that no single optimal learning sequence exists for this student population, and that instructional flexibility — offering different orderings across different course sessions — may better serve the range of learner preferences.

d. Learning Expectations: A Student Body That Knows What It Needs

The finding that critical thinking enhancement was overwhelmingly the most expected outcome of game-based Philosophy of Science learning (78.2%) — substantially ahead of enjoyment (71.8%) and abstract concept comprehension (66.7%) — reveals a student body with clear metacognitive awareness of what Philosophy of Science demands and what they need games to deliver. This is not a trivial finding: it suggests that these pre-service teachers are not approaching GBL as a form of edutainment, but as a vehicle for developing the genuine intellectual capacities they associate with philosophical inquiry.

Equally significant is the fact that relevance to the science teaching profession — while the least frequently expected outcome (53.8%) — was still endorsed by more than half of participants. This reflects the broader context of these participants as pre-service teachers: they are simultaneously learning philosophy and preparing to teach science, and they bring both of these identities to their evaluation of game-based learning. Instructional designs that make the connection between philosophical understanding and future science teaching practice explicit — for example, through games that require participants to design science lessons incorporating O-E-A thinking — could strengthen this professional relevance dimension.

e. Student-Generated Suggestions: A Design Roadmap

The qualitative richness of student-generated game suggestions — particularly the Black Box Mystery simulation, the three-position philosophical debate, and the science ethics dilemma case — provides a valuable design roadmap for future course iterations. Three implications stand out. First, the dominance of debate-based suggestions (31.3%) reinforces the quantitative finding that argumentation-demanding formats are most valued; future game designs should systematically incorporate structured philosophical debate as a core mechanic. Second, several suggestions (Black Box Mystery, peer review simulation, journal simulation) reflect sophisticated understanding of how scientific epistemology works in practice — suggesting that games simulating actual scientific processes, rather than merely quizzing about them, would be both pedagogically powerful and student-aligned. Third, the role-play suggestions targeting specific philosophical figures (Karl Popper, Thomas Kuhn, Aristoteles) indicate student interest in historically and biographically grounded philosophical learning — an approach that has strong theoretical support in history and philosophy of science education ([Erduran et al., 2022](#)).

f. Limitations

Several limitations should be acknowledged. First, although participants had experienced all three game modality types before completing the preference survey, exposure was not perfectly balanced across modalities — offline games were implemented across more sessions than digital or

psychomotor formats, which may have inflated offline preference ratings. Second, Class B ($n = 16$) is substantially smaller than Classes A and C, limiting the reliability of cross-class comparisons for this group. Third, the preference data reflect post-intervention evaluations, which may be influenced by recency bias and the overall emotional valence of the course experience. Longitudinal preference tracking — assessing preferences before, during, and after the course — would provide richer insight into preference formation and change. Fourth, the open-ended suggestions were not followed up with interviews or focus groups; participant reasoning behind specific suggestions is therefore inferred from textual responses rather than verified through dialogue

D. Conclusion

This study investigated the game modality preferences and learning expectations of 78 pre-service science teachers following participation in a multiplatform game-based Philosophy of Science course at Universitas Negeri Makassar. Four principal findings emerged. First, offline games were the single most preferred game modality (42.3%), with digital games as the exclusive preference representing only 6.4% of selections — challenging the assumption that digital games are universally preferred by Gen-Z university learners, particularly for abstract subject matter. Second, across all three game modality categories, argumentation-demanding and conceptually active formats were consistently most preferred: Concept Puzzle and Socratic Discussion Cards (offline), Embodied Concept Enactment and Standing Debate (psychomotor), Quizizz (digital). Third, critical thinking enhancement was the overwhelmingly dominant learning expectation (78.2%), indicating metacognitive awareness of philosophical learning demands. Fourth, student-generated game suggestions — dominated by debate formats, Black Box simulations, and historical roleplay — provide a concrete design roadmap for future course development.

Together, these findings suggest that the design of game-based learning for Philosophy of Science and analogous abstract higher education courses should prioritise argumentative depth over entertainment appeal, exploit the distinctive interpersonal affordances of offline and psychomotor formats alongside digital platforms, and engage students as active co-designers of game formats through systematic preference elicitation. This study contributes to the developing literature on multiplatform GBL design by providing the first systematic empirical documentation of game modality preferences in a Philosophy of Science course for pre-service science teachers. Kesimpulan adalah pernyataan singkat dan tepat yang merupakan jawaban dari rumusan masalah. Saran berisi pertimbangan yang ditujukan kepada pihak lain yang terkait dengan hasil penelitian.

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