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How HEXAD types influence systemic and finer-grained experiences in gameful educational media: an exploratory study

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Abstract
Education in the 21st century demands technological support, which gameful media, such as educational games, amply provide. Providing this support also requires the media to accommodate the different needs of players, which can be identified by first grouping the players into types, such as through the robust HEXAD typology. However, how a player's HEXAD type influences their experience in gameful media is still vague. This study aims to combat this vagueness by exploring the use of HEXAD in a more systemic and fine-grained manner through a playtest of an educational role-playing game. We measured the playtesters' gameplay and learning experiences (n = 60) through a questionnaire based on the HEXAD scale, the GUESS scale, and the EGameFlow scale. We then conducted tests for correlations between the playtesters' HEXAD types and their gameplay and learning experiences. Our analysis of the correlations uncovers exciting findings, including that the "achiever" type strongly appreciates playability features and that playability is among the essential gameplay factors for HEXAD types. We also propose design principles that can guide future research and development of the media.

1. Introduction

Despite the surface-level diversity between games and education, they share some core principles, leading to a myriad of gameful educational media such as educational games and gamification. Among these shared principles is recognizing and facilitating the different needs of players or learners [1], [2]. The "one size fits all" viewpoint has become obsolete in both fields [3], primarily since today's complex challenges call for creativity and personal initiative [4]. To adapt their products to their players' various demands, developers of gameful media can employ several tools to understand their players on a more personal level. Among popular tools for player personalization are typologies, which classify players into types based on specific dimensions or attributes [5].

Many player typologies have been applied in the industry or discussed in the literature [5]. Among them, only a few bridges gameful media and education. HEXAD, a gamification user typology [3], is among these rare ones. The typology has enjoyed increasing popularity due to its scale's validity, reliability, and availability in multiple languages [6]. Furthermore, it has also found use in adjacent gameful media like educational games [7], [8]. However, despite HEXAD's increasingly widespread usage, the exact effects of HEXAD types on player experiences are still uncertain, mainly because the way HEXAD has typically been used lacks precision and neglects the systemic nature of gameful media. Thus, there is a need to investigate the use of HEXAD to precisely adapt the systemic constituents of gameful educational media to the player's preferences regarding learning [9], game mechanics [10], and other aspects.

We aim to study this matter by applying HEXAD in a gameful educational medium case study and empirically analyzing the results. Accordingly, this paper presents our study as follows. A review of the relevant state of the art, presented in the following subsection, formed our study's theoretical foundation. A research gap uncovered at the end of the review became the basis of our research goals, which we state in Subsection 1.2. Section 2 explains the study's method in detail, including four research questions that flesh out the research goals. Section 3 discusses the study's results, limitations, and validity threats, and Section 4 concludes the study.

1.1 State of the Art

Gameful media such as games and gamification increasingly deliver personal [1] or adaptive gameplay [11] for optimal player engagement and satisfaction. Personalizing or adapting a game to the player's needs requires understanding the player, whether through a survey [12], analysis of their behaviors [13], or physiological sensing [14]. Since separately treating every player can be very costly, game developers can instead treat groups of players based on similarities of traits or preferences. Many typologies are available to classify players based on the dimensions of their traits of preferences, such as achievement and immersion [5]. Despite shortcomings like a tendency to oversimplify

player characteristics [15], typologies have remained popular because it is easy to understand and apply, such as through questionnaires.

As previously discussed, player typologies in games or gamified systems for educational purposes constitute only a small subset of available player typologies. We will first discuss two notable members of the subset. Barata, Gama, Jorge, and Gonçalves conducted long-term research on a gamified college course and clustered the participants into six types based on their behaviors and academic performances [16]. For example, the best or ideal type is "Achievers," and one of the lowest-performing ones is "Disheartened." Meanwhile, Gholizadeh, Taghirayeh, and Alvandkoohi employed a similar behavior- and performance-based approach to propose a propensity-oriented educational game player typology [17]. The typology differentiates players through five variables, namely punctuality, presence, perfection, precision, and pace. Thus, specific values of the variables constitute a player profile.

Although promising, both typologies unfortunately hardly take gameplay preferences into account. These preferences are crucial in gameful educational media due to their inherent duality: they must simultaneously facilitate gameplay and learning [18], [19]. Consequently, one must look elsewhere for typologies that balance both purposes. Alternatives to education-oriented player typologies are general-purpose ones that also cover learning-related aspects. Two typologies in the literature fit the description. The first is BrainHex [20], which connects the Myers-Briggs Type Indicator (MBTI), a popular psychological typology, with various theories and typologies of player preferences, such as Bartle's player types. The typology's usage in education covers games [21] and beyond [22]. Unfortunately, the BrainHex questionnaire is psychometrically flawed [23], leading to BrainHex's abandonment by scholars. Furthermore, MBTI has been shown to have little scientific merit [24], which weakens BrainHex's theoretical basis.

The second typology, HEXAD, does not suffer from such issues and thus has been used continuously. The typology takes the intrinsic and extrinsic motivations from the robust self-determination theory (SDT) [25] and personifies them into six user types: the altruistic Philanthropist, the relation-building Socialiser, the freedom-loving Free Spirit, the task-completing Achiever, the rule-breaking Disruptor, and the reward-hunting Player. These types are not mutually exclusive; thus, anyone can belong to multiple HEXAD types at once.

Although HEXAD is a general-purpose typology of gameful media users, it is especially relevant in educational contexts due to the prominence of SDT in education [25]. Multiple studies have confirmed and also improved the HEXAD scale's reliability and validity [3], [6], [26]. In addition to having adequate psychometric properties, the scale is also available in many languages, including Spanish [6], Dutch [27], and Turkish [28]. Thus, it is no wonder that HEXAD has seen many applications, even outside gamification, such as in educational games [7], [8].

Meanwhile, Figure 1 illustrates a typical theoretical basis of gameful media based on the widely used MDA (Mechanics, Dynamics, Aesthetics) framework [29]. Firstly, a gameful medium is a system that dynamically interacts with the player [30], and its elements, or "mechanics," work together to deliver various experiences, or "aesthetics," to the player. The player's gameplay-related experiences cover quality factors such as fun and playability [31], while their learning experiences ideally include knowledge improvement, appropriate challenges, and other aspects of a good learning process [32]. As proven in a recent study [33], the player's traits influence their experiences with a gameful educational medium; in other words, what arrangements of game elements are considered fun, playable, appropriately challenging, and such differ among players and especially player groups.

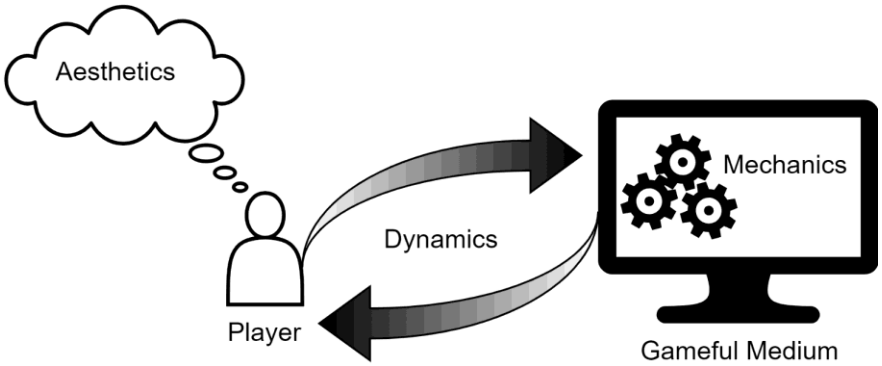

Figure 1. A Gameful Medium, its Systemic Mechanics, its Dynamics with the Player, and the Player's Aesthetics

Heretofore, each HEXAD type's preferred game elements have been identified [3], [34], most recently by Krath and von Korflesch [26]. Unfortunately, this research tends to lack precision. Firstly, instead of treating gameful media as systems, it often investigates coarse-grained bundles of game elements, such as a "narrative" and a "quest system" separately without considering their interactions, leading to ambiguities such as some bundles aligning with multiple HEXAD types [34]. Secondly, an element being "preferred" hardly reveals the exact gameplay or learning experiences it delivers, which, again, has produced vague findings, such as the lack of consistent pattern of associations between

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HEXAD types and game elements in Santos et al. [35]. These problems point to the need to investigate how HEXAD types influence, on a systemic and finer-grained level, the relationships between game elements and player experiences, preferably in more ecologically valid contexts [35], such as the actual use of gameful media. Unfortunately, such investigations are still rare, which represents a glaring gap.

1.2 Research Goals and Questions

This study aims for two goals regarding the identified research gap: (1) gathering preliminary insights into how HEXAD types influence the systemic and finer-grained relationships between gameful educational media and gameplay and learning experiences in real applications of the media, and (2) extracting considerations from the insights for scholars and practitioners. Since "player experience" alone is a vast topic [36], this exploratory study merely tries to illuminate a small part of it, which future research can confirm or deny with much higher certainty [37].

This study pursues these research questions (RQs) to achieve the goals:

RQ1) How are the HEXAD types different regarding their general influences on systemic and finer-grained gameplay and learning experiences?
RQ2) Which gameplay quality factors does each HEXAD type appreciate and how?
RQ3) Which learning quality factors does each HEXAD type appreciate and how?
RQ4) What gameful educational media design principles can we derive from the findings?

2. Method

This study is one part of our larger exploratory study on gameful educational media. The larger study is a case study of a specific gameful educational medium: a single-player, educational role-playing game (RPG) [38]. A playtest of the RPG within the case study yielded various post-playtest questionnaire responses as quantitative data, which the smaller studies have processed for different purposes. Consequently, the smaller studies have similar methods as they took data from the same source. Regardless, each smaller study ultimately contributes differently to the literature on educational media. Four smaller studies other than this one have been published [19], [39]–[41]. In this study, we conducted correlation tests and analyses on the larger study's data to answer the four RQs.

Method-wise, this study exhibits these characteristics. It observed the effects of HEXAD types on player experiences at one specific time; thus, it is a cross-sectional study, a common one in human-computer interaction [42]. To deduce said effects, the study first conducted correlation tests and analyses on the results of a multi-part Likert-scale questionnaire [43]. Afterward, based on an assumption supported by domain knowledge of the observation subject, it inferred causal effects from the correlations [44]. In this case, the study assumes that HEXAD types may influence short-term player experiences but not the other way around. This assumption rests on the fact that HEXAD types are stable over a long period, up to six months according to recent research [45].

2.1 Playtest Design

Our RPG's gameplay elements, which comprised specific narrative features and game mechanics, delivered three sets of lessons for the player's learning process. Each playtester played the game in three sessions, each presenting the entire gameplay but only one lesson set, which was selectable at the beginning of the session. Thus, the lesson set selection neither altered nor disrupted the gameplay. Such "lesson-agnostic" gameplay was possible due to the "medium-coupling" design approach [46], which partially integrated gameplay and learning for flexibility. A more comprehensive discussion of the approach is available in our previous paper [19].

The online playtest involved 60 first-year informatics students (n = 60). This sample size surpassed the minimum of 20 suggested in the literature [47]. Each playtester was free to decide the order of the lesson sets within their three gameplay sessions. Afterward, they reported their HEXAD type and their gameplay and learning experiences through the post-playtest questionnaire to receive an honorarium.

The questionnaire measured four quality factors of the gameplay: playability, creative freedom, narrative, and play engrossment, the latter also known as immersion [48]. Three learning-related quality factors of each lesson set were also measured: knowledge improvement, challenge appropriateness, and learner autonomy [32]. The first factor concerned how much each playtester thought they learned from the game, while the second factor measured how appropriate the lessons' difficulty levels were, i.e., somewhere between too hard and too easy. Lastly, the third factor measured how much control each playtester could exert on their learning process. Since the playtest was online, we could not fully control the players' activities; thus, it was possible that they collaborated or sought help outside the game. We will consider the possibility of such out-of-game activities in our analysis of the questionnaire's results.

2.2 Design of the Lessons

Figure 1's upper part shows the game's learning scenario for each lesson, which taught a concept in two ways. First, it allowed the player to memorize the concept's elements and their order. Second, it explained the concept's definition briefly. Thus, the two activities supported the knowledge improvement factor. Memorization was each lesson's

core activity since it determined the player's learning success. Thus, we could put the lessons on the "remembering" level in the Revised Bloom's Taxonomy (RBT) [49]. In contrast, the explanation was optional since the game did not assess the player's understanding of the concept's definition.

The flow of the memorization process was as follows. First, the player learned about a concept's elements and their order. Afterward, the player began collecting the elements sequentially according to their order. The collected elements then underwent a verification process: The lesson ended successfully if the elements and their arrangement were deemed correct; otherwise, the player received *feedback* on their failure and restarted the process.

Since each lesson set consisted of three lessons, the player would follow the learning scenario thrice in a gameplay session. As with the lesson set order, the player could freely decide when to complete each lesson. There was also no requirement to keep following each lesson, i.e., the player could switch to another lesson anytime. We expected this flexibility to support the challenge and autonomy factors.

Each lesson set was on one of three informatics-related topics: propositional logic (LT1), software development (LT2), and algorithms (LT3). Respectively, the lesson sets taught the player about logic laws (e.g., the De Morgan's), steps of software development methodologies (e.g., Waterfall), and pseudocode lines of algorithms (e.g., Insertion Sort). For example, the lesson on Waterfall would task the player to memorize and arrange the methodology's steps, e.g., "Requirement Gathering" and "Design."

The lesson topics differed in familiarity [50] and ease of following. Whether a topic was easy to follow was determined by its comprehensibility [51] and memorability [52]. Being a first-year informatics student, our participants were familiar with only LT1 as they had learned it in high school. Meanwhile, the number and characteristics of each lesson topic's elements determined its ease of following. LT1 and LT2 satisfied the aspect due to their elements' low numbers and simplicity: simple symbols for LT1 and common words for LT2. On the other hand, LT3 was much more challenging to follow due to (1) the pseudocodes' cryptic nature, which hampered understanding, and (2) the numerous unique pseudocode lines as the topic's elements, which complicated the memorization. However, writing down a concept's elements to help with memorization was entirely possible, which would again contribute to the challenge and autonomy factors.

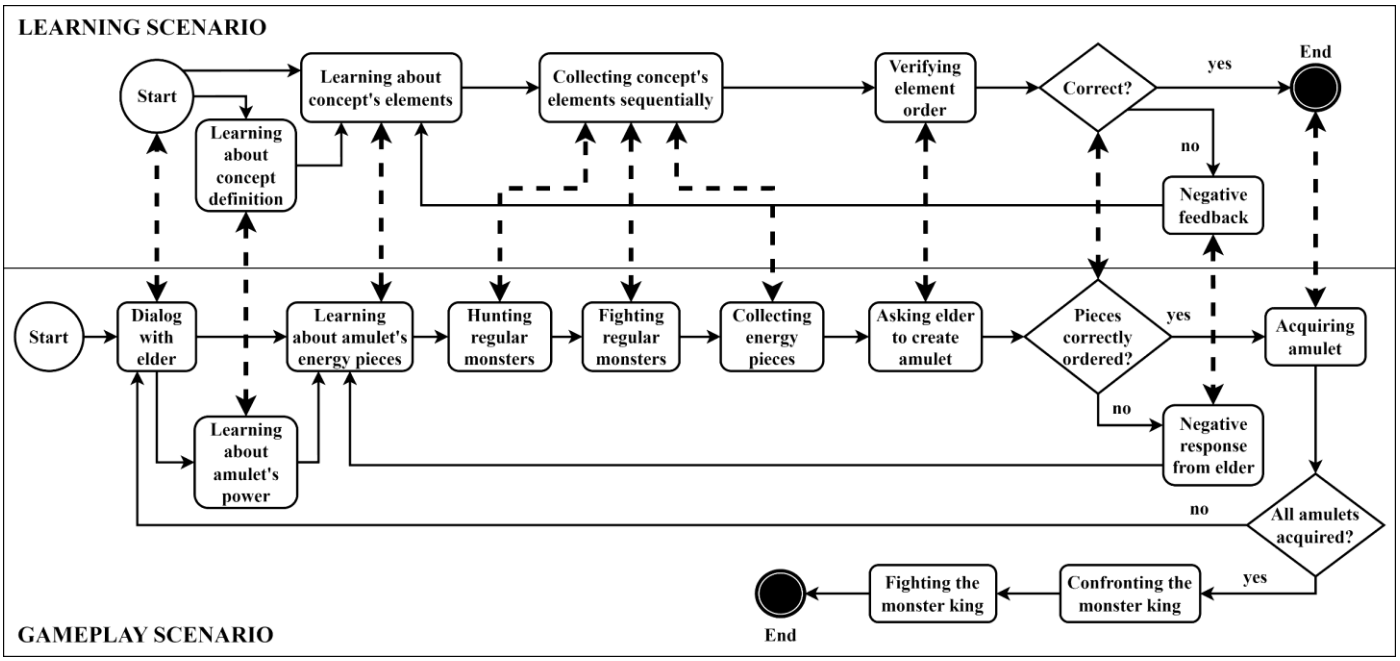

Figure 2. The Game's Learning Scenario, Gameplay Scenario, and How Their Activities Integrated

2.3 Game Elements and How They Delivered the Lessons

As is typical in the RPG genre, the game provided several real-time and turn-based actions to the player: attacking, moving around, picking up items, managing inventory, and conversing with other characters, with the latter two being turn-based. The player performed these actions in activities within the gameplay scenario, as seen in Figure 1's lower part. The thick dashed arrows represent the integration between gameplay and learning activities. For example, learning about the power of an amulet, which the player would conduct through conversing with an elder character, would equal learning about the definition of a lesson's concept corresponding to that power.

To deliver the learning scenario engagingly, the gameplay scenario told a story of the player character's heroic mission to stop a horde of monsters from terrorizing a village. The only way to eliminate the monsters was to slay their

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king (Figure 3a), yet the creature was invulnerable to regular attacks. The powers of three amulets, which the village elders could create, were the key to nullifying the king's invulnerability. First, the player would approach and talk to an elder (Figure 3b). The elder would then inform the player of an amulet, whose supernatural power represented a lesson's concept. The amulet's ingredients were specific and correctly ordered energy pieces, representing the concept's elements and their order. After receiving the information, the player would explore the game world to find regular monsters, i.e., the monster king's minions. After defeating them in combat (Figure 4a), the player could collect their energy pieces sequentially. The player would then revisit the elder and ask him or her to create an amulet from the pieces. The elder's negative and positive responses—commenting on the pieces not suitable for creating the amulet or praising the player and granting their request—represented the feedback in the learning scenario. Consequently, the player must first return to the village and seek the elder to receive his or her feedback.

The elder could also explain the amulet's power (response 2 in Figure 3b), and in doing so, explain the corresponding concept's definition. For example, the elder in Figure 3b would describe the Waterfall Methodology as linear and well-suited for specific types of software. One amulet was available per elder from three elders available in total, although the player could converse with any elder at any time. After acquiring every amulet, the player would again explore the game world to find and defeat the monster king. This last task was purely for entertainment and thus not integrated with the learning scenario.

2.4 Game Elements Supporting Gameplay Quality Factors

We will describe the details of game elements that supported each gameplay quality factor except for play engrossment, which we did not explicitly design. Firstly, as explained in one of our previous papers [41], the playability factor consisted of five subfactors: learnability, in-game goals, control scheme, user interfaces, and information presentation. As seen in Figure 3b, conversing with the villagers was the primary way of learning how to play the game and knowing the in-game goals. The player then could reach the goals with the help of navigational markers, such as the one in Figure 4b. A control scheme consisting of keyboard buttons and the mouse allowed the player to employ the available gameplay actions to reach the goals. Elements of user interfaces, e.g., the energy piece window and the rectangle-shaped speech bubble in Figure 5a, presented gameplay and learning information concisely. By pressing a button, the player could open the energy piece window to check their energy pieces, which would be arranged from left to right and top to bottom on the window. In case of a wrong arrangement, pressing the "DEL" button would delete all pieces so that the player could start over.

We have covered the creative freedom factor in another previous paper [40], but we will explain it briefly here. Gameplay features supporting the player's creative freedom were an imaginative story, explorable world, curiosity-inducing plot, and choices in dialogue and combat preparation. Figure 5b shows a dialogue with a non-hostile monster, where the player could choose between two responses. Such choices would allow them to express themself. Meanwhile, Figure 6a shows five areas in the game world and their connections. The player was free to visit and explore the areas anytime, even the plain where the monster king resided. The forest area also contained the optional encounter shown in Figure 5b, making the exploration more exciting. Lastly, Figure 6b shows one of the *plot hooks*, i.e., mysterious or curious events, which sparked and maintained the player's curiosity.

The game's narrative consisted of four building blocks: theme, storytelling, plot, and characters. Due to the monsters and supernatural powers, the story's theme fell under the widely popular fantasy genre. The storytelling style was straightforward; the characters were simple yet relatable and humorous; and the plot employed hooks to keep it interesting (Figure 6b). A more detailed discussion of the narrative's building blocks can be found in [39].

(a) (b)

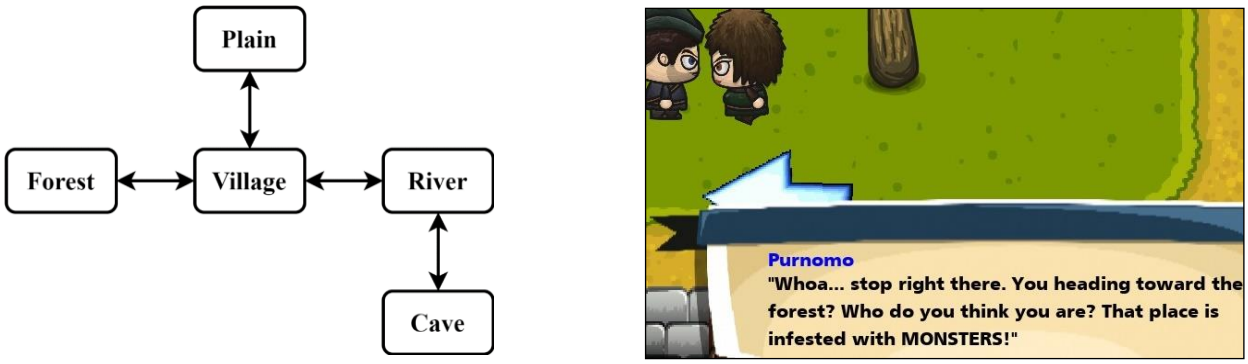
Figure 3. The Confrontation against the Monster King (a) and a Dialogue with a Village Elder (b)

(a) (b)

Figure 4. A Combat Activity against a Regular Monster (a) and a Blinking Arrow Pointing Toward Another Area (b)

(a) (b)

Figure 5. The Window for the Player's Energy Pieces (a) and an Optional Dialogue with a Non-hostile Monster (b)



(a) (b)

Figure 6. Areas in the Game World (a) and a Villager's Warning as a Plot Hook (b)

2.5 Questionnaire Design

Our questionnaire was in Indonesian and consisted of five parts. The first part's items were taken from the HEXAD scale [3] and identified each player's HEXAD type. For the second part, we took items from the playability, play engrossment, creative freedom, and narrative factors from the GUESS scale [48], which reliably measures a game's quality. Meanwhile, each of the remaining three parts took the same items from the knowledge improvement, challenge, and autonomy factors of a scale for evaluating gameful educational media: EGameFlow [32]. The three parts measured learning experiences related to LT1, LT2, and LT3, respectively.

To shorten the questionnaire, we took only some items from each GUESS or EGameFlow factor. For example, out of the seven items of GUESS's creative freedom factor, we took only four items for the corresponding factor in our questionnaire. For the autonomy factor of each lesson topic, we took only one item from EGameFlow, "I feel a sense of control over the game," which we translated into "*Saya merasa dapat mengontrol pembelajaran* [topic]-*nya agar sesuai keinginan atau kebutuhan saya*." Unlike the original item, the translation of every learning experience item also explicitly mentioned the related lesson topic.

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2.6 Data Processing

There were two "sides" involved in our correlation tests on the questionnaire responses, and each correlation test paired a variable from the first side with another from the second side. The first part of the questionnaire served as the "first side," whereas the four other parts became the "second side." Therefore, there were six variables on the first side (i.e., the HEXAD types) and 13 on the second side (i.e., the GUESS factors and the lesson topics' EGameFlow factors), resulting in 78 correlation tests. We used Pearson's and Spearman's correlations since some variables were normally distributed and others were not.

Since many tests were done, the occurrence of false positives would sharply rise, which prompted us to apply a procedure to lower the alpha, i.e., the *p*-value significance threshold [53]. We employed the classic Bonferroni procedure in Equation 1 to divide the standard alpha of 0.05 with the test number (*m*) to get the corrected alpha (*a*) [54]. Thus, with *m* equalling 78, the alpha was corrected to 0.0006. However, since our study is exploratory, we will consider both corrected and uncorrected alphas in our analysis.

$$a = \frac{0.05}{m} \tag{1}$$

3. Results and Discussions

3.1 Results of the Correlation Tests

Table 1 shows the strengths of correlations between pairs of HEXAD types and gameplay or learning quality factors. Unnumbered cells mean that the corresponding pairs' correlations fail to pass the uncorrected alpha, while correlations in bold and marked with two asterisks pass the Bonferroni-corrected one. The *p*-value of every correlation marked with one asterisk is between 0.002 and 0.0009, whereas the bolded ones all have *p*-values below 0.0006.

In analyzing the correlations, we follow Dancey and Reidy's convention of considering correlation strengths below 0.4 as weak and between 0.4 and 0.6 as moderate [55]. Thus, every correlation not marked with an asterisk is "weak," and the remaining ones are "moderate." For better clarity, we will separate our findings into *decisive* (DF) and *indecisive* (IF) based on the corresponding correlations' *p*-values, i.e., whether they pass the Bonferroni-corrected alpha or not. In the case of a finding stemming from multiple correlations, we will consider it indecisive if only some correlations pass the alpha.

Table 1. Correlation Strengths between HEXAD Types and Factors of Gameplay and Learning Experiences (p < 0.002, ** p < 0.0006)*

		Philanthropist	Socialiser	Free Spirit	Achiever	Disruptor	Player
Gameplay Experience	Playability	0.3610	0.2779	0.3503	**0.4727****	-	0.3411
	Play Engrossment	0.3528	0.2669	-	0.2751	-	-
	Creative Freedom	0.3872	-	-	0.2674	-	-
	Narrative	0.4173*	0.4019*	-	0.3198	-	-
LT1 Learning Experience	Knowledge improvement	0.3714	**0.4856****	**0.4389****	**0.4332****	-	-
	Challenge	0.3032	0.2907	0.3875	**0.5427****	-	0.2953
	Autonomy	0.2864	-	-	-	-	0.2615
LT2 Learning Experience	Knowledge improvement	-	0.3061	0.3374	0.3010	-	-
	Challenge	-	-	-	-	-	-
	Autonomy	0.3381	0.2580	0.2917	0.3301	-	-
LT3 Learning Experience	Knowledge improvement	0.2809	-	0.2901	0.2677	-	-
	Challenge	0.2582	-	0.3183	0.2834	-	-
	Autonomy	0.2900	-	0.3519	0.3446	-	-

3.2 Answering RQ1

To answer RQ1, we will first seek any pattern of correlation strength distribution among HEXAD types and aspects of gameplay and learning experiences. With only two insignificant correlations and three moderate and Bonferroni-passing ones, achievers correlate the most with the gameplay and learning experience quality factors. Philanthropists, socialisers, and free spirits seem to follow achievers in no particular order regarding their correlations. Conversely, disruptors and players are the least and second least correlated types. Indeed, by definition, disruptors tend to be

unappreciative of any gameful media and even the whole educational system [3]. Additionally, the lack of rewards from playing our educational RPG may have caused players' overall lack of correlations with any gameplay or learning experience. In conclusion:

IF1) Achievers may be quite appreciative of a range of gameplay and learning experiences;
IF2) Philanthropists, socialisers, and free spirits may be less appreciative than achievers, although not drastically so;
IF3) Players and especially disruptors may be the least appreciative HEXAD types.

3.3 Answering RQ2

We will answer RQ2 by first analyzing the HEXAD types' preferences for the playability factor. Except for disruptors, every HEXAD type seems to appreciate the factor. Achievers (p = 0.0001) is especially notable here, which should come as no surprise: to achieve the in-game goals perfectly, the player should be able to play the game smoothly.

Due to the absence of Bonferroni-safe correlations, the other three GUESS factors did not yield such a convincing finding. However, we can at least acquire some directions for future research. Regarding the play engrossment factor, it correlates weakly with achievers (p = 0.03), socialisers (p = 0.04), and, most notably, philanthropists (p = 0.006). The last two are particularly interesting since previous research has associated immersion-related game elements with only achievers and free spirits [34].

It should be noted that "the experience of immersion," i.e., the one we tested for, may correlate with, yet also differs from, elements associated with immersion. However, since such elements include narratives [34], and the narrative factor correlates strongly with play engrossment (Pearson's r = 0.764, p < 0.00001), we assume that, indeed, the game's narrative caused the correlations between the three HEXAD types and play engrossment. The narrative factor correlating with only the three types further corroborates our assumption.

Meanwhile, on the one hand, the correlations between the narrative factor and philanthropists (p = 0.0009), socialisers (p = 0.0015), and achievers (p = 0.013) are unsurprising since the story's protagonist was altruistic and heroic. On the other hand, the correlations challenge Krath and von Korflesch's recent validation of game element preferences [26], which found no significant correlations between narratives and any HEXAD type. However, we should consider two things here. First, since their p-values are higher than the Bonferroni-corrected alpha, the three correlations may be merely false positives. Second, our finding is slightly different from that of Krath and von Korflesch in that people who enjoy narratives may not always *prefer* to experience them, whether inside or outside learning activities.

On another note, the creative freedom factor seems to be appreciated by only philanthropists (p = 0.002) and achievers (p = 0.039); even then, their appreciation is indecisive due to the corresponding correlations' p-values. We can assume that achievers' appreciation for the factor stemmed from the creative freedom features (e.g., the freely-explorable world) helping them complete the lessons. On the other hand, philanthropists' appreciation for the factor is harder to explain; however, the dialogue response choices may have played a part in it since some were sympathetic toward the villagers.

Curiously, the creative freedom factor does not correlate with free spirits, regarded in the literature as the freedom and creativity-oriented HEXAD type [6], [26]. Upon closer inspection, there seem to be few agreements between questionnaire items of the factor and the HEXAD type: among 16 possible item pairs, only free spirits' 2nd item and creative freedom's 4th item correlate significantly (Spearman's rho = 0.263, p = 0.043). Thus, this finding hints at a potential disconnect between HEXAD's body of knowledge and that of player experience, something that merits further research.

We can summarize the findings regarding RQ2 as follows:

DF1) Achievers strongly appreciate playability features;
IF3) Philanthropists, socialisers, free spirits, and players may also appreciate playability features, albeit to a lesser degree than achievers;
IF4) Among gameplay experience factors, playability may be one of the most appreciated by HEXAD types;
IF5) Achievers, socialisers, and philanthropists may appreciate play engrossment;
IF6) Achievers, socialisers, and philanthropists may appreciate imaginative or fantasy-themed narratives with altruism or heroism values;
IF7) Achievers and philanthropists may appreciate gameplay features supporting creative freedom.

3.4 Answering RQ3

We will now discuss the HEXAD types' preferences regarding learning experiences. We will start by analyzing each lesson topic as a whole. Based on the correlations with the HEXAD types, LT1 seems the most successful among the lesson topics. It suggests the importance of familiar and easy-to-follow lessons in gameful media.

Next, we will discuss the HEXAD types' preferences for each EGameFlow factor, starting with knowledge improvement. Out of six HEXAD types, four correlate with the factor across the lesson topics. We can readily understand

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the factor's correlation with achievers: their dedication toward completing tasks helps them learn. On the other hand, the other three correlations are harder to interpret, thus forcing us to make some preliminary assumptions. Although the game does not have social or multiplayer features, which would benefit philanthropists and socialisers, the participants could have instead collaborated outside the game. Similarly, although free spirits do not correlate with the creative freedom factor due to the corresponding features not aligning with free spirit traits, the traits, e.g., curiosity, could still support the corresponding participants' learning experiences.

The four HEXAD types seem to learn most optimally from LT1. The topic's knowledge improvement factor correlates weakly with philanthropists (p = 0.004) and moderately with socialisers (p = 0.00008), free spirits (p = 0.0005), and achievers (p = 0.00055), the last three being decisive. Thus, this finding reiterates the importance of lessons satisfying familiarity and ease of following in gameful media. The four types' weaker correlations with LT2 and LT3's knowledge improvement factors corroborate the finding, albeit indecisively due to their p-values. Furthermore, lessons that fail to satisfy only familiarity (LT2) seem better, knowledge improvement-wise, than those not satisfying familiarity and ease of following (LT3). Indeed, teaching algorithms through memorization tasks accompanied by textbook-like explanations is hardly effective. Moreover, repeatedly scouring the game world for energy pieces only to fail to verify them because the pseudocode lines are hard to memorize can exhaust the player's will to learn. Writing down the pseudocodes may only slightly ease the process, especially since writing long lines of code is prone to errors.

Surprisingly, however, philanthropists are an anomaly here. The type correlates with LT3's knowledge improvement but not with LT2's, suggesting that the corresponding participants learned more from LT3 than from LT2. LT3's hard-to-follow lessons may have stimulated the participants' sense of altruism and pushed them to collaborate more with others, resulting in better learning gain.

It is also curious that socialisers, instead of the other three, correlate the most with LT1's knowledge improvement. Two likely reasons for the type's greater learning gain are the previous "out-of-game collaboration" and socialisers' preferences for game elements like "social comparison" and "social competition" [26]. More research is required to validate the two reasons—or whether the learning gain advantage is a true positive. Additionally, the advantage may require lessons satisfying familiarity and ease of following, which is unsurprising: the participants' collaboration would be less fruitful if they struggled to make sense of the lessons.

Moving on to the next factor, the moderate and Bonferroni-safe correlation (p = 0.00001) between LT1's challenge and achievers corroborates the type's core characteristic: they can readily appreciate a task's difficulty level, especially when the task is perfectly completable, such as due to being familiar and easy to follow. This finding implies that achievers, to some degree, tolerate or even enjoy tasks with "inappropriate" difficulty levels, which ambiguously mean above or below their skill levels. Unfortunately, we cannot disambiguate it as we did not measure how difficult the lessons were for each participant. It is worth pursuing further as previous studies [3], [26] have confirmed only achievers' preference toward challenging tasks and not their preference, or lack thereof, toward trivial ones.

Besides achievers, four other HEXAD types also correlate, albeit indecisively, with LT1's challenge factor: philanthropists, socialisers, free spirits, and players. We can apply the previous assumptions to the first three types' correlations with the factor. Namely, the out-of-game collaboration may have caused philanthropists and socialisers to tolerate LT1's lessons' difficulty levels, and free spirits' tolerance may have been due to their traits' effects on learning. On the other hand, players' tolerance for the difficulty levels may have stemmed from the external reward: the honorarium for playtesting the game.

As with the knowledge improvement factor, we can observe the negative effect of unfamiliar or hard-to-follow lessons on the challenge factor. LT2 and LT3's challenge factors correlate more weakly or not at all with the five HEXAD types. Curiously, however, the HEXAD types correlate with LT3's challenge but not with LT2's, suggesting that the participants tolerated LT2's lessons' difficulty levels the least. The previously assumed "stimulated sense of altruism" may explain philanthropists' higher tolerance for LT3's lessons' difficulty levels. Likewise, the significant challenge from the topic's hard-to-follow lessons may have stimulated the participants' curiosity and task orientation, leading to a higher tolerance for the challenge.

The last EGameFlow factor, autonomy, is unfortunately also the least insightful. It seems unreasonable for socialisers, free spirits, and achievers to correlate with LT2's autonomy but not with LT1's. Should familiar lessons not be easier to complete and collaborate on, thus easier to control? Likewise, it is questionable that free spirits and achievers correlate more strongly with LT3's autonomy than with LT2's (a curious or task-oriented learner should feel a reduced, instead of an increased, sense of control over hard-to-follow lessons). Therefore, we regard the factor as riddled with false positives and refrain from analyzing its correlations.

Concisely, the findings regarding RQ3 are as follows:

DF2) Free spirits, achievers, and especially socialisers appreciate familiar and easy-to-follow lessons;
DF3) Achievers appreciate or tolerate the difficulty levels of familiar and easy-to-follow lessons;
IF8) DF2 may also apply to philanthropists;
IF9) DF3 may also apply to philanthropists, socialisers, free spirits, and players;
IF10) Topic familiarity and ease of following may be essential to most HEXAD types' learning experience;

IF11) Unfamiliar or hard-to-follow lessons may be suboptimal in terms of learning gain and difficulty level appropriateness;
IF12) Hard-to-follow lessons may stimulate philanthropists' sense of altruism, which in turn may improve their learning gain and difficulty level tolerance;
IF13) Hard-to-follow lessons may also stimulate free spirits and achievers, leading to their higher tolerance for the lessons' difficulty levels.

3.5 Gameful Educational Media Design Principles from the Findings

To answer RQ4, we will extract several principles of designing HEXAD-optimized gameful educational media from the findings. Some of these principles overlap with the ones from our previous works. The principles are:

1) *Design for achievers, philanthropists, socialisers, or free spirits as the main target users:* Although this principle may lead to neglecting disruptors and players, the benefits may outweigh the drawbacks. First, players and disruptors may require peculiar gameplay and learning features that are more costly or difficult to develop. Second, disruptors and players have been known to be rare among learners [3].
2) *Prioritize playability regardless of the target users' HEXAD types:* Although working more or less as intended, our game's playability features are considerably bare-bones. Our previous work has suggested more advanced features, from a quest system to interactive and narrative lesson explanations [41].
3) *Design engaging gameplay with a heroic narrative:* Indeed, the use of heroic narratives, such as those based on the Hero's Journey arc [56], has been a staple in technology-enhanced education [57].
4) *Ensure familiar and easy-to-follow lessons:* This principle, too, has been discussed in our previous works [19], [39]–[41]. "Familiar" here does not restrict the lessons to which the player has known; any lesson is suitable as long as the game lets the player familiarize themselves with it [39], such as through analogies [58]. Likewise, playability features can help the player follow any learning lesson more easily [19], [41].
5) *Let the player emotionally connect to hard-to-follow lessons:* When such lessons cannot be avoided, the game can at least frame them in a way that appeals to the player's HEXAD type. For example, complex lessons on algorithms may be framed as intriguing puzzles to stimulate free spirits and achievers.

3.6 Limitations

The first limitation of our study concerns our sample size. Although it meets the minimum size of 20 as suggested in the literature [47], the sample size of 60 is considerably small for statistical analysis. One consequence of the size is the low power of our correlation tests, which may have produced many false negatives [59]. Fortunately, this limitation is acceptable in a preliminary or exploratory study [53].

Our study's second limitation stems from the game's use of remembering-level lessons. Due to "remembering" being the lowest RBT level, our findings may or may not generalize to gameful media with more complex lessons.

3.7 Threats to Validity

We have identified two threats to our results' validity. First, as explained in our previous work [39], playing the game multiple times under the same gameplay could have adverse effects: boredom and the lessened impacts of subsequent lesson topics. Fortunately, due to having learned how to play the game, each playtester would take no more than 15 minutes for each session after their first, and this short duration should have minimized or altogether prevented the adverse effects.

The second threat concerns the reliability of each questionnaire part, primarily since the scales had never been translated into Indonesian. Therefore, as seen in Table 2, we have calculated Cronbach's alphas of the five parts except for the autonomy factor, which consists of only one item. Unfortunately, some subparts acquire lower alphas, which may have stemmed from four reasons. First, the fewer items in each gameplay or learning factor—compared to the original scale's factor—may have reduced its Cronbach's alpha. Second, some translated items may have failed to convey the original items' intentions to the test participants. It is especially true for the first questionnaire part due to HEXAD items such as "Return of investment is important to me," which is difficult to translate to Indonesian and difficult for first-year university students to comprehend. This problem has been addressed by Krath and von Korflesch [26]. Third, we, unfortunately, took and translated an older version of the HEXAD scale from [3] for our questionnaire. The version has been revised in [6], resulting in better psychometric properties overall. Fourth, in the case of LT1's challenge factor, the much lower Cronbach's alpha (compared to the challenge factors of LT2 and LT3) may have been caused by familiarity with the topic: those who could recall propositional logic lessons from high school may have found LT1's lessons less challenging.

4. Conclusions

It has become increasingly more pressing for gameful educational media to fulfill their players' different needs, and player typologies are among the tools available for understanding these needs. HEXAD is one of the best typologies

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available for gameful educational media, yet vague research findings have hampered its potential. This study has explored the effects of HEXAD player's type on finer-grained gameplay and learning experiences stemming from their systemic interactions with gameful educational media. To do so, we conducted a playtest of an educational game presenting three sets of lessons on three different topics. Our correlation tests and analyses on the playtesters' HEXAD types, gameplay quality factors, and learning quality factors, although preliminary, have produced practical design principles and shown the merit of treating the media and their dynamics with the player in a finer-grained and systemic manner, particularly regarding a better alignment between the media and their educational aspirations, something that has been voiced for years in the field [30], [60].

Table 2. Cronbach's Alphas of Questionnaire Parts

Questionnaire Part		Cronbach's Alpha
HEXAD Type	Philanthropist	0.599
	Socialiser	0.763
	Free Spirit	0.575
	Achiever	0.598
	Disruptor	0.689
	Player	0.667
Gameplay Experience	Playability	0.661
	Play Engrossment	0.662
	Creative Freedom	0.772
	Narratives	0.868
LT1 Learning Experience	Knowledge Improvement	0.748
	Challenge	0.582
	Autonomy	-
LT2 Learning Experience	Knowledge Improvement	0.909
	Challenge	0.858
	Autonomy	-
LT3 Learning Experience	Knowledge Improvement	0.966
	Challenge	0.962
	Autonomy	-

Future research may concern the following issues. First, our small sample size has caused the indecisiveness of the majority of our findings. Since many of these findings, such as IF3 and IF4, seem intriguing, fellow scholars may want to confirm them with much higher statistical power through player experience questionnaires and other data-gathering methods, such as game analytics [61]. On the one hand, similar to our study, these follow-up studies should take real, applied gameful media as their subjects. On the other hand, this requirement may raise the question of the generalizability of the findings, primarily since (1) as systems, gameful media are widely varied, and (2) there is a lack of consensus regarding their designs [10]. In short, the ambiguity surrounding HEXAD links to the much bigger one that has afflicted gameful educational media for many years [62]. Consequently, before we resolve the latter, such as through a comprehensive design framework, the practical usefulness of HEXAD or any other typology may remain limited.

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