Beyond Genre: Classifying Virtual Reality Experiences

Maxwell Foxman, David Beyea, Alex P. Leith, Rabindra A. Ratan, Vivian Hsueh Hua Chen, and Brian Klebig

***Abstract*—Because virtual reality (VR) shares common features with video games, consumer content is usually classified according to traditional game genres and standards. However, VR offers different experiences based on the medium's unique affordances. To account for this disparity, the article presents a comparative analysis of titles from the Steam digital store across three platform types: VR only, VR supported, and non-VR. We analyzed data from a subset of the most popular applications within each category (N = 141, 93, and 1217, respectively). The three classification types we analyzed were academic game genres, developer defined categories, and user-denoted tags. Results identify the most common content classifications (e.g., Action and Shooter within VR only applications), the relative availability of each between platforms (e.g., Casual is more common in VR only than VR supported or non-VR), general platform popularity (e.g., VR only received less positive ratings than VR supported and non-VR), and which content types are associated with higher user ratings across platforms (e.g., Action and Music/Rhythm are most positively rated in VR only). Our findings ultimately provide a foundational framework for future theoretical constructions of classification systems based on content, market, interactivity, sociality, and service dependencies, which underlay how consumer VR is currently categorized.**

***Index Terms*—Digital communication, entertainment industry, virtual enterprises, virtual reality (VR).**

I. Introduction

VIDEO game genres are systems devised by academics, media makers, and industry to classify styles or types [26] of content and user experiences. Egenfeldt-Nielsen *et al.* argue that "scholars and journalists find it hugely useful to establish systems of categorizing games" [14], adding that genre conventions create expectations, especially for consumers, about what they will find in their next purchase [14]. Despite this, as we argued in previous work, genres systems, derived from a complex mix of industry norms, mechanics, content, and tradition, are inconsistent [19]. Because virtual reality's (VR) commercial success is linked to games such as *Half-Life: Alyx* [49] and *Beat Saber* [6] that dominate the marketplace, titles tend to be identified by game genre. However, VR renders new types of engagement and control. Furthermore, content is shaped by practical considerations such as motion sickness, locomotion, user interactions, and cognitive load. VR applications are even called "experiences" (as opposed to games) by the popular press because of the unique features afforded by the medium, such as presence, or a sense of "being there" [4], immersion in computer-generated surroundings [5], and embodiment of beings [4], [5]—all of which complement richer, open-world environments [10]. Popular digital distribution platforms such as Steam or Oculus not only eschew these features in their VR categorization but generally rely on an irregular set of genres to classify content. This circumstance makes it often problematic to distinguish what makes experiences unique from each other and their flatscreen counterparts, especially when the types are derived from other media formats.

Thus, our article draws upon user, developer, and research-/academic-based data to categorize VR experiences from the Steam digital store and investigate how they relate to ratings and popularity. Because Steam also offers experiences that apply across VR and traditional screens, we examined how platform type (e.g., VR only, VR supported, non-VR) relates to content and user assessment.

II. VR Content Classification

Challenges to consistent classification stem in part because VR is a "centrally situated medium, in that VR is capable … of absorbing aspects of other mediums at will" [16]. Research tends to center on phenomenal affordances of room-scale head-mounted displays (HMDs) [4], [8] instead of style. Academic analyses emphasize attributes such as presence [25], immersion [7], embodiment [4], [5], [32], transportation [22], and perspective-taking [31]; comparisons between games and VR focus on characteristics like levels of immersion, flow [38], [46], [47], and presence [41], rather than commercial content. Developers and researchers alike struggle to situate their work

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Maxwell Foxman is with the School of Journalism and Communication, University of Oregon, Eugene, OR 97403-1299 USA (e-mail: mfoxman@uoregon.edu).

David Beyea is with the Department of Communication, University of Wisconsin-Whitewater, Whitewater, WI 53190 USA (e-mail: beyea.david@gmail.com).

Alex P. Leith is with the Department of Mass Communication, Southern Illinois University Edwardsville, Edwardsville, IL 62026-1001 USA (e-mail: aleith@siue.edu).

Rabindra A. Ratan is with Michigan State University, East Lansing, MI 48823 USA (e-mail: rar@msu.edu).

Vivian Hsueh Hua Chen is with Nanyang Technological University, Wee Kim Wee School of Communication and Information, 637718, Singapore (e-mail: chenhh@ntu.edu.sg).

Brian Klebig is with Bethany Lutheran College, Mankato, MN 56001 USA (e-mail: bklebig@blc.edu).

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through easy-to-identify benchmarks. Not only is there a surfeit of content which falls under the "VR" heading (e.g., films, games, and tools), but understanding what makes a meaningful VR experience is difficult because it depends on convincing users that virtual events are real, which can be augmented by multisensory additions such as haptics or even olfactory simulations [36]. Such add-ons do not neatly fit into most content-based classification systems. And this discrepancy can affect public perception; for instance, Epp *et al.*'s investigation of consumer VR complaints highlights that most experiences did not live up to expectations regarding content [15]. Opinions may shift with more comprehensive classification systems and standards.

To muddle the situation further, VR does share fundamental characteristics of video game play including narrativity, simulation, interactivity, and intelligence [42]. Content is intertwined with "how game mechanics work" [20]. However, video game genres themselves are not simple to articulate. They stem from variables different from other forms of entertainment (such as interactivity) [1] and are intimately tied to the evolution of technology, gameplay, and production of the medium [3]. Confusion stems from the tension between genre conventions, interactive metaphors, game pace, and controller types, all of which influence player experience [51] but are "not clearly or consistently defined" [26]. Consequently, new offerings are simply likened to old ones: for instance, the "Roguelike" genre references signature patterns from the classic title *Rogue*. Even though genres lack neat categorization [2], researchers use them to gauge player personality/choices [29], [40], predict addiction [13], and creative and cognitive enhancements [11]. Similarly, "[v]ideo game genres provide a design lens through which developers can analyze gameplay preferences and player experiences" [33]. Genres also drive innovation because they define "new area[s] of possibility" for future titles [3]. Games' styles and content build on past aesthetics and technology [3]. Studies similarly found that new titles succeeded by building on (rather than deviating from) previous genres [48]. Like games, how VR is classified can directly shape future content.

Instead of having standardized classifications, commercially available VR experiences are defined by industry whims and the peculiarities of distribution hubs, which create issues of validity and reliability for researchers and consumers. A typology is further constrained by varying perspectives between customers, academics, developers, and industry. Popular shops, such as Steam [51] and the Oculus Rift Store [37], inconsistently demarcate categories, including everything from user-generated tags to economic models (e.g., Free to Play) and studio formats (e.g., Indie). The absence of a coherent system affects producers who draw on and utilize existing game genres and formats in their creative strategies. Developers must maneuver and label their content based on these haphazard criteria. The plethora of categorization models in both industry and academia underscores the need for lucidity among styles, features, and experiences of games generally and VR specifically.

To reiterate, games do not represent the entire ambit of immersive content, which covers a gamut from journalism [39] to healthcare [43], education [35], training, and enterprise [27]. Clearly, there are differences between the medium's potential, what is on the market, and how users find/consume VR applications (based on classification). For instance, social uses of the medium have been classified independently [30] and promoted as the future of the technology by companies like Facebook [12]. However, since games make up a major portion of the VR landscape, scholars and critics ponder how hardcore gamer culture and aesthetics affect VR [21], [23], [24] instead of experimentation with the medium's singular affordances or potential styles. Practical considerations compound these concerns: developers tactically deploy traditional industry conventions to engage a gaming audience and for merchandising reasons, utilizing existing platforms, controller norms, and code bases to accelerate content distribution [18].

Recognizing the inconsistencies of genre classification systems, our goal is to build a more inclusive framework that encompasses affordances, mechanics, and key features of the medium. Practically, such arrangements designate the parameters for distributing and tagging content. However, from a theoretical point of view, categorizing common genres can be pivotal in forging VR's next generation as developers, consumers, and even academics collectively employ them to define their experiences.

As a first, exploratory step in a larger research initiative, we compare titles from one distribution store (i.e., Steam): experiences made only for VR use (VR only), those supported on both flatscreens and VR (VR supported), and content only on flatscreens (non-VR). We undertake an overarching research objective: What is the relationship between traditional content classification availability and user ratings in Steam VR-related experiences based on VR only, VR supported, and non-VR modes?

To this end, we pose the following targeted research questions:

> RQ_1: What content classifications are most common in Steam-provided VR experiences based on hardware support?
>
> RQ_2: How do content classifications (academic game genres, developer categories, and user tags) differ across hardware-support platforms (VR only, VR supported, and non-VR)?
>
> RQ_3: How do user ratings differ across hardware-support platforms (VR only, VR supported, and non-VR)?
>
> RQ_4: Which content classifications (academic game genre, developer categories, and user tags) are associated with higher user ratings across hardware-support platforms (VR only, VR supported, and non-VR)?

In general, the research expands upon existing conventions and interests to establish a framework of categories associated with the medium. This framework lays the foundation for future novel classifications based on differences between VR and non-VR discovered in the data.

III. Methods

To address these questions, we performed a content analysis comparing titles on the Steam digital store, in part because of its prominence as a distributor of VR content. A preliminary study between non-VR and VR-only titles was performed looking solely at academic genres [19]. The investigation acted as a means to establish methodological best practices, but was

expanded upon to include VR supported work and further categories articulated below.

A. Data Collection and Measures

Steam has become the central hub for PC games, especially VR [17], [49], [50]. Though other clients are rapidly developing collections (e.g., Epic Games Store), Steam still has the largest library and actively pursues a range of accessible VR/AR headsets. Steam also provides a robust API that allows users to pull information on titles they hold.

The first stage of data collection was to identify the top titles. To find these, we first assembled a full list of relevant applications using Steam tools that produced "VR only" (playable through an HMD) and "VR supported" (playable with and without an HMD) titles, as well as non-VR titles (in most cases, traditional video games). We then ran these titles through the SteamSpy API to receive the estimated range of ownership. The popularity threshold for VR only and VR supported experiences was 50 000–100 000 estimated ownership ($N = 141$ and 93 respectively; approximately 3.25% and 10.3% of all VR only and supported experiences). Because non-VR titles include traditional games with a much larger player base, the threshold for all non-VR titles was 500 000–1 000 000 estimated ownership ($N = 1217$; approximately 3.31% of all applications). Additional information was pulled using both Steam and SteamSpy API, including developer categories, user tags, and user ratings. Developer categories and user tags were included in the analysis only if the tag appeared more than once within the dataset. User ratings were recorded for each application based on the count of positive (thumbs-up) ratings posted on Steam. For the analysis, we created a "ratings" variable by dividing the number of positive ratings by the total number of days the title had been published to control for differences in availability.

B. Content Analysis Coding Procedure

Coding was performed through data-pulling scripts and human coders who were trained to recognize attributes of programs the scrapers missed. Both developer categories and user tags consisted of a few words. Descriptors included more traditional game genres, but each was developed from different stakeholders on Steam. Developer categories, which are showcased on the front of the Steam Store page, are set by publishers and confirmed by company representatives as titles are posted. While genres are included, many of these developer categories are also based on other types of information, such as the economics surrounding titles (e.g., Free to Play, Indie). Steam contains a wizard to help developers assign categories, which can be based on "Genres," "Visual properties," "Themes & Moods," and "Features" [45]. User tags—presumably assigned by users with experience of the application—are meant to increase the visibility of titles within the store for consumers. Neither developer categories nor user tags neatly explain the genre of games and applications on Steam.

To make up for this discrepancy, human coders utilized a set of academic genres derived from the Lucas and Sherry system [34], with minor modifications: Action, Adventure, Classic Board Games, Dice, Fighter, Flight, Music/Rhythm, Puzzle, Quiz/Trivia, Racing/Speed, Role-Playing Game (RPG), Shooter, Simulation, Sports, Strategy, and Turn-Based Strategy. We chose to rely on human coders as a first step because they are better able to categorize games systematically and consistently. Three independent coders, who were not the authors, were trained on the coding protocols for identifying content (see Appendix for full descriptions). For VR only and VR supported, two coders were assigned for each title. For non-VR, only one coder was assigned per title to avoid fatigue given the large number of applications. Researchers also spot-checked 5% of the codes for irregularities and found none. Multiple genres could be assigned to each experience. These methods follow conventions to answer the research questions. Additionally, a minimal acceptable threshold of $\alpha = 0.7$ was established, which all variables met or exceeded. The data also met regression assumptions for homogeneity of variance, linearity, and homoscedasticity. Cohen's Kappa was not used due to the highly skewed nature of the data.

IV. Results

A. What Content Classifications are Most Common in Steam-Provided VR Experiences Based on Hardware Support?

The five most commonly featured genres in VR only were Action (45%), Shooter (30%), Simulation (22%), Adventure (13%), and Puzzle (12%). The median number of genres was 1 for VR only experiences (in contrast to 4 for non-VR and 2 for VR supported games).

The most commonly featured developer categories in VR only were Indie (53%), Action (42%), Adventure (35%), Simulation (35%), and Free To Play (32%). The median number of categories was 3 for VR only experiences (in contrast to 2 for non-VR games and 3 for VR supported games).

The most commonly featured user tags in VR only were Single Player (89%), Steam Achievements (25%), Multiplayer (23%), VR supported (21%), and player-versus-player (PvP) (19%). The median number of categories was 2 for VR only experiences (in contrast to 6 for non-VR games and 7 for VR supported Games). Results across classifications can be found in Fig. 1.

B. How Do Content Classifications (Academic Game Genres, Developer Categories, and User Tags) Differ Across Hardware Support Platforms (VR Only, VR Supported, and Non-VR)?

A series of chi-squared tests of independence were performed to examine the relative availability of different academic game genres, developer categories, and user tags in VR only, VR supported, and non-VR platforms. Each test examined an individual genre, category, or tag to see if it existed equally within all three platforms, or if one modality had a higher representation of the classification in question. The full results are in Table I, followed by explanations of notable trends.

C. Academic Genres

The genres that occurred less frequently in VR only and VR supported than in non-VR were Action, Adventure, and Shooter.

Fig. 1. Percentages of classifications included in analysis across type and platform. Pink represents VR only, green represents non-VR, and purple represents VR supported. The grey line represents the difference between VR only and non-VR.

The genres that occurred less frequently in VR than non-VR experiences, with VR supported experiences not having enough cases for statistical analysis, were Fighter and RPG. The genres that occurred more frequently in VR-only and VR-supported than in non-VR experiences were Simulation and Flight. The Racing/Speed genre occurred more frequently in VR-supported titles, with not enough instances of VR-only experiences for analysis. The remaining genres had either nonsignificant chi-squared results or lacked the necessary number of cases for any analysis. However, for these cases, the frequencies suggest extremely few Turn-Based Strategy (0 in VR-supported and VR-only) and Strategy titles (1 in VR-supported), with slightly more frequent Classic Board Games (5 in VR-only and VR-supported) and Puzzle (19 in VR-supported and VR-only). Given their rarity overall, this suggests they occur more frequently in non-VR content.

D. Developer Categories

The developer categories that occurred more frequently in VR-only than VR-supported and non-VR were Indie and Free to Play. The category that occurred more frequently in non-VR than VR-only and VR-supported was Action. The categories that occurred more frequently in VR-only and VR-supported than non-VR were Simulation, Casual, Sports, and Racing. In cases where VR-supported did not have enough categories for analysis the categories that occurred more in VR-only compared to non-VR are Utilities, Early Access, and Violent. When it comes to non-VR compared to VR, the category that appeared more frequently was Strategy. Adventure and Massively Multiplayer returned nonsignificant results.

E. User Tags

The user tags that occurred more frequently in VR-supported and non-VR than VR-only were Multiplayer, Co-op, Steam Achievements, Full Controller Support, Partial Controller Support, and Steam Trading Cards. The tags that occurred more frequently in VR-supported than VR-only and non-VR were Online PvP and PvP. The tag that occurred more frequently in non-VR than VR-only and VR-supported was Steam Cloud. The tag that occurred more frequently in VR-only and VR-supported than non-VR was VR-Support (i.e., the "VR-Support" user tag). In cases where VR-only did not have enough tags for analysis, tags that occurred more frequently in VR-supported than non-VR were Shared/Split Screen and Workshop. In cases where VR-supported did not have enough tags for analysis, the tag that occurred more frequently in VR-only than non-VR was Steam VR Collectibles.

F. Unanalyzed Variables

We did not run chi-squared tests on various conditions within our data due to a failure to meet a required assumption; a chi-squared test of independence requires a minimum of five

TABLE I
RELATIVE AVAILABILITY OF EACH CLASSIFICATION COMPARED AMONG THE THREE PLATFORMS. SIGNIFICANT OCCURRENCES BOLDED

					Adj. Residuals for Item Presence		
Genre	df	*N*	$\chi 2$	*p*	VR Only	VR Supported	Non-VR
Action	2	1377	71.321***	<.001	-7.5	-3.4	8.4
Adventure	2	1377	206.16***	<.001	-12.9	-5.5	14.3
Fighter	1	1336	67.488***	<.001	-8.2	x	8.2
Flight	**2**	**1377**	**40.516*** **	**<.001**	**1.4**	**6.1**	**-4.3**
Music/Rhythm	**1**	**1336**	**9.467** **	**0.002**	**3.1**	**x**	**-3.1**
Puzzle	1	1336	3.802	0.051	1.9	x	-1.9
Racing/Speed	1	1238	95.402***	<.001	x	9.8	-9.8
RPG	1	1336	81.815***	<.001	-9	x	9
Shooter	2	1377	53.876***	<.001	-6.3	-3.3	7.3
Simulation	**2**	**1377**	**15.063*** **	**<.001**	**3.9**	**0.1**	**-3.5**
Categories	df	*N*	$\chi 2$	*p*	VR Only	VR Supported	Non-VR
Action	2	1377	21.852***	<.001	-3.8	-2.5	4.7
Adventure	2	1377	1.375	0.503	1.2	-0.2	-0.9
Casual	**2**	**1377**	**39.637*** **	**<.001**	**6.3**	**0.1**	**-5.7**
Early Access	**1**	**1238**	**20.219*** **	**<.001**	**4.5**	**x**	**-4.5**
Free to Play	**2**	**1377**	**8.296***	**0.016**	**2.9**	**-0.5**	**-2.3**
Indie	**2**	**1377**	**11.755** **	**0.003**	**3.3**	**-1.1**	**-2.4**
Massively Multiplayer	1	1238	0.002	0.962	x	0	0
Racing	**2**	**1377**	**115.64*** **	**<.001**	**0**	**10.7**	**-5.4**
RPG	2	1377	22.365***	<.001	-4.3	-1.6	4.7
Simulation	**2**	**1377**	**52.127*** **	**<.001**	**4.4**	**5.4**	**-6.7**
Sports	**2**	**1377**	**48.188*** **	**<.001**	**1.4**	**6.7**	**-4.6**
Strategy	1	1238	18.331***	<.001	-4.3	x	4.3
Utilities	**1**	**1238**	**20.366*** **	**<.001**	**4.5**	**x**	**-4.5**
Violent	**1**	**1238**	**12.696*** **	**<.001**	**3.6**	**x**	**-3.6**
Tags	df	*N*	$\chi 2$	*p*	VR Only	VR Supported	Non-VR
Co-op	2	1377	13.382***	<.001	-3.5	1.3	2.5
Full controller Support	2	1377	30.923***	<.001	-5.5	1.4	4.2
In-App Purchases	1	1336	0.03	0.863	x	-0.2	0.2
Level Editor	1	1336	2.178	0.14	x	1.5	-1.5
Multi-player	2	1377	64.956***	<.001	-7.7	2.8	5.5
Online Co-Op	2	1377	1.396	0.498	-0.6	1	0.1
Online PvP	2	1377	12.29***	<.001	-1	3.4	-0.8
Partial Controller Support	2	1377	39.072***	<.001	-4.5	4.6	1.8
Platform Multiplayer	2	1377	5.203	0.074	-1.8	1.5	0.9
PvP	2	1377	19.614***	<.001	-1.1	4.4	-1.2
Remote Play on TV	1	1336	0.012	0.912	x	-0.1	0.1
Remote Play Together	1	1336	1.54	0.215	x	1.2	-1.2
Shared/Split Screen	1	1336	3.938*	0.047	x	2	-2
Single-Player	**2**	**1376**	**2.736**	**0.255**	**1.3**	**1**	**-1.6**
Stats	1	1336	3.597	0.058	-1.9	x	1.9
Steam Achievements	2	1377	71.178***	<.001	-8.4	0.4	7.3
Steam Cloud	2	1377	66.793***	<.001	-8.1	-0.5	7.5
Steam Leaderboards	2	1377	3.616	0.164	-1.2	1.5	0.3
Steam Trading Cards	2	1377	99.46***	<.001	-10	0	8.9
Steam VR Collectibles	**1**	**1336**	**99.055*** **	**<.001**	**10**	**x**	**-10**
VR Support	**2**	**1377**	**162.45*** **	**<.001**	**10.9**	**6**	**-12.7**
Workshop	1	1336	5.247*	0.022	x	2.3	-2.3

Note. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$; x: indicates less than five occurrences of item; Chi-squared test of independence assumption not met. Cases with greater VR Only and VR Supported representation than non-VR are bolded.

cases in each category to be included in the analysis [44]. For the academic genres, Classic Board Games, Dice, Music/Rhythm, Quiz/Trivia, Sports, Strategy, and Turn-Based Strategy were not run. For the genres of Fighter, Puzzle, Racing/Speed and Shooter, the chi-squared test was run using only two hardware support platforms, as each had one platform with fewer than five cases (See Table I).

The Utilities, Early Access, Violent, Strategy, and Massively Multiplayer developer categories were reduced to two groupings to meet the assumption (See Table I). The Stats, Steam VR Collectibles, In-App Purchases, Shared/Split Screen, Workshop, Level Editor, Remote Play Together, and Remote Play on TV user tags were similarly reduced to two groupings to meet the assumption (see Table I).

While a chi-squared test of independence could not statistically analyze these variables, an examination of the frequency tables can identify cases where a given category is likely to occur more in a specific hardware-support platform. For example, the Turn-Based Strategy genre has 80 cases in non-VR, and zero cases in both the VR supported and VR only platforms. This

suggests a clear platform preference for Turn-Based Strategy. While similar observations can be made with other nonanalyzed classifications, any such assumption is suspect. Future research should attempt to collect a large enough data pool to subject these observations to statistical analysis.

G. How Do User Ratings Differ Across Hardware-Support Platforms (VR-Only, VR-Support, and Non-VR)?

A linear regression was performed to examine differences in ratings between VR only, VR supported, and non-VR titles using the same ratings metric derived to answer RQ_2. There was a significant effect ($F(2,1374) = 5.438$, $p = 0.004$), such that VR supported ($M = 0.03$, $SD = 0.17$) and non-VR ($M = 0.87$, $SD = 0.34$) titles were more likely to attain positive ratings than VR only ($M = 0.10$, $SD = 0.30$).

H. Which Content Classifications (Academic Game Genre, Developer Categories, and User Tags) are Associated With Higher User Ratings Across Hardware-Support Platforms (VR Only, VR Supported, and Non-VR)?

We conducted a series of stepwise linear regressions for each hardware support platform, the full results of which are in Table II. For VR only academic genres, a significant regression equation was found ($F(2, 136) = 15.57$, $p<0.001$) such that experiences with Action and Music/Rhythm genres increased the likelihood of positive ratings for the application. Classic Board Games, Dice, RPG, Quiz/Trivia, Racing/Speed, Sports, Strategy, and Turn-Based Strategy were dropped from the regression analysis due to a lack of significance or too few cases in a given condition. Linear regression requires the number of cases in a condition to be greater than the total number of conditions being regressed (varying between 16, in an analysis of a model containing all the academic game genres, and two for the final model). Stepwise linear regressions were also calculated to predict the effects of developer categories and user tags on the positive rating variable. A significant regression model was not found for either set of variables.

With VR supported games, a significant regression equation of academic genres on user rating was found, $F(2, 38) = 90.63$, $p<0.001$. The Fighter and Strategy genres were more likely to have positive ratings. Further, a significant regression equation of developer categories on user rating was found, $F(1, 39) = 4.44$, $p<0.05$, with Action more likely to be rated positively. Last, a significant regression equation of user tags on user rating was found, $F(2, 38) = 5.70$, $p = 0.01$, with Co-op more likely to be rated positively and PvP more likely to be rated negatively.

Within non-VR, a significant regression equation of academic genres on user rating was found ($F(3, 1993) = 8.09$, $p<0.001$). Strategy, Sports, and Shooter games were more likely to have positive ratings. These results contrast with earlier findings that within VR only titles, Action, and Music/Rhythm were most likely to receive positive ratings. Further, a significant regression equation of developer categories on user rating was found, $F(2, 1194) = 12.61$, $p<0.001$, with Early Access and Action more likely to be rated positively. Last, a significant regression equation of user tags on user rating was found, $F(10, 1186) = 12.82$, $p<0.001$, with Steam Workshop, In-App Purchases, Remote Play on TV, Valve Anti-Cheat Enabled, Stats, Multi-player, and Online Co-op more likely to be rated positively and Steam Leaderboards, Remote Play Together, and MMO more likely to be rated negatively.

TABLE II
REGRESSIONS ON POSITIVE RATINGS BY DAYS ACROSS THE HARDWARE-SUPPORT PLATFORMS

Hardware-Support Platform		*t*	*p*	β
VR Only				
Genres				
	Action	2.37	0.02	0.18
	Music/Rhythm	4.78	<.001	0.37
VR Supported				
Genres				
	Fighter	5.96	<.001	0.40
	Strategy	12.22	<.001	0.83
Categories				
	Action	2.11	0.04	0.32
Tags				
	Co-op	2.73	0.01	0.39
	PvP	-2.34	0.03	-0.34
All Apps				
Genres				
	Shooter	2.35	0.02	0.07
	Strategy	3.21	0.00	0.09
	Sports	2.82	0.01	0.08
Categories				
	Early Access	4.29	<.001	0.12
	Action	2.66	0.01	0.08
Tags				
	Steam Workshop	3.76	<.001	0.11
	In-App Purchases	3.91	<.001	0.12
	Remote Play on TV	4.88	<.001	0.15
	Valve Anti-Cheat Enabled	2.14	0.03	0.06
	Steam Leaderboards	-4.37	0.00	-0.13
	Stats	3.76	<.001	0.11
	Remote Play Together	-3.70	<.001	-0.12
	Multi-player	2.99	0.00	0.10
	MMO	-3.02	0.00	-0.09
	Online Co-OP	2.00	0.05	0.06

Note. VR Only: Genres [$F(2, 136) = 15.57^{***}$, $p<0.001$, $R^2 = 0.19$], Categories & Tags: No significant models were found; VR Supported: Genres [$F(2, 38) = 90.63^{***}$, $p<0.001$, $R^2 = 0.83$], Categories [$F(1, 39) = 4.44^{*}$, $p = 0.04$, $R^2 = 0.10$], Tags [$F(2, 38) = 5.70^{**}$, $p = 0.01$, $R^2 = 0.23$]; Non-VR: Genres [$F(3, 1193) = 8.10^{***}$, $p<0.001$, $R^2 = 0.02$], Categories ($F(2, 1194) = 12.61^{***}$, $p<0.001$, $R^2 = 0.02$], Tags ($F(10, 186) = 12.82^{***}$, $p<0.001$, $R^2 = 0.10$].
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

V. DISCUSSION

These results offer researchers and developers a snapshot of the types of experiences both available and highly regarded by consumers. At the same time, the findings spotlight the discrepancies in formulating a coherent classification system for commercial VR, especially compared to video games. There is little overlap between academic genres, developer categories, and user tags. For instance, the developer category Action exhibits dissimilar frequencies to the academic genre of the same name. Given how data was collected, a lack of uniformity may be expected. Each classification type also serves a different purpose: academic game genres focus more on style;

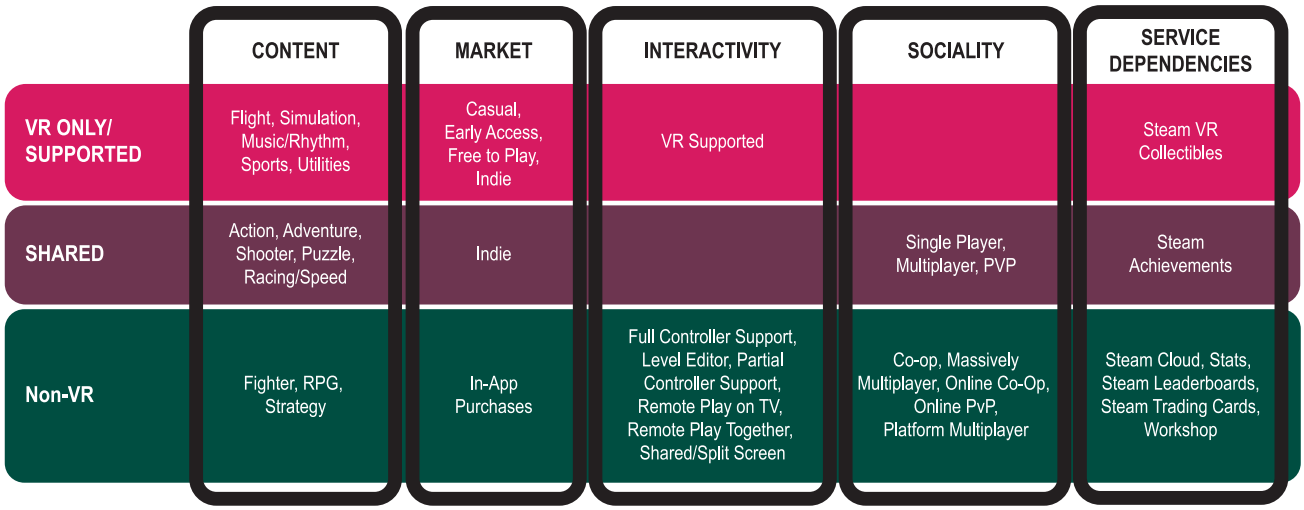

Fig. 2. Diagram identifying prevalent and shared classifications based on VR (both VR only and VR supported) and non-VR. Each are grouped based around common themes of content, market, interactivity, sociality, and service dependencies.

developer categories cater to marketing games; and user tags are explicitly generated to identify specific features important to the community. The result, however, is often contradictory. Titles like *Fruit Ninja VR* or *Adventure Climb VR* are categorized by developers as "Sports" possibly to appeal to a wider consumer base, while not containing any content that features athletics, sporting events, or teams, which make up the academic definition of the genre from Lucas and Sherry [34]. In fact, they may more closely resemble "exergames" [17] given the physical activity required, but this option is neither included in the academic system, nor was it chosen by game makers or users. At very least, inconsistency may speak to external validity issues that should be taken into account when researchers look at commercial genres more broadly.

Our exploratory research also provides a means to discern VR's predominant aspects. Along with recognizing the diversity of components represented by genres, categories, and tags, the start of a classification system for VR emerges that can immediately be used by designers and researchers to identify qualities that make experiences exceptional. We grouped together five main themes that encompass the most notable tags, genres and categories: content, market, interactivity, sociality, and service dependencies. We explain each theme below, and discuss how VR (both VR only and VR supported) and non-VR share certain commonalities and differences, as illustrated in Fig. 2. Additionally, after discussing implications and limitations based on these findings, we consider next steps for classifying VR content.

A. Content

Content refers to prevalent styles embedded within VR experiences. Many academic game genres fall into this group, as do some overlapping developer categories. VR and non-VR have some shared content: Action, Adventure, and Shooter are top genres and categories across all titles. Similarly, Puzzle and Racing appear in the top applications of VR, even while relatively more available in non-VR, indicating their prevalence among both media. The difference may reflect the popularity of certain types of content on Steam itself regardless of the medium. However, given Steam's dominance in distributing VR, their prominence should not be dismissed, but rather underscores how the store determines the type of accessible content for consumption.

Certain types of content were more widespread for VR. Particularly, Flight, Simulations, and Sports had a larger number of applications and relative availability, while Music/Rhythm and Utilities had high relative availability. The success of these types of content makes intuitive sense because VR's depth of immersion caters not only to obvious titles like Shooter, but enhances other genres like Flight and Racing. Some of the trendier titles featured in widely viewed Let's Play tutorial videos come from longstanding series such as *DiRT* and *Project CARS* that already use ancillary components like steering wheels for play and where headsets accentuate the lifelike experience [28]. By contrast, certain genres like RPG and Strategy (both of which make heavy use of the third-person perspective) were more popular for non-VR content.

The findings display the need for a typology of VR content beyond traditional academic game genres. The higher relative availability of categories like Simulation and Utility means that some of the most downloaded VR titles on Steam are not games and include apps like *VRCapture* that allow for filming experiences in VR, *DeoVR Video Player*, *Google Earth VR* (which provides a navigable 3-D map), and casual near-cinematic experiences, like *theBlu*. In other words, the findings show not only that VR content tends toward certain existing genres, but current experiences serve a broad range of purposes beyond gaming, whether with applications like *Google Earth* or even a computer-generated opera (*Senza Peso*).

B. Market

Market refers to categories and tags related to the production and monetization of VR experiences. It precludes most academic genres, which tend to concentrate on content. Some service specific market tags were excluded from this category to be explained further below. Across VR and non-VR experiences, several market classifications dominated. "Indie," referring to the size of studios, was in the top five categories for both media. Its ubiquity makes sense because Steam's business model is based on appealing to and distributing independent and AAA (major studio) developers. However, Indie experiences were also relatively more available for VR, along with Casual, Early Access, and Free to Play. This implies that, unlike 2-D counterparts, VR makers are not necessarily relying on the traditional economics of the AAA industry. To some degree, producers may be experimenting with a variety of relatively novel modes of monetization. The preponderance of the Indie category also underscores that VR experiences are not necessarily developed by mainstream publishers. Instead, some of the most successful experiences, like *Beat Saber*, originate from startups with limited products. By contrast, VR supported experiences are appended to existing franchises, either making the game compatible with an HMD (as was the case with *No Man's Sky*) or an add-on that uses the headset (as with *Rise of the Tomb Raider*).

The prevalence of such market labels defied our expectation that traditional game genres and economics dominated VR titles, especially given the gamer-oriented vision promulgated by early adherents [21], [23]. Instead, the frequency of categories like Casual (and Utilities mentioned above) hints at the fact that VR may offer more relaxed and accessible experiences to users. Even Steam's most popular VR only title, *Beat Saber*, is a music and rhythm game, as opposed to a more "hardcore" genre like Shooter or Strategy. VR may demand new articulations and categorizations for how it is produced and even monetized as its economic and cultural trajectory diverges from traditional games.

C. Interactivity

When it comes to *how* users interact with VR content, a few stark differences surface. There are numerous ways to identify interactivity, or engagement with content, but developers and users classified it primarily based on controller and hardware support. Regarding relative availability, no major interactive categories overlapped and only one interactivity-based criterion, "VR Supported," was (understandably) more relatively available for VR experiences. By contrast, a surfeit of tags existed for non-VR content: full and partial controller support, level editors, various kinds of remote play, and even shared/split screen play.

These findings underscore that there is a robust language generated by users for game control and interactivity that is absent for VR, possibly because Steam provides separate information on headset compatibility (e.g., Oculus Rift and Valve Index), controllers and play space (e.g., seated, standing) for each VR title. However, the dearth of user tags may also indicate that there is less nomenclature for experiences created by the community. After all, traditional games are associated with many conventions in terms of user control and interface that are difficult to translate into VR.

Some of these conventions pertain to gameplay: buttons on gamepads and keyboards facilitate a particular form of interaction. A player who could, on a gaming console, press a button and nimbly perform a bicycle kick would find the same move difficult (and dangerous) to execute in VR. Modes like "split screen" are also uncomfortable in an HMD. This may begin to explain discrepancies in genre as well: Music/Rhythm and certain Sports (e.g., frisbee or tennis) make the most of a user's gesticulations and allow lifelike actions, while Strategy games are relatively less available because they rely on traditional modes of gaming interactivity (e.g., a mouse, keyboard, and screen). VR, therefore, may provide naturalistic, intuitive modes of engagement, which may be difficult to classify but are potentially more accessible than traditional games to a wider array of novice users—assuming they can afford the headset—who have not mastered game controllers and associated maneuvers.

Differences in interactivity and genre between VR and non-VR also manifest in the length of experiences. RPGs and Strategy games require less physical activity, which can allow for long periods of play on flat screens, while prolonged use of HMDs may cause discomfort from heat, eye strain, physical fatigue, and simulator sickness [9]. Additionally, being "disconnected" from reality for long periods of time may cause apprehension. In traditional video games, players hear and see their normal surroundings; by contrast, VR suspends users from the natural environment and real-world information, which is often disturbing. These potential hindrances merit future studies of interactivity and engagement in virtual environments.

D. Sociality

Categories and tags surrounding sociality, or in what ways (if any) one plays with others, were also grouped haphazardly between VR and non-VR. Certain versions of sociality, like Massively Multiplayer, are incorporated into the design and monetization of games and experiences. However, users also tagged an assortment of social interplay. Single Player and Multiplayer frequently occurred in VR and non-VR applications. By contrast, PvP happened frequently in VR experiences but was relatively more available in non-VR. Given how foundational these modes of socializing are on Steam overall, it is unsurprising that many titles were labeled as such.

However, VR experiences were categorized as Single Player at a much higher rate than non-VR. The implication is that most available VR titles lean toward being more solitary in their gameplay. Like interactivity, users developed a significant number of tags to describe forms of co-op (cooperative) play for non-VR games. The imbalance suggests the need for new modes of social classifications for VR, particularly as spaces like *VR Chat* defy traditional categories.

E. Service Dependencies

Finally, both VR and non-VR contained titles that had user tags explicitly associated with Steam, which we called "service dependencies" because they were mostly ancillary to in-game

play and required recognition by Steam in one way or another. Steam Achievements appeared as one of the most common tags for both VR and non-VR. However, once again, there was a diversity of tags for non-VR content that were relatively more available: for instance, Steam Cloud, Leaderboards, and Trading Cards. The only relatively more available tag for VR was "Steam VR Collectibles," which were made by the company for VR experiences. Clearly, this difference reinforces the notion that there is a robust ecosystem within Steam for game content, but not for VR. The medium is still very much in a formative and experimental phase, defying the norms of the service on which it is distributed.

F. Rethinking Classifications

In total, these criteria signal that VR in many instances defies or narrows the set of genres found in traditional games. Not only are certain types of content more available, such as Simulation and Flight, but the future trajectory of the medium revolves around other factors, which may not be neatly or cleanly classified yet (such as sociality and interactivity). Also, distribution service and production shape how content is made (as seen through the market) and are key to how VR content is perceived. Because of their reliance on distribution channels like Steam or Oculus, developers and consumers must work within (somewhat limited) classification systems to create content that conforms to narrow parameters. Our findings highlight trends for the medium within such circumstances, where VR is dominated by solitary (in terms of sociality), active and physical (in terms of interactivity) casual and indie games, even while there is the potential to have much more diverse content.

The data magnifies the need for a new taxonomy for VR beyond traditional genres. Based on our grounded approach, we believe content, market, interactivity, and sociality provide potential avenues for further refinement and categorization—service dependencies were excluded because of their reliance on Steam. Although not an exhaustive list, it begins to illuminate new standards by which consumers and developers can judge content, as well as direct researchers in devising new modes of classification, which we aim to do in future research.

Our article represents a first phase in assessing commercial VR experiences, for which large-scale analysis and classifications are rare. The findings provide valuable measurements that will aid developers to determine what types of VR products will do well in the market, which we aim to confirm in future interview and survey work. We argued from the onset that traditional genres offer a limited perceptual filter on how titles differ, something that was borne out in the research. Our goal is to combine these discoveries with other factors, including the categories set forth in the previous section, to expand this foundational framework and ultimately share and test it with publishers in future research and development.

G. Low Ratings for an Emerging Medium

While this article was able to reveal potential classifications, it is less obvious why VR only titles received fewer positive reviews compared to non-VR and VR supported titles in the dataset. A few anecdotal reasons may explain this, including the possibility of less refined "Indie" titles, or users comparing VR experiences to games rather than evaluating them independently. Additionally, there are human factors, like perception, cognition, and ergonomics that are unrepresented in this system, but given previous research likely affect user experience [36]. These conjectures deserve future consideration, and only support the need to classify VR consumer content with different criteria beyond traditional gaming.

H. Limitations

Genre systems' general lack of uniformity impacts any study's methodology because different classifications might yield other results regarding popularity, although our findings were statistically reliable. Further, this was not an experimental study, with no control over classifications given to developer categories and user tags. Especially because of the fluid interpretation of genre among researchers, developers, and consumers alike, a mixed-method and qualitative approach, such as thematic analysis of user comments, as well as comparing human coding to the data-scraped tags, seems necessary to advance this initial work. Our results should certainly be considered a starting—rather than ending—point for an exploration of VR classification. Certain titles may be hard to classify according to this framework (particularly those that are not games or forms of entertainment). Therefore, future research should expand beyond our taxonomy to account for the unique affordances of VR. Further, the Steam store's limited set of categories is informed by its longstanding relationship to games. By contrast, alternative services for accessing VR experiences, such as the Oculus store, do not necessarily have this history. However, since VR and digital game makers do not regularly allow access to data, nor publish sales figures, SteamSpy offers one of the better avenues for gaining this information [50].

VI. Conclusion

Our findings begin to bridge the gaps between academic, consumer, and industry perceptions of VR by comparing features from each. It is also the first step in building new frameworks to specify qualities that differentiate commercial VR titles from games. While affiliated with games and gaming, VR is maturing into a medium with distinct features and styles as well as novel approaches to familiar genres. We analyzed how users respond to the medium by first reviewing the complicated relationship between genre, games, and VR and then by empirically assessing the frequency and rating of academic genres, developer categories, and user tags currently available to users across VR only, VR supported, and non-VR experiences on Steam. Results identify the most common content types (e.g., Action and Shooter within VR only applications), the relative availability of each between platforms (e.g., Casual is more common in VR only than VR supported or non-VR), general platform popularity (e.g., VR only received less positive ratings than VR supported and non-VR), and which content classifications are associated with higher user ratings across hardware-support platforms (e.g., Action and Music/Rhythm are most positively rated in VR only).

Additionally, distinct differences were found between non-VR games and VR experiences regarding content, market, interactivity, sociality, and service dependencies. Ultimately, the article serves as an important steppingstone for distinguishing the types of VR experiences users gravitate toward that can benefit designers, industry, online reviewers, and influencers (who warrant a study in their own right), and players alike in future production. It also lays the foundation for a classification framework which can help deal with the ongoing challenges in utilizing genre in the appraisal of emerging media. When mapping how different labels apply to VR, the necessity for a more comprehensive and substantial evaluation of titles generally becomes evident; one that fills out our framework with considerations of psychological and technical attributes and effects. After all, many users are still selecting their very first commercial VR experiences, and it is important that they have classification systems that actually reflect the (virtual) reality of content they are about to consume.

APPENDIX

Genre Coding Instructions:

Genre:	Game includes ANY of these genres as a major focus (<20% of the player's experience). If it MIGHT be a focus, mark MAYBE and add notes. Else, leave blank.
Action:	Game relies on a player's reflexes, coordination, or reaction time.
Adventure:	Game involves using problem-solving skills.
Dice:	Game has an element of chance (e.g., randomly generated events or maps, dice).
Classic Board Games:	Game is a digital version of a board game.
Fighter:	Game focuses on martial arts or hand-to-hand combat.
Flight:	Player flies around the digital environment (e.g., in aircraft, spacecraft, bird).
Music/Rhythm:	Game involves playing instruments and/or challenges sense of rhythm.
Puzzle:	Game involves a puzzle that can be solved, with low if any element of chance.
Quiz/Trivia:	Game tests the player's knowledge.
Racing/Speed:	Player in competition to move (on foot/vehicle) faster/better than others.
Role-Playing Game:	Game lets the player assume a character role (e.g., create a persona, add a background story, interact with other characters/NPCs to create a story).
Shooter:	Game involves shooting others or non-player characters (NPCs).
Simulation:	Game closely simulates real world activities (e.g., flying, driving, working in factory).
Sports:	Game focuses on athletic teams and/or sporting events.
Strategy:	Game focuses on strategic planning skills; not turn-based (e.g., speed-based).
Turn-Based Strategy:	Game focuses on strategic planning skills and is turn-based.

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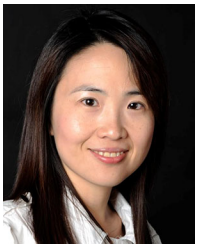
Maxwell Foxman received a Ph.D. in communications from Columbia University, in 2018. He is currently an Assistant Professor of media studies and game studies with the School of Journalism and Communication, University of Oregon, Eugene, OR, USA. He has authored/coauthored work in *New Media & Society*, *Frontiers in Virtual Reality, Social Media + Society*, and *Games and Culture*, among other outlets. His research interests include the influence of games, play, and game industries in non-game contexts, including immersive media (VR/AR/XR), esports, and gamification.

David Beyea received a Ph.D. in communication from Michigan State University, in 2019. He is currently an Assistant Professor with the Communication Department, University of Wisconsin–Whitewater, Whitewater, WI, USA. His research interests include computer-mediated communication (CMC) and media effects. His work seeks to identify how the cues found in traditional text-based CMC and high-fidelity media, such as virtual reality and video games, interact to affect our communication behavior in contemporary digital environments.

Alex P. Leith received a Ph.D. in information and media from Michigan State University, in 2019. He currently serves as an Assistant Professor of data analytics and design with the Department of Mass Communications, Southern Illinois University Edwardsville, Edwardsville, IL, USA. He has authored/coauthored various manuscripts and book chapters, including in *Cyberpsychology, Behavior, and Social Networking*, and *Communication Monographs*. His research interests lie at the intersection of data science and communication, with special interests in the expression of interpersonal and parasocial relationships through social media and digital games.

Rabindra A. Ratan received a Ph.D. in communication from the Annenberg School for Communication and Journalism at the University of Southern California in 2011. He is currently an Associate Professor and AT&T Scholar with the Department of Media and Information, Michigan State University, East Lansing, MI, USA, as well as the Director of the Social and Psychological Approaches to Research on Technology-Interaction Effect Lab. His research interests include how media technologies (e.g., video games, virtual worlds, and avatars) influence meaningful outcomes (e.g., education, health, and well-being). He is particularly interested in the Proteus effect, the implications of avatars in both gaming and non-gaming (education, health, and business) contexts, and the effects of gender stereotypes in gaming on STEM engagement.



Vivian Hsueh Hua Chen received a Ph.D. in communication from Arizona State University in 2006. She is currently an Associate Professor with the Wee Kim Wee School of Communication and Information, Nanyang Technological University, Singapore. She has authored/coauthored extensively in well-known journals such as *Computers in Human Behavior*, *New Media & Society*, and highly reputable conference proceedings such as ACM CHI and SIGGRAPH. Her research interests include new communication technologies, virtual reality, impacts of digital games, gamification, human–computer interaction, and intergroup communication.

Ms. Chen was the recipient of a total of approximately $8 million of research funding. She is an associate editor for the *Journal of Media Psychology*.

Brian Klebig received a M.A. in communication and mass communication from the University of Central Florida, Orlando, FL, USA, in 2014.

He is currently an Associate Professor with the Department of Communication, Bethany Lutheran College, Mankato, MN, USA. His research interests include preconscious drives that influence subsequent thought and behavior.