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Homesteading the "Wild West" of educational apps: Ranking cultures and the struggle for algorithmic visibility on Apple's App Store

by Karla Zavala Barreda and Bernhard Rieder

Abstract

The proliferation of preschool apps marketed as educational has created a challenging landscape in which their actual educational value is difficult to assess, a phenomenon some authors have described as a "digital Wild West." While education apps have received continuous scholarly attention, the specific conditions governing their distribution remain understudied. From a software and platform studies perspective and drawing on digital methods, this paper investigates how app stores mediate access to educational apps for young children. We examine the "ranking cultures" on Apple's App Store through the empirical study of search results of early literacy apps. We present our findings, paying attention to both the strategies employed by app stores and the tactics used by app developers to adapt to algorithmic governance. This lens prompts a discussion on the ranking dynamics that influence app makers' tactics and how these negotiations shape the current offer for preschool education.

Contents

1. Introduction

The rise of computing over the last decades has affected education in many ways, including access to vast troves of information via the Internet and increased focus on "digital skills" in school curricula. The quick diffusion of touchscreen devices like smartphones and tablets, in particular, has brought even the youngest children into contact with digital devices (Herodotou, 2018; Nansen, 2015), often to the dismay of parents and educators (Colliver, *et al.*, 2019). Software makers have quickly discovered this new audience, leading to a proliferation of apps aimed at young children (up to five years old), including games and illustrated books, as well as apps explicitly marketed as *educational*. Indeed, over half of the apps in the Education category on Apple's App Store [1] and Google's Play Store target children under five (Callaghan and

Reich, 2018). However, the key selling point of these products — their pedagogic value — is usually not determined by any educational vetting processes.

Educational researchers have consequently criticized what they describe as the “Wild West” of the app landscape (Guernsey, *et al.*, 2012; Hirsh-Pasek, *et al.*, 2015), emphasizing the difficulties in evaluating the many educational apps available, the lack of transparency regarding development teams’ expertise in early childhood education, and the uncertainty about whether these apps have been reviewed by educational experts prior to release (Starke, *et al.*, 2021). The “Wild West” metaphor is, however, not only problematic due to its associations with Western colonial expansion; it also frames app stores as an “electronic frontier” (Chun, 2002), as uncharted and lawless land ready for exploitation. But this obscures important socio-technical contexts, namely that screen-based education (partially) replaces previous cultural practices and that app stores are neither uncharted nor “unregulated.” They rely on a variety of technical, legal, commercial, and bureaucratic means to govern what happens within their confines (Gillespie, 2018; Morris and Morris, 2019; Poell, *et al.*, 2022).

In line with other domains where large quantities of information are sorted into more manageable lists and selections, app stores — the principal venues for app distribution on smartphones and tablets — rely on algorithmic ordering rather than curation by domain experts. While education apps have received continuous scholarly attention (*e.g.*, Sari, *et al.*, 2019; Vaala, *et al.*, 2015), particularly regarding content and quality (*e.g.*, Callaghan and Reich, 2018), their specific distribution conditions, including how app stores make them visible, remain understudied. However, as Ito (2009) noted, studying only the content of educational software without considering its social and cultural contexts is insufficient. Analyzing the socio-technical environment around educational software, on the other hand, enables researchers to “understand how it is that technology fails to deliver on some of the explicit claims made by its developers and at the same time is tied to broader systemic changes” [2].

To fill this gap, this paper takes cues from the fields of platform (Bogost and Montfort, 2009; Plantin, *et al.*, 2018) and software studies (Fuller, 2008) to investigate how educational apps are algorithmically ordered on app stores. Ranking and recommendation mechanisms, in particular, play an important role in orienting user choice by modulating the visibility and findability of apps. These mechanisms rely mainly on quantitative signals and differ substantially from traditional modes of editorial selection.

Although the power of “algorithmic governance” (Bucher, 2012; Gillespie, 2018; Morris, 2015; Poell, *et al.*, 2022) has been emphasized in recent scholarship, software developers adapt to the conditions set by app stores and employ various tactics to promote their products. The “platformization” (Helmond, 2015) of educational software is thus not merely a shift from traditional figures of authority to a new set of editors but to a complex socio-technical ecology where different actor groups negotiate outcomes. The main goal of this paper is to better understand this emerging ecology: How do app stores mediate access to educational apps for young children?

To answer this question, we employ digital methods (Rogers, 2013) and adapt the technique proposed by Rieder, *et al.* (2018) for collecting and analyzing search results, the central discovery mechanism on app stores. We focus on apps targeting preschoolers, which are mainly used outside formal education settings, making platform mediation even more critical. To further sharpen our empirical protocol, we focus on literacy skills, one of the most popular types of apps (Sari, *et al.*, 2019). These apps are particularly sensitive, as they are used during a critical childhood period, where written and spoken language inputs play a crucial role (Vulchanova, *et al.*, 2017).

Research on early literacy apps has reported that the most frequently targeted skills are letter identification, word spelling, and phoneme awareness (Vaala, *et al.*, 2015; Callaghan and Reich, 2018). Sari, *et al.* (2019) further described this market as dominated by international companies that often fail to tailor their content to local languages or cultural contexts. Their apps typically feature simple interactive activities in domains such as alphabet knowledge, letter and vowel sounds, and understanding upper vs. lowercase letters. The learning activities often take the form of puzzles, short games, and quizzes (Callaghan and Reich, 2018;

Hirsh-Pasek, *et al.*, 2015).

Given the immense popularity of the iPad with young children, although mostly within more affluent demographics, we focus on Apple's App Store to better understand the distribution conditions for these educational contents and, in particular, the search function and its empirical outcomes. The "multi-situated" methods outlined by Dieter, *et al.* (2019), which approach apps as relational to data infrastructures and platforms' economic models, frame this shift from content analysis to app distribution practices. Our analysis takes two complementary directions, accounting for the negotiated character of visibility. First, we audit search results for several relevant queries, asking what kind of apps appear in the top positions and comparing change over time. Second, we qualitatively analyze how app developers exploit visibility opportunities using app store optimization (ASO) tactics.

The paper proceeds in four steps. In the first section, we review the literature on the infrastructural conditions and tethered relationships between app developers and platforms, highlighting the challenges developers face in this context. Subsequently, we discuss methodological considerations and introduce our approach. The third section summarizes our findings in mainly descriptive terms, paying attention to the strategies employed by app stores to govern app distribution and the tactics app developers use to adapt to algorithmic governance. Finally, we interpret, evaluate, and critically contextualize these findings in the discussion section and conclude by pointing toward possibilities for further research.

2. Platformization, algorithmic ordering, and app store optimization

2.1. Platformization and Apple's App Store

Online platforms have come to play a crucial role in many different social and economic domains, to the point where scholars diagnose a transformation toward a "platform society" (van Dijck, *et al.*, 2018). Platforms, in this context, are sometimes defined more broadly as online services that "afford an opportunity to communicate, interact, or sell" [3], sometimes more restrictively as computing systems "upon which further computing development can be done" [4], and sometimes in purely economic terms as "two-sided markets" (Rochet and Tirole, 2003). The consensus, however, is that platforms have become central with regard to all of these definitions, describing a larger movement of "platformization" (Helmond, 2015) affecting one sector after the other.

App stores — and the mobile devices they connect with — can be seen as platforms in both the computational and economic sense. In computational terms, Apple and Google create the operating systems and software tools that make tablets and smartphones "programmable" and operate app stores as the principal distribution infrastructures for third-party software makers, leading to tight control over the whole production chain. To quote Fagerjord (2015), "[t]o create an app is to enter a network of, Apple's programming languages and the Xcode application, Apple's approval service, Apple's App Store, users, and the iPhone itself" [5]. Companies govern what happens on their platforms by controlling the technical base layers and through various rules and review mechanisms, app content (Poell, *et al.*, 2022; van Dijck, 2020). In economic terms, app stores connect two "sides," users and app makers, taking a percentage of every transaction between them. The question of how these two sides are *matched* is crucial, and algorithmic mechanisms constitute the most common answer.

By streamlining both technical (*e.g.*, SDKs or software development kits, development software) and commercial (*e.g.*, payment handling, contracting) processes, app stores have lowered the barriers for publishers and developers to create and distribute apps (Nieborg, 2015). Their relative openness has led to an overabundance of content that is ordered, ranked, and governed algorithmically (Morris and Morris, 2019). What Striphas (2015) has identified as "the work of culture," namely the "sorting, classifying, and hierarchizing people, places, objects and ideas" [6] is thus entrusted to technical systems that "survey, select, prioritize, and predict information, items and users" [7]. These systems reduce the massive number of apps to dynamic shortlists, thereby modulating content visibility on the platform (Bucher, 2012). While they do not fully determine which contents are ultimately selected or how these contents are engaged with, they are increasingly part of the "webs of significance" that Geertz (1973) defined as *culture*.

In contrast to an editorial logic relying on socially authorized experts, algorithmic systems represent "the proceduralized choices of a machine, designed by human operators to automate some proxy of human judgment or unearth patterns across collected social traces" [8]. These systems are neither neutral nor autonomous. While users generate the inputs ranking and recommendation mechanisms draw on (Rieder, *et al.*, 2018), these inputs are "refracted" (Christin, 2020) in ways that serve companies' business prerogatives. This does not to suggest that the pre-digital landscape was without its own challenges. In the past, bookstores, libraries, and publishers acted as the primary gatekeepers of preschool content, curating selections for parents, caregivers, and children. However, as Buckingham and Scanlon (2005) observed, early learning materials also lacked oversight, with no formal inspection systems or requirements for providers to be deemed educational. Even so, app stores have significantly complicated this dynamic by lowering barriers of entry into the preschool market and shifting to algorithmic rankings as the primary selection mechanism.

The development and distribution of educational apps for children thus happen in a distinct cultural logic that drives digital media production. The vertical integration of hardware, software, and distribution infrastructure has resulted in platforms becoming central players, subsuming other industrial actors, including network operators and financial institutions. This "platformization of cultural production" (Nieborg and Poell, 2018) means that app developers indeed find themselves in a tethered relationship with powerful companies that both enable and delimit their activities.

2.2. App store optimization

Despite the various ways app stores govern activities, developers are not without agency. With reference to Certeau's (2002) work, one could argue that the *strategies* deployed by platform companies are met by *tactics*, that is, by "a calculated action determined by the absence of a proper locus" [9]. While app stores set the ground rules, there is leeway for developers to pursue their interests. Morris and Morris (2019) have widely discussed developers' challenges regarding app discoverability in cluttered and highly competitive markets. App stores impose a regime of algorithmic visibility, where a higher position in search results leads to a greater chance of users discovering and downloading an app (Apple, 2022; Mickle, 2019). Whereas some developers are concerned that their apps may become "zombies," only accessible through a search for the exact title and thus rarely downloaded, others are on alert for "copycats" that duplicate successful apps' mechanics, design, or specific functionalities.

Against this backdrop, ASO has emerged as an industry practice and burgeoning business that claims expertise to help developers improve visibility and, consequently, receive more downloads. Common optimization tactics entail tweaking an app's title, description, and keywords. Other practices include bulk downloads, fake reviews, bot installs, and keyword stuffing, which are often labeled as "gaming the system" (Petre, *et al.*, 2019) and explicitly against app stores' terms of service. As such, platform companies position themselves as paternalistic figures that "uphold the ideals of authenticity and integrity" [10], even if the boundaries between legitimate and fraudulent practices continuously shift as business strategies evolve.

Focusing on the perspective of content creators, Bishop's (2020) ethnographic work highlighted algorithmic invisibility as a fundamental risk factor. Uneven power relations push developers to employ tactics based on their interpretation of how ranking and recommendation systems work. This often takes the shape of "algorithmic lore," defined as "a mix of data-informed assumptions that are weaved into a subjective narrative" [11]. Through this lens, ASO tactics emerge as a form of risk management since audience reception and return on investment are contingent on being visible. It is from the visibility negotiations between platforms and app makers that the actual selections of apps perceivable to users emerge.

In summary, ASO tactics respond to app stores' central role and reliance on algorithmic ordering. Taking the interplay between strategies and tactics as a starting point, this paper sheds light on both "sides" in conjunction, focusing on search ranking on the one hand and ASO tactics on the other. Specifically, we aim to understand the larger role of app stores in mediating access to apps for young children. The next section presents the methodological considerations for studying app stores and their rankings.

3. Methodology

Following the conceptual perspective outlined by Dieter, *et al.* (2019), we understand apps not as fixed objects but as relational to data infrastructures and platforms' economic models. The study of apps should thus consider their dependency on proprietary platforms, situating them within a specific socio-technical and institutional context. Each app store has affordances and governance frameworks that control app production and distribution, developer relations, and user practices in specific ways (Morris and Murray, 2018; Nieborg and Poell, 2018). To guarantee consistency and comparability, we thus limit ourselves to Apple's App Store. In addition, we focus on the tablet interface used on iPads. Although studies have identified these devices as particularly popular among young children (Dardanou, *et al.*, 2020; Herodotou, 2018), we acknowledge that their cost excludes children and caregivers from low-income households and regions. Our second caveat concerns children's role in the app selection process. Even though our study centers on early literacy apps whose end-users are young children, this population is unlikely to engage meaningfully with the App Store because its interface is not tailored to this unique and pre-literate demographic. Thus, we base our study on the premise that caregivers are the primary users actively interacting with the App Store, even if children may be able to make their preferences heard. Ranking affects what users see, but it does not determine use.

In the remainder of this section, we first discuss the App Store interface to situate our empirical focus — search results — within a broader context of app discoverability. We then outline our data collection strategy and the analytical gestures we applied.

3.1. Layers of visibility on the App Store

For all but the most adventurous users, the App Store is the only way to load apps onto an iPad. Its interface organizes what Gillespie (2018) called "layers of visibility" in the sense that apps are "categorized, recommended, sequenced into browsing flows, ranked by sales, identified as 'trending,' featured on the front page, included in an Apple ad" [12]. The bottom menu indicates the five main "spaces" for discovering apps: Today, Games, Apps, Arcade, and Search (Figure 1). The first four tabs are primarily curated by Apple editors, displayed in different layouts, and arranged in groups to provide a coherent narrative (Morris and Murray, 2018). In addition, the Apps tab offers 27 sub-pages that correspond to the content categories Apple uses to distinguish specific types of apps. One of them, the Kids page, is presented as a space for helping caregivers discover apps designed for children under 11 years, constructing and delineating a specific demographic for software consumption in the process.

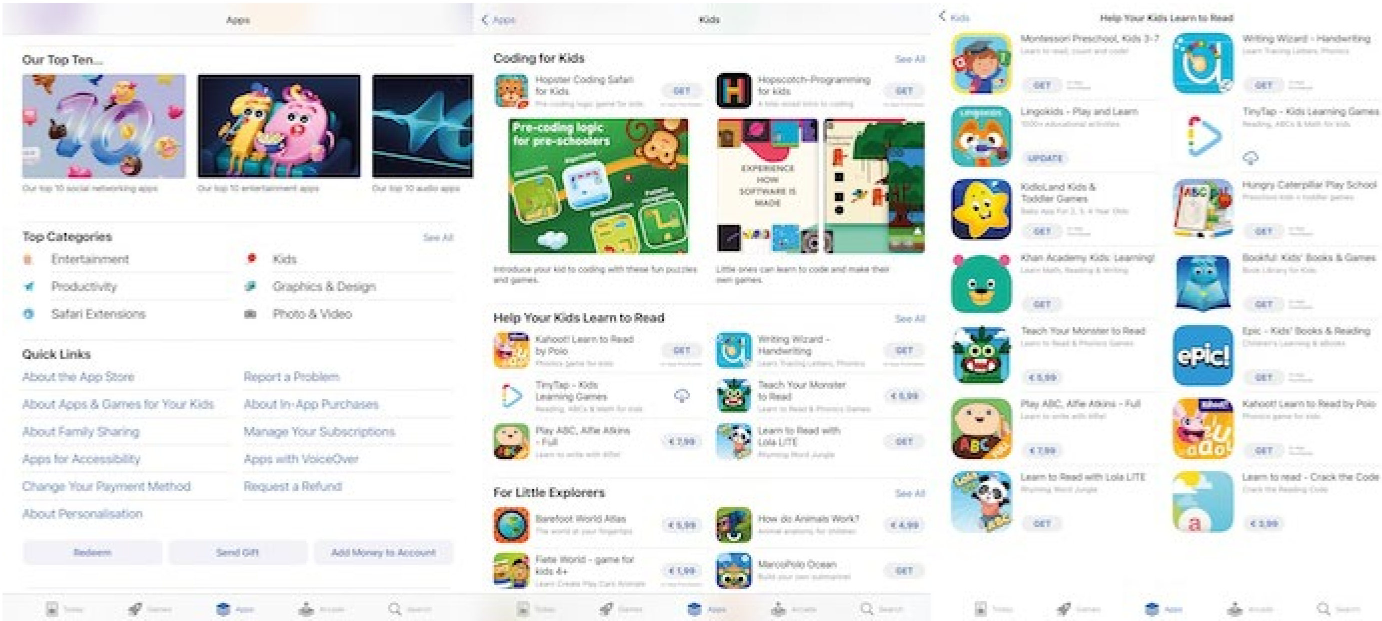

Figure 1: The user pathway to the Kids category sub-page on the App Tab.

Note: Larger version of Figure 1 available here.

Early literacy apps, the focus of our paper, receive their own “grouping” within this larger organizational frame. “Help Your Kids Learn to Read,” a list curated by Apple’s editors, is one of the subdivisions on the Kids page, visible when scrolling down further. Personalization may affect the organization of discoverability, for example, by placing categories and app groups more prominently on the Today tab, but we could not confirm this for our case.

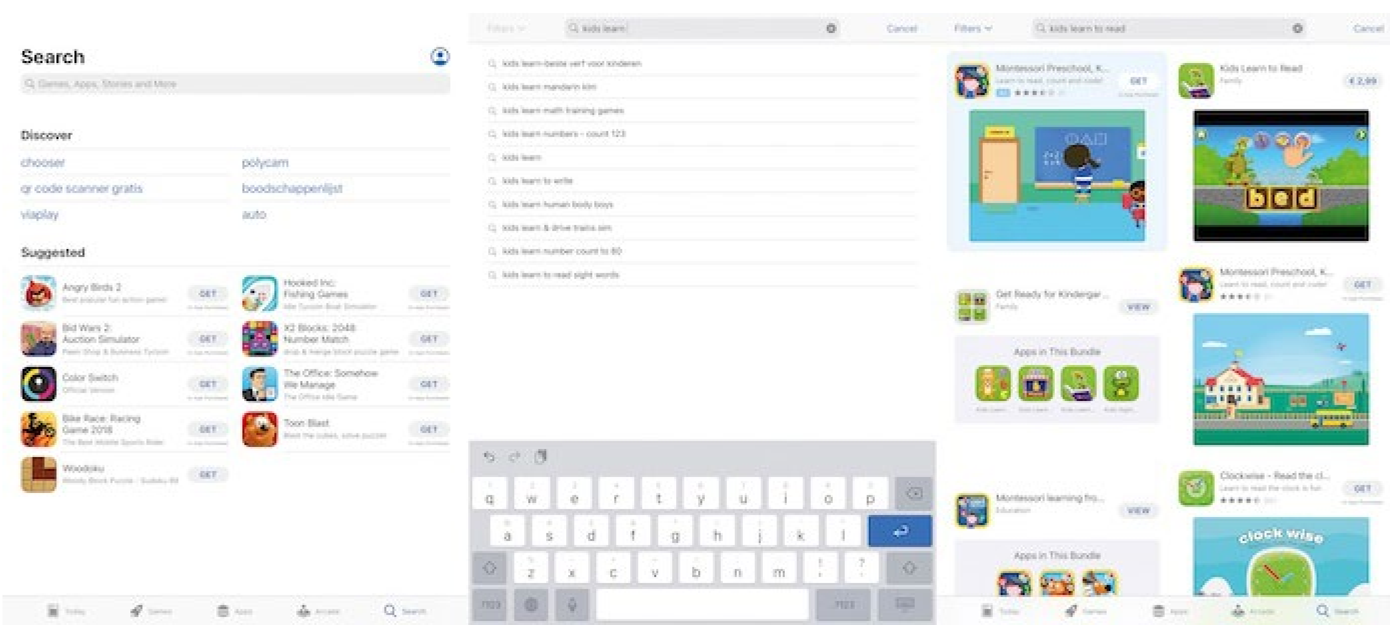

Figure 2: Search tab, query suggestions, and search results.

Note: Larger version of Figure 2 available here.

A more straightforward mode of app discovery is Search (Figure 2), used by 70 percent of users to find new apps, with 65 percent of all app downloads happening directly after a query (Apple, 2022). Search can be understood as a two-stage process consisting of selecting matching apps from a database and ranking them (Rieder, *et al.*, 2018). While the first step involves query matching techniques, for example, based on query-title correspondence, the ranking stage employs algorithmic ordering methods that rely on various evaluation metrics to quantify each item's "relevance" (Chun, 2020). Indeed, results are presented as lists, which "reinforce the idea that some contents deserve more prominence than others" [13].

Search is thus a critical layer of distribution and visibility since it plays a central role in matching users and developers, the two main actor groups in the App Store's two-sided market. As the creator of this market, Apple has incentives to optimize ranking to maximize revenues without losing participants. While the company, as the sole operator of the only distribution channel for iPad and iPhone apps, holds formidable power in this setting, both users and app makers have agency, to the point where Search can be seen as an ongoing *negotiation* between all three. While we will consider Apple's "Help Your Kids Learn to Read" subdivision further down, our main interest concerns this negotiation process and, crucially, its observable outcomes.

3.2. Our approach

To operationalize our research interest, we adapt and expand the method proposed by Rieder, *et al.* (2018) for their empirical study of YouTube's search feature. Recognizing the fundamental limitations of studying complex and opaque commercial systems, including the impossibility of replicating the interplay between probabilistic algorithms and vast amounts of user interactions, the authors refrain from trying to "reverse engineer" the platform's internal mechanisms and, instead, focus on observing and analyzing the actual outputs generated by the system: ranked search results. These results are not seen as static entities but as dynamic and distributed accomplishments that involve multiple actors.

This methodological shift suggests that information ordering is not simply a product of ranking algorithms but of "ranking cultures," that is, the "unfolding processes of hierarchization and modulation of visibility that call on users, content creators and a platform that intervenes and circumscribes in various ways" [14]. While Rieder, *et al.* (2018) aimed to establish connections between platform technicities, user practices, and creator tactics to comprehend the patterns of change and stability within "ranking cultures," their investigation of actual videos and creator practices is limited. By adding ASO practices to our empirical protocol, we thus extend the approach to include the tactics employed by app developers to negotiate visibility.

Dieter, *et al.* (2019) suggested that the study of apps should depart from the affordances available to researchers, for example, the APIs (application programming interfaces) of app stores. By drawing on these interfaces, app stores become "key sites for studying how users, developers, and other actors influence the production, distribution, and reception of apps and app cultures" [15]. We thus apply the "ranking cultures" methodology to data collected from the App Store API to examine the agencies that underlie the central role of Search within this broader configuration. We mirror Certeau's (2002) distinction between strategies and tactics to structure our approach. First, we investigate the App Store's search ranking as a strategy for governing the (educational) app space by managing algorithmic visibility. Second, we examine ASO practices as tactics app developers employ to gain visibility. The following section discusses data collection and the analytical steps we employed in more detail.

3.3. Data collection and analytical steps

To collect the main dataset for our empirical analysis, we used the iTunes App Store Scraper (OILab, 2020) to retrieve ranked lists for early literacy apps based on selected queries. This data-capturing process, however, presents a notable limitation. As Rieder, *et al.* acknowledged, the procedure “fails to exactly reproduce the search experience of concrete end-users because it bypasses localization and personalization” [16]. However, Rieder, *et al.* suggested that API data can be considered a “baseline” perspective. Journalistic research also reported minimal variation between searches made from different accounts (Mickle, 2019).

After conducting a pilot study in mid-2022, the final results were captured on four dates at weekly intervals from 17 May to 7 June 2023. Taking a purposive sampling approach that seeks to emulate how actual users would search for applications, we selected five query combinations to collect our data: “children read,” “kids read,” “kids learn to read,” “learn to read,” and “children learn to read.” These queries represent colloquial phrases caregivers might use to search for early literacy apps, as opposed to specialist terminology such as “phonological awareness” or “vocabulary acquisition.” In addition, we controlled the search results through the country parameter. When using the selected keywords on the Dutch App Store, some results assumed that we were looking for apps to learn English as a second language, and we, therefore, limited data collection to the U.S. store. Lastly, given that users rarely scroll beyond the first set of results (Lewandowski, 2023) and that screen space limits the number of immediately visible apps when searching on the iPad (Figure 2), we captured only up to the first 25 entries for each query [17]. In total, we retrieved 441 search results and 72 unique apps. The collected data for each app included the app title, release date, primary and secondary genre, developer name, user rating count, average user rating, and supported languages.

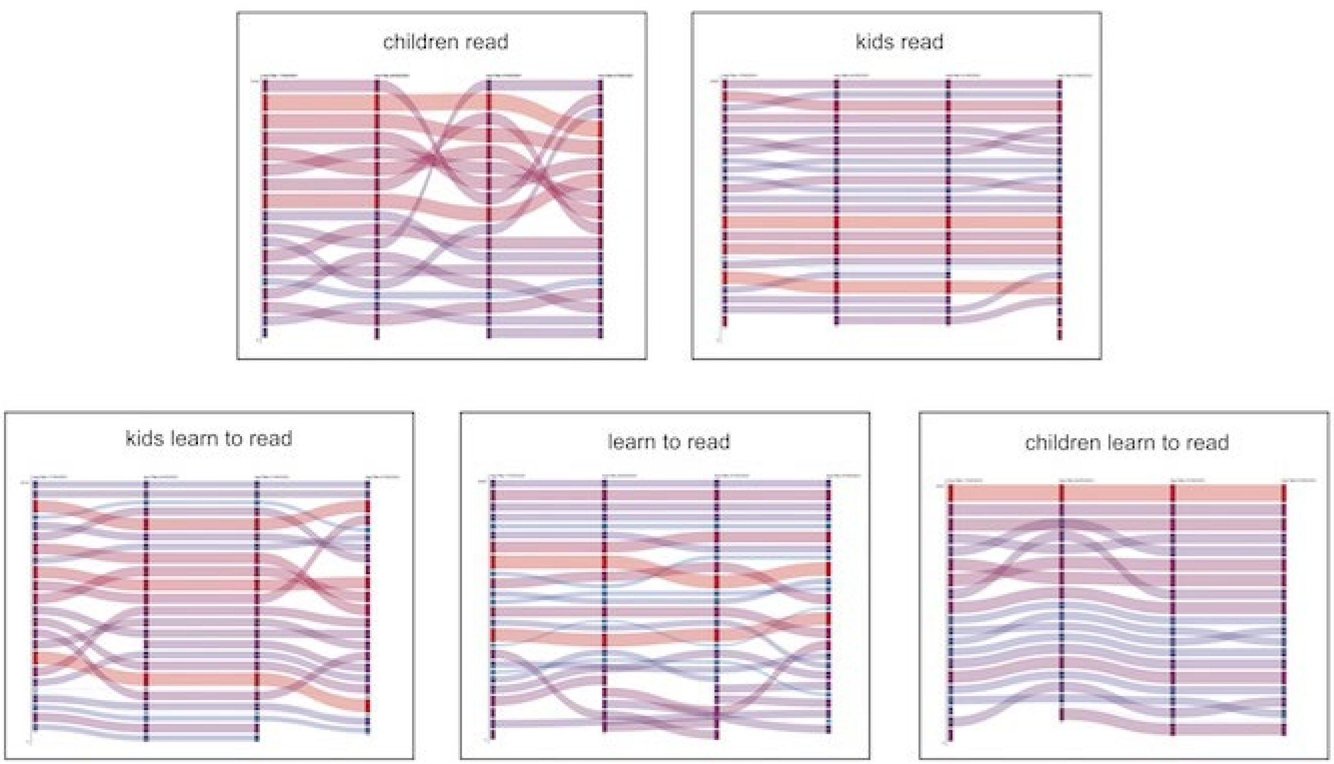

Figure 3: RankFlow visualization of weekly variance and user rating count for the five selected queries.

Note: Larger version of Figure 3 available here.

The first direction for analyzing this data focused on App Store search ranking. While we did not aim to reverse engineer the exact mechanisms at work, we investigated their broad orientation by correlating app positions with metrics indicating "popularity" and user-perceived "quality." To understand the stability of search results, we analyzed weekly variations using the RankFlow tool (Rieder, 2016), which visualizes differences between sequences of ranked lists of items.

Subsequently, we investigated the potential for new apps to enter these highly competitive spaces and qualitatively identified the metadata characteristics shared among apps that consistently maintained top rankings. We also retrieved the 14 apps from the "Help Your Kids Learn to Read" list through their appId to contrast the App Store's algorithmic ordering practices with Apple's editor-curated recommendations.

Motivated by the understanding that being visible to the ranking system is a form of "platform risk management" (Bishop, 2019), our second analytical direction examined the tactics app developers used to adapt to Apple's visibility management. To explore this aspect and identify prominent ASO practices, we analyzed the collected apps' metadata, including titles, keywords, and supported languages.

4. Searching for early literacy apps

4.1. Strategies: Search and ranking on the App Store

Ranking factors

In response to the international scrutiny and antitrust hearings surrounding App Store Search in 2019, Apple claimed that the feature relies on machine learning, 42 data points, and past consumer behavior to determine the ranking of apps (Mickle, 2019). However, the platform has not disclosed the precise mechanisms on the grounds that malicious actors could exploit this information.

Despite the lack of publicly available information, we were able to investigate the broad relationship between rankings on the one side and indicators for popularity and user-perceived quality on the other. The *userRatingCount* variable provides the number of times an app has been rated, which can serve as a rough stand-in for popularity if we estimate that each app receives a similar percentage of ratings compared to how often it has been downloaded. The *averageUserRating* variable then indicates the average number of " stars" received, giving us an idea about user satisfaction. To understand how these variables relate to apps' position in search results, we calculated the correlation coefficient [18] for each search query for all four weeks and then took the average. We found a correlation of 0.12 for *userRatingCount* and 0.23 for *averageUserRating*, which suggests an influence of both popularity and perceived quality, albeit more pronounced for the latter. Interestingly, there was significant variation between our five queries as well as between the four weeks of observation, suggesting that other, more context- and time-sensitive variables play an essential role.

Variation over time

To understand the stability of search rankings, we analyzed how positions changed over four weeks (Figure 3). We noticed that small clusters of two to five apps alternated places while maintaining roughly the same places in the rankings. However, starting from the eighteenth position, more significant variation was observed as new apps were introduced. Two explanations can account for this dynamic. First, Apple could explicitly seek to inject greater variety by promoting more pluralistic search results. As the RankFlow visualizations show, even top-ranked apps can occasionally experience abrupt drops in position, only to move back up the following week. Second, the ASO tactics employed by developers and changing user practices could also contribute to these variations. As the concept of "ranking cultures" suggests, search results are not static entities but socio-algorithmic processes involving multiple actors unfolding over time.

Despite the observed fluctuations, search results were overall remarkably stable for our selected queries over a longer timeframe. When comparing the mid-2023 data with our mid-2022 pilot study results, we noticed that roughly 80 percent of ranked apps remained the same.

Top-ranked apps

Since top-ranked apps experienced only minor position variations over time, a small group of apps consistently occupied the first positions. This finding aligns with a widely discussed issue in search engine research called the Matthew effect (Perc, 2014). The term refers to the “cumulative advantage” items at the top of the lists acquire when ranking includes popularity metrics. Once an app achieves a high position, it receives further attention, and its position solidifies, leaving limited space and “opportunity” for newer apps. In our case, this effect was particularly noticeable within the first five results per query, where about 70 percent of the apps were released before 2018. We were, however, able to identify two characteristics shared by successful apps released after 2018: the first involved affiliation with renowned app developers, such as Amazon Kids+ and Khan Academy Kids; the second consisted of belonging to an “app family” (Helmond, *et al.*, 2022), meaning that they were part of a group or app collection from a single developer. For instance, RV AppStudios has fourteen apps for children published, while Bini Bambini Academy has eight apps aimed at children. Their collections range from basic numeracy and literacy apps to simple interactive activities like coloring books.

Finally, we found that only four percent of all the apps in our sample were paid or “premium” apps. The dominant business model among the top-ranked apps is “freemium,” where apps are free for download and generate income through in-app purchases, subscription models, or advertising. At least for our case, we can thus confirm the larger shift from premium to combined pricing strategies (Nieborg, *et al.*, 2020).

Algorithmic vs. editorial

Comparing the “Help Your Kids Learn to Read” list with the collected search results (Table 1) demonstrates that algorithmic visibility is elusive, even when receiving editorial approval: most of the apps deemed high quality by Apple’s editors were not at the top of the rankings. More than half did not even appear in our search results, regardless of whether app titles contained keywords like “kids” or “read.” A case in point, *KidloLand Kids & Toddler Games* was not featured in our search results at all, even though the app offers segmented age preferences (0–2, 2–4, 4–6, 6–8) and tailored learning activities for early literacy that follow educational research.

The success of educational apps in the App Store — as measured by *userRatingCount* (Table 1) — is ultimately more contingent on algorithmic visibility than developmentally appropriate content or pedagogical quality. Illustrating the staggering contrast between editor-curated and algorithmically mediated visibility regimes, the apps in the top 25 have, on average, three times more ratings than those on the editor’s list.

Table 1: Apple’s editor-curated list “Help Your Kids Learn to Read,” sorted by the number of search queries each app appeared in.

		Position per query					
	Frequency	children read	kids read	kids learn to read	learn to read	children learn to read	*userRatingCount*
Epic — Kids’	5	2	2	9	15	1	501968

Books & Reading							
Teach Your Monster to Read	4	15	22	0	17	2	9246
Lingokids: Kids — Play and Learn	3	3	15	11	0	0	122984
Khan Academy Kids	3	0	4	10	7	0	71860
Montessori Preschool, Kids 3–7	3	11	0	0	24	4	3083
Learn to Read with Lola LITE	1	0	0	19	0	0	1
TinyTap: Kids' Learning Games	0	0	0	0	0	0	10559
Bookful: Kids' Books & Games	0	0	0	0	0	0	2150
KidloLand Toddler & Kids Games	0	0	0	0	0	0	75777
Hungry Caterpillar Play School	0	0	0	0	0	0	5738
Writing Wizard for Kids	0	0	0	0	0	0	2702
Play ABC, Alfie Atkins — Full	0	0	0	0	0	0	12
Learn to Read — Crack the Code	0	0	0	0	0	0	0
Kahoot!							

Learn to Read by Poio	0	0	0	0	0	0	594

4.2. Tactics: ASO to prevent algorithmic invisibility

Having shed some light on how Apple algorithmically governs app visibility, this section explores how app developers seek to adapt to and exploit these conditions. A fundamental difference between SEO (search engine optimization) and ASO is that search engines crawl the open Web while Apple controls information through a centralized app submission interface: *App Store Connect*. It is thus during the submission process that developers can deploy ASO tactics and “play on and with the terrain imposed on [them] and organized by the law of a foreign power” [19]. These practices enable app developers to react to the search feature’s central role in app distribution, as the provided metadata directly affects visibility on the platform.

Apple recommends simple and memorable app titles with up to 30 characters and using subtitles for further specification (Apple, 2021a). However, our collected search results did not align with these supposed best practices. The top positions in the rankings were consistently populated by lengthy titles that incorporated multiple keywords and generic descriptions.

From the 72 unique app titles, we counted the most repeated keywords. Notably, “kids,” “games,” “learn,” “read,” “kids,” and “ABC” were the most used terms. Algorithmic experts often suggest this kind of “keyword stuffing” to help developers mitigate algorithmic invisibility and consequent revenue loss. In our sample, even prominent developers like Duolingo adopted titles like *Learn to Read — Duolingo ABC*, and a popular children’s book series calls itself *Dr. Seuss’s ABC — Read & Learn*. This shows that app developers feel the need to address the ranking system even in the most prominent communicational facet of the app, its title.

Developers can also use the number of languages an app supports for ASO. By localizing an app in multiple languages, they can gain an extra 100 characters for keywords per language. ASO experts recommend utilizing keywords not included in the title or subtitle (Kollegger, 2024). However, since the keyword field is neither public nor displayed on the product page, its use is hard to study. We still noticed the use of language metadata to gain keyword space when studying five early literacy apps claiming to be available in over ten languages. We investigated whether their descriptions and supported languages corresponded to language audio cues and writing systems (*e.g.*, Latin/Roman, Cyrillic, Hangul) available within their settings and user interface. We found discrepancies in four out of five apps. For example, *Drawing Games Learning Kids 3* claims to support 23 languages but only had twelve available, indicating that the language “trick” was used to boost findability.

While analyzing the same group of apps, we identified another tactic employed by two app makers: Bini Bambini Academy and LetterSchool Enabling Learning. This involved publishing apps with (nearly) identical user interfaces under different titles and icons. For instance, a striking parallel was evident in the interface design, characters, and interactive activities between *ABC Phonics Kids Reading Games* and *ABC Phonics Games for Girls!* Although research suggests a female advantage in early language production and comprehension (*cf.*, Frank, *et al.*, 2021), which could justify the development of an app exclusively for young female users, the fact that both apps share the same activities without distinction undermines this interpretation. Instead, our findings point toward what the App Store review guidelines (Apple, 2021b) call “design spam.” While this tactic may result in app removal or a lengthier review process, it enables targeting keywords not covered by the first app, further expanding the chance to be found by users.

5. Discussion

Following Poell, *et al.'s* (2022) assertion that "governance by platforms shapes cultural production because cultural producers willfully and knowingly adapt to platform governance" [20], this paper investigated the most prominent pathway to app discovery on Apple's App Store, the search function (Apple, 2022). While the details of the technical mechanisms informing this function remain elusive to both researchers and society at large, we were able to inspect the results that the platform provides to users searching for early literacy apps. Using stand-in measures, we were able to confirm that these mechanisms follow "popularity" and user-perceived "quality" to at least some degree, even if other contextual and time-sensitive factors certainly play a role. The fact that we cannot say much more than that without access to additional data points highlights the problematic opacity of algorithmic systems that play critical cultural roles in areas as important as early childhood education. It remains to be seen whether the European Union's *Digital Services Act* [21], which promises to strengthen researchers' access to data on "very large online platforms," including both of the leading app stores, will be able to improve this situation.

Comparing search results over time, we detected only a limited level of variation, with the effect that visibility opportunities are scarce, especially within the first 25 positions. Returning to our pilot study confirmed that rankings remain rather stable, even over the span of a year. This stability leads to a small group of apps dominating across the five search terms, corroborating Shuler, *et al.'s* (2012) pioneering study, which anticipated that "[g]eneral early learning apps for toddler/preschool children may become a saturated market and could become difficult for new developers to enter" [22]. Even a sector such as preschool apps is not exempt from the broader socio-technical changes brought about by platformization and its "winner-take-all" tendencies (Nieborg and Poell, 2018).

Furthermore, the first positions were predominantly held by older apps, suggesting the presence of the Matthew effect. The cumulative advantage older apps are able to harness was recognized in industry reports as early as 2015, pointing to the challenges newer apps face when trying to gain visibility in listings dominated by well-established incumbents (Lotan, 2015). The few newer apps we found then shared two crucial characteristics: they were either published by a renowned developer or belonged to an app family. From a researcher's perspective, the emergence of such app families complicates the study of app performance as research designs may have to consider "collective" success rather than the trajectory of single titles.

Our analysis then revealed a substantial disparity between algorithmic rankings and Apple's editor-curated list for literacy apps. Over half of the apps on that list did not make it into the search results, and their popularity was, on average, three times lower. The (commercial) success of preschool apps depends on how well they are able to deal with the "threat of invisibility" (Bucher, 2012). Looking at the low number of ratings for several apps on the editorial list (Table 1), fairing badly in Search clearly reduces the chances of being discovered and downloaded, regardless of pedagogical quality or developmentally appropriate content. These apps remain hidden as "zombies" until caregivers search for them through their exact name, scroll below the top 25 search results, read about them on third-party Web sites, or explore the Kids' sub-page.

The proliferation of ASO practices within can be seen as a symptom of both the importance of ranking and the highly competitive market conditions in this popular genre of educational apps. While previous work on children's software has demonstrated that the design and marketing of educational software have traditionally focused on meeting parental expectations of academic achievement and learning (Ito, 2009), app makers now leverage these expectations to make their products visible to caregivers. Terms such as " learning," "reading," and "children" are sprinkled over metadata fields to anticipate popular search terms and signal educational value. This mirrors, to a degree, the promotional strategies already employed by publishers to market educational content for home use. Buckingham and Scanlon (2005) indeed observed that educational publishers capitalized on the increasing emphasis on parental involvement in children's learning and development and the marketing of home computers as "symbols" of good parenting by providing additional resources such as books, magazines, CD-ROMs, and Web sites. Our examination of

ASO tactics suggests that app developers of early literacy apps have adapted the neoliberal exploitation of parents' anxieties about their children's futures to the App Store recommendation systems. The responsibility to discern the educational value of these apps again remains on the caregivers, who must navigate this promotional discourse, which is also present in app descriptions for preschool apps (Holloway, *et al.*, 2021).

While we cannot truly ascertain that ASO tactics actually "work," we indeed found that they are widely applied, at least in our sample of popular literacy apps. If practices like keyword stuffing are probably unavoidable and ultimately relatively benign, using language flags to add keyword space is already more problematic, as it creates false expectations. The presence of hardly changed apps covering different genres or keywords and other forms of "design spam" points toward the mass production of "low-cost" apps and a potential drop in quality due to a lack of specialized knowledge, as observed in research regarding apps targeting early literacy. This finding also echoes Bishop's (2019) observations that platform risk management "often results in the reproduction of a small pool of stereotyped and generic content" [23].

While legal frameworks like COPPA (the U.S.'s Children's Online Privacy Protection Act) and GDPR (the EU's General Data Protection Regulation) are put in place to protect children's privacy, media policy should not overlook the role of recommendation systems in shaping the preschool app market and its promotional strategies. Following Banet-Wieser's (2013) critique of rankings in higher education, it is essential to consider what rankings and user feedback might *replace*. Concerning our study, an app's popularity informs an app's discoverability and visibility, favoring those able to adapt to the App Store's algorithmic ordering practices. Metrics such as user ratings and download numbers also play a role in the promotional discourse of early literacy apps, with the number of downloads and users often used as indicators of *educational* quality.

A final point to raise is the almost universal implementation of free-to-play pricing strategies in the apps in our sample, which follows the overall trend in the sector (Nieborg, *et al.*, 2020). This results in educational apps with limited features and frequent exposure to promotional messages, ultimately commercializing children's play (Grimes, 2015) and their earliest educational experiences.

6. Conclusion

In recent years, the rise of touchscreen devices and the consequent proliferation of software products aimed at children have led to an unprecedented and challenging situation, dubbed by researchers as the "Wild West" of educational apps (Guernsey, *et al.*, 2012; Hirsh-Pasek, *et al.*, 2015). While most education research has focused on assessing their quality and impact on learning, we took a different direction by situating the study of these apps in a broader socio-technical context. As such, this paper addressed their distribution and visibility against the backdrop of "platformization" (Helmond, 2015; Nieborg and Poell, 2018) and algorithmic systems' central role in app stores.

It is essential to acknowledge the limitations of our study, which focused solely on data collected from the U.S. version of Apple's App Store and covers a short timeframe. Additionally, our approach based on digital methods only captures the outcomes of dynamic ranking negotiations and could be complemented, for example, with developer interviews to better understand the complex forces at play. Nevertheless, we argue that these outcomes provide a valuable entry point for the study of the educational landscape and the social-technical infrastructures that it relies on.

These limitations create opportunities for future research in the form of cross-platform and cross-regional studies, especially given the widespread presence and regional dominance of Android-operated tablets. Furthermore, coupling our approach with a deeper analysis of the most visible content would allow for a more substantial assessment of the potential pedagogical effects of existing ranking and recommendation logics. Our relatively short examination of ASO tactics also points to an increased “industrialization” of software production in the educational sector, with a limited number of developers dominating the space, possibly due to their capacity to adapt to the App Store’s visibility management. This observation calls for further research on educational app families, their business trajectories, and the evolution of their production models.

Overall, our study demonstrates that access to educational software is contingent on algorithmic systems and the “ranking cultures” that emerge around them. Within this configuration, app stores set the ground rules, users search and click, and app developers compete for visibility. Besides claiming to improve users’ experience, the mechanisms used to match participants and govern the app ecosystem (also) serve business interests. Whether the aim is to sell hardware, build user loyalty, or increase profit margins from transaction fees, these business interests might not always coincide with the public interest. As van Dijck (2020) argued, “[p]latformization is overwhelmingly driven by commercial interests which often take precedence over societal values” [24].

This also suggests that the metaphor of the “Wild West” is only appropriate if we consider that the educational app landscape has been “colonized” along two main lines: on the one side, algorithmic systems regulate visibility negotiations in ways that structure outcomes to benefit the platform company; on the other side, due to cumulative advantage, app developers have been able to “homestead” the visibility real estate they gained early on. The question, then, is how researchers from fields such as education research and platform studies can use their growing understanding of these developments to promote the distribution of apps for children that do not put commercial imperatives first.

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Notes

1. We capitalize App Store when speaking specifically about Apple’s app distribution platform.

2. Ito, 2009, p. 4.

3. Gillespie, 2010, p. 351.

4. Bogost and Montfort, 2009, p. 2.

5. Fagerjord, 2015, p. 100.

6. Striphas, 2015, p. 395.

7. Chun, 2020, p. 239.

8. Gillespie, 2014, p. 192.

9. Certeau, 2002, p. 36.

10. Petre, *et al.*, 2019, p. 1.

11. Bishop, 2020, p. 1.

12. Gillespie, 2018, p. 58.

13. Rieder, *et al.*, 2018, p. 52.

14. *Ibid.*

15. Dieter, *et al.*, 2019, p. 3.

16. Rieder, *et al.*, 2018, p. 54.

17. For some queries and data combinations, the API delivered fewer than 25 results.

18. Since we use a non-probabilistic purposive sampling approach that does not extrapolate to a full population, we do not calculate significance levels here.

19. Certeau, 2002, p. 36.

20. Poell, *et al.*, 2022, p. 102.

21. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/digital-services-act_en.

22. Shuler, *et al.*, 2012, p. 13.

23. Bishop, 2019, p. 2,592.

24. van Dijck, 2020, p. 2.

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