What are we downloading for our children?

Best-selling children's apps in four European countries

Burcu Sari

Zsofia Takacs

Adriana Bus

A revised draft with appear in Journal of Early Childhood Literacy

Abstract

The present article provides an overview of the best-selling apps for the age range of 0-8 years old under various categories, including ‘Kids’, ‘Books’, ‘Educational games’, ‘Family games’ and ‘Word games’ in the two major application stores (Google Play and iTunes App Store) in four economically diverse European countries: Hungary, Turkey, Greece and the Netherlands. As tablet usage seems to be a substantial part of children’s leisure activities and thus apps they use might have an important role in their development we conducted a content analysis to highlight two issues: the educational value of the most popular children’s apps and fine-tuning of the apps on the local culture and language of non-English speaking countries. There is a large overlap between the best-selling apps in the four countries, in fact, half of the apps appear among the most popular lists in more than one country. Consequently, most children’s apps do not include any oral language and, if so, they are not available in the local language. Furthermore, results show that a substantial part of the apps supported early literacy skills. In the majority of apps teaching literacy, although advertised for the youngest, the mode of instruction was more suited for school-aged children.

Keywords: Children’s Apps, Tablets, Educational Apps, Emergent Literacy, Content Analysis.

Introduction

The ownership of tablet computers among adults has grown from 3% to 45% since computer tablets were first introduced in 2010 in the United States (Anderson, 2015). Tablets have also started to find their ways into children's daily life more and more (Chiong & Shuler, 2010). Common Sense Media, a nonprofit organization dedicated to helping kids thrive in a world of media and technology, reports that 80% of the children aged 2 to 10 in the U.S. use educational media that are offered on TV and computer and mobile devices at least once a week, including about one-third of the children who use them daily (Rideout, 2014). According to the yearly Iene Miene Media report in the Netherlands, the ownership of tablets has grown till 65% of the households in 2015 (Statista, 2015) and children go digital at an increasingly younger age. In 2014, 70% of Dutch children up to age 7 were reported to often use tablets (Iene Miene Media, 2014). Tablet usage seems to be a substantial part of children's leisure activities and thus apps they use might have an important role in their development. At the same time, we have very little data regarding the language and content of those apps. Consequently, it is of high importance to assess apps children spend time with in order to make an educated guess of the impact tablet usage may have on children's development and advise developers, educators and policy makers. We expect similar growth in the three other target countries but reports about children's use of computer and mobile devices are not available for Greece, Turkey and Hungary.

Potential of apps as an educational activity

With more than one million apps available for IOS and Android devices and the vast majority in the Education category targeting children, it is of utmost importance to examine the type of content that young children are engaging with (Lauricella, Blackwell, & Wartella, 2017). Even though apps may provide an active, enjoyable and engaging context, the question is whether they attune to children's educational needs: Do popular apps offer opportunities to

foster children's emergent academic skills including language, literacy, numeracy and science? For playing a role in language development the minimum seems to be that they include oral language, preferably the local language of young children. There are, however, popular app series like Toca Boca that do not include any language. There is only nonverbal information in these apps probably in order to expand the market.

Furthermore, there is an abundance of studies indicating that young children show interest in academic skills and develop those skills through various voluntary activities in the preschool period (e.g., Duncan, Dowsett, Claessens et. al.,2007; Ferreiro & Teberosky, 1982; La Paro & Pianta, 2000). Parents and teachers read storybooks to children which improves their vocabulary and reading comprehension skills (Reference Withheld); they practice writing their names and other words which may contribute to letter knowledge and phonemic awareness (Reference Withheld); they count objects in the surroundings which may foster number skills (LeFevre et. al., 2009); and the like. Apps, if well-designed, may have the potential to elicit similar activities in the preschool period and give a boost to early literacy and numeracy skills. They may even have the potential to involve the child in these activities without any adult support because they provide guidance and feedback that is similar to adult scaffolding (Falloon, 2013; Reference Withheld; Reference Withheld).

In fact, technology, if well designed, may give an advantage to learning materials. Apps have the potential to include nonverbal information that may, if congruent with the verbal content, including a story, numbers or letters, facilitate learning, in accordance with the multimedia learning theory (Mayer, 2003). For instance, in a recent review, digitized storybooks with nonverbal representations of the story, in addition to the narration, were found more facilitative of story comprehension and word learning than traditional paper storybooks (Reference Withheld). However, unlike research on digitized picture storybooks, where studies have explored whether and how the multimedia additions of the e-books affect

young children's learning, only few studies have investigated other types or features of apps to test effects on children's learning (Lauricella et al., 2017).

The aim of the current study was testing the availability of apps as a substitute for the traditional playful activities that promote early skills in the language, literacy and mathematics domain. As a minimum, we propose that the majority of apps should expose young children to language, and preferably the local language, as one of the best predictors for academic success (Morgan, Farkas, Hillemeier, Hammer, & Maczuga, 2015). There are quite a few apps that enable activities like cutting, decorating, cooking dishes, or using make-up, designed to replicate aspects of children's free play on digital devices (Lauricella et al., 2017). Although many apps do not include any language they are promoted as "educational" in the online stores (e.g., Toca Boca apps). As reported on the official website of Toca Boca, these applications may improve "children's creativity" (Toca Boca n.d.). This and other app series are quite famous and rank high on the best-selling lists but the question arises: are they a substitute for traditional activities in early childhood like drawing, writing and dramatizing?

In line with findings by the Joan Ganz Cooney Society, we expect that a substantial part of apps (about 40%) will provide educational content related to basic academic skills and probably more to literacy than to math and science as children overall spend more time with literacy-related activities in daily life (Vaala, Ly, & Levine, 2015). However, whether findings from the American market apply to the European market is, so far, an unanswered question. We also wonder whether popular apps available in main stores include language, in particular the local language, thus promoting language skills as a critical aspect of preschool development. Many apps are promoted in more countries without localized content, which makes sense from a commercial point of view, in order to sell the same app in different countries without the costs of translation and localization. However, bringing out apps in a

way that they are sold in different countries may go at the expense of fine-tuning on the specific culture and the local language.

This study

The two major international online application stores, the App Store (iOS) and the Google Play Store (Android), offer increasingly more apps including games and electronic storybooks specifically designed for children (Guernsey, Levine, Chiong, & Severns, 2012). In every country it is possible to download all available apps in all languages but a partly different set of featured apps appears when you enter the store. The Aim of the present study was, apart from an inventory of the most popular available apps in four European countries, a test of overlap between the lists of the most popular children's apps across European countries and what the consequences are. When apps rank high on best-selling lists in different countries they may not include the local language, especially when the language area is small as is the case for the countries included in the present study. This trend is of high significance because, considering the amount of time that young children spend with mobile devices, this may be a missed opportunity for language development as compared to other activities (e.g. watching educational television).

The number of apps that is available in the local language may differ as a result of fine-tuning, which might be related to prosperity. This would be another illustration of the finding that the quality of educational materials differs, at the expense of children growing up in less wealthy circumstances (Putnam, 2015). In order to test this hypothesis, we compared lists of most popular children's apps in four European countries: Hungary, Turkey, Greece, and the Netherlands. Among the most popular apps in the Netherlands, the most prosperous country of the four, we may expect more apps in the local language than in the other countries.

In sum, in the present content analysis of the most popular children's applications in four European countries we aimed to answer the following questions:

(1) *Are apps available in the local language and more so in more prosperous countries?*

We hypothesized that there is a significant overlap between the best-selling apps in the different countries. Consequently, we expected that most of these apps were developed by international companies, and accordingly, the majority of apps do not include any oral language and/or are not available in the local language. This is of high significance as such a trend means that applications do not provide any stimulation in the local language, which is a serious issue for language development of children in the preschool age and for their emerging academic skills that are founded in language skills.

We expected more apps in the local language on the Dutch market as compared to the other three countries; GDP (Gross Domestic Products) per capita for Greece, Turkey and Hungary ranges between 20-26.000$, but is about twice as high in the Netherlands (World Bank, 2015).

(2) *To what extent do apps serve educational aims?*

In line with previous results regarding the U.S. market (Guernsey et. al., 2012), we expected that a substantial part of the best-selling apps will not serve purely entertainment for children but will have educational content. In so far apps are educational, they are expected to relate more often to literacy than to other academic skills and are mainly developed for children in the preschool age rather than for school-aged children.

Method

Sample of apps

Popular online stores offer apps for children under various categories. According to the scope of our study, we selected from the two main app stores categories that might include educational apps for children. In the iTunes App Store, we targeted: *Kids*, *Books*, *Education*, *Educational Games*, *Word Games* and *Family Games*. In the Google Play Store we focused on the categories *Books and References*, *Education*, *Family Games*, *Word Games* and *Educational Games*. We made a print screen of the top 50 best-selling paid and the top 50 most downloaded free apps in each category on the same day regarding the Dutch, the Turkish and the Hungarian markets (23rd March, 2015). The same procedure was applied with the best-selling lists in Greece, but about half a year later (16th January, 2016). In some cases, 2-5 apps were included in one package in the paid section of iTunes App Store as a bundle deal. We decided to include all these apps.

We focused on the top 50. The exact ranking in each category seems to change daily, but apps may stay for a longer period among the top 50. About a quarter of the apps were still on the best-selling lists one-and-half year after the first downloads. The number of same apps was for the Netherlands, Turkey and Hungary 22%, 30% and 25%, respectively (on 5th of December, 2016).

We excluded any apps that were not designed for children such as foreign language learning apps (e.g. *Duolingo*), word games, dictionaries, adult audio books, e-book readers, holy books (e.g. Bible, Quran), sky observation apps, topology apps, etc. When the same apps appeared in different categories we excluded duplicates. However, if the same app appeared in both stores, Android and iOS, both apps were included because the two versions are not necessarily the same. In the end, we analyzed 560 Dutch, 492 Hungarian, 532 Greek and 494 Turkish apps for children found in the Android and the iOS stores.

Coding

Each app was coded on the basis of the following dimensions:

1. **General Characteristics**

1.1.Overlap across countries: We coded for each app if it was unique on the best-selling list of the country or also appeared on the list of any of the other countries.

1.2. Device: We coded the app store where we found the app: iTunes (IOS) or the Google Play Store (Android).

1.3. Developer: We coded whether the company who developed the app was a local or an international developer.

1.4. Age range: We coded if the app was recommended in the app store for infants (0-3 years old), preschool/kindergarten (4-6 years old) or children in primary education (6-12 years old).

1.5.Price of the app: We coded the price of every paid application in Euros. In case it was part of a bundle we divided the price with the number of apps in the bundle.

2. **Oral language**

We coded whether the app contained any oral language (at least 5 words) or not.

2.1. Availability of oral language in the local language: We coded whether the apps that contained oral language used the local language or a foreign language.

3. **Educational content:** We coded whether the app included any content that was relevant for basic academic skills, that is, language and literacy, math or science. In any other cases we coded the app as entertaining. For example, quite some of the most popular apps was designed by the company Dr. Panda Ltd. In the apps in this series there is hardly any dialogue or narration. Instead, these apps offer nonverbal games such as driving, cooking, and decorating, which we did not code as educational. Other apps that we considered purely entertaining typically included dressing and make-up games,

activities like taking care of a pet or a baby, or decorating cakes or a room. These activities and games are not directly related to any basic academic areas like language and literacy or math and science skills.

3.1. Literacy content: We coded whether the educational content of the app was relevant for language and literacy development or not. We considered narrative stories in addition to games and activities identifying sounds or letter forms, teaching vocabulary and letter-sound relationships or practicing emergent writing as related to language and literacy.

3.1.1. Direct/indirect literacy content: We coded whether the literacy skills were trained directly (e.g. games with words, letters and the alphabet), indirectly by means of stories and nursery rhymes (Goodman, 1989) or a mix of the two approaches was utilized which meant that they included elements of both direct and indirect teaching. Finally, we included mixed approach apps into indirect apps because these apps typically had a focus on storytelling primarily and included some letter games, for instance, in addition to the stories.

Inter-coder agreement

The top 10 apps in all categories in the Dutch iTunes App Store were coded by two independent coders in order to calculate inter-coder reliability statistics. Coding these apps Cohen's kappa was satisfactory for all categories: ($k > 0.78$) whether the app was designed for children ($k = 0.97$), whether it was educational ($k = 0.78$), whether it was relevant for children's literacy development ($k = 0.82$), whether it instructed literacy skills in a direct or an indirect manner ($k = 0.78$), and whether the content of the app was available in the local language or only in another foreign language like English ($k = 1.0$). Findings were very similar for the three other countries where agreements between coders were also checked. All disagreements were settled by discussion between the two coders.

Results and Discussion

As shown in Table 1, there were similar numbers of apps on the best-selling lists that we coded as intended for children in the four countries: about five hundred in each country. Somewhat more than half of these children's apps (on average 55%) were found in the iTunes App Store. Most apps were advertised for the youngest age groups, that is, for infants and preschoolers and less so for school-aged children. This was similar in all four countries. Note must also be taken of that the app stores provided very large age ranges the apps were meant for, and consequently, applications were often suggested for children between, for instance, 0 and 5 years of age. For educational applications, this might be problematic as it is unlikely that what is educational for a toddler is also educational for a 5-year-old.

Fine-tuning on the local language and culture

Overall, only 43% of the children's applications included oral language. There was a significant effect of country (χ^2 (3) = 15.68, $p < .001$) with Hungary having the smallest percentage of applications including any oral language (36%) and Turkey the largest percentage (47%). On average, only 27% of the apps included oral language in the local language. Regarding local language speaking apps, there were significant differences between countries (χ^2 (3) = 56.81, $p < .001$). As expected, in the most prosperous country, the Netherlands, there were by far the most apps in the local language on the best-selling lists (50%) while in Hungary only 10% of the apps was in the local language. In the same vein, overall 10% of the apps was released by local developers and there were significant differences between countries (χ^2 (3) = 67.10, $p < .001$) with the most locally developed apps appearing on the Dutch best-selling lists (18%) and the least on the Hungarian list (5%).

As expected, there was a substantial overlap between the best-selling lists of the four countries: half of the children's apps appeared on the list of two or more countries as shown in Table 1. There was a significant effect of country on this variable (χ^2 (3) = 56.81, $p < .001$)

with the largest percentage of unique titles in Greece (56%) and the Netherlands (49%), as compared to 34% in Hungary and 41% in Turkey. As a consequence of substantial overlap, one might expect that apps that are intended for the market of more countries will either have no oral language or, in so far there is language, it is not in the local language.

In fact, we found evidence for these hypotheses. As shown in Table 2, there was no difference in the proportion of apps including oral language between overlapping and unique titles (χ^2 (1) = 0.45, p = .50). However, when only considering the apps that included oral language there were much more unique apps featuring the local oral language (85%) as compared to overlapping titles (15%), χ^2 (1) = 197.48, p < .001. In the same vein, more apps that were uniquely popular in one country were developed by a local developer (19%) as compared to overlapping titles (2%), χ^2 (1) = 177.30, p < .001. In other words, the unique apps, more often offered on the iOS platform than on Android, are more fine-tuned on the specific culture and the local language. It is tempting to attribute these differences between countries to differences between the countries' prosperity but these results might reflect either the preference of parents and educators (there are apps in the local language but those are not chosen), the availability of such applications (apps in the local language are not available) or both.

Apps serving emergent academic skills

Similar to the results of the American content analysis (Guernsey & Levine, 2015), 37% of the best-selling apps were categorized as educational regarding basic academic skills, meaning that 63% of the most popular apps were coded as purely entertaining. There were significant differences between countries (χ^2 (3) = 27.22, p < .001) with the largest percentage of educational apps appearing on the Dutch best-selling lists (45%) and the lowest percentage on the Hungarian list (30%). More educational apps were recommended for preschool-aged children (72%, n = 339) as compared to apps advised for school-aged children (n = 113). This

finding was similar for all four countries. Country-specific popular apps were more likely to be educational (45%) than overlapping apps on the best-selling lists of more than one country (31%), χ^2 (1) = 42.57, $p < .001$. It is important to note that whether the app was available in the local language and whether it was categorized as educational was highly confounded in all four countries (the Netherlands: χ^2 (1) = 26.19, $p < .001$, Hungary: χ^2 (1) = 10.33, $p < .001$, Greece: χ^2 (1) = 14.87, $p < .001$, Turkey: χ^2 (1) = 5.49, $p < .05$). Thus, 75-100% of the apps that were in the local language in the four countries were educational. This makes sense as letter sounds, and similar topics in educational apps, differ across countries.

When considering educational apps, about 72% of the apps were relevant for children's language and literacy development. There were, again, significant differences between the countries (χ^2 (3) = 23.57, $p < .001$) with the largest proportion of literacy-related apps in Greece (80%) and the smallest percentage in the Netherlands (64%). This also means that the largest proportion of math and science apps appeared on the Dutch best-selling lists. Within the category of literacy apps, 34% taught literacy skills in a direct manner. Most of these apps targeted teaching letters, spelling words, identifying phonemes in words, and the like. The rest of the literacy apps, included stories instead of or in addition to direct teaching of basic literacy skills. It is doubtful that direct practice of basic literacy skills (e.g. letter knowledge, phoneme awareness) matches the interest of children in preschool age.

There was a significant effect of country (χ^2 (3) = 25.29, $p < .001$), with the smallest percentage of apps directly teaching basic literacy skills on the Greek best-selling lists (19%) and the largest on the Dutch list (44%). It might be that there are less Greek apps because international literacy apps are not useful due to the Greek alphabet. The data support this hypothesis; overall 50% of the literacy apps were international, while in Greece only 23%.

Main conclusions and future directions

Overall, the results of this first inventory of popular apps are not very promising. One consequence of the huge overlap in popular apps across countries (55%) is that most apps are not designed by local developers, which may have serious consequences for the content. They may, for instance, not include local characters, typical visualizations and local language thus preserving cultural heritage and fostering children's developing language and literacy skills. In the current study, we tested whether the set of apps that is available in more than one country is less fine-tuned to children. We were particularly interested in the language: do apps make use of the local language? We found that the majority of apps that are on the lists of popular apps in more than one country and that include language are not available in the local language (75%). This is a serious issue particularly when we consider that children spend an, each year increasing amount of time with apps. The effect is stronger the less prosperous a country is. The trend of children's apps that do not contain any language might be explained by considering the ease of adaptation of the apps to other countries. Apps without any language can be easily offered in all the countries without the additional cost of translating the app. Although this makes sense from a commercial point of view, it is a loss from the educational perspective, as these apps provide no language input for young children. To illustrate this, in comparison, even television programming that is not educational or designed for children provides language stimulation for children.

About 30-40% of the popular apps are educational according to our definition: they practice skills that are related to emergent literacy, numeracy and science. This is not a change compared to the pre-computer era: Since the seminal work of Ferreiro and Teberosky (1982) we are aware that preschoolers spend substantial time on practicing academic skills. It is a reaction to the fact that adults are continuously modelling academic skills and children respond to that by showing interest in doing the same activities and making attempts to imitate. Purcell-Gates (1996), for instance, gives numerous examples of activities in the home

environment that include literacy skills and that contribute to emergent literacy. We do not yet know whether educational apps outweigh the benefits of traditional activities that relate to academic skills and what the long-term effects are when traditional activities are replaced by apps.

In line with Hisrich and Blanchard (2009), our findings suggest that few quality apps are available for emergent literacy skills. Activities promoted by educational apps often include assignments that are not age-appropriate. Many apps advertised to preschoolers utilize direct teaching, for instance letter training by making children click on the letter that matches the name, while it is doubtful that this kind of practice matches the interest of children in that age range. According to emergent literacy research children in this age range do show interest in reading and writing, however, in a different way. From the research, it can be derived that when, for instance, they make attempts to write they are more interested in "drawing" writing: they often produce writing-like scribbles or strings of pseudo letters and they mix writing with drawing (Reference Withheld). More in-depth content analysis is needed to test whether apps reflect such interests. However, from what we have seen it is our impression that among the popular educational apps there are no apps promoting this kind of age-appropriate writing and reading activities. Note that computer programs like Kid Pix that came out in the 1980s to elicit writing and reading activities by young children are no longer available (see Labbo, 1996). It is more common to practice school-like subskills of reading and writing as in the school curriculum. The echoes of thirty years of research into emergent literacy and numeracy raise the need of developmentally appropriate assignments. However, these echoes do not seem to reach the domain of educational apps maybe because the development of apps is the exclusive domain of computer experts and designers and does not include educators or educational experts. This might provide an explanation for previous findings showing an ambiguous effect of tablet use on children's emergent literacy skills (Neumann, 2014).

In sum. Our findings align with what Guernsey and colleagues (2012) describe as the "fast evolving and chaotic Wild West of digital apps" and we gave some explanations for this. Many apps are developed without oral language probably to expand the market for the apps. As a result of that, about 60% of all apps do not include any oral language and, if they include oral language, they are not available in the local language, while language input is abundantly available in most alternative activities of children in early childhood. Another trend is that many popular apps targeting educational issues are recommended for a much too broad age range between 0 and 5 years. Many apps offer direct training of basic literacy skills of phonics/word recognition and letters/sounds – all activities that are not developmentally appropriate for the youngest children between 0 and 4 years of age. The advantage of apps is that they are cheap and easily accessible, also for children growing up in less wealthy circumstances but, unfortunately, the quality of educational materials is mostly not satisfying, at the expense of these children most in need of stimulating materials.

Limitations

The long lists of best-selling or most downloaded apps indicate how popular apps are. The exact ranking seems to change daily. However, after several attempts we could not figure out how the best-selling lists are constructed and which underlying parameters are considered. For instance, it is not known exactly how many downloads are behind the rankings. Furthermore, the ranking might change the exact time when someone downloads an app or ranking is based on daily or weekly data. Additionally, the high overlap between countries might be a result of how the lists are constructed: it might be that it is not only the local sales that affect the ranking on the best-selling lists. Also, we do not know how the lists relate to what is available in the stores. There may be few popular apps in the local language because these apps are not selected or they may not be available. The low percentage of apps with educational content could be both a result of availability and/or preference of parents and

educators. As reported in the study, 72 % of the apps are suggested for the children between 0 - 6 years old. However, for 51 % of the apps no recommendation regarding the age of audience was available. Lastly, the download of the Greek list was not done at the same time as the other downloads which probably resulted in an underestimation of overlap between the best-selling lists of Greece and the other countries.

References

Anderson, M. (2015, October 29). *Technology Device Ownership: 2015*. Pew Internet & American Life Project. http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/. Accessed 25 August 2016.

Chiong, C., & Shuler, C. (2010). Learning: Is there an app for that? Investigations of young children's usage and learning with mobile devices and apps. New York: The Joan Ganz Cooney Center at Sesame Workshop. http://pbskids.org/read/files/cooney_learning_apps.pdf. Accessed 25 August 2016.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., & Sexton, H. (2007). School readiness and later achievement. *Developmental Psychology*, *43*, 1428. doi: 10.1037/0012-1649.43.6.1428

Falloon G. (2013). Young students using iPads: app design and content influences on their learning pathways. *Computers & Education,* 68, 505–521. doi:10.1016/j.compedu.2013.06.006

Ferreiro, E., & Teberosky, A. (1982). *Literacy before schooling*. Portsmouth: Heinemann Educational Books Inc.

Goodman, K. S. (1989). Whole-language research: Foundations and development. *The Elementary School Journal*, 207-221.

Guernsey, L., Levine, M., Chiong, C., & Severns, M. (2012). *Pioneering literacy in the digital wild west: Empowering parents and educators.* New York: The Joan Ganz Cooney Center at Sesame Workshop. http://gradelevelreading.net/wp-content/uploads/2012/12/GLR_TechnologyGuide_final.pdf. Accessed 25 August 2016.

Guernsey, L. & Levine, M. H. (2015). *Tap, click, read growing readers in a world of screens*. San Francisco, CA: Joses-Bass.

Hirsrich, K., & Blanchard, J. (2009). Digital media and emergent literacy. *Computers in the school, 26,* 240-255. doi: 10.1080/07380560903360160

Iene Meine Media. (2014). *Een onderzoek naar mediagebruik door kleine kinderen*. Resource Document. Iene Meine Media. http://www.mediawijzer.net/wp-content/uploads/iene_miene_media_2014.pdf. Accessed 25 August 2016.

Labbo, L. (1996). A semiotic analysis of young children's symbol making in a classroom computer center. *Reading Research Quarterly, 31*(4), 356-385. doi:10.1598/RRQ.31.4.2

La Paro, K. M., & Pianta, R. C. (2000). Predicting children's competence in the early school years: A meta-analytic review. *Review of Educational Research, 70,* 443-484. doi: 10.3102/00346543070004443

Lauricella, A.R., Blackwell, C.K., & Wartella, E. (2017). The "new" technology environment: The role of content and context on learning and development from mobile media. In R. Barr & D. Nichols Linebarger (Eds.), *Media exposure during infancy and early childhood* (pp. 1-23). Cham, Switzerland: Springer.

LeFevre, J. A., Skwarchuk, S. L., Smith-Chant, B. L., Fast, L., Kamawar, D., & Bisanz, J. (2009). Home numeracy experiences and children's math performance in the early school years. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement, 41*, 55-66. doi:0.1037/a0014532

Morgan, P. L., Farkas, G., Hillemeier, M. M., Hammer, C. S. & Maczuga, S. (2015). 24-Month-Old Children with Larger Oral Vocabularies Display Greater Academic and Behavioral Functioning at Kindergarten Entry. Child Development, 86(5), 1351-1370. doi: 10.1111/cdev.12398

Neumann, M. M. (2014). An examination of touch screen tablets and emergent literacy in Australian pre-school children. *Australian Journal of Education*, Vol 58, 2, 109 - 122doi:0004944114523368.

Purcell-Gates, V. (1996). Stories, coupons, and the TV Guide: Relationships between home literacy experiences and emergent literacy knowledge. *Reading Research Quarterly, 31*, 406-428. doi:10.1598/RRQ.31.4.4

Putnam R. (2015). *Our Kids. The American Dream in Crisis*. New York, NY: Simon & Schuster Publisher.

Rideout, V. J. (2014). *Learning at home: Families' educational media use in America. A report of the Families and Media Project*. The Joan Ganz Cooney Center at Sesame Workshop. http://www.joanganzcooneycenter.org/wp-content/uploads/2014/01/jgcc_learningathome.pdf. Accessed 25 August 2016.

Statista, (2015). Share of internet users who owned a tablet in the Netherlands as of June 2014 and June 2015. https://www.statista.com/statistics/451498/tablet-penetration-in-the-netherlands/ Accessed 25 August 2016.

Toca Boca, (n.d.). Toca Boca: a new way to play. Toca Boca. https://tocaboca.com/. Accessed 25 August 2016.

Vaala, S., Ly, A., & Levine, M.H. (2015) *Getting a read on the app stores: A market scan and analysis of children's literacy apps*. The Joan Ganz Cooney Center at Sesame Workshop. http://www.joanganzcooneycenter.org/wp-content/uploads/2015/12/jgcc_gettingaread.pdf. Accessed 25 August 2016.

World Bank, (2015). GPD per capita. http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD. Accessed 25 August 2016.

Tables

Table 1. Descriptives of the characteristics of the most popular children's apps in the four countries.

	Overall	Netherlands	Hungary	Greece	Turkey
Total number of apps	2078	560	492	532	494
Device					
Apple (iOS)	55.15% (49.75)	55.54% (49.74)	56.10% (49.68)	56.77% (49.59)	52.02% (50.01)
Target Audience					
Infants (0-3 years old)	71.54% (45.14)	74.83% (43.48)	73.47% (44.26)	68.32% (46.61)	69.82% (45.99)
Preschool Age (4-6 years old)	71.64% (45.10)	74.83% (43.48)	73.47% (44.26)	68.70% (46.46)	69.82% (45.99)
Primary School Age (6-12 years old)	51.72% (49.10)	49.30% (50.08)	42.86% (49.61)	57.63% (49.51)	54.91% (49.84)
Percentage of unique titles	45.43% (49.80)	49.46% (50.04)	33.94% (47.40)	55.83% (49.71)	41.09% (49.25)
Created by local developer	9.67% (29.55)	18.21% (38.63)	5.08% (21.98)	7.14% (25.78)	8.10% (27.31)
Language					
Percentage of apps including oral	42.77%	45.71%	35.57%	41.92%	46.76%

language	(49.68)	(49.86)	(47.92)	(49.39)	(49.95)
Percentage of apps including oral language in the local language	24.80% (43.21)	50.39% (50.10)	9.71% (29.70)	15.21% (35.99)	16.88% (37.54)
Content					
Percentage of apps that are considered educational	37.48% (48.41)	44.64% (49.76)	29.67% (45.73)	39.47% (48.93)	35.02% (47.75)
Percentage of educational apps that are considered educational for language and literacy development	71.81% (45.02)	64.00% (48.10)	76.71% (42.41)	77.88% (41.60)	71.68% (45.19)
Percentage of educational apps that targeted language and literacy skills directly (e.g., letter training)	33.51% (47.25)	43.75% (49.76)	38.39% (48.85)	18.52% (38.97)	35.48% (48.04)
Average price of the paid applications (in euros)	2.51 (1.33)	2.59 (1.26)	2.54 (1.38)	2.79 (1.49)	2.07 (1.05)

Table 2. Differences between apps that are unique titles for one country and apps that are on the best-selling lists in two or more countries

	Unique	Overlapping	Difference
	M (SD)	*M* (SD)	(χ^2)
From iTunes App Store	63.88% (48.06)	47.88% (49.77)	53.27*
Local Developer	19.19% (39.39)	1.77% (13.20)	177.30*
With Educational content	45.12% (49.79)	31.14 (46.33)	42.57*
Oral language	41.87% (49.36)	43.52% (49.96)	0.20
Local Language	47.31% (49.99)	6.76% (25.14)	191.41*
Price	2.37 (1.41)	2.59 (1.27)	331.66*

Note. * $p < .01$.