Mobile games and science learning: A comparative study of 4 and 5 years old playing the game Angry Birds

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Title:

Mobile Games and Science Learning: A Comparative Study of 4 and 5 years old Playing the Game Angry Birds

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Biography:

Dr Christothea Herodotou is a Lecturer in Innovating Pedagogy at The Open University, UK. She is interested in the design and use of innovative technologies, in particular web-based technologies, digital games and mobile applications for learning and their relationship to human motivation and cognition. She is also particularly interested in how learning analytics can inform our understanding of the use of technologies and improve the learning experience. She has recently received funding from the British Educational Research Association (BERA) to examine the learning impact of mobile applications on young children under the BERA BJET Fellowship.

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Structured practitioner notes

What is already known about this topic

· Mobile apps are increasingly popular amongst young children.

· Apps for young children prevail other educational apps online.

. Our understanding of the impact of apps on young children's learning is limited.

What this paper adds

· Knowledge about how game apps affect science understanding.

· Knowledge about learning and gaming differences between 4 and 5 years old.

· Knowledge about how preconceptions about projectile motion modify after playing a game app.

Implications for practice and/or policy

· Developmental differences should be considered when choosing apps for preschoolers.

· Game apps might be more effective when accompanied by appropriate scaffolding.

· Mobile apps should be tested with young children to account for preconceptions prevalent in early years.

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Abstract

A popular activity amongst young children is the use of mobile devices and apps. Yet, their impact on learning and development is rather underexplored. The limited studies identified explore effects on literacy development and communication and reports on mixed findings. A considerable gap is observed as to how the use of mobile apps relates to young children's understanding in diverse domains including science learning, and to extend, whether and how mobile apps should be used and how in early years' settings. The aim of this paper is to shed light on this area by examining the learning effects of touch screen mobile game applications, in particular the game Angry Birds, on two groups of preschoolers 4 and 5 years old respectively. Evidence from a comparative study with 32 participants reveal significant differences between the two groups in terms of game skills and understanding of projectile motion. Implications for educational stakeholders, parents and app designers are discussed along with future research directions.

Keywords: mobile games; mobile applications; preschoolers; science learning; projectile motion.

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Children are naturally involved in play, a process which facilitates mental growth and promotes positive development (Piaget, 1957). Mobile technologies allow for modern forms of play, including the use of mobile game applications (apps) hosted on interactive screen media such as smartphones and tablets. Recent demographic analysis points to 39% of 2-4 years old to have used a smart device in the US (iPad or iPod) (MDG Advertising, 2012) and 40% of the 3-4 years old to have made use of a tablet computer at home in the UK (OfCom, 2014). Mobile devices may hold the potential to raise barriers in relation to access to technology and the internet; 97% of children from low-income families make use of a mobile device and 75% of 4 years old own such a device (Kabali et al., 2015). The design of mobile apps targeting young children has been the focus of interest of educational app designers with 72% of educational apps online aiming at preschoolers and toddlers (Shuler, Levine, & Ree, 2012).

Yet, despite the apps' growth and popularity amongst young children, limited studies have examined their effects on learning, raising an urgent need for further research in the field (e.g., Kabali et al., 2015). These studies explored the effects of mobile apps mainly on literacy development (e.g., Ihmeideh, 2014), peer communication and engagement (e.g., Miller, Robertson, Hudson, Shimi, 2012), with mixed findings as to which applications and how should be used by young children. Understanding the impacts of apps on learning and development is essential in multiple respects. First, it contributes to knowledge development and existing theorizations about the role of technologies on learning and social and emotional growth. Second, it provides insights to educational stakeholders, as to whether and how mobile apps should be integrated and used in early years' curricula and parents, as to which

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apps to select and use with their children. At the moment, there are no specific recommendations about the use of mobile devices for learning (e.g., Neumann & Neumann, 2014) and the use of rote-learning applications is becoming the current state of the art (Herold, 2015). Lastly, it contributes to withstanding controversies as to whether mobile devices are good or bad for the development of young children; organizations such as the American Academy of Pediatrics (2016) discourages any time interacting with media screen other than video chatting for children younger than 18 months old and advices for shared use between parents and children. Yet, ICT experiences in early years might be crucial to set the foundations for ICT efficiency in later years (Siraj-Blatchford & Siraj-Blatchford, 2000).

This study aims to shed light on our understanding of the impact of mobile apps on young children by examining the learning effects of a specific mobile game application, Angry Birds (www.angrybirds.com), on the science learning and understanding of two groups children, 4 and 5 years old. Few studies have examined the use of mobile games by preschoolers. Mccarthy, Li, and Tiu (2013) reported a positive impact on maths comprehension after using a mobile game specifically designed for maths learning. The early mathematic skills of preschoolers were improved after playing the game at home with the support of their parents. Young children from low income families managed to outperform their peers in a maths test indicating that early exposure to digital games and support from parents may have a positive impact on maths preparation and school readiness. Yet, other studies point to inequalities in mobile usage and skills and engagement of disadvantaged children with less beneficial online activities strengthening existing inequalities and digital exclusion (Mascheroni & Ólafsson, 2016). In another study, Miller et al. (2012) used the commercial simulation game Nintendogs with 74, 5-6 years old in classroom conditions and reported improvements in children's knowledge about pets especially when mediated by

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appropriate pedagogical approaches. Finally, Ryokai, Farzin, Kaltman, and Niemeyer (2013) designed a mobile game for examining the object tracking performance of 31, 3-5 year olds, that is, the ability to focus on relevant visual information and ignore irrelevant stimuli preventing sensory overload. Findings revealed that mobile games are suitable for measuring object tracking performance away from the research laboratory. Yet, more research is needed to identify whether the game might enhance object tracking abilities.

Angry Birds and Science Learning

Developed in 2009 by a Finnish company, Angry Birds was deemed as a suitable research arena due to its popularity across mobile games; it is the most downloaded free game of all ages at the moment. In addition, it has recently attracted the interest of educators; the 'Angry Birds Playground' is an innovative early years' curriculum designed by the University of Helsinki and the game designer company with the aim to bring fun and creativity into learning in preschool years by blending free play, books, teachers and digital devices (see www.funlearning.com/angry-birds-playground/).

The aim of the game is simple; users throw birds against pigs with the help of a slingshot. It is comprised of different versions each one consisting of various levels. Leveling up unlocks new levels. Angry Birds supports learning of basic physics principles such as speed and velocity, making observations, and hypothesis testing (See official description https://play.google.com/store/apps/details?id=com.rovio.angrybirds&hl=en_GB. Users interact with the properties and applications of projectile motion, that is, the movement of an object into two dimensions both horizontally and vertically at the same time. Playing the game requires scientific thinking evidenced in experimenting with how the slingshot works and identification of cause and effect relationships such as how the angle of the slingshot might affect the pathway and landing position of the birds.

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To the best of author's knowledge, no scientific studies have been identified examining the impact of mobile apps including mobile games on preschoolers' science learning and understanding. The use of such tools, if proved to be beneficial, would be particularly useful in early years' science education. Engagement with science is a thorny issue within the field of education in general. Significant levels of disengagement and lack of achievement are observed in relation to Science, Technology, Engineering and Maths (STEM) in formal education (Tapscott, 2012). In early years, science teaching is relatively underemphasized despite the critical role of early exposure to science experiences for increasing comfort, engagement and long-term achievement later in school life, especially for preschoolers from disadvantaged backgrounds (Greenfield, Dominguez, Greenberg, Fuccillo, & Maier, 2011). The importance of early exposure to positive learning experiences has been stressed in a number of initiatives targeting kindergarten science education (e.g., Brenneman, 2011) and school readiness (William, Gormley, Phillips, & Gayer., 2008). School readiness in science allows for experimentation and exploration that can extend the boundaries of learning within which children are learning leading to the acquisition of more complex skills (Bowman, Donovan, & Burns, 2001). In particular for children from disadvantaged backgrounds, early science learning experiences are critical for school readiness and future learning, as they can impact long-term educational and societal outcomes (Barnett, 2008).

Furthermore, little is known about the effective teaching of science topics in preschool years given the fact that educators are less interested in supporting learning in those domains as opposed to other domains such as literacy and numeracy (e.g., Greenfield et al., 2011). Preparing preschoolers for science lags behind other domains raising the need for high-quality science education which can set the foundations for science understanding and

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interest reinforcing language, literacy, and math readiness skills in authentic ways (Gerde, Schachter, & Wasik, 2013).

Aim, Research Questions and Rationale

The aim of this study is to capture and analyse the interactions of 4 and 5 years old with the game Angry Birds and report on their impact on science learning and development. Angry Birds is labelled as suitable for all ages yet, given the developmental differences amongst preschoolers, it was deemed important to examine whether such games are beneficial or not across different preschool ages and whether special attention should be given in testing these games with specific ages and labelling them as appropriate accordingly. Through a comparative study of two groups of children (group 1: 5 years old; group 2: 4 years old), it aims to answer the following research questions (RQs):

RQ1: What are young children's preconceptions about projectile motion?
RQ2: How do young children's age and general performance relate to playing the game?
RQ3: How does playing the game affect scientific thinking about projectile motion?

Preschool children present basic abilities to engage in scientific thinking that is, reasoning to evaluate evidence and understand experimentation in simple tasks. Preschoolers' scientific reasoning skills appear in the age of 4 in the form of evaluating evidence and understanding experimentation in simple tasks. Sobel, Tenenbaum, and Gopnik (2004) demonstrated that children's causal inferences cannot be explained by mere recognitions of associations amongst events similar to classical conditioning (conditioned versus unconditioned stimuli) and/or a calculation of their associative strength (associative strength is translated into causal strength). Rather, causal relationships were explained through probabilistic reasoning by taking into account how the prior probability of the outcome might inform observed data. Sobel et al. concluded that despite the children's inability to explicitly

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reason about probabilities, they can use probabilistic information to infer causal relationships. By the age of 5 and 6, they can successfully infer causal relationships between variables in the lack of evidence (Piekny, Grube, & Maehler, 2013) in areas such as folk physics (Baillargeon, Kotovsky, & Needham, 1995).

Children start using causal language to describe force relations by the age of 4 which, however, supplement with gestures to form complete causal sentences (Göksun, George, Hirsh-Pasek, & Golinkoff, 2013). The understanding of simple causes precedes the development of causal language. Göksun et al. examined whether children are able to combine multiple forces and process events in terms of force dynamics before productive talk about causal relationships. Results revealed the children's ability to correctly judge the direction and end point of a single-force trial indicating that children before the age of 5 focus on a single direction when predicting the direction of the movement of objects while after 5 they begin considering secondary dimensions (e.g., gravity and inertia, force dynamics).

This line of research suggests that there are substantial differences in scientific thinking skills and understanding of force dynamics between preschool age children in particular 4 and 5 years old which should be taken into account when examining the effects of mobile technologies on preschool age children. Considering this cognitive variation, this study accounted for the age and scientific capabilities of children and made the following hypothesis:

Hypothesis 1: There will be significant differences between 4 and 5 years old in their understanding of projectile motion after playing the game for a period of time.

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Children tend to form intuitive theories based on experiential thinking often incorporating a number of misconceptions in their theories. Everyday explanations such as direct observations of phenomena and fragmented stories from adults are prevalent in preschool and affect the interpretation of new information and the development of scientific thinking (Kikas, 2010). Theory-based explanations and misconceptions fade out as children grow older due to executive control over thinking (Gropen, Clark-Chiarelli, Hoisington, & Ehrlich, 2011). Preschoolers have misconceptions about objects' trajectories when more than one causal force are combined. Children (mean age 5) when asked to predict the path of a rolling ball off a table predicted a straight rather than a parabolic line (Hood, 1995). One exemption to this misconception was the preschoolers' ability to predict a straight path as the right path of a ball exiting a curved tube - an understanding that changed when entering primary school (predicted to be a curved path) (Kaiser, McCloskey, & Proffitt, 1986). Children can correctly predict where a ball that rolled off a slanted ramp will be landed at the age of 5-6 indicating a conceptual understanding of the notion of inertia on projectile motion (Kim & Spelke, 1999). Following the above line of research, the following hypothesis is made:

Hypothesis 2: There will be significant differences between 4 and 5 years old in their preconceptions about projectile motion prior to playing the game.

A discrepancy is identified between intuitive knowledge about projectile motion in action and knowledge expressed in explicit judgements (Bertamini, Spooner, & Hecht, 2004). In a number of experiments, Krist et al. (1993) compared intuitive knowledge about projectile motion in action (the motion of an object as influenced by gravity) with knowledge expressed in explicit judgements in 5-6 years old and adults. In the action condition, participants

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propelled a tennis ball from a wooden board with adjustable height towards a target on the ground. Distance from target and height of board varied in between trials. In the judgement condition, a speedometerlike rating scale was used to estimate the optimal speed for different height-distance combinations. The majority of preschoolers took into account one dimension only. The integration of both dimensions when calculating optimal speed was found to increase with age. On the contrary, in the action condition, preschoolers achieved similar results as fourth graders and adults when throwing the ball to the target accounting for both the height and distance as affecting optimal speed.

Hypothesis 3: There will be significant differences between 4 and 5 years old in knowledge about projectile motion in action as measured by gaming performance after playing the game for a period of time.

Children from disadvantaged backgrounds are individuals whose personal or social circumstances such as gender, ethnic origin, or family background may comprise obstacles to 'achieving educational potential (fairness)' (OECD, 2012, p.2). These children are at a higher risk of facing school problems including, learning difficulties and high dropout rates (OECD, 2012). Preschool educational experiences are crucial for disadvantaged children as they can affect their cognitive and socio-emotional development and potentially impact 'longer-term educational, employment and wider social outcomes' including better cognitive and socio behavioural outcomes and lasting effects in early years at school (Sylva, 2010). Technology instruction interventions might be promising in bridging the socioeconomic gap. For example, computer materials were found to improve phonological awareness, word recognition, and letter naming skills for 5-6 years old children at risk compared to printed materials given to their peers (Mioduser, Tur-Kaspa, & Leitner, 2000). Curriculum policy

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makers consider ICT experiences in early years as important for setting the foundations for ICT efficiency in later years (Siraj-Blatchford & Siraj-Blatchford, 2000). The educational potential of participating children was examined in this study to identify whether mobile learning can support better children with low performance.

Hypothesis 4: There will be significant differences between high and low performing children in understanding projectile motion after playing the game for a period of time.

Methodology

Sample

Children aged 4 and 5 years old from two preschools in England took part in the study. Consent forms from parents were received from 32 children. Each child played the game for approx. 8 minutes for a maximum duration of 7 days. The mean time of overall gameplay per child was 50 minutes (M=50.5, SD= 14.49).

Methods of Data Collection

Data were collected from: a) A pre/post learning task designed to examine children's knowledge about projectile motion before and after playing the game. It consisted of two activities. The first activity examined how the angle of a slingshot affects the pathway and landing position of a ball and the second one how force affects motion and landing position. Children were asked to draw the pathway and landing position of a ball in five different pictures (5 questions). b) Questionnaire with demographics and game preferences: A number of questions about demographics (age, gender) and previous experience of using tablets and playing mobile games were asked to each child before the enactment of the intervention and answers were noted down. c) Screen-recordings: Children's gameplay was recorded using a screen recording software providing information about the number of levels completed by

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each child and the score achieved. d) Children's general performance as assessed by classroom teachers in a scale of 0 to 10.

Process of Data Collection

To ensure that children have a basic understanding of what a slingshot is and how it works, a plastic slingshot (toy) was shown to them and demonstrated how it works by pulling the sling and throwing away some soft balls. Any teaching or reference to concepts related to projectile motion was avoided to eliminate any effects on children's understanding. Prior to playing the game, preschoolers completed the pre-test. The author explained what each picture was showing and what it was asked from them to do. Children were divided into groups of five and given one tablet each with the game Angry Bird. Tablets were used in offline mode, therefore no geo-located or other information could be collected from children while in-app ads were disabled. Children played the game for up to seven days. The last day of the intervention, they played the game and then completed the post-tests.

Process of Data Analysis

a) Pre-post tests were evaluated by two independent raters. Cohen's κ was run to determine the degree of inter-rater agreement in the two activities. There was good (range 0.61-0.80) agreement between the two raters as defined by the guidelines from Altman (1999), $\kappa = .750$ (N=170), $p < .0005$. b) Screen recordings (N=172) were analysed to identify each child's score per level per day and time playing the game per day.

Results

Eighteen participants (56.3%) were female and 14 participants (43.8%) male. The majority of them (56.3%) were 5 years old (M= 4.5, SD=.57). Almost all children reported to

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have a mobile device at home (90.6%) and 78.1% were found to make use of such devices at home. Angry birds was played for the first time during this study by the majority of children (62.5%) with the rest of the children playing the game occasionally. The mean general school performance as reported by teachers was 8.5/10 (M=8.5, SD=1.43).

Game Performance

Game scores in Day 2 and Day 7 were compared. Day 1 was treated as an introductory session and was excluded from the analysis. The mean time of gameplay in Day 2 was M=8.65, SD=1.21, and in Day 7 was M=9.27, SD=1.61. A paired sample t-test revealed statistically significant outcomes for the 5 years old suggesting improvements in gameplay by the end of the intervention (M=24.64, SD=21.31) (M=37.85, SD=19.91) (t=-3.3, df=10, p=.007). No significant results were observed for the 4 years old. These findings confirmed Hypothesis 3 indicating that older children's knowledge about projectile motion in action was improved after playing the game.

Pre/post-tests: Knowledge about Projectile Motion

Tests of normality indicated that data did not follow normal distribution, therefore the Wilcoxon Signed Ranks test was used to identify any changes between pre/post-tests. The analysis revealed significant differences in activity 2 in the group of 5 years old only (z=-2.88, p=.004; Mdnpre=9.25, Mdnpost=11). In terms of whether the pathway of the ball was correctly predicted as being a parabola, a statistically significant improvement in post-test ranks was observed for the 5 years old only (z=-1.99, p=.047) (Mdnpre=4, Mdnpost=4). These findings confirm Hypothesis 1 indicating that older children benefited more from

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playing the game as evidenced in their improved understanding of how projectile motion works.

Pre/post-tests: Preconceptions

To identify children' preconceptions about projectile motion, their responses to pre-tests were analysed. A 37.5% of children correctly predicted the pathway of the ball as a parabola in all or 4 of the questions while a 37.5% did not predict correctly any of the questions. Drawing the pathway as a parabola occurred in 45.7% of all responses, as a straight line 27.8%, as a pointy line 6.6 %, and as a curly line 14.6% (5.3% other) (see F1 supplementary material). After considering for age, the great majority of 5 years old was found to predict correctly most of the answers (activity 1: a=77.8%. b=72.2%, c=44.4%; activity 2: a=55.6%, b=72.2%) as opposed to the younger group of children. These findings confirm Hypothesis 2 and indicate a developmental trend in terms of children's intuitive understanding of force dynamics.

Pre/post-tests: General Performance

The majority of children was graded by their teacher as being excellent (9-10/10) (53.1%) and very good (7-8.5/10) (37.5%). Children were divided into two groups based on performance (low performing and high performing children). A statistically significant difference was observed in the low performing group in activity 2 only (Mdnpre=7.25; Mdnpost=10,25) ($z=-2.61$, $p=.009$) indicating improvements in children's understanding of how force relates to projectile motion after the intervention. This evidence may support Hypothesis 4 and the assumption that mobile technologies might be of greater benefit to low performing students. Yet, these outcomes should be interpreted with caution. First, it should

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be noted that the 'low performing' group consisted of children with very good performance thus, is less likely to be representative of 'low performing' children. Second, the reported post-test improvement may have been observed due to the high performing children reaching a ceiling effect while the low performing children having to process and learn more information as compared to the high-performing group. This may explain the significant difference between the two groups.

Discussion

This paper described a comparative study of the use of the mobile game Angry Birds by 32 preschoolers aged 4 and 5 years old. Children played the game repeatedly for seven days with the aim to collect evidence about the learning effects of commercial mobile games on young children's scientific thinking about projectile motion. Findings advocate for substantial cognitive and gaming differences between children 4 and 5 years old evidenced in their game performance, preconceptions about projectile motion, and post-test scores. An improvement in learning was observed only for the 5 years old specifically in relation to their understanding of how force affects projectile motion and the prediction of the pathway of the ball as being a parabola. No improvement was observed in relation to how the angle of the slingshot affects motion. These findings might be explained by developmental differences between young children in particular children's inability to focus on more than one dimension when predicting the direction of the movement of objects before the age of 5 (Göksun, et al., 2013). The cognitive load when the angle of the slingshot varied might have interfered with children's understanding. In contrast, in the case of force, having to consider for less options (pulling the slingshot little or much) might have facilitated understanding. Also, the task

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might have been more familiar due to previous similar experiences such as throwing a ball in a basket.

These findings could be interpreted in light of game design parameters. They may suggest that transfer of learning from 3D gaming to 2D non-gaming contexts is hard to be achieved intuitively. Although the two contexts presented similarities in terms of their learning objectives, a condition facilitating transfer, the static 2D nature of pre/post tests might have led children to perceive the two contexts as separate hindering transfer. Appropriate scaffolding either integrated into the design and structure of the game or offered by more knowledgeable others (e.g., teachers, parents) might be needed to make learning from gaming visible (e.g., Mccarthy, Li, & Tiu, 2013). Pinpointing to children the learning underling their gameplay may enhance their understanding of how the game works leading to a more sophisticated engagement with it.

Even though an understanding of projectile motion was only partially achieved as evidenced in pre/post-tests, the analysis of game scores revealed improvements in game performance for the older children, suggesting that children could effectively manipulate the slingshot to reach targets and progress to a next level. This evidence advocates that the knowledge of children about projectile motion in action was developed after interacting with the game for a period of time. It could be argued that there is a discrepancy between children's knowledge as expressed in pre/post-tests and their actual performance, with the former pointing to a limited understanding of projectile motion as opposed to the latter. This finding aligns well with existing studies about projectile motion in action (Bertamini, Spooner, & Hecht, 2004).

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In terms of children's preconceptions about projectile motion (hypothesis 2), evidence from this study suggest that understanding projectile motion varies as a function of age; it is less-developed for 4 years old and often involves misconceptions such as the shape of the pathway of objects when moved in the air. Findings from this study align well with studies about children's understanding of the notion of inertia on projectile motion (Kim & Spelke, 1999). Preconceptions should be considered when mobile apps are designed for preschoolers. Such apps should be rigorously tested with different age children to identify how certain features might hinder comprehension or support preconceptions.

In terms of the relationships between pre/post-tests and general performance (hypothesis 4), evidence from this study advocate that mobile games might be of greater benefit to low performing children. This group of students was found to perform better in post-tests in relation to understanding how force relates to projectile motion as compared to their high performing peers. It is noted though that children in the low performing group had minimum average general performance 7/10 indicating that these were very good performing students. Also, any differences between the groups may be explained by the high performing group reaching a ceiling effect and the low performing group having to comprehend more information. Mobile game-based interventions might hold the potential to support in particular children with low educational attainment and potentially minimise previously identified gaps in socio-economic background. Yet, this is more likely to be the case when ICT experiences are mediated and supported by peers, teachers and caregivers (e.g., Neumann & Neumann, 2014).

Conclusions

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Science learning and teaching lag behind other subjects such as literacy and numeracy in early years education. In addition, educators are found to be less interested and less confident to teach science to young children. Hence, a great interest from policy makers is observed in supporting preschool STEM initiatives, given the crucial role of early exposure to science experiences in engagement and achievement later in school life, especially for preschoolers from disadvantaged backgrounds (Greenfield et al., 2011). Yet, there is still a need for research-based evidence as to what type of teaching environments are more beneficial to young children and better support their learning and cognitive development.

Young children's enthusiasm and engagement with mobile games such as Angry Birds could be used to raise interest in science and provide motivating science learning and teaching experiences (e.g., Plass et al., 2013). Yet, prior to making any decisions as to what types of mobile games or apps in general might be used in supporting science learning, rigorous research is needed to identify their impact on children's learning and understanding. Such research should heavily consider for children's preconceptions as these are prevalent in early years. The content and structure of mobile apps should be crafted to children's' needs and tested with them to ensure that it does not support preconceptions or develops new ones. In practice, more research is needed to understand the effects of mobile apps on young children and to extend design mobile apps that are appropriate to the age and developmental capacities of young children.

In this comparative study, children played the game Angry Birds under self-regulatory learning conditions and with limited guidance as to how to use the game. Evidence suggest that commercial mobile games could be used by young children and be of cognitive benefit especially if the gaming and learning experience is mediated by more knowledgeable others

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(teachers, parents, siblings etc.). In terms of self-regulated learning, it is advocated that the design of commercial or educational games should support self-regulatory processes and scaffold children's learning in the absence of others. For example, cognitive and metacognitive scaffolds could be integrated into the design of such games to make learning behind games visible and support children in not only playing the game effectively, but also getting the most out of it in terms of learning.

Overall, more studies are needed to capture the effects of mobile apps on young children's development across all the areas of the Early Years Foundation Stage including science in order to inform policy makers and practitioners as to how to best integrate such technologies in the classroom and achieve a continuity between learning at home and learning in formal settings. Findings from this study should not be generalised across other science-related mobile games and apps yet they could inform the use of the specific game in early years settings. Also, the duration of the intervention (seven days) should be considered when compared to other studies in the field in particular ones with a more extensive life span (e.g., Ihmeideh, 2014; Mccarthy et al. 2013; Miller et al, 2012).

Conflict of Interest Statement

No conflict of interest declared. Ethical approvals were gained from the hosting institution. Data can be accessed by contacting the author (saved in a personal repository).

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