



Psychosocial Impacts of Mobile Game on K12 Students and Trend Exploration for Future Educational Mobile Games

Yuanzhe Li^{1*}, Zezheng Xu², Yu Hao³, Peng Xiao⁴ and Jingyan Liu⁵

¹ School of Materials Science and Engineering, Nanyang Technological University, Singapore, Singapore, ² China Foreign Affairs University, Beijing, China, ³ School of Chemistry and Biomolecules Engineering, National University of Singapore, Singapore, Singapore, ⁴ Faculty of Public Health, Mahidol University, Nakhon Pathom, Thailand, ⁵ School of Communication and Information, Nanyang Technological University, Singapore, Singapore

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*Correspondence:

Yuanzhe Li
yuanzhe001@e.ntu.edu.sg

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Due to the popularity and advancement of 4G/5G networks, mobile games have already currently become profitable tools for major internet platforms. These games are even refined to cover almost all age groups of the population rather than the young people. Yet in the perception of the public, mobile games have always seemed to be associated with various derogatory terms such as interfering with learning, addiction, and violence. K12 students usually have less self-control capability, and they are undoubtedly the biggest advocates of mobile games. This paper summarizes the technological development of mobile games from the aspects of hardware and software in chronological order. The psychological and social problems that mobile games have brought to K12 students are analyzed from a neutral perspective. At the end of the paper, the future development of educational games and current limitations of mobile games are also given for the explorations of future trends of game-based education. This position paper aims to provide the insight of what psychosocial impacts that the current mobile games have on the student, and it may also serve as a reference for the how the game-based education has been developing according to the mobile technology wise.

Keywords: psychosocial impacts, mobile game, K12 student, future development, educational mobile games

INTRODUCTION

Due to the popularity of smart terminals and the advancement of 5G networks, mobile games are currently the most popular type of games, as well as profitable tools for major internet platforms. Mobile games can be combined from different levels and content categories, covering different personalities and preferences (Martin et al., 2020). As a result mobile games are now refined to cover almost all age groups of the population, not just young people. Yet in the perception of the public, mobile games have always seemed to be associated with various derogatory terms such as interfering with learning, addiction and violence.

K12 students refer to the students in the age group from Kindergarten (usually 5–6 years old) to Grade 12 (usually 17–18 years old) (Kurt et al., 2022). Students in this age group usually have less self-control capability, and they are undoubtedly the biggest advocates of mobile game. When they play certain games for long periods of time their behavior and psychological state will be changed in a subtle way. The main issue is that mobile games may contain unhealthy contents such as pornography, violence, ignorance, superstition, etc. which implicitly affect the formation of the correct value system and the healthy development of their body and mind for these K12 students (Destyanto et al., 2017). In addition, some young people indulge in mobile games due to lack of self-control, which not only result in harmful influence on their studies but also induces a series of negative social activities and social relationship (Kurt et al., 2022).

The pioneers of communication science, Lazarsfeld and Merton, argued that modern mass media have a clear negative function of “psychoanesthesia.” Some violent mobile games reveal the nature of the “psychoanesthesia” function in another textual dimension: they create illusions through inexpensive and negative entertainment, thus eating away at the social mobility of those young people in an implicit cultural way (Kurt et al., 2022). Craig Anderson found that the “psychoanesthetic” mechanism of violent mobile games increases the physiological arousal of aggressive behavior, cognition, emotions, and violent impulses, and reduces pro-social behavior in adolescents (Elsherbiny and Al Maamari, 2021; Kurt et al., 2022). Accordingly, violent behavior has become the main “product component” of mobile games “inflicted” on adolescents. Moreover, its basic social manifestations can be summarized in four points: firstly, it creates and activates networks of thinking related to violent aggression; secondly, it weakens the inhibition process of violence; thirdly, the game’s violent reward rules allow aggressive behavior to be imitated and reinforced in the “mimetic environment;” and fourthly, the binary values of right and wrong in games can reduce young people’s empathy (Elsherbiny and Al Maamari, 2021).

Mobile games do not only imply a behavior, but also contain a value, which might be sometimes anti-social in nature. Violent mobile games on the Internet may portray the grandeur, hooliganism, and banditry of triad bosses and gangsters, contributing to the psychology of adolescent violence. In particular, the propaganda of “materialism” in violent online games can easily lead young people to abandon their original morals and values, so that the “money first” mentality gradually seeps into their minds and leads to a distorted way of thinking and personality.

This position paper therefore infer the future development of educational games from existing mobile games, and shares some insights into the current limitations, and critically analyses the above issues from a neutral perspective, discusses the psychological impacts and social problems that mobile games may cause for K12 students (Arteaga et al., 2012). It also offers the future development of mobile games and the limitations of current educational games in order to explore future trends in gamified education. This paper can also be considered as

a reference on how gamified education is evolving in light of mobile technology.

TECHNOLOGICAL DEVELOPMENT OF MOBILE GAME

From Feature Phone to Smartphone

Nowadays, almost everyone who owns a smartphone has been exposed to mobile games at one time or another. It may be a mini-game embedded in a web page or app, or a large 3D online game like “Arena of Alor” or “Player Unknown’s Battlegrounds” (De Gloria et al., 2014). These games have a huge update from the mobile games of over a decade ago, both in scale and in audio and video experience. And most mobile phones now have larger screens and touch screens have become the main way to use mobile phones, which did not exist on the same level mobile phones in 10 years ago, which has promoted the development of mobile games (Rubino et al., 2015).

The continuous evolution of cell phone hardware has brought about a constant change in the needs of gamers. There was a time when the only requirement for gamers was that their phones could run a particular game, but now gamers want smoother games, no lag when playing online, and even want their phones to be able to turn on the highest picture quality of the game (Ma et al., 2019). This means that the hardware that provides key performance in the phone and the network environment that the phone relies on also needs to evolve to meet the increasingly diverse needs of gamers (Wang et al., 2020). Gradually, mobile phones and mobile games have worked together to promote growth and form the industry shape we see today. In addition to entertainment, mobile games also carry part of people’s social needs in their daily lives (Yang and Gong, 2021).

Twenty years ago, the average person was still using 2G networks and physical button phones were just starting to become popular (Jang et al., 2019). At the time, most phones only had a black and white screen of about 1 inch, and due to system and network capacity limitations, only the games built into the phone could be played, such as Snake, Tetris, etc (Figure 1). These were indeed interesting, but they were just ordinary games to kill the time.

After 2003, color screen cell phones and PDAs began to occupy the consumers’ vision, the hardware performance of cell phones began to improve, the software and system functions were gradually enriched. At the same time, electronic games began to appear on cell phones in various forms (Syahrivar et al., 2022). Since Symbian had strict limits on the resolution and number of threads for software development, and J2ME development had a maximum memory limit, the vast majority of mobile games did not exceed 1 MB in size until the new Symbian system appeared in 2006, when these restrictions were lifted one by one (de Byl, 2014).

The popularity of color-screened phones allowed game developers to see the opportunity, and some very well-known games such as Need for Speed, Call of Duty, Command and Conquer, and many others launched dedicated mobile versions (Berlo et al., 2020). Many small development teams and



enthusiasts also developed board games such as chess, Texas hold'em into mobile versions. A variety of mobile phone native games began to appear at this time, such as "Tower Bloxx" and "Galaxy on Fire" in 2005 were enjoyable for handheld gamers at the time (Haney, 2017). Around 2005, when client-side mobile games were just exploding, there were already many specialized game makers developing mobile games for non-smartphones, but limited by the speed and stability of cell phone networks, and they were eagerly anticipating the popularity of 3G and 4G, but failed to foresee the rapid explosion of smartphones (Sosins, 2013; Manning and Buttfield-Addison, 2017; Papadakis, 2021).

From Keyboard to Touch Screen

In 2008, with the birth of iOS and Android, Apple successfully pioneered the touch screen cell phone, after the mobile game from the constraints of the physical keyboard, such as "Angry Birds," "Plants vs. Zombies," "Fruit Ninja," "Temple Run" and a series of new hand quickly occupied the market share in 1 year (Vaiopoulou et al., 2021). The introduction of Angry Birds made the public realize for the first time that the era of mobile games may be coming (Kalogiannakis et al., 2022).

"Angry Birds", developed by Rovio and launched in 2009, is another phenomenal product. Throughout the game, gamers only need to do one action, which is to press and hold the bird on the slingshot in the screen to drag and release (Villasana et al., 2020). Such a simple operation overturned the public's inherent impression of how mobile games are presented, so Fruit Ninja and Cut the Rope, launched a year later, both became star products at the time for their sophisticated gameplay design and simple sliding operation (Thomas et al., 2019). Few people may know that the first release of the game Doodle Jump in 2009 was developed for touchscreen phones, and only a year later came a version that supported physical button phones. That's because around 2010, the popularity of large-screen touch phones with smart systems made a radical change in the way mobile games were operated (Thomas et al., 2019).

The birth of the iPhone and the resulting trend in the use of touch screen created not only revolutionized the user's experience

of operating cell phones, but also made hand games free from the limitations of the physical keyboard, with new operation ways of playing other than "up, down, left and right" (Škařupová et al., 2016). If we say that the high price of iPhone may to a certain extent prevent the further expansion of the user scale of smartphones, Android is waiting for the opportunity to fill the gap to complete the last blow of smart phones to feature phones (Ghosh et al., 2018).

Take iOS as an example, App Store is the only (or the main) channel value, hand game developers still have the leisure of "slow work, fine work," but by the limitation of iPhone ownership, the income of developers at this time is much shabbier compared with today (Bagaa et al., 2018). For example, in 2011, the highest-grossing handheld game in China was "World War II Storm," and its monthly flow was only \$800,000 (Paseka and Schwab, 2020).

In 2010, Google announced its withdrawal from China because of its refusal to censor content. Although Android as an operating system was not affected much, but as we all know, Google Play, a connected service, was given the risk of instability (Liu et al., 2020). The reason why smart phones are "smart" is that they allow users to obtain applications through channels and support users to freely configure applications in hardware terminals, when the official channels of Android are covered with a layer of haze, coupled with the unique openness of Android, the status of channel providers for distributing handicraft products is increasingly important (Thien et al., 2020). This is the biggest enlightenment brought to practitioners by the mobile Internet in the outbreak stage.

From 2G to 5G

With the issuance of 4G LTE license by the Ministry of Industry and Information Technology in 2013, domestic cell phone users officially ushered in the 4G era (Karabiyik et al., 2020). In 2014, the real-time competitive MOBA hand game "Vainglory" was launched, emphasizing the real-time nature of network online, while "Magic Spirit Summoning," "Tower Legend" and other nurturing RPG games, although the gameplay is focused on the standalone part, the official will regularly update a large

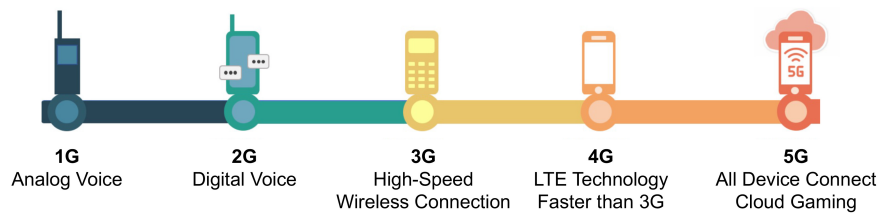


FIGURE 2 | Evolution of mobile generation from 1G to 5G.

amount of game content to keep the game fresh and the passion of gamers, so an efficient network becomes very important (Wang et al., 2015).

4G networks (Figure 2) use LTE technology on the prime 1,800 and 800 M spectrum bands, with a theoretical maximum mobile network speed of 100 Mbps and actual 10 M–30 Mbps. 5G networks use Massive MIMO technology in the 3.5 GHz range, which can theoretically reach a wireless data rate of 1 Gbps, greatly increasing wireless data bandwidth and enabling mobile games with less hourly delay and faster rate, giving gamers a better and faster gaming experience (Zappone et al., 2016). Mobile games are a cross-regional, cross-cultural, cross-racial, and cross-religious entertainment. It allows gamers to realize the ability to be entertained at home, on the subway, and outdoors with gamers around the world at any time. These demands reflect the advantages of 4G LTE and later 4G LTE-A networks, which can provide bandwidth based on priority, allowing more traffic to devices with higher download demands and transferring data to multiple devices at the same time, thus making the mobile network a stronger experience. Whether it's skin updates for MOBAs or massive updates for nurturing games, which can be downloaded to gamers' phones faster (Buzzi et al., 2012).

In 2015, "Arena of Alor" was publicly tested together with "We MOBA" and other multiplayer online battle arena (MOBA) games, and most handheld gamers were brought into the tide of MOBA games (Buzzi et al., 2016). These games are not only fast to get started, but also have compact gameplay and gorgeous graphics effects, which not only require excellent performance of network environment where the handheld gamers are located, but also challenge the hardware performance of cell phones (Zhang et al., 2017). The complex lighting and particle effects in the game make the CPU and GPU in the SoC take a lot of pressure; at this time, the modem in the phone can't be idle and needs to coordinate the network to cope with transferring the various data that occur in the game. Such comprehensive needs have led more cell phone manufacturers to start launching products that emphasize cell phone performance and networking capabilities (Chiang et al., 2021).

This trend has prompted more developers to bring a wider variety of games with richer titles to the mobile platform. Almost every year, several topical titles emerge, such as "Crackdown 3" in 2016, "Monument Valley 2" in 2017, and "World in Pictures" and "Florence" in 2018, which expose more smartphone users to the "video game" entertainment genre (Guo et al., 2019). For most gamers, the connected competitive games like 2018's Peaceful Elite handheld, Wild Ride 9: Racing Legends

and the new Call of Duty Mobile in 2019 are their best choices (Guo et al., 2019).

From black and white screen feature phones to large screen touch smartphones, not only cell phones have changed over the past 10 years, but the way we work, live and play games has changed dramatically. As 5G technology gets closer to us, mobile games will take on a more diverse look with new technology and new hardware, such as 5G cloud games will also bring richer game products to more gamers, using 5G's high speed and low latency advantages, host and PC games will also become possible to load in real time on the mobile side (Habiba and Hossain, 2018). This will also bring a different game experience for handheld gamers.

The 4G era has brought about the rise of handheld gaming, which has now become an important part of the global gaming landscape, with countless numbers of handheld gamers, and the demand for mobile gaming performance continues to increase. The advent of the 5G era will change the game experience for gamers at this stage, which is limited by equipment and network latency (Akbar et al., 2021). Although 5G is still in its infancy, it will definitely have a significant impact on the global gaming market in the future (Oberst et al., 2017).

As 5G technology matures, one of its main applications is to provide a smooth cloud gaming experience. In addition, the low latency of 5G and the convenience of smartphones will make mobile devices a key platform for cloud gaming. Due to the advancement in the network, major mobile manufacturers are now launching 5G gaming phones to cater to the market and provide a better gaming experience to the gamers. Therefore gaming phones have also become one of the selling points for cell phone manufacturers.

PSYCHOSOCIAL EFFECT OF MOBILE GAME ON K12 CHILDREN EDUCATION PERFORMANCE

Public Awareness—Negative Content of Mobile Game

Many elementary school students are addicted to mobile games and cannot extricate themselves from games, some of them even steal their parents' money to recharge for playing games and play truant. They only think about the mobile games all day and all night, and think of all the ways to play games, so they are not interested in studying at all and their academic performance is in a mess. It seems obvious that the more time you spend

playing games, the worse your academic performance, and there are studies that have found a correlation between time spent on video games and students' academic performance (Padilla-Walker et al., 2009). But is poor academic performance really the fault of gaming? It is important to note that "correlation" does not mean "causation": for example, just because "sleeping in shoes" is associated with "getting up in the morning with a headache," does that mean that "sleeping in shoes causes headaches" is causal? In fact, why do you sleep with your shoes on? The most likely reason is that one forgets to take off one's shoes before lying down in bed after drinking too much, and this is the factor that has a real causal relationship with "getting up in the morning with a headache" (Seo et al., 2019).

A student who is repeatedly frustrated with his grades, expects appreciation and has high expectations of himself, has no outlet for his pent-up emotions. But in mobile games he can not only vent his stress but also receive a quick reward (Chafouleas et al., 2021). The situation of students who are already not excelling in their academic performance will get worse because playing games will waste time in learning, thus creating a vicious circle (Laws and Millward, 2001), i.e., although playing games takes away from our studies, playing games may only be one point in the chain, and the reasons that lead us to play games are actually more complex.

Why Are Games Addictive but Learning Is Usually NOT?

Compared with learning, mobile games have distinct advantages that games tend to have some measure the progress of participants to some extent, meaning that their effort is visible and obvious, whereas learning does not (Luder et al., 2020). There is progress in learning, but it is a slow process and people are not sensitive to small changes (Chen, 2017). The simplest example should be hair, i.e., hair grows every day, but it is generally unconscious. If you get a haircut once a year, and within a year your hair changes from short to long, people around you will not think you have changed, but 1 day you get a haircut and it becomes as short again as it was a year ago, people will be surprised and say what a big change you have made. But take that big change and put it over a long period of time and it won't feel like much. It's the same with studying, but many people fist pump and swear, then study for a while, feel they haven't made much progress, and give up. This is the objective basis for the old cliché on Know Your Enemy that "hard work doesn't always lead to progress" (Chen and Gregory, 2009). The game makes this process visible, turning a large amount into many tiny amounts, and it is important to feel that you are improving.

Long-Term and Short-Term Goals

The tasks set in the game are mostly achievable goals, not too easy and not too hard. There is a lot of data analysis behind this degree of accuracy (Wang et al., 2020). Increasing participation in games is linked to their benefits and results. Not so with learning. The average person does not have this analysis; you put a 500-page book in front of them and they will not even read it because they think it is so thick that they will not be able to finish it in their lifetime (Hsieh, 2021). However, these are perfectly achievable if they are divided into smaller goals after scientific analysis.

Rewards

The game does such a good job of this. It is clear on the game that for everything you achieve, you will be rewarded accordingly and your efforts will be recognized. On the other hand, learning, has a great deal of uncertainty. Working very hard and not getting good results happens to almost everyone (Bavelier et al., 2011). This puts a lot of people off, so they choose not to try to work hard, so if they succeed they will be complacent and think they are clever, and if they fail it won't matter, after all they haven't put much effort into it.

Uncertainty

A known reward will motivate people, but unknown factors will really keep them going. A reward with appropriate uncertainty will be exciting, it will increase people's dopamine production and fascinate people (Gentile et al., 2004). We encounter same situation when we read a novel. But when listening to a lesson, this is simply not possible. If we could figure out how humans learn and what motivates people to act from the development of games, then apply it beyond games, the value it could create is immeasurable, and it would be a ground-breaking thing.

The Psychosocial Impact of Mobile Games

In fact, the psychosocial mechanisms behind playing games deserve more attention than academic performance. Often the decline in academic performance is the most easily observed, but the relationship between playing video games and soft aspects such as feelings of loneliness, loss, self-esteem, social anxiety and social skills is often overlooked. These commonly overlooked factors largely contribute to negative events that influence our perceptions of mobile games (Han et al., 2009).

According to Maslow's Hierarchy of Needs theory (Figure 3), human needs are divided into five categories from low to high: *physiological needs, security needs, social needs, respect needs, and self-actualization needs*. When the lower level needs are satisfied, the next level needs will become the primary motivation (Boyer, 2015; Li et al., 2021). So when we have satisfied the two basic needs of physiological needs and security needs, the pursuit of spirituality will rise to become the main conflict. So people who

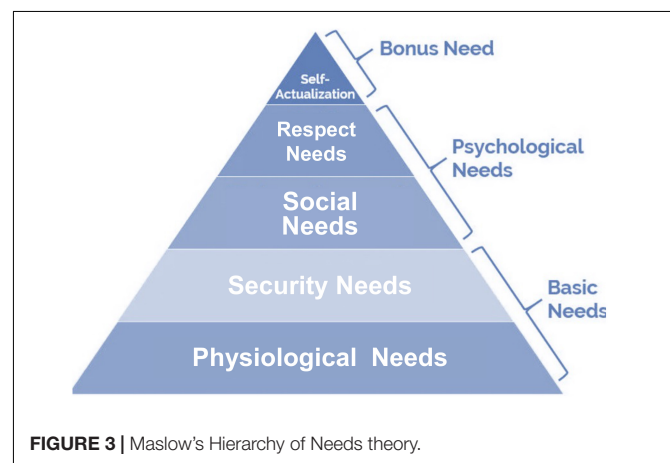


FIGURE 3 | Maslow's Hierarchy of Needs theory.

are not able to socialize properly have no way of satisfying their social needs and other higher needs, so for such people there is a greater need for a space to socialize and achieve things that are not possible in real life. (Kowert et al., 2015) have found that people who have low self-esteem in real life, are lonely, lack social skills, and are less successful in real life tend to spend more time in video games (Winter et al., 2016). In turn, playing video games further exacerbates gamers' feelings of loneliness and increased dissatisfaction with life (Kowert et al., 2015).

A successful mobile game is inevitably appealing because of the high sense of achievement that teenagers can feel in the game again. Imagine that people who are not respected in real life can be admired for their virtual achievements in the game, either through kryptonite (spending money to increase combat power) or through their skill in playing the game. Even if you don't make it to the top of the leader boards, you can still find a presence in a variety of ways. Moreover, in online games, without the constraints of real identities and conditions, gamers can communicate more flexibly and with less embarrassment of being rejected due to real conditions, communication between people is easier and gamers can easily build closer relationships through various tasks (Caplan et al., 2009).

These people who are dissatisfied with their real lives can find a sense of presence in the game in a variety of ways to escape their real-life dissatisfaction (Figure 4). However, after being satisfied in the virtual world, when they return to their real life, the gap will be even greater, and this will deepen their dissatisfaction with their real life. In addition, it is important to note that excessive play can also cause distraction, attention-deficit hyperactivity disorder (ADHD) and psychological disorders such as depression, bipolar disorder and anxiety in children (Chan and Cheng, 2004; Bulduklu, 2017).

Anti-social Behavior Caused by Mobile Games

The content of many mobile games is full of fighting and killing, gunfire, wild and weird characters, mechanical and rough movements, absurd plot and fast rhythm, which have a serious negative impact on students' moral and psychological health. Those students who are addicted to games are often not calm enough, restless, impulsive, indifferent to others, and more violent, bringing certain destabilizing factors to the campus, family and society. They are in reality, but their minds are in the online world, and they are prone to schizophrenia symptoms, and few children who are addicted to mobile games are psychologically healthy. Nowadays, anti-social behavior also brings much attention to mobile game study. Although video games have been designed and developed to entertain (or educate), it has to be admitted that many of them contain violent content. According to data from Children Now 2001, a non-profit organization concerned with children's learning and development, as early as 15 years ago, 89% of all games contained violent content, and nearly half of them contained severe violence (Bulduklu, 2017).

Researchers have found that excessive immersion in games with antisocial content (violence) can easily lead to addiction

and that such games have a subtle effect on gamers: they lack empathy and are prone to destructive behavior in real life. In fact, for gamers, the violent stimuli provided by virtual worlds such as combat are not only a stress relief, but also a training exercise that allows them to become accustomed to such aggressive emotions and destructive behavior in games, which they gradually carry over into real life (Huizenga et al., 2009).

In a study conducted in 2011, Anderson and Bushman surveyed over 4,000 gamers and found that violent games increased aggressive emotions and decreased pro-social behaviour. Both children and adults, men and women were deeply affected by this (Foerster et al., 2019). This is not to say that violent play necessarily leads to violent behavior. However, when we are constantly trained to think about our enemies in games and reinforced to react quickly and aggressively to each other's actions, we constantly rehearse this script in our minds and feel threatened all the time, which translates into real-life situations where we are also hostile to those around us and develop "hostile attribution bias" (Venetz et al., 2014). For example, if Ming knocks over my cup, I will think that Ming thinks I am a bad person, that he is doing it on purpose, and that I have to beat him up to show him so that he would not do it again. But in reality, the aisle was too narrow and Ming was too fat and accidentally knocked it over. This attribution error is the "hostile attribution bias."

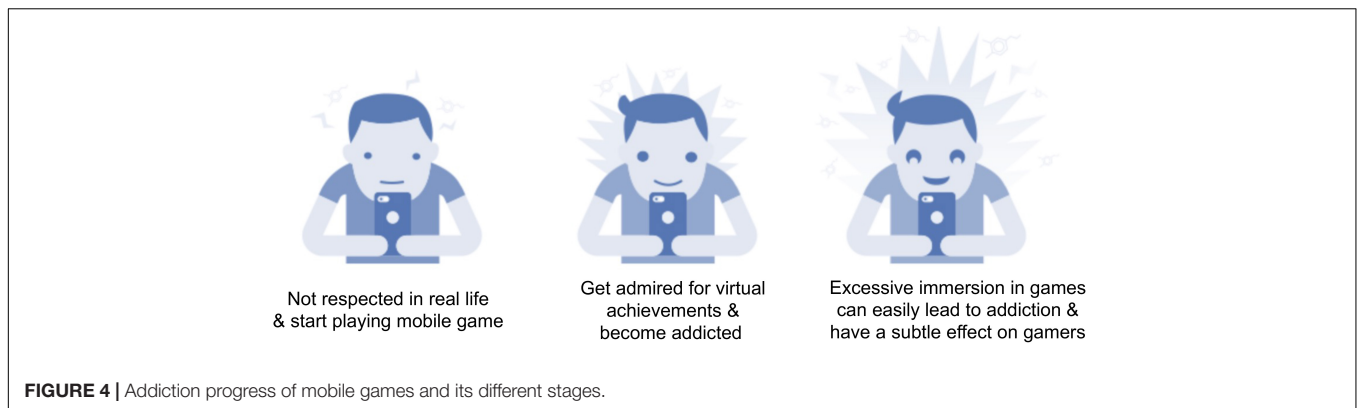
It must be clear here that it is not the video game that causes the gamer's antisocial behavior, but the violent content of the video game. It is pointless and even counterproductive to make a blanket statement. We should advocate for the regulation of the video game market and the development of sensible game content, rather than a blanket ban on all video games.

FURTHER ACTIONS MAY TAKE FOR CORRECT GUIDANCE

The Core Educational Value of Mobile Games

Most scholars are studying how to make learning more interesting, so that students can learn by doing as what the mobile game does. This is the dream of our educational researchers, and Dewey's emphasis on "learning by doing" does not seem to be working particularly well. In contrast, in a virtual environment we can learn by doing, which is similar to the real thing, improving students' problem-solving skills, creativity and other higher-order skills, and helping to develop emotional and attitudinal values (Villasana et al., 2020). This is why educational scholars are proposing to implement gamified learning, using educational games to achieve gamified learning. Gamified learning in a narrow sense generally refers to pure video games, while gamified learning in a broad sense includes game mechanics, game element design concepts, etc.

The core educational values of games are mainly acting on the aspects of psychology, socialization, and culture. With its effect on **play motivation, playful thinking, and playfulness** (Figure 5), a good mobile game does need multiple aspects



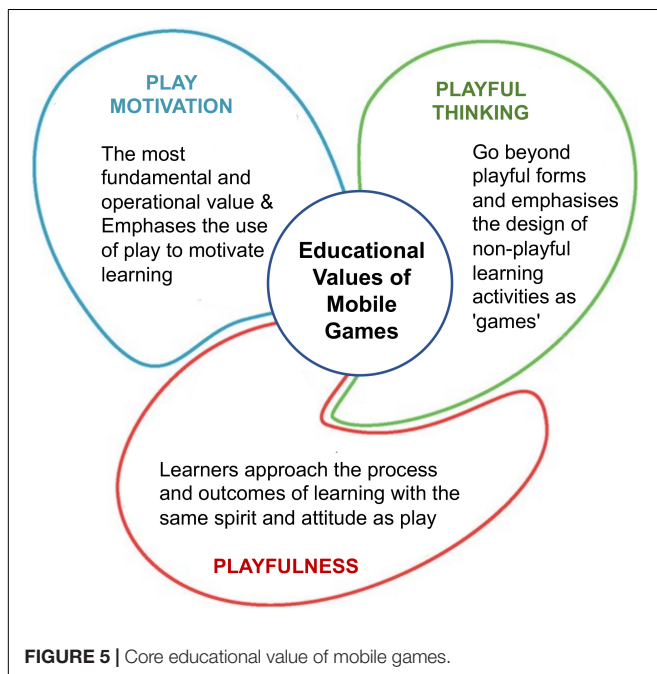
of knowledge, ability, emotions, attitudes and values (Schwab, 2018). Play motivation is the most fundamental and operational value, emphasizing the use of play to motivate learning. Playful thinking suggests going beyond playful forms and emphasizes the design of non-playful learning activities as “games.” Playfulness is the most meaningful value emphasizing that learners approach the process and outcomes of learning with the same spirit and attitude as play. The core link between the three aspects is deep intrinsic motivation (Škařupová et al., 2016). Getting people to do something because they are challenged and to be curious, rather than being pushed to do something every day by external rewards and pressures.

Gamification of Education/Educational Mobile Games

In the design of educational gamification, it is important to focus on an important issues: distinguishing the age group of the user. Gamification of education is more suitable for the

K12 age group and should generally be in the form of simple games, with the degree of gamification decreasing with the age of the user increasing; there will be some adults over 18 who prefer educational products in the form of large-scale games such as online games, but this may be a niche market (Abeele et al., 2017). A light game should be a balance between learning and gameplay, it is like a layer of ketchup in the middle of a hamburger, it can be a little less, but too much is definitely not. If the game is too complex, it will take away from the main focus, the child will appear to be learning but spend more time playing, and the level of emotional arousal will be too high, which is not the desired learning effect. Don’t design a product to be “revolutionary” right out of the box, ground it and then change it incrementally, although this is the opposite of what Google’s Page says (Huijismans, 2019).

This is because schooling is absolutely dominant in the educational lives of primary and secondary school children, and most of the people who deliver schooling—the teachers—have extremely difficult to change work habits and lack the motivation to change. There are many reasons for this, which will not be expanded. Therefore the initial product should ideally be close to the actual working habits of teachers, close to the teaching content of the school, find a real solution to certain high frequency needs of teachers in their daily work and cut in, so that they can first get started, develop trust and dependence, and then expand step by step, it will be more feasible. Educational products are not super viable just because they are gamified, and you can’t expect them to get a lot of users and get the desired conversion rate just because they are “happy learning” (Schneider et al., 2020). It is always believed that educational products for primary and secondary schools should be a combination of online and offline. In addition to the online part of the product, it also needs to include an offline package for teachers and parents, including training, guidance, evaluation, consultation and follow-up, and so on. For example, how teachers use the product in the classroom, how they use it after school, or what they do to provide daily feedback to parents, are all parts of the product and need to be developed into an actionable solution, not optional. Otherwise, even the best design will be short-lived and will end up like a normal game after its life cycle. So, as well as the product team, the operations team is equally important (Cha and Seo, 2018). While designing the gamification, don’t forget to



build and polish the educational content itself, which is the main part of the “hamburger.” Entrepreneurs are often in a hurry to get their products to market quickly and can easily over-gamify them. But the lifeblood of an educational product is still the quality of education, and when the learning effect is not reflected, it will face the dilemma of further development.

FUTURE TRENDS AND LIMITATIONS IN EDUCATIONAL MOBILE GAMES

Future trends, from a technological perspective, combine gamified learning with mobile learning; with VR/AR; with intelligent bodies; with brain science; with artificial intelligence and big data (Quelly et al., 2016; Black et al., 2018). If the research is to solve students’ learning problems through mobile games, it is necessary to combine various research results and educational results from game design. Experimental research in this area has been conducted and found it to be quite effective. Through this experiment, it is found that the difficulty in developing this type of game is decided by how it can really enhance their learning effectiveness (Calpbinici and Tas Arslan, 2019).

Still, games are games, and still there are four major limitation for the current development of educational mobile games.:

- The first major limitation is portability, that is, how what is learned in a mobile game transfers to the real world, which exposes the Achilles heel of mobile games. The challenges in video games are often fictional and have no connection to everyday life, but are rather a fantasy. The knowledge and skills that K12 students acquire in games such as battling dragons, racing jousts, and Tetris are not meaningful to everyday life and therefore not directly transferable.

- The second major limitation is simplicity. Mobile games simplify complex systems to their core and are procedural representations of the real world. The world we live in is much more complex and often defies the simple logic of the game. This results in learners often losing touch with the systems modeled in the game.

- The third major limitation is that games lack real-life environments. Mobile games are not designed to have an effect on the gamer after the game is over. The K12 students are too different from the world they live in, and the real world is too complex. Even those games that have a realistic purpose, so-called serious games or educational games, mostly fail in their transfer from the game to the real world. This is good news for those who fear that violent games make people violent, and bad news for those who think that smart games automatically make people smart.

- The fourth major limitation relates to the above question about the environment. K12 students are usually unable to spontaneously establish a relationship between what they learn in mobile games and real life. They can grasp a great deal of information in mobile games and remember it over time, but are unable to recall the simplest historical data in the classroom. The link between learning achievements in games and in the real world is often overlooked by many K12 students and teachers.

Games open the door to the transfer of learning experiences, but K12 students must go through this door themselves. For that matter, the role of teaching behavior in the use of mobile games is clearly underestimated. Learners need constructive support to draw outcomes relevant to their own learning from a rewarding play space. There may not be a fundamental difference in the traditional sense of learning, but there is a difference in the logical growth and understanding of games (Rahim et al., 2020). Besides, the illusory nature of the mobile gaming experience makes the transfer of results very difficult. In response, external forces are needed to drive attention toward the potential and the knowledge learned. Teachers can and should use this meta-perspective to promote the pedagogical potential of play. The content of the learning outcomes, the enhancement of skills and knowledge, should be explored together with the K12 students. A bridge between the virtual and real worlds is built when all these gamers take note of the content and learning outcomes in question. The questions that need to be answered on the teaching side are which real-world environments can apply what is learned in the game and which aspects of the game are worth learning from. And gamers, the K12 students, should be motivated to notice this connection and to test what they have learned in their everyday lives (Kyriakou and Glentis, 2021).

CONCLUSION

This paper summarizes the technological development of mobile games from the aspects of hardware and software. A neutral perspective is given to analyze the psychological and social problems that mobile games have brought to K12 students. At the end of the paper, the insights of the future development of educational games and current limitations of mobile games are also addressed. The major task for the development is to reflect on the content of the mobile game, which is not directly accessible. It is difficult to examine what is learned with a critical eye during play and must therefore be stimulated externally. The act of teaching and learning enables knowledge and skills transfer if the teacher has the ability to build bridges between the virtual and real worlds. Radically speaking, it is only through pedagogical support that the barriers to knowledge transfer in gamified learning can be overcome and the potential for learning unlocked. This new pedagogical role requires the teacher’s own interest, as well as active access to the space of gamified learning. This area deserves to be explored and experimented with and will present teachers with new pedagogical challenges.

AUTHOR CONTRIBUTIONS

YL designed the guideline of the articles. JL contributed to the drafting of material for individual section. ZX and YH compiled the writing and conducted the analysis. YH and PX aligned the manuscript. YL and JL reviewed and provided corrections on the original draft. All authors contributed to the article and approved the submitted version.

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