Design Guidelines for Educational Games Targeting Children

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***Abstract*—There exists a wide range of frameworks with design guidelines within child-computer interaction and educational games. However, hardly any frameworks can be found that combine both these areas. This work aims to develop accessible and easily applicable design guidelines aimed towards educational games for children. A literature review was conducted within the areas of games, educational games, and child-computer interaction. From the publications, 42 guidelines within educational games and child-computer interaction were elicited. The guidelines were applied and tested on a healthcare application. Based on the outcome of the evaluation, formulations of the guidelines were updated and resulted in a new, more easily applicable compact version of the framework, named the Educational Games for Children (EGC) framework, presenting 24 guidelines within educational games for children.**

Keywords - educational games; child-computer interaction; design guidelines; game design.

I. INTRODUCTION

Applications aiming at educating and preparing children require consideration of several design aspects. When designing educational games, both motivation to use, and achievement of intended learning goals are important aspects. While guidelines regarding games, educational games and child-computer interaction are all well documented areas [1]-[5] it is more difficult to find guidelines that combine these areas, all relevant when developing and designing educational games for children. Guidelines and recommendations in the academic literature are also often complicated for practitioners to access and there is a need for accessible easy to use guidelines in the area [3].

The aim with this work was to define a framework for guidelines when developing and designing educational games for children. This work was a first explorative step towards developing a tool that easily can be used by designers of educational games. The work was conducted in an iterative way alongside with the development of an educational game for children. Initially, a literature study within the areas of games, game-based learning (educational games) and child-computer interaction was conducted. Based on the literature study, a first draft of a framework for guidelines was created. In the next step, this first version of the framework was tested on the COSMO@HOME project, an ongoing project that develops a healthcare educational game to prepare children for Magnetic Resonance Imaging (MRI) procedures. Based on an evaluation and interviews with game designers in the COSMO@HOME project, the guidelines were modified, and a final version of the framework was created.

The paper starts by presenting the results from the literature study, describing the area of game-based learning and education (Section 2), followed by a section about child-computer interaction (Section 3). Section 4 elaborates on existing frameworks and their advantages and disadvantages, in relationship to the suggested framework. In Section 5, a first version of the suggested framework is described. In Section 6, insights from evaluating the framework are presented and applied to create an updated version of the guidelines. Lastly, Sections 7 and 8 comprise a discussion, conclusion, and future work.

II. GAME-BASED LEARNING AND EDUCATIONAL GAMES

Since the beginning of 1980, computer games and TV games have been used not only for entertainment but also for learning, and during the early 1990s, games were brought to academia to be researched as beneficial. The area of educational games is still discussed today, and was questioned from its early beginnings due to the detrimental impact computer and TV games in general were considered to have on children. Opinions such as *waste of time and money* were common, but so were the cognitive effects games were thought to have on children [6]. These might well be opinions that we still can hear today, but the views on games are nowadays more nuanced, and the area of games has become a popular research topic. Researchers have argued that games are a unique way to engage and motivate people in learning and education [7][8].

To understand how a game can be a tool for learning, we first need to define the concept of a game and the different parts that build it. Kapp [9] defines a game in the following way:

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"A game is a system in which players engage in an abstract challenge, defined by rules, interactivity, and feedback, that results in a quantified outcome often eliciting an emotional reaction."

Through feedback and interaction, coupled with challenge, the player will interact and engage with the game. The game, that is defined by the rules of its system, and that is designed as an abstract version of a larger system, will result in a quantifiable outcome that in turn will give rise to an emotional reaction from the player. These are, according to Kapp, the factors that will promote learning and engagement [9]. The concept of gamification uses these elements to bring further meaning and motivation for a certain task. Kapp [9] defines the term as:

"Gamification is using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems."

As in learning, games also use typical techniques that can be found in educational psychology. Techniques, such as giving points, feedback, and encouragement to collaborate are common practice for teachers as well as typical elements of a game. What gamification adds to learning is, according to Kapp [9], another layer of interest that both engages and motivates the player to learn. Appreciation sounds given after completed tasks can be an effective way of encouraging the user [10], as well as points and badges [3][10][11].

There are several advantages of using games for learning. As a game can be used to model parts of the real world it makes it possible for people to play around with and visit an abstract reality of a real life setting or place, but in a simplified form [9]. However, many aspects of real life are complex and do not necessarily enrich the experience of a game. The concept of purchasing different artifacts is, for example, a common act a player can perform in games, and being able to acquire better tools etc can enrich the game for players. Yet other actions associated with the concept of buying, such as standing in line, counting your money, and packing your goods do not enrich the experience. These kinds of real-world concepts can both make the game less interesting and overwhelming [9]. Other educational settings that games can be used for is to understand the effects of one's actions, since the player can get immediate feedback during play [9]. In this way, players can learn about concepts in the real world and how their actions can result in certain outcomes.

A. Motivation and Learning

Winn [2] states that the intended learning goals should be central and primarily set clear as the development of a game is started. Setting these goals can then help the designer throughout the development phase as they provide a practical way of measuring the intended learning outcome.

A significant motivation for using educational games in learning is the engagement and joy they bring to the user [11]. Motivation is crucial for engagement and is fostered by several factors in games, such as challenges and feedback but is also connected to other elements such as graphics and the storyline of the game. Provision of good audio and sound quality are also important within educational games [5]. A study conducted by Linek [5] showed that lack of good sound quality can cause a greater degree of disruption than poor image quality. Kapp [9] discuss the concept of internal and external motivation which is referred to as intrinsic motivation and extrinsic motivation. Extrinsic motivation is experienced when the focus is put on the reward or the outcome of a certain task. Intrinsic motivation on the other hand, is when the activity is the main purpose and not the reward upon completion [12].

Providing choice is another way to create motivation [5]. Choice makes the player feel powerful in the game-situation and is a way of engaging the player even more. Further, Chiasson and Gutwin [13] imply that providing the feeling of control has been seen as a good way of enhancing engagement. Choice can be incorporated in many ways, such as selecting game paths, but also through the ability to customize avatars, items, and other appearances of the game [3][11]. Winn [2] implies that it is important to balance the number of available choices, so as not to overwhelm the player early in the game. Choices within games should progress during the game as the player is learning and becoming more comfortable with it.

Role-playing games have also been seen as beneficial for learning as they are a way to address engagement [11]. By letting the player take on a role, for example through an avatar, the player becomes more involved in the game-play and emotional engagement and motivation is created.

B. Feedback and Rewards

Clear goals and rules within the game are important for the player, and are also important for creating intrinsic motivation [5]. If the player does not know what to do or if the goals of the game are unclear, it creates frustration and becomes unmotivating. Feedback is an important tool for learning through games and it can optimize learning by directly giving the player tips and tricks with respect to the performance and actions within the game [5]. Feedback can be incorporated in many ways, one of which is by using pedagogical characters often referred to as animated agents [3][13]. According to the Touchscreen Interaction Design Recommendations for Children (TIDRC)-framework and research done by Chiasson and Gutwin [3][13], this can improve learning outcomes, even though it is important to ensure they are not too intrusive [13].

Rewards are typical components of games and are a good way of encouraging and motivating the player [3][11][13]. Winn [2] implies that is important to balance the number of awards to better maintain player motivation.

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This work suggests that rewards should be given more frequently when the challenge is greater, or when the learning curve is steeper. Further, the TIDRC-framework recommends being careful with the frequency of rewards given as this can rule out the intrinsic motivation of users [3]

C. Challenge

One of the challenges when creating a game for a broader user group is to find the right level of challenge that will keep players with different skills entertained. One way to handle this is to use levels that change during gameplay according to the skills of the user [9]. Either the level can be set for the whole game beforehand, or it can be used and evolved throughout the game until the end. Kapp [9] points out that levels can help the user to learn certain skills that are required to achieve the main goal. For example, to slay a dragon requires skills such as swinging a sword or dodging attacks from an enemy. These and other skills can be practiced by using the concept of levels. When creating educational games, Kapp [9] suggests creating three levels of interaction: easy, intermediate, and difficult. Linek [5] also points out the importance of adapting the level of challenge to optimize learning. If a user finds a game too easy to play it can quickly become unchallenging and unmotivating. Additionally, lack of motivation can also appear if the player instead finds the game too challenging and difficult to master [5]. Another way for the player to test and practice skills is to master obstacles and quests [11]. Abdul [11] implies that these moments of challenge improve learning since the player is forced to employ skills that they have already been trained in.

III. CHILD-COMPUTER INTERACTION

Children's media usage is increasing [14]. The time exposure to media, such as computers, is a general concern at the same time that computers creates opportunities for children to learn and experience things in a new way [4]. Gelderblom and Kotzé [15] found that computers even supported children's development in writing, verbal creativity, mathematics, and language, among others. The use of computers, given that the experience is developmentally appropriate, could benefit construction of knowledge, as they encourage children in active learning. The use of computers could also be an opportunity to experience virtual environments where children can learn and acquire knowledge in other contexts at the same time as being provided with challenge and fantasy, which creates curiosity. By using the interactive opportunities of computers, children can effectively be given feedback, which can speed up their development in learning new things [15].

Designing interfaces for children creates different challenges to designing for adults. Children, as they are in their developmental stage, have different cognitive, social, and physical needs and skills than adults. These are the three main aspects in which children's development can be divided and categorized [10] and all of them need to be considered when creating technology for children [10]. Cognitive abilities of children usually cover reading and understanding, but also their attention skills. Physical abilities in the area of human-computer interaction usually refer to the fine motor skills needed when interacting with different devices such as computers, video games, or smartphones. Socio-emotional abilities in this context are connected to social-sharing and customization [3].

A. Cognitive Abilities

Using technology requires mental processing, such as perception, attention, information handling, and decision making, and is tightly coupled with the area of cognition [4]. As children have different needs and skills to adults, designers for children's technology should be aware of the differences between child and adult users.

Reading knowledge: In many applications and games, instructions are given in text. Menus and choices available are commonly written in text, which can clearly be a challenge for children of pre-reading age. Navigating through menus can also be challenging for younger children as it may still be an unknown and abstract concept for them [10]. Even older children may experience written instructions as challenging, which is why audio and animation can be a useful tool to support their understanding of instructions. Due to the limitations of children's reading capacity, it cannot be expected that games can be learnt through text instructions unless they are easy enough to follow and understand. Further, it has been suggested that in-app tutorials should be avoided, since there is a tendency that children may not read or remember instructions given in this way. A better solution is to provide guidance whereby the user can be active [3]. Further, Chiasson and Gutwin [10] also suggest that the interface should be intuitive enough to be used without instructions, or that child-users are given guidance until the intended task is understood. This is usually referred to as scaffolding [10].

Graphics: An alternative to written text and instructions is graphical metaphors and interfaces where minimal use of text is required, especially for the youngest users. Giving instructions in speech with corresponding pictures and animations can also help the users to both remember and understand the instructions. This is also a good way of catching the attention of the user [10]. As children usually have less experience with computer interfaces than adults, many of the typical visual representations and symbols are not yet common knowledge for child-users. Icons such as "stop" or "play" can be abstract for a novice user and should not be expected to be familiar icons for a child [3][10]. Therefore, icons and symbols should be represented by pictures and concepts recognizable and intuitive for children. Gelderblom and Kotzé [4] also formed a guideline of this based on Piaget's theory of Cognition. This states that children's knowledge is structured in schemes which

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can be reorganized and adapted to environmental change as the child becomes older. To understand and acquire a new skill, therefore, demands that prior schemes and knowledge fit the presented information. Due to this, it is also important for designers to consider and acknowledge the existing schemes and knowledge of the intended user. Interactive components such as buttons should also be designed in a way that show that they are clickable. One way is to give buttons a 3D-looking design [10]. Another way to differentiate certain items is to make them stand out from the background using distinct outlines, colours, and backgrounds. Another recommendation within the TIDRC-framework is to avoid too-complex backgrounds as these may confuse the child integrating with the system [3].

B. Physical Abilities

Several design choices have to be considered when forming the more practical components and possible interactions within software for children. Children's developing physical and motor skills put other requirements on the usual gestures used when integrating with a device. Chiasson and Gutwin [10] found that touch screen devices rather than computers are better and more appropriate tools for children. Even though touchscreen devices are a good choice for child users, there are limitations to these. As mentioned, the interaction of these devices is often limited by the motor skills of a child and thereby not all available touchscreen gestures can be implemented.

Primarily, the gestures used within the interface should be consistent throughout the game [10][11][16]. Typical gestures such as *drag-and-drop*, *rotate*, *pinch*, *double-tap,* and *spread* should be avoided [3], as well as gestures that require an object being dragged a longer distance. Ways to overcome some of the challenges that may come with these gestures are to allow partial gesture completion, accepting both single and multi-touch, and increasing the time between taps in the double tap gesture [3][10]. Another aspect to consider when designing interfaces for children is to avoid targets being too small and also ensure that the distance between targets are long enough to deal with outbound touches. Another good solution is to increase the active area of targets [3].

IV. Existing Framework and Guidelines

The MDA-framework, from 2004, is one of the earlier formal approaches to describe how games are built and, thereby, how they can be understood and evaluated. MDA stands for Mechanics, Dynamics, and Aesthetics which represent different game layers, from hard coded objects and components (mechanics) to all actions a player can perform within the game and with the objects (dynamics). These two concepts give rise to different feelings and impressions that the player gets from playing the game (aesthetics) [17]. The MDA-framework has become one of the most widely used and accepted theories within game design for decomposing and evaluating games [1]. While the theory has been popular and appreciated, it has also become a topic of discussion.

Walk et al. [1] found two main aspects of weaknesses within the MDA-framework as discussed in the academic literature. Primarily, they questioned the absence of visual design aspects of games as the MDA-theory merely focuses on mechanics. Because of this, the authors found that the theory is not applicable to gamified content or experience-oriented design as it focuses more on functionality. Further, Walk et al. [1] found that the framework is barely applicable to narrative designs as those components are hard to break down into the main concepts of MDA. Instead, the authors [1] suggested a new, updated version of MDA to address its weaknesses, namely, the DDE-framework, which stands for Design, Dynamics, and Experience. The DDE-framework was an attempt to further define the concepts within the MDA theory.

Another alternative to the MDA-framework was presented by Winn [2], who also found weaknesses with the MDA-framework. He argued that the framework was difficult to apply on serious games that have requirements other than just entertainment. Optimizing fun within a serious game can be challenging as it also needs to fulfil requirements for more serious outcomes. To address these weaknesses of MDA and to create a framework more suitable for serious games, Winn suggested an extended version of MDA called the DPE-framework. DPE stands for Design, Play, and Experience. These three main concepts are built on sub-categories or "layers" within learning, storytelling, gameplay, and user experience.

With respect to design recommendations for children, Soni et al. [3] created a set of guidelines – the TIDRC-framework. Building on evidence-based studies, the authors created their own framework consisting of 57 recommendations elicited from the literature. The recommendations were grouped into categories important within the field of child development: cognitive, physical, and socio-emotional abilities, considering children in the age-span 2 to 11 years.

V. Developing a New Framework Targeting Educational Games for Children

Guidelines regarding games, game-based learning, and child-computer interaction are all well documented areas. Yet, it is more difficult to find guidelines that combine these areas, which are all relevant when developing and designing educational games for children. The early and frequently used game theories MDA [17], DDE [1], and DPE [2] work well for breaking down game elements to understand their components and functions [2]. The game-design part of the guidelines in this work is mainly inspired by the DDE- and DPE-frameworks. Other important insights have been obtained by analyzing guidelines for educational games and game-based learning, which narrows down the general game-design principles even more. Designing for children is, however, different to designing for adults [17].

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Therefore, it was also of interest to examine the literature about child-computer interaction.

Guidelines from the literature were collected continually into a 3x4 table. The guidelines were structured into specific columns based on the area to which they belonged, either game-based learning or child-computer interaction. Further, these columns were separated by rows to sort the guidelines into specific aspects of game design. The left-most column categorizes the guidelines into game design within the areas of Design, Dynamics, and Experience [10]. This column, describing educational games, suggests guidelines specifically elicited from game-based learning theory. The column named child-computer interaction suggests design recommendations specifically aimed for children as users. A compressed version of the constructed framework is presented in Table 1 below.

TABLE I. COMPRESSED VERSION OF THE THEORETICAL FRAMEWORK OF DESIGN PRINCIPLES FOR EDUCATIONAL GAMES AND CHILD-COMPUTER INTERACTION.

Guidelines within:		A. Educational games	B. Child-computer interaction
Game Design	Design		
	Dynamics		
	Experience		

Design: The first row describes all components and design choices implemented in a game that are under direct control of the designer. Examples of such components are colours, characters, and story elements incorporated in quests and obstacles.

Dynamics: In the second row of the table, guidelines within dynamics and interaction are given. Dynamics within a game refer to the runtime behaviour of the implemented design-components when input is given from a player. One common example in games is when the player can collect money or select clothes for its avatar.

Experience: The last row provides guidelines within the area of Experience within game design. As other game design researchers [1][2][17] have renamed the "Aesthetics" area of MDA in their framework, the same adjustment has also been implemented in this framework. Experience in this framework stands for, as the title implies, the experience and reactions of the player.

VI. EVALUATING THE FRAMEWORK

Within an ongoing project, an application for children to be used before undergoing an MRI-scanning procedure was developed. By preparing children in their home environment, the amount of sedation can be lowered and through that, the discomfort of patients is reduced, as well as the costs associated with preparing and sedating children. The application COSMO@HOME consists of games and interactive exercises to prepare the children, and to convey important learning goals. For example, increase the understanding of the size of the MRI-scanner and its sounds, the need for lying still for a long period of time, and information about not being allowed to bring metal objects into the MRI-scanner.

The framework was evaluated and tested on the COSMO@HOME application to investigate how useful and usable the framework was. A walkthrough of the application was conducted by an expert by reviewing and comparing the application with the guidelines. User testing with children was continually made within the COSMO@HOME project. In April 2020, user testing was conducted by the project group at the University Hospital Leuven (KU Leuven). Eight children participated in the user tests, ranging from four to nine years old. The average age of the children was 6.5 years. Results from the tests have been examined to detect possible similarities between the findings from the walkthrough and experiences from the user tests. Finally, interviews with two game designers/developers within the COSMO@HOME project were made to obtain further insights about the framework.

To highlight the implications, that the evaluations had on the framework, the outcome of the evaluations is presented in relationship to the different aspects of the framework. Topics that were brought up during the interviews were mainly in the areas of designing for children and learning through games. The interviewees also evaluated the framework and provided feedback about structure and applicability. Based on the findings from the different evaluation methods, a new version of the framework was created to increase the usability of the guidelines.

The experience from the walkthrough showed that most of the guidelines were applicable to the application. However, some guidelines were easier to apply than others, which was also pointed out by the interviewees. The guidelines that had more concrete recommendations – for example, "Avoid too-small targets, especially on the edge of the screen" – were easier to identify with regard to whether the application met the recommendation or not. More abstract guidelines, such as "Incorporate a reasonable level of challenge; not too easy or too hard" or "Designers should be aware of individual differences and preferences", were more challenging to apply. The perception of these guidelines can be both subjective and dependent on the intended user group; although it was possible to reason about the guideline with respect to the application, it was harder to clarify whether the recommendations were met or not.

The experience of evaluating the application via the walkthrough was that written guidelines can be applied and used to reason about design choices in educational games for children, and that concrete recommendations are easier to apply. Although more abstract or generic guidelines can work as good reminders or aspects to reason about, it is harder to answer whether such a recommendation is met or not.

To create a framework of guidelines that can be used in an easy and accessible way by designers was also an

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important aim of this study. By applying the framework to the application, important indications were given about which design choices of the framework and updates of guidelines should be made to make them easier to use.

The first version of the guidelines consisted of 17 guidelines within educational games and 25 guidelines within child-computer interaction, to give a total number of 42 guidelines. The guidelines were divided into two columns in the two research areas. The number of guidelines and the distribution of these into two columns, which spanned over three pages, were not favourable for giving a good overview of the framework. To create a more usable and accessible framework, some guidelines were excluded, and some were pulled together to compress the first version of the framework.

The columns in the framework worked well to clarify which guideline corresponded to which research area – either educational games or child-computer interaction. However, many of the guidelines acknowledge similar aspects, and the benefit of dividing the guidelines in the framework was not particularly useful when applying to the evaluation. Therefore, another improvement for the updated framework was to merge the current columns into one. The order in which the guidelines were presented by the game design components: *design, dynamics,* and *experience* was changed to start with recommendations that were more abstracts or generic, and end with more specific guidelines. The new version of the guidelines instead followed the order: *experience, dynamics,* and *design.* To summarize, updates regarding the design and formulations of the guidelines for the second version were:

- New order of game design components into experience, dynamics, and design.
- A merging of the two columns and presenting the guidelines together.
- Grouping of similar guidelines near each other to improve the structure of the framework.
- Summary of recurrent guidelines to shorten the framework and not to repeat concepts.
- Reformulation of some of the guidelines to provide a better understanding.
- New layout of the framework to improve the overview.

Changes according to the bullets mentioned above resulted in a new version with 24 guidelines presented as the Educational Games for Children (EGC) framework; see Figure 1.

VII. Discussion

In this work, theories and guidelines from 16 peer reviewed publications within the field of games, game-based learning, and child-computer interaction were combined into a new framework in the specific field of educational games for children, called the EGC-framework. The final product presents 24 guidelines in an accessible format, concerning important aspects to consider for educational games with children as users.

One of the main challenges was to combine and design a framework that incorporates the three different research fields that are all relevant for educational games targeting children. To make the framework easy to use and follow, it was decided not to group the guidelines with respect to their research fields, but rather to which aspect within a game they refer to.

It is important to keep in mind that the framework is not intended to be used as a checklist but rather as a means to reflect and be aware of aspects to consider when developing educational games for children. However, it can give an indication of how well a game meets these recommendations, and detect which aspects could be given further consideration. The guidelines are intended to give advice based on previous research, and it is possible to apply them before, after, or during game development.

VIII. Conclusion and Future Work

In conclusion, this work suggests that it could be beneficial to combine guidelines and theories from different areas. The walkthrough showed that it worked well to apply the framework of design guidelines in the development of an educational game for healthcare, and that it was also possible to evaluate how well the game met the recommendations.

Moreover, findings from the user tests conducted at the University Hospital Leuven supported several aspects and findings that were also acknowledged by the walkthrough. Through interviews with designers/developers within the COSMO@HOME project it was confirmed that the framework is able to provide insights and acknowledge aspects when developing an application within this particular field.

One final important conclusion is that the framework should not be seen as a checklist but rather as a way in which to reflect and acknowledge important aspects within game-based learning and child-computer interaction.

A next step is to evaluate the framework based on the field trials with the children in the COSMO@HOME project. Another next step to further develop the framework is to systematically review it in future projects. This could be done by letting developers use the framework when designing a game within the field, and continuously evaluate the usefulness and usability of the framework. Interviews could be conducted to get concrete feedback, and after being updated, another usability test of the framework could be performed. Future research within the field of educational games for children can contribute with further recommendations, but also broaden the field by including different aspects, for example, regarding research about socio-emotional needs in relationship to social interaction and social sharing.

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DESIGN-GUIDELINES FOR EDUCATIONAL GAMES FOR CHILDREN

EXPERIENCE

1) Consider the intended learning goals of the game early in the development process.
2) Designers should be aware of individual differences and preferences to address self-expression and engagement.
3) Provide the feeling of control to empower and engage the player.
4) Implementing fantasy and roleplay creates enjoyment and the feeling of escapism which in turn can support engagement and learning.
5) The cultural context of the end users should be considered.

DYNAMICS

6) Provide clear goals and rules within the game.
7) Provide choice to address engagement but make sure it is balanced within the game.

Cognitive aspects

8) Provide scaffolding & guidance with positive feedback and feedback by giving hints, tips and tricks. Provide immediate feedback to avoid impatience.
9) Show current state for when the system is processing (buffering) or when the system is waiting for input to avoid impatience.
10) Provide customization to enhance intrinsic motivation and self-expression.

DESIGN

11) Use rewards to motivate and engage but be careful with too frequent rewards not to overweight the intrinsic motivation. Do also make sure to balance the number of rewards along the gameplay and the level of challenge or when the learning curve is steeper.

Motor aspects

12) Touchscreen is a good choice for younger users rather than a computer and mouse interaction.

Gestures

13) Use consistent gestures throughout the app.
14) Avoid too small targets, especially on the edge of the screen. Do also provide enough of distance between targets and increase the active area around them.

Avoid gestures as:

a. *drag & drop* (use "sticky-drag-and-drop" instead.
b. *rotate, pinch* and *spread* for younger users <4.
c. *double tap* gesture or allow longer delay between the taps.

Accept gestures as:

d. partial gesture completion, single- and multi-touch.

Cognitive aspects

15) Design buttons and clickable items in a 3D- or a clickable-looking way to differentiate these from the background by using different colors and outlines.
16) Avoid visually complex backgrounds as it can create confusion and use a neutral color palette to lower the cognitive load.
17) Limit the behavior of interactive elements to their sole purposes not to draw attention from their core functions.
18) Use content specific metaphors and meaningful icons and minimize abstract concepts (e.g. "left" and "right") or symbols.
19) Avoid menus and submenus as it can be challenging for children in the pre-reading age and difficult to understanding this kind of navigation.
20) Entertainment "click-ons" and hotspots can keep the child engaged and entertained between tasks but use these carefully as they may distract from learning.
21) Use good quality audio and visual cues instead of text to support understanding. Audio supported by animations can help to uphold the attention.
22) Expand the complexity and the level of challenge along the users learning curve in order to optimize learning. Provide levels to increase challenge in a natural way.
23) Preschoolers tend to appreciate challenge with short term awards (e.g. collecting items rather than longer problems/quests with long term rewards).
24) Three-dimensional images and virtual worlds can teach and let children explore new environments and objects.

Figure 1. The updated version of the guidelines – the Educational Games for Children (EGC) framework

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