Towards a Framework for Design Guidelines for Young Children's Computer Games

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Abstract. This paper describes a number of general design problems with adventure-like computer games for young children in order to demonstrate the need for specific design guidelines for this type of products. These problems were experienced by children participating in a number of user tests of existing computer games. By providing a generalization of these problems some first directions are given for the nature of the design guidelines that could be developed. Furthermore, a first proposal for a unifying framework to organize these guidelines is given.

1 Introduction

Computer games form a major part of the software market nowadays, and for young children (educational) games are probably even the biggest component of this market. The first experience with the computer for young children is also likely to be the playing of an (educational) game. Because this first experience can influence the attitudes of children towards computers it is very important to pay attention to the quality of these games. One way to enhance the quality of a game is by user testing it with real children from the envisioned user group. An additional way to ensure the quality is by translating the findings of these user tests into design guidelines or heuristics, and using these guidelines as input for the design process. Some well-known heuristics for work-related products are, for example, those of Nielsen [1] and Shneiderman [2]. Gilutz and Nielsen [3] created a highly detailed set of dedicated design guidelines for children's websites. Other guidelines focus specifically on the design of computer games, for example those created by Lepper and Malone [4], Pagulayan et al. [5], and Shelley [6]. Some of these guidelines, like Lepper and Malone's, focus primarily on creating fun or motivation in games and focus less on usability aspects of games. However, usability is an important prerequisite for pleasure [7]. As Pagulayan et al. [5] wrote: 'The ease of use of a game's controls and interface is closely related to fun ratings for that game. Think of this factor as the gatekeeper on the fun of a game'. Or as Clanton [8] stated: 'Problems should be in the game play, not in the interface, or game mechanics'. Other guidelines do focus on both fun and usability but are rather high level, for example Clanton's guideline 'Make it easy to learn' [8]. With guidelines at this level it is still difficult to determine

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the concrete implementation in a game for a specific user group such as young children.

We think there is a need for detailed design guidelines for computer games for young children that enable designers to create both easy to use and fun products. To illustrate this we will discuss some examples of types of problems in this paper that are specific for computer games for young children. Furthermore, it is important that all guidelines are organized into a manageable framework [9], which keeps the relationship between these guidelines and an underlying theory about user system interaction. In this way it is much clearer which existing guidelines can be used, where they need to be made more specific for this type of product and user group and where possible gaps are. For designers it also provides an easy overview of all guidelines. The unifying framework that we propose is based on Norman's [10] theory of action model. This theory of action model is commonly used for the evaluation of non-entertainment products for adults but will be used in a novel way to help evaluate computer games for children and structure the design guidelines.

In the following sections we will first give some typical examples of problems in computer games for young children to illustrate the need for specific guidelines. Although (variants of) these problems can also be found in computer products for adults, the impact of these problems is often quite different for children and the solutions are not necessarily the same as for adults. Subsequently, we will describe the unifying framework to organize these guidelines, illustrated with further examples.

2 Age Group and Type of Games

In this paper we focus on computer games for children in the group 3 and 4 of primary school, around 5 to 7 years according to the Dutch school system. Many of the computer games for this young age group are adventure games. Prensky [11], a researcher of education through games defines adventure games as 'find your way around the unknown world, pick up objects, and solve puzzles' games. In this type of games children have to play a number of sub games in order to reach a certain goal. These sub games sometimes have an educational character, like choosing the right emotion to express how Grover is feeling in 'Sesame Street: Reading with Grover' ('Sesamstraat Lezen met Grover ©' in Dutch [12]), but they can also be more motor skill based, like saving the rabbit by clicking the wolves before they can eat it.

3 Examples of Problems in Games for Young Children

Our research group examines ways to evaluate children's computer products with children [13-15]. For this purpose we have tested a wide range of computer games over the last few years according to several different evaluation methods with children [14; 16]. Some of these games were tested with over thirty children, others were tested with fewer children but showed the same types of problems. Based on our experience we have selected some of the most salient examples of types of usability

problems experienced by young children. These problems include issues related to starting up and closing down games, user/character perspective, cursor shapes, and modalities. While we are aware that for every problematic example we present there are numerous good design examples, we are convinced that specific design guidelines will contribute to even higher quality games. By using examples of problems in existing games we could give the impression that these games are not usable or fun to play. This is not our intention; by pointing out these problems in this article we would just like to illustrate the need for specific guidelines and a unifying framework without giving an overall judgement of the quality of any of the mentioned games.

3.1 Starting the Game

Many of these adventure-type games have an option to save the game. It is therefore possible that the player wants to open one of the saved games. When a game is started for the first time, a question like: 'Do you want to start a new game?' is often posed to distinguish between starting a new game and an already saved game. However, children often think that this question means: 'Do you want to play another game than this one?' Therefore they will answer 'No'. A reason for this misunderstanding could be that many children do not yet know that it is common to have saved games and that the game itself also does not make this clear before posing the question. Guidelines for starting a game should make the designer aware of the level of computer literacy and game experience that can be expected of this age group.

3.2 Perspective and Indirect Manipulation

Many adventure-type games apply one or more characters that the child has to help to achieve a goal. For example, in 'Milo and the magical stones' ('Max en de toverstenen ©' in Dutch [17]) the child has to help Milo and his friends to find magical stones on an island, and in 'Robbie Rabbit: Fun in the Clouds' ('Robbie Konijn: Pret in de wolken' in Dutch [18]) the child has to help Robbie and his friend Sam to prevent an island in the clouds from collapsing under a load of raingear. The characters are usually visible in the screen as companions, so it is clear that the child him/herself is not the character. However, in many games the instructions do not always maintain this separation between the character and the child. For example, in 'Milo and the magical stones' the child is instructed to 'catch the flies by jumping from one water plant leave to the next when a fly is in front of you'. To many children it is unclear that actually Milo has to jump the leaves, resulting in many children trying to catch the flies directly with the cursor without using Milo (see figure 1).

Guidelines about the wording of instructions to clarify the perspective could prevent designers from making such mistakes. However, clarifying the perspective is not always enough. In the above mentioned example, during a user test children were made aware of the fact that Milo was the one who had to catch the flies. Although this explanation helped many children for a while in trying to move Milo, there still was a tendency to return to trying to catch the flies directly by clicking them with the cursor, something that adults are less likely to do. It seems that this indirect way of

manipulation is too unclear for some of the children, especially when there are moving objects attracting their attention. Guidelines for the appropriate level of (in)directness for manipulation for this age group should help designers.

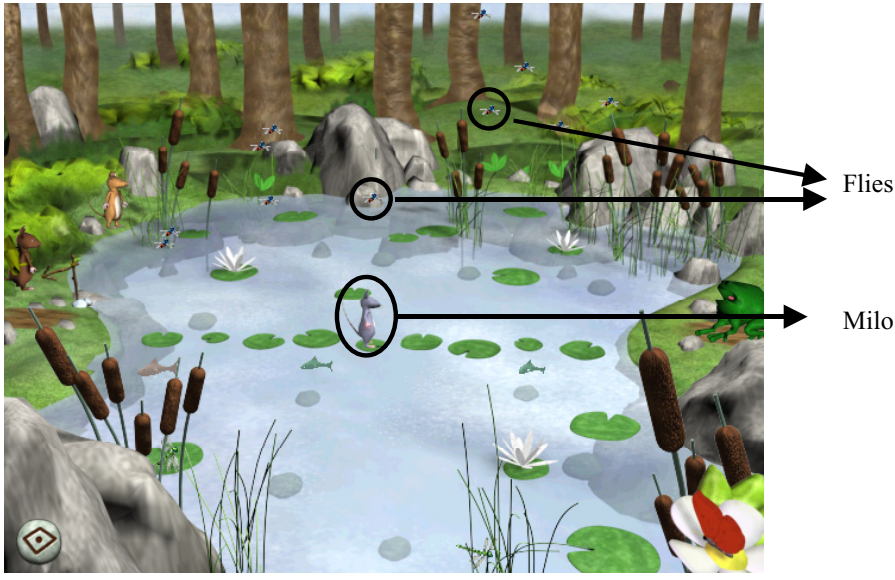

Fig. 1. Children have to make Milo jump to the next water plant leave when one of the flies is in front of him. By doing this Milo will catch the fly. Instead the children just keep clicking the flies with the cursor. (Milo and the magical stones ©)

3.3 Cursor Shapes and Hotspots

Some games apply an alternative cursor-shape that is related to the game environment, for example a snake or some other animal. Normal arrow-shaped cursors have as their activation point the arrow tip, which is usually in the upper left corner. For these differently shaped cursors the actual activation point does not always comply with the perceived activation point. For example, in 'Milo and the magical stones' the cursor is shaped like a ladybird with the feelers as activation point (see figure 2). However, most children in our user tests used the body of the ladybird as the activation point, resulting in numerous wrong clicks and frustration about why the clicking did not result in any action. Some children even adopted a strategy of clicking so rapidly and wildly around the objects that they complained about an aching hand and had to shake it from time to time.

Of course, when the hotspots of the objects that have to be clicked are large enough there is probably less of a problem with such a cursor shape. Although adults may have the same problem with this type of cursor, children seem not to be able to overcome this problem on their own while adults can adapt their strategy more easily. Therefore, specific guidelines for children about the combination of cursor shape and the size and shape of the hotspots of objects should be created.

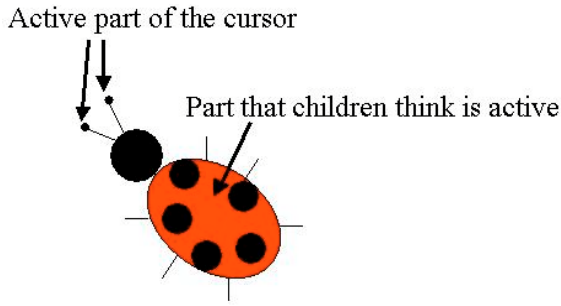

Fig. 2. Ladybird shaped cursor in which the actual activation point is different from the perceived activation point.

3.4 Modalities

Computer games for young children usually use mouse input as interaction technique. Sometimes they also require keyboard input but they are almost never equipped for speech input. Children can get quite confused about the expected modality when this is not clearly explained in the instructions that are given about how to play a subgame. For example, in 'Rainbow, the most beautiful fish in the ocean' ('Regenboog, de mooiste vis van de zee ©' in Dutch [19]) children are induced to try speech input due to the type of instruction the character gives. The character says: 'Would you help me count the scales that I still have to find?' and children spontaneously respond by starting to count verbally. While adults know this kind of input is probably not available, young children are sometimes quite confused that the computer cannot hear them. An instruction like 'Would you help me count the scales that I still have to find by clicking them?' would make the expected modality much clearer. Guidelines about how to indicate the right modality in instructions could prevent this type of problem.

3.5 Stopping the Game

Most games have some button or icon available on every screen to quit the game. Many children use this button in their search for the right way to play a subgame or to navigate to another screen. Usually, a question is asked like: 'Do you want to quit the game?' but many children interpret this question as 'Do you want to quit this *sub*game?' and because they are already puzzled about the way to play the subgame they click Yes, making them quit the whole game by accident. Guidelines that take in mind considerations about computer literacy of children should be developed about the way stop-options can be presented and explained more clearly.

4 Framework for the Organization of Design Guidelines

The examples above demonstrate the need for specific design guidelines for computer games for young children. Furthermore, there are numerous existing guidelines for other types of products and/or user groups that should be included. We propose to use a framework to organize these guidelines. There are many reasons why such a framework is useful and important. The first reason is the criticism on existing predictive methods, such as Nielsen's heuristic evaluation method.

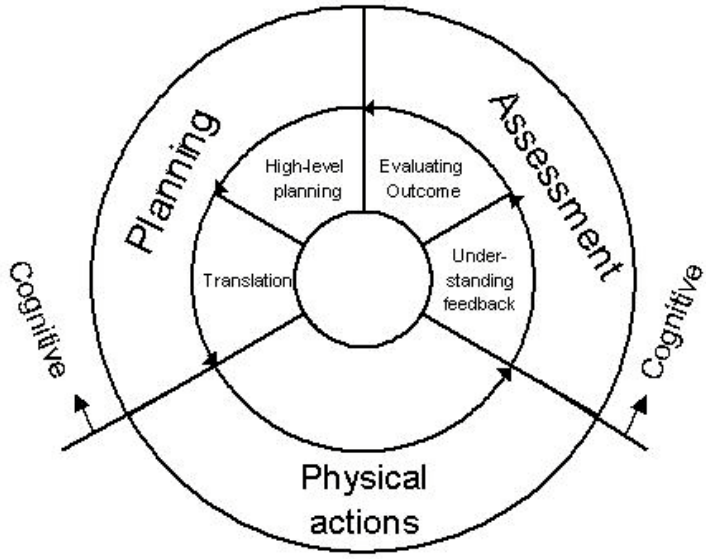

Fig. 3. The Interaction Cycle of Andre et. al's [23] User Action Framework describing how interaction between a human and any product or system happens in terms of cognitive and physical user actions.

The main point of critique to Nielsen's method is that the set is not clearly related to theory and that the rules are ambiguous and hard to interpret. A framework helps to keep the relationship between the guidelines and the underlying theory about user system interaction. The second reason is that the application of guidelines used for evaluation purposes relies heavily on the knowledge of the experts applying them [20]. By providing the experts with structured knowledge about the interaction and tasks the quality of the outcome may be increased. Finally, a framework makes it much clearer which existing guidelines can be used, where overlaps exist, where they need to be made more specific for this type of product and user group, and where possible gaps are. As a basis for our framework we use Norman's theory of action model [10] which applies to the interaction between humans and almost any kind of product or system. Many researchers have used this model in various ways for similar purposes [21; 22]. One of the frameworks that use the concepts of all Norman's stages is the User Action Framework [23] (see figure 3). This framework uses an adapted

version of Norman's model, called the Interaction cycle, as an underlying structure to help think pragmatically about usability problems.

Fig. 4. The sandwich shop in 'Robbie Rabbit' where children have to buy ingredients to make a sandwich. (Robbie Konijn, Pret in de Wolken ©)

Although this interaction cycle is meant to model the interaction between a human and any kind of product or system, not specifically games, we think it can also be used for games. An example of interpreting this interaction cycle in the light of a subgame of an adventure is the following. In 'Robbie Rabbit: Fun in the Clouds' children have to buy a number of ingredients to make a sandwich (see figure 4):

- First, in the High-level planning phase, the children have to understand that the goal is to buy ingredients for the sandwich.
- In the Translation phase the children have to understand that to buy one ingredient they have to select it, put the right amount of money on the counter by clicking each coin and dragging it, and ring the bell to indicate that they are ready.
- Then the child has to actually select and drag the coins and click the bell in the Physical actions phase.
- When the child has rung the bell and the feedback comes whether the given amount of money is correct, the child has to perceive and understand this feedback in the Understanding Feedback phase
- Finally the child has to evaluate whether this is the desired outcome in the Evaluating Outcome phase.

So although the interaction cycle in the UAF is not specifically created for games, it is possible to use it to model the interaction in games. In the same way, specific guidelines for games fit well in this structure. For example, guidelines that deal with the level of indirect manipulation fit in the category Translation. In our example of a problem with indirect manipulation the child knows that flies should be caught, but the translation to the indirect manipulation by jumping with Milo from leave to leave is not clear.

4.1 What About Fun?

The examples of guidelines described above all covered aspects of making a game easy to use. However, computer games differ from productivity applications in a number of ways. One of the main differences is that games are designed to be pleasurable [24]. So, additional to the usability related guidelines we also need guidelines to help design fun. Fortunately many already exist [4; 6; 25]. The question is whether the proposed framework can also be used to organize these guidelines in order to create a complete set of guidelines to design easy to use and pleasurable games. We think it can, and even better, we think the framework can sometimes help to create much more specific guidelines. An important example of how the Interaction Cycle can help to make guidelines more specific is in the notion of Challenge. Many researchers agree that an appropriate level of challenge is one of the main aspects that make a game fun to use [4; 11; 24]. However, challenge can be created in different ways. For example by making the objects that have to be clicked very small or by letting them move very rapidly. Another example is by making the right way out of a maze not directly clear. In theory it is possible to create challenge by making any of the phases in the interaction cycle difficult. The first example is challenge created at the **'Physical actions'** level while the second example is challenge at the **'Translation'** level.

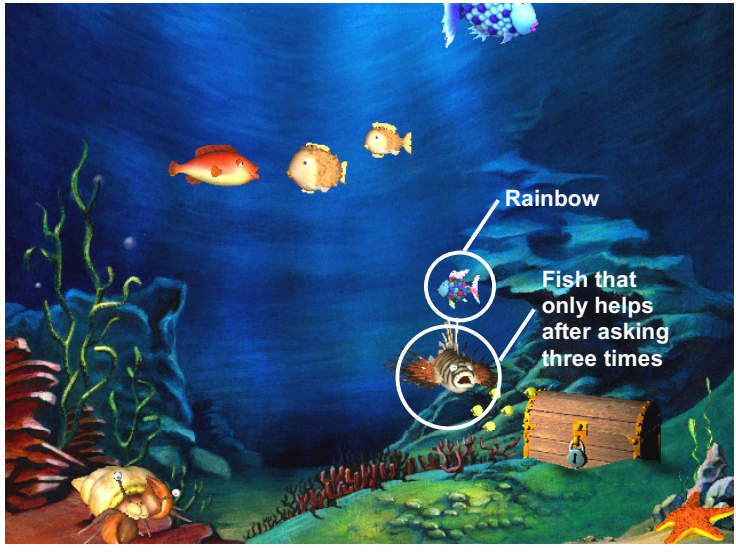

Fig. 5. Screen with fishes that have to be clicked to go to other parts of the game. While most of the fishes will guide the user to another part of the game when they are clicked once, the circled fish will only help after being clicked three times. (Regenboog, de mooiste vis van de zee ©')

By using the interaction cycle, guidelines about the appropriate level of challenge for young children can be more specific about the different ways to create challenge. For example, it is possible to create challenge by providing feedback that makes it

difficult to determine whether the outcome is the desired outcome or not. In 'Rainbow, the most beautiful fish in the ocean' children have to click one of the navigational fishes three separate times to make it help them to go to another screen. The first two times that the child clicks the fish it says: I don't want to help you because I am hungry'. Children understand this feedback properly and conclude that by clicking this fish they will not get the desired outcome. However, the third time this fish is clicked it will be helpful, but the children have usually given up on trying to get help from this fish (see figure 5).

So, in this particular game, challenge is created by making the **'Evaluating outcome'** phase difficult. However, it is debatable whether this is the best way to create challenge for children at this age.

The Interaction Cycle helps to think of the different ways to create challenge and the specific guidelines for different kinds of challenge.

4.2 Adaptations to the Interaction Cycle

To make the Interaction Cycle more specific for use with games we propose to change some of the wording and split one of the phases in order to emphasize some parts of the cycle that are especially important for games. This adaptation is shown in Figure 6. The first change is the wording of the phase **'High level planning'** into **'Determining goal'**. For games goals are extremely important, especially to create challenge. In productivity applications goals are often defined externally, whereas games define their own goals. This implies also that goals should be clear and interesting to the user at all times. Some examples of games in which the goals are not always clear are 'Oscar the balloonist and the secrets of the forest' (Oscar de ballonvaarder en de geheimen van het bos ©' in Dutch [26]) and 'Witchstuff - With Hennie the Witch and the cat Helmer' ('Heksenspul - Met Hennie de Heks en de kat Helmer ©' in Dutch [27]). In 'Oscar' children can find information about different animals by clicking the animals in a forest. This is necessary to be able to play some games about what the animals are eating or when they are sleeping. However, this goal is not made clear beforehand so the children don't know why they should want to gather this information.

In 'Witchstuff' children can click objects in the rooms of Hennie's house. These objects then make a funny sound and show a little animation but there is no reason to click these objects other than that. One child in our test sessions therefore complained 'Actually, you cannot do anything here!'

By changing the wording of this phase from **'High-level Planning'** into **'Determining Goal'** the necessity of providing clear and interesting goals is made clearer. The other change in the Interaction Cycle is the addition of the phase **'Assess motivation to go on'**. While this assessment could be part of the phase **'Evaluating Outcome'** we feel it is important to make it more explicit. In games it is possible that although the user knows how to reach a goal he/she decides that reaching the goal is boring, too time-consuming or too stressful. In productivity applications, like for example a word processor, this is much less likely. An example of this assessment can be found in our test sessions of the educational adventure game 'World in Numbers,

The Fun-fair' ('Wereld in Getallen, Het Pretpark ©' in Dutch [28]). In this game, children have to perform three screens of arithmetic operations in order to help a ticket officer clean up his room. Some children in our tests, although able to perform the necessary arithmetic, stopped after one or two screens because they decided it took too much time to reach the end goal.

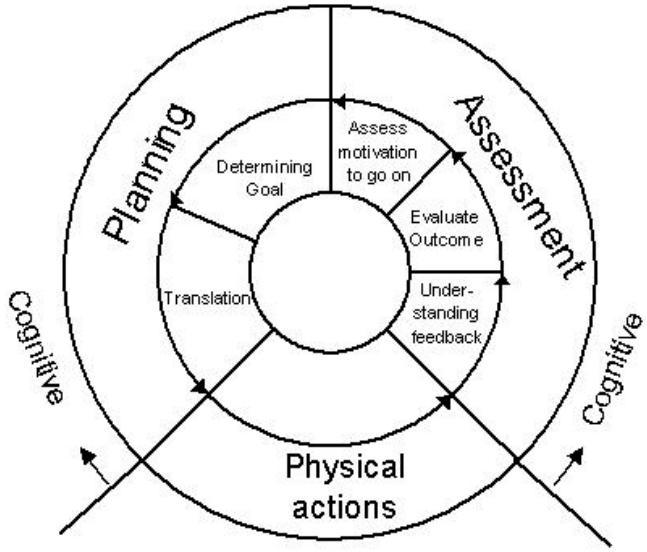

Fig. 6. Adapted Interaction Cycle for games describing how the interaction between a user and a computer game happens in terms of cognitive and physical user actions.

5 Discussion and Conclusions

Based on our experience we have argued for the need of specific guidelines for children's computer games. Subsequently, we suggested an integrated framework for organizing both usability and fun guidelines based on Norman's theory of action model. These guidelines can be either new or more specific guidelines for the user group, like the ones proposed in this paper, or existing guidelines [1; 2; 4; 8]. Although we propose to use this framework for adventure type computer games for young children it should be applicable for other types of games and user groups as well. For example, consider applying it to the design of a racing game:

- First, it must be clear what the goal is, for example reaching the finish first, or within a certain time, and/or with the highest score.
- Second, it must be clear how one should control the car to reach the goal, e.g. what is left, right, faster, slower etc.
- Next, the physical actions to control the car need to be performed. This is probably the most important challenge of the game.

- Then the feedback whether the car is moving, which way it is moving, or what is going wrong should be understood. E.g. after having slipped it should be clear which way to drive to reach the finish.
- Then the outcome should be evaluated: Am I taking the right steps towards the goal?
- Finally, the user should be able to assess whether the goals are reachable within the amount of time the user wants to spend on trying and practicing.

For different age groups it is likely that specific guidelines that relate to cognitive, emotional, and physical aspects of the age group should be adapted. However, the global organization of the guidelines in terms of the Interaction Cycle remains the same.

Finally, the way to represent the guidelines in this framework depends on the envisioned use, for example as an evaluative tool or as a design tool. Designers and evaluators are not necessarily the same people with the same background or the same working process. Therefore, more research on the best way to present the information for the different purposes of the framework is necessary. The way in which we want to proceed in developing this framework is in combination with a structured method for usability experts to evaluate games for children.

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References

1. Nielsen, J.: Usability Engineering. Boston: Academic Press Inc. (2003)
2. Shneiderman, B.: Designing the User Interface: Strategies for Effective Human-Computer Interaction. Reading, Mass.: Addison-Wesley. (1998)
3. Gilutz, S. & Nielsen, J.: Usability of Websites for children: 70 design guidelines based on usability studies with kids.(2002)
4. Malone, T. W. & Lepper, M. R.: Making learning fun: a taxonomy of intrinsic motivations for learning. In R.E.Snow & M. J. Farr (Eds.), Aptitude, Learning and Interaction III Cognitive and Affective Process Analysis. Hillsdale, N.J.: Erlbaum.(1987)
5. Pagulayan, R. J., Keeker, K., Wixon, D., Romero, R., & Fuller, T.: User-centered design in games. In J.Jacko & A. Sears (Eds.), Handbook for Human-Computer Interaction in Interactive Systems. Mahwah, NJ: Lawrence Erlbaum Associates.(2003) pp. 883-906
6. Shelley, B.: Guidelines for Developing Successful Games. http://www.gamasutra.com/features/20010815/shelley_01.htm . 15-8-2001.
7. Jordan, P. W.: Pleasure with Products: Human Factors for Body, Mind and Soul. In W.Green & P. Jordan (Eds.), Human Factors in Product Design: Current Practise and Future Trends.. Taylor & Francis UK.(1996)
8. Clanton, C.: An Interpreted Demonstration of Computer Game Design. Proceedings of the conference on CHI 98 summary: human factors in computing systems. (1998) pp. 1-2

9. Hartson, H. R., Andre, T. S., Williges, R. C., & Rens, v. L.: The User Action Framework: A Theory-Based Foundation for Inspection and Classification of Usability Problems. HCI International 99. Munich, Germany: Aug 99. (1999)
10. Norman, D. A. & Draper, S. W.: User centered system design : new perspectives on human-computer interaction. Hillsdale: Erlbaum. (1986)
11. Prensky, M.: Digital game-based learning. New York: McGraw-Hill. (2000)
12. Sesamstraat: Lezen met Grover (Sesame Street: Reading with Grover) . [Computer software] TLC Domus (1999)
13. Bekker, M. M. & Kersten-Tsikalkina, M.: Evaluating Usability and pleasure of children's products. Proceedings of International Conference on Affective Human Factors Design. Singapore. (2001)
14. Barendregt, W., Bekker, M. M., & Speerstra, M.: Empirical evaluation of usability and fun in computer games for children. Proceedings of Interact Conference 2003. Zürich, Switzerland. (2003) pp. 705-708
15. Markopoulos, P. & Bekker, M. M.: On the assessment of usability testing methods for children. Interacting with Computers, 15(3), 227-243. (2003)
16. Bekker, M. M., Barendregt, W., Crombeen, S., & Biesheuvel, M.: Evaluating usability and fun during initial and extended use of children's computer games. Proceedings of the BCS-HCI, September 2004. Leeds. (2004)
17. Max en de toverstenen (Milo and the magical stones) . [Computer software] MediaMix Benelux (2002)
18. Robbie Konijn, Groep 3: Pret in de Wolken (Robbie Rabbit, Group 3: Fun in the Clouds) . [Computer software] Mindscape (2003)
19. Regenboog, de mooiste vis van de zee (Rainbow, the most beautiful fish in the ocean) . [Computer software] MediaMix Benelux (2002)
20. Cockton, G. & Woolrych, A.: Understanding Inspection Methods: Lessons from an Assessment of Heuristic Evaluation. In A.Blandford, J. Vanderdonckt, & P. D. Gray (Eds.). Springer-Verlag.(2001) pp. 171-192
21. Sutcliffe, A. G., Ryan, M., Doubleday, A., & Springett, M. V.: Model mismatch analysis: towards a deeper explanation of users' usability problems. Behaviour & Information Technology, 19(1), 43-55. (2000)
22. Vermeeren, A. P. O. S., den Bouwmeester, K., Aasman, J., & de Ridder, H.: DEVAN: a detailed video analysis of user test data. Behaviour & Information Technology. (2002)
23. Andre, T. S., Hartson, H. R., Belz, S. M., & McCreary, F. A.: The User action framework: a reliable foundation for usability engineering support tools. Int.J.of Human-Computer Studies, 54, 107-136. (2001)
24. Pagulayan, R. J., Steury, K. R., Fulton, B., & Romero, R.: Designing for fun: User-testing case studies. In M.Blythe, K. Overbeeke, A. Monk, & P. Wright (Eds.), Funology: From Usability to Enjoyment. Kluwer Academic Publishers.(2003) pp. 137-150
25. Federoff, M. A.: Heuristics and usability guidelines for the creation and evaluation of fun in video games Msc Department of Telecommunications of Indiana University. (2002)
26. Oscar en de geheimen van het bos (Oscar the balloonist and the secrets of the forest) . [Computer software] Lannoo (2000)
27. Heksenspul - Met Hennie de Heks en de kat Helmer (Witchstuff - With Hennie the Witch and the cat Helmer) . [Computer software] Karakter Interactive (2002)
28. Wereld in getallen, Groep: 3 Het Pretpark (World in numbers, group 3: The Fun-fair) . [Computer software] Malmberg Uitgeverij (2003)