Is edutainment software really educational?

A feature analysis of Dutch edutainment software for young children

This study examines the educational power of edutainment software for young children. A theoretically justified checklist is presented, based on literature about characteristics of powerful learning environments. The checklist can be used to evaluate characteristics of edutainment (online) games for children in order to obtain an overview of the power of educational software as a powerful learning environment. Eight Dutch edutainment games for young children were selected based on two criteria: the educational aspect of the game and the child's recommended age. This article suggests that current Dutch edutainment software does not seem to meet the theoretical requirements for powerful learning environments. The current checklist can help designers of new edutainment games to improve the educational quality of edutainment software.
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Thirty years ago educators and technologists discovered the educational power of computers (Bryce & Rutter, 2003). As a consequence, new educational computer programs for young children have been developed, also called: 'educational software' or 'edutainment software'. 'Edutainment software' is a contraction of education and entertainment. It means that learning takes places through software that both educates and entertains (Egenfeldt-Nielsen, 2007).

Edutainment software relies heavily on technology, especially computer software (Rapeepisarn, Wong, Fung, & Depickere, 2006). It usually exists in the form of educational electronic games aimed at teaching and learning concepts and processes. It is a game genre that heavily relies on visuals and narratives or game formats, but also incorporates some type of learning objective, for example concepts and processes (Buckingham & Scanlon, 2000; Okan, 2003). The purpose of edutainment is to attract and hold the attention and high motivation of the learners by means of a computer monitor showing rich displays of vividly coloured animations (Embi & Hussain, 2005), in order for learning to take place.

Parents of young children are encouraged to believe that edutainment software stimulates the development of their children's skills (Okan, 2003). Edutainment is therefore advertised as a meaningful experience for young children, because the aim of edutainment is playful learning of one or multiple skills in a particular developmental domain. Edutainment learning depends on the belief that learning is 'fun'.

Many designers of edutainment software for young children (preschool children) claim that their software is beneficial for the development of specific or multiple skills in children. Edutainment software frequently provides messages such as: 'develop preschool skills: vocabulary, early reading, numbers and counting' or 'discover and learn: letters, shapes, colours, cause and effects and memory skills' (for example Disney, 2007; Go Diego Go, 2008). The

marketing often suggests that learning can be fun and that edutainment offers a technology in which playful learning can take place.

However, it is currently still largely unclear whether software for young children that claims a learning effect is really educational and really provides a playful and at the same time powerful learning environment for children. For that reason, it is important to investigate whether the claims of the game designers are empirically supported. Given the wealth of available edutainment software, it is almost impossible to study the effects of each software product. We suggest that a good way of making a preliminary selection of educationally promising edutainment is to first check to what extent a particular software product complies with a number of theoretical criteria for powerful learning. By way of a working definition, we describe powerful learning as learning that takes place effectively and efficiently, leading to permanent increases in relevant and usable knowledge and skills that stimulate and support further learning.

The aim of our paper is firstly to present and theoretically justify a checklist, mainly based on literature about characteristics of powerful learning environments, containing criteria according to which edutainment software can be classified as a more or less powerful learning environment, aimed at achieving powerful learning in young children. Secondly, we will describe how the checklist has been used in a pilot study, evaluating characteristics of Dutch edutainment (online) games for children (between six months and six years) to obtain an overview of the power of educational software as a powerful learning environment.

Characteristics of powerful learning in preschool children

Learning is a complex phenomenon. It can be defined as a relatively permanent change of behaviour or behavioural modification. Learning is a process by which an organism's behaviour is modified. These changes can be more or less permanent and cannot be attributed to maturation, but to exercise or experience (Keller & Werchan, 2006; Smolak, 1986). Learning can also be defined as the act, process, or experience of gaining knowledge or skill, gained in many contexts, for example school or family. It can be seen as a constructivist process: learning is enhanced when the learner actively engages with the content (Elliott, Kratochwill, Littlefield-Cook, & Travers, 2000). Knowledge is built by the learner and not simply supplied or transmitted by the teacher. The building of knowledge can be stimulated by a number of teaching strategies: learning best occurs when children engage in activities that are at the peak of their abilities, when they have to work to their full potential to accomplish a task.

Many factors influence a learning process, for example emotional, motivational, social and cognitive components (Birenbaum, 2003; Howard, Morgan, & Ellis, 2006; Langelier & Connell, 2005). However, there is one major force in learning: social interaction (Vygotsky, 1978). Social contexts are important in learning: they can present new information that may be inconsistent with the child's existing knowledge structures. The central feature of a social learning context is that it provides adaptive, learning-oriented interaction and feedback. For this reason, learning profits from interactions with peers, parents or teachers, but also from human-machine interaction. New structures can be constructed and existing knowledge can be adapted (Birenbaum, 2003).

In Guralnick's (2005) model of factors influencing children's developmental outcomes, family patterns are seen as primarily responsible for child outcomes. An important property of such patterns is the family-orchestrated child experiences, which are defined as things families do to provide meaningful experiences for children. Such orchestrated experiences are responsible, conditional or beneficial for developmental outcomes in children (Guralnick, 2005). Families can provide the child with learning experiences by creating and maintaining the opportunity of developmentally adequate human machine interaction, for example through the internet or computer games. The genuinely social nature of interactions, however, provides an additional value to the machine-based opportunities. In particular, collaboration fosters the learning process of both less and more advanced learners: children tend to perform better in pairs than if they work alone (Lehtinen, 2003).

Social interaction fosters the learner's engagement in particular if it takes place in an environment with playful learning characteristics. Play contexts are environments that strongly engage the learner, and learner engagement is positively related to learning success (Herrington, Oliver, & Reeves, 2003; Kearsley & Shneiderman, 1998). Engagement can be defined as the active focus and energetic involvement with a task. Playful learning characteristics engage or motivate children and these children achieve earlier or better school readiness (Diamond, Barnett, Thomas, & Munro, 2007). Playful learning characteristics therefore foster powerful learning, in that they encourage academic exploration and actively engage children. Development of language, acquisition of emergent literacy skills, capturing attention and knowledge of maths are supported

through play and through guided playful learning (Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009). The National Association for the Education of Young Children (NAEYC) notes that play 'provides a context for children to practice newly acquired skills and also to function on the edge of their developing capacities, to take on new social roles, attempt novel or challenging tasks, and solve complex problems that they would not (or could not) otherwise do' (Hirsh-Pasek et al., 2009, p.23).

An important predictor of powerful learning is the child's ability to self-regulate its actions (Slavin, 2009). Self-regulation or cognitive control (such as goal setting, planning, listening to directions, paying attention or solving a task without continuous supervision) predict academic achievement from preschool to high school (Diamond et al., 2007). Learning self-regulatory skills requires having goals and motivation to attain goals, and learning of this takes place through play (Boekaerts, 1995; Diamond et al., 2007). In this respect, it is important to note that Blair and Razza (2007) have clearly demonstrated the importance of play for teaching preschool children to regulate their own behaviour, thus showing that early playful learning can make a strong contribution to later academic performance. As mentioned earlier, social interaction (e.g. adult-guided interaction) fosters learning in children in playful learning environments (Hirsh-Pasek et al., 2009). However, this interaction should be adapted to at least two characteristics to achieve high engagement. The first aspect is that interaction or instruction should be adapted to the cognitive level and already achieved skills of the child (Vygotsky, 1978). The second characteristic is that the interaction should evoke self-sustaining interest or curiosity of the child (Csikszentmihalyi, 1990).

To begin with the first aspect, interaction or instruction must be matched with a child's cognition or developmental level. Vygotsky introduced the concept of the Zone of Proximal Development (ZPD), which is the difference of what the child can do or learn independently and what the child can do or learn with a more skilled partner (Vygotsky, 1978). Powerful learning can only take place if there is a balance between challenge and already achieved skills (the interaction takes place within the ZPD). The effectiveness of peer interaction (cooperative learning) is also supported by Vygotsky (1978). Peers usually operate within each other's ZPD; they are likely to understand the other child's reasoning process and to provide support that stimulates meaningful learning. This element of social interaction can also be present in activities other than interpersonal interaction, for example computer tools for instruction. The computer can also serve as a ZPD, thus as a 'more capable peer', in which the child is left in much freedom to explore and expend effort in the process (Salomon, Globerson, & Guterman, 1989).

As regards the second aspect, interest and curiosity are central aspects in Csikszentmihalyi's flow theory. He describes *flow* as a way to achieve powerful learning: a form of intrinsic motivation, a feeling of optimal experience (engagement in a task comes from enjoyment or satisfaction to complete a task) (Csikszentmihalyi, 1990; Davis, Bagozzi, & Warshaw, 1992). Flow can be considered 'a psychological state describing the optimal feeling of learners who are cognitively efficient, motivated and happy' (Csikszentmihalyi, 1990). Challenging activities that reach and support the learner's self-sustaining curiosity are central in flow theory. Such self-sustaining curiosity occurs if there is a balance between high challenge and skills (Csikszentmihalyi, 1990). Flow theory integrates three components that are related to engagement: cognition, motivation and emotions (Csikszentmihalyi, 1975; Csikszentmihalyi & Csikszentmihalyi, 1988). One assumption of this theory is that powerful learning environments involve enhanced cognitive processing, are intrinsically motivated and are related to positive emotions (Meyer & Turner, 2006).

Csikszentmihalyi (1990, 1993) constructed the concept of flow along nine dimensions: (1) sensing that one's skills are balanced to the challenges, (2) merging action and awareness, (3) engaging clear goals, (4) directing unambiguous feedback, (5) concentrating on the task at hand, (6) feeling in control, (7) loss of self-consciousness, (8) transforming of time. The ninth dimension implies that the learner has a so-called autotelic experience (intrinsic motivation): the end result of being in flow, a feeling of doing something for its own sake, with no expectation of future reward or benefit (Tenenbaum, Fogarty, & Jackson, 1999). Powerful learning environments should entail all or at least a significant subset of these nine characteristics.

Vygotsky's theory parallels Csikszentmihalyi's flow theory in the sense that powerful learning activities are a balance between challenge and already achieved skills (moderate challenge). A learner feels that his skills are 'stretched' to meet the challenge and experiences flow when his or her perceived skills and challenges are both high (Meyer & Turner, 2006; Liao, 2006). However, an important difference between these theories is that Csikszentmihalyi (1990) is primarily focussed on the self-sustaining interest of the learner to evoke curiosity and achieve engagement, whereas Vygotsky (1978) more explicitly focuses on the readiness of the learner and

on the possibilities implied in the already achieved skills of the child.

Our conclusion is that to achieve powerful learning in children, high engagement or flow should be attained. Interaction or instruction should evoke self-sustaining curiosity and interest in understanding new concepts or tasks. Playful learning environments can therefore function as an appropriate environment for young children to optimally learn new skills and concepts. In addition, in order to achieve powerful learning, social interaction or instruction should be provided within the ZPD of the learner.

The concept of a powerful learning environment

A definition

Educators can promote powerful learning by designing powerful learning environments. According to Bétrancourt, Dillenbourg, and Montarnal (2003) a powerful learning environment generates high learning gains for its users. Learners in powerful learning environments are encouraged to construct their own knowledge, learn in realistic situations and to learn together with others.
There are various slightly different definitions of powerful learning environments, but the common interpretation is that powerful learning environments promote active and constructive learning and present collaborative activities (De Jong & Pieters, 2006).

The level of interactivity (the learners' activity (practice) and interactivity in instruction) is the core 'powerful' mechanism in computer technology (Bétrancourt et al., 2003). In powerful learning environments children can make decisions and are allowed to take initiative in learning. They can make choices which can be explored or manipulated (Gillespie & Beisser, 2001). The instructional design is aimed at integrated sets of learning goals (De Corte, Verschaffel, Entwistle, & Van Merriënboer, 2003). The main goal of powerful learning environments is to learn through practice by improving one or more skills of a child on a particular developmental domain. Instruction must be fully aligned with individual differences and human cognitive architecture (for instance, the limited processing capacity of the human mind; De Corte et al., 2003). The learners' capacities are enhanced or the learners' cognitive capacities are 'stretched' through specific types of support. This support facilitates knowledge acquisition or practice of one or more skills (Linn, Davis, & Bell, 2004; Quintana, et al., 2004).

In this context, engagement can be defined as an energetic involvement as a result of a powerful learning environment. In a similar vein, flow can also be defined as a psychological state of a child that emerges in a powerful learning environment. Powerful learning environments are based on what we know of child developmental theories: they are age appropriate, individually appropriate: they should take an eclectic view of learning (people learn in different ways) and also be socioculturally appropriate (De Corte et al., 2003; Bredekamp & Copple, 1997).

Based on this information, our working definition of a *powerful learning environment* in this context is as follows: an environment in which active and constructive learning is promoted by playful learning and is aligned with individual differences (Vygotsky, 1978) to reach high engagement and flow (curiosity or interest) (Csikszentmihalyi, 1990) in a learner.

Important characteristics

The aim of a powerful learning environment is to create a context in which characteristics of powerful learning are reinforced (see our working definition of powerful learning in the introductory section). Developmental theories related to active and constructive learning have therefore implications for the construction of powerful learning environments (McCarrick & Li, 2007; Gillespie & Beisser, 2001). To enhance powerful learning, children have to be actively involved or highly engaged in order to obtain direct experiences. High engagement and flow can be achieved when children get the occasion to explore in a social and playful learning environment. Through these experiences, children can construct knowledge independently (Hirsh-Pasek et al., 2009).

Effective instructional interactions respond to emotions of the learner, thus suggesting how a goal structure in a learning environment may be emotionally scaffolded, i.e. positively and interactively supported (Meyer & Turner, 2006; Patrick, Turner, Meyer, & Midgley, 2003; Turner, Meijer, Midgley, & Patrick, 2003; Turner & Patrick, 2004). Positive support is associated with the learners' motivation or interest: behaviour is strengthened by praises or rewards (Turner & Patrick, 2004; Slavin, 2009). We have seen that self-sustained interest is an important aspect of flow. Additional elements of flow manifested in powerful learning environments are, for instance, tasks that can be completed, clear goals and immediate, specific feedback (Csikszentmihalyi, 1990).

Vygotsky's developmental notion of the Zone of Proximal Development has its pedagogical counterpart in the notion of scaffolding. The concept of scaffolding was introduced by Bruner in the 1970s and was defined as '… an adult controlling those elements of a task that are essentially beyond the learner's capacity, thus permitting him to concentrate

upon and complete only those elements that are within his range of competence' (Wood, Bruner, & Ross, 1976, p. 90).

In the current article we wish to propose an enriched notion of scaffolding, which entails a general theory of powerful learning environments that is based on the theory of Vygotsky (1978) and on the flow theory of Csikszentmihalyi (1990). In our view, a powerful learning theory should thus be consistent with the characteristics of a scaffolding situation as described by this enriched definition, which we shall develop further in this section. A scaffolding situation stimulates characteristics of powerful learning in young children, for example play, social context, high engagement or flow. It supports and facilitates active and constructive learning (McKenzie, 2000). Scaffolding in the enriched sense also implies that peers, parents and teachers have an influence on the construction of knowledge in the child. They provide the socially mediated practice and experiences within the child's Zone of Proximal Development that Vygotsky (1978) saw as an important mechanism of cognitive development.

Granott (2005) defines successful scaffolding as 'an increase in the scaffoldee's (child/novice) independent activity level following the scaffolder's (adult/expert) scaffolding'. Scaffolding strategies differ among contexts and individuals: they are used to break the task into pieces that are easy to handle for an individual child. Scaffolding is the use of some support that makes a particular learning process possible and can be withdrawn when the child is capable of doing the task independently, that is, when the scaffoldee is inside his Zone of Current Development (ZCD) (Vygotsky, 1978; Granott, Fischer, & Parziale, 2002; Van Geert & Steenbeek, 2006; Granott, 2005). Paraphrasing Van Geert & Steenbeek (2006), scaffolding is a dynamic and self-sustaining coupling between two changing levels: the level of competence embodied in the learner and the level of competence embodied in the level of teaching. It stimulates engagement of the learner: comprehension of a task, motivation, instruction, social interaction and asking questions. It results in effective learning: the skill is advanced and internalised by appropriating the level incorporated in the past scaffolding (McKenzie, 2000; Van Geert & Steenbeek, 2006).

The scaffoldee loses engagement when unsuccessful scaffolding takes place. Unsuccessful scaffolding can be defined as the lack of a relation between the scaffolder's input and the scaffoldee's current or preceding level (Granott, 2005).

The strong positive relationship between scaffolding strategies, based on Vygotsky's ZPD and curiosity (moderate challenge for the learner) of the learner, emphasises the presence of these strategies in powerful learning environments, as defined in the preceding section.

In Van Geert and Steenbeek's (2006) dynamic model of scaffolding, the help and instruction provided by a more competent person (e.g. a teacher, or an edutainment software program) is a function of the learner's current level and of the ultimate goal that the supporting instance wishes to achieve. The goals embedded in a current interaction between a scaffolder and a scaffoldee are thus dynamically inferred from an overarching goal structure that guides the action. Goal structures, but also the participants' concerns and interests, not only guide the process but also guide the emotions that play an important role in the 'flow' of the scaffolding process (Steenbeek & Van Geert, 2007).

Is edutainment a powerful learning environment?

Characteristics of powerful edutainment software

Edutainment that contributes to learning one or more specific skills in a particular developmental domain should have characteristics theoretically substantiated in the literature about characteristics of powerful learning environments.

Powerful learning can be achieved if edutainment contains a number of individually, age and socioculturally appropriate characteristics that stimulate playful learning, motivation, engagement and flow and that allow for the establishment of a scaffolding interaction according to the enriched notion described above. General scaffolding strategies that can be directly related to edutainment software are summarised below.

One of these strategies is conceptual or supportive scaffolding (Cagiltay, 2006; McKenzie, 2000). Examples of mechanisms of supportive scaffolding are: cueing and hinting, prompting, coaching comments, providing **feedback**[1] and advice on performance, provoking reflection or providing a model for design or a structure to design in. Other characteristics of scaffolding that can be used in edutainment software are, for instance, giving clear directions to reduce confusion of the learner or clarifying the purpose. The learner must understand why he is doing the task and why it is important (it provides directions adapted to individual differences of the learner, in order to help the child to achieve the goal). Keeping the learner on task and motivated by providing structure or simplifying the task are two important scaffolding strategies. More examples

[1] Concepts in bold print correspond to the main categories of the checklist in Figure 1.

of scaffolding techniques are: offering assessment and **feedback** to clarify expectations, pointing learners to worthy sources, reducing uncertainty, techniques to surprise and disappoint, delivering efficiency (McKenzie, 2000; Bransford, Brown, & Cocking, 2000).

Other scaffolding strategies necessary for turning edutainment software into powerful learning environments are positive feedback and scaffolding strategies within the ZPD of the individual child, in which there is mutual adaptation between scaffolder and scaffoldee in an iterative or gradual process (Meyer & Turner, 2006; Van Geert & Steenbeek, 2006). Individual capacities (for example intellectual capacities or age, in terms of levels) should be taken into account when instruction is given to a child (Van Geert & Steenbeek, 2006; Vygotsky, 1978; Webb, 1991). Giving examples or demonstrations in terms of **instruction** is also an important aspect of teaching: showing, rather than only telling, is essential for children to learn specific skills (Slavin, 2009).

In order to maintain the dynamics of the scaffolding situation, there should be an overarching or distal **goal** that explicitly guides the scaffolding actions, in function of the current level of competence or skill attained by the child (Van Geert and Steenbeek, 2006).

To stimulate a child's high engagement and flow and in order to achieve a high learning effect, powerful edutainment software should contain scaffolding characteristics such as variety, diversity or novelty to achieve curiosity (Arnone, 2003), perceived control (Ryan & Deci, 2000; Deci, Connell, & Ryan, 1989), challenge and fantasy (Lim & Kim, 2003), competition (Tripathi, 1992), cooperation and recognition (Collopy & Green, 1995). Assessment of performances, e.g. giving insight into norms and gathering information about a child's abilities, improves the skills of the child. If a child monitors his progress toward a goal, the child makes an evaluative judgment about his performances. This can be a motivating influence on the performance and is a critical component of self-regulation: a child takes action to reduce the discrepancy between his own performance and the standard or goal (Slavin, 2009; Driscoll, 1999).

Additional strategies for obtaining powerful learning are moderate challenge, features that simulate interest or curiosity and enhance a child's control and embedded short-term goals (Ames, 1992; Brophy, 2004; Eccles, Wigfield, & Schiefele, 1998; Pintrich, 2003; Pintrich & Schunk, 2002; Stipek, 1996; Meyer & Turner, 2006; Lim & Kim, 2003). **The interface** should not distract from the learning process (e.g. splashy special effects foster impulsive mouse clicks; Healy, 1998). There should be a relation between the displays and the task or goal, but in such a way that a child does not fully realise that the task is educational (Okan, 2003; Embi & Hussain, 2005).

The **content** of edutainment software should be free of ethnicity, gender, and other stereotypes (Aronson, 2002). Interface-learner interaction (the process of manipulating tools to complete a task by interacting with technology) is positively related to flow experience and to a positive learning effect (Liao, 2006).

A systematic list of criteria for edutainment software as a powerful learning environment

Based on the preceding survey of properties and based on often referenced heuristics in the literature of specific characteristics of computer games (e.g. Embi & Hussain, 2005; Polonoli, 2004), a systematic list with concrete, measurable characteristics has been developed to evaluate the quality of edutainment software as a powerful learning environment.

The goal of the checklist (Figure 1) is to provide information about the educational power of edutainment software. The list makes it possible to check whether software contains scientifically or heuristically based characteristics that contribute to learning or development of one or multiple skills in children. With this checklist, users (for example parents, teachers) are informed about the value of particular edutainment software as an educational environment.

Software designers are informed about which positive criteria edutainment games should satisfy in order to count as powerful learning environments. The more positive characteristics a game contains from those mentioned in the list, the higher the probability that the edutainment software will indeed provide a powerful learning environment. Further studies of powerful learning environments, especially in the context of digitally supported learning, may help to extend and improve the current checklist.

Checklists often contain a cut-off score, implying that if certain requirements are not fulfilled, the evaluated product (for example a test or an educational software program) is not acceptable or does not meet minimal standards. Because the current list has still a provisional character, a cut-off score has not yet been determined. Instead, for each scale, three possible scores are presented: unsatisfactory, satisfactory and good.

At present, the checklist's *validity* is confined to theoretical or concept validity. That is, it is based on the theoretical criteria for powerful learning environments extracted from the literature and on heuristic and common-sense-based criteria for educationally adequate software. Predictive validity could be established by investigating the association, for instance by means of correlations, between the checklist scores of particular edutainment software and that software's learning effects. Such investigation would be highly labour-intensive and a goal for future research. As regards the checklist's discriminatory validity, we will discuss a pilot study in which eight (commercially) available edutainment programs were compared in the next section.
The checklist contains a number of main questions (for example feedback, instruction, learning goals, and interface), which are subdivided into more

Table 1 Percentage agreement between two raters per item

Item number in checklist	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Game 7	Game 8	Percentage agreement
1	1	1	1	1	1	1	1	1	100
2	0	0	1	1	1	0	1	0	50
3	1	1	1	1	1	1	1	1	100
4	1	1	1	1	1	1	1	1	100
5	1	1	1	1	0	1	0	1	75
6	1	1	1	1	1	1	1	1	100
7	1	1	1	1	1	1	1	1	100
8	1	1	1	1	1	1	1	1	100
9	1	0	1	1	0	1	0	0	50
10	1	1	1	1	1	1	1	1	100
11	1	1	1	0	1	1	1	1	87.5
12	1	1	1	1	1	1	1	1	100
13	1	1	1	1	1	1	1	1	100
14	1	0	1	1	1	1	1	1	87.5
15	1	1	1	1	1	1	0	0	75
16	1	1	1	1	1	1	1	1	100
17	1	0	0	1	1	1	1	1	75
18	0	1	0	0	1	1	1	1	62.5
19	1	1	1	1	1	1	0	1	87.5
20	1	1	1	1	0	1	0	1	75
21	1	1	1	1	1	1	1	0	87.5
22	0	1	1	0	0	1	0	0	37.5
23	1	1	1	1	1	1	0	1	87.5
24	1	0	1	1	1	1	1	1	87.5
25	1	1	1	1	1	1	1	1	100
26	1	0	1	1	1	1	1	1	87.5
27	1	0	1	1	1	1	1	1	87.5
28	1	1	1	1	1	1	1	1	100
29	1	1	1	1	1	1	1	1	100
30	1	1	1	1	1	1	1	1	100
31	1	0	1	1	0	0	0	0	37.5
32	1	0	0	1	1	1	1	1	75
33	1	1	1	1	1	1	1	1	100
34	1	0	1	1	1	1	1	1	87.5
35	1	1	1	1	1	1	1	0	87.5
Percentage agreement	91.4	71.4	91.4	91.4	85.7	94.3	77.1	80	85.4

Score 1: agreement between the raters, score 0: no agreement on the specific item

specific items. If the main question is answered negatively, the user is directed to the next main category. To score the questions in the checklist, users have to study the instructions about the operationalisations of the main definitions used in the checklist (Appendix I).

As to the reliability of the checklist, we present the results of a small pilot study in which eight edutainment games were evaluated by two raters. The study showed that the inter-rater reliability was .85. This reliability can be considered as good or acceptable (Table 1). 100% agreement was measured on many items, e.g. items 1, 3 and 4, although some items have a relatively low score on the percentage agreement, in this case items 22 and 31. Concerning item 22 it was unclear whether technical support was included or not. This item should be changed into 'the child can independently operate the program (with the exception of technical support)'. The formulation of item 31 should be adapted into 'the game is arranged for all ethnicities (not provided by information on the cover)'.

A critical evaluation of current edutainment software

Educational claims

In this pilot study eight randomly selected games of 30 purchased edutainment games and one available online game are evaluated with the Edutainment Software Evaluation Checklist (ESEC) (Figure 1).

The aim of the study was to evaluate whether Dutch edutainment software contains important educational features as mentioned in the ESEC. In Table 2 the game properties and educational claims are summarised.

Two game selection criteria were determined to evaluate an appropriate game in this study. Firstly, games had to provide explicit information about the educational aspect of the game in order to decide whether a game can be called edutainment software or mainly entertainment. Games with entertainment as the only goal were of course not selected in this study. To decide whether the game contains an educational aspect, information about educational claims had to be clearly available to the customer, a criterion that we operationalised by the requirement that the educational aim had to be clearly formulated on the cover of the game package or in the manual. The educational aims must specify which skill, or multiple skills, will be fostered through playing the specific game. Secondly, the game had to be suitable for young children between six months and six years of age.

The games in this study were purchased in the period November 2008 to February 2009 in Dutch online shops, in Dutch toy and entertainment/media shops. Thirty edutainment games were purchased, based on the two selection criteria mentioned in this section. Two mini-laptops of five purchased laptops were randomly selected in this evaluative study. Five CD-ROM games were randomly selected of the ten purchased CD-ROM and one Dutch *free* online game on an internet-website was selected, based on the first selection criterion. No other *free* online Dutch games with clear educational aspects mentioned on their website were found on the internet. This aselect sample of selected games therefore seems to be statistically reasonably representative.

Figure 1 and Table 2 see next pages →

Figure 1 Edutainment Software Evaluation Checklist (ESEC)	
Game name:	
User name:	
Date:	
Particularities:	

Evaluation		
Category	Total score (write the total raw score per scale in this column)	Conclusion (circle the appropriate category based on the column 'total score')
1. Feedback		0-4: unsatisfactory 5-8: satisfactory 9-10: good
2. Learning goals		0-3: unsatisfactory 4-6: satisfactory 7-8: good
3. Instruction		0-2: unsatisfactory 3-4: satisfactory 5: good
4. Interface		0-3: unsatisfactory 4-5: satisfactory 6-7: good
5. Level		0-2: unsatisfactory 3-7: satisfactory 8-9: good
6. Content		0-3: unsatisfactory 4-5: satisfactory 6-7: good

Question number	Question	Correct/most appropriate answer
Category 1	Scaffolding/feedback strategies	
1	**Is there feedback in the game?**	**1 - yes** **0 - no** **→ If 'no', go to question 8**
2	After playing the whole game	1 – yes 0 – no
3	During playing	2 – yes, immediately after the child's action 1 – yes, with delay 0 – no
4	Automatically	2 – yes 1 – only when the child asks for it 0 – no
5	Quality of feedback: value	2 – feedback is given mostly positively (stimulating) (e.g. no, that's not correct, but look further!) 1 – mostly neutral feedback is given 0 – mostly negative feedback is given (only as a correction) (e.g., no that's not correct)
6	Quality of feedback: specificity	1 – specific (e.g. this (spec) is right) 0 – global – (e.g. that's right)
7	Quality of feedback: clarity	1 – (mostly) clear and logical for children 0 – (mostly) incomprehensible
		Total score Feedback: 0-1-2-3-4-5-6-7-8-9-10 *(circle the total raw score of this category)*

Category 2	Clear (learning) goals in the manual or in the game	
8	**Are there clear learning goals in the manual/ cover for parents and/or child (either paper or digital manual or in-game support)?** ***(e.g. improves spatial insight or improves mouse skills)***	**1 - yes** **0 - no** **→ If 'no', go to question 11**
9	Information/instruction about how to play the game to reach the goal *(e.g. information how to find the golden coins: when all the golden coins have been found, spatial insight has been improved)*	1 – yes 0 – no
10	It is clear how the performances of the child are in comparison with the learning goal *(e.g. 50% of the golden coins have been found)*	1 – yes 0 – no
11	Clear goal(s) in the game *(e.g. 'find the golden coins')*	1 – yes 0 – no
12	**There are skills that will be improved according to the game designers**	**1 - yes** **0 - no** **→ If 'no', go to question 15**
13	The improvement of skills is based on empirical studies and/or theoretical foundations	2 – yes, with information about theory and/or empirical studies 1 – yes, but only with references 0 – no
14	The improvement of skills through this specific game is scientifically founded	1 – yes 0 – no
		Total score Feedback: 0-1-2-3-4-5-6-7-8-9-10 *(circle the total raw score of this category)*

Category 3	Instruction in the game or in the manual	
15	**Before the game starts, is there instruction for the child about how to play the game?**	**1 - yes** **0 - no** **→ If 'no', go to question 19**
16	Possibility to practice the game before the task will be carried out?	1 – yes 0 – no
17	Examples or demonstration of the game before it starts or during the game	1 – yes 0 – no
18	Supervision of an adult/more capable peer necessary to play the game (with exception of technical support/installation)	2 – no 2 – yes, with information that supervision is necessary, AND with instruction about how to assist the child 1 – yes, with information that supervision is necessary OR with instruction about how to assist the child 0 – yes, with no information that supervision is necessary AND no instruction about how to assist the child
		Total score Feedback: 0-1-2-3-4-5-6-7-8-9-10 *(circle the total raw score of this category)*

Category 4	Interface	
19	Graphics/colour/sound are appropriate, clear and attractive and not distractive (e.g. many splashy special effects) for the user group	1 – yes 0 – no
20	Spoken language in the game is clear and understandable for the user group	2 – yes 1 – sometimes too difficult for the user group 0 – no, mostly too difficult
21	The navigation buttons are clear and consistent for the user group	1 – yes 0 – no
22	The child can easily and independently operate the program (if the child is mouse skilled)	1 – yes 0 – no
23	The game has a high level of interactivity	2 – yes, by non-verbal or verbal actions of figures in the game 1 – yes, by feedback in general (e.g. only invisible but auditive feedback) 0 - no
		Total score Feedback: 0-1-2-3-4-5-6-7-8-9-10 *(circle the total raw score of this category)*

Category 5	Level	
24	**Are there levels in the game(s)?**	**1 - yes** **0 - no** **→ If 'no', go to question 29**
25	Possibility in the game to start at the appropriate level and to skip unadaptive levels	1 – yes 0 – no
26	Difficulty is adaptive to the performances of the child?	2 – yes, automatically 1 – yes, but not automatically 0 - no
27	Are there norms in the game that give insight for parents/teachers in the development of the child?	2 – yes, based on (empirical) research 1 - yes, but not based on (empirical) research 0 - no
28	Is it clear what child criteria are needed to play the levels adequately? (Information on cover/in manual/in game about minimal requirements age, cognitive and motor skills of the child per level)	*Calendar age:* 1 – yes 0 – no *Cognitive skills:* 1 – yes 0 – no *Fine motor skills (mouse skills):* 1 - yes 0 - no
		Total score Feedback: 0-1-2-3-4-5-6-7-8-9-10 *(circle the total raw score of this category)*

Category 6	Content characteristics	
	Gender/ethnicity	
29	Information on the cover or in the manual about gender and/or ethnicity of the user group	1 – yes 0 – no
30	The game is designed and appropriate for both sexes (boys and girls)	1 – yes 0 – no
31	The game is arranged for all ethnicities	1 – yes 0 – no
	Engagement or flow	
32	The game contains variety, diversity or novelty (e.g. in setting, goal or task) to achieve curiosity	1 – yes 0 – no
33	The game contains competitive elements	1 – yes 0 – no
34	The game stimulates cooperation with peers	1 – yes 0 – no
35	The child is challenged in the game	1 – yes 0 – no
		Total score Feedback: 0-1-2-3-4-5-6-7-8-9-10 *(circle the total raw score of this category)*

Table 2 see next page →

Table 2 Game properties and educational claims of the eight selected games

Game name	Publisher	Kind of game	Advised Age	Educational claims
Computer Kid Friend	Clementoni	Mini-laptop	from 3 years	Learning letters, numbers, forms and colours
Bumba Laptop	VTech	Mini-laptop	from 9 months	Learning forms, objects, words, sounds and music, language development, sensory development, discovering and exploring, motor skills
Teletubbies (1998)	BBC Worldwide Ltd. Memphis Belle B.V.	CD-ROM	from 2 years	Learning areas: eye-hand coordination, talking and listening, recognising forms, places, sizes, amounts, spatial insight, following patterns, fantasy and creativity
Tweenies – Mega Knutselfeest (2004)	BBC Worldwide Ltd. Memphis Belle B.V.	CD-ROM	from 3 years	Creativity and fantasy
Go Diego go! (Nick Jr) (2008)	Viacom International Inc.	CD-ROM	from 3 years	Learning new animals, animal sounds and tracks, development of visual and motor skills, solving problems, counting, respecting animals and environment
Disney - Het boek van Poeh – Verhaal met een staartje (2007)	Disney Interactive Studios	CD-ROM	from 3 years	Numbers, letters and word associations, recognising patterns, forms and colours, making connections, critical thinking, memory training, analytical and creative thinking, solving problems and following directions, spatial insight
Sesamstraat – De avonturen van Elmo in Mopperland (2004)	Sesame Workshop	CD-ROM	from 3 till 6 years	Solving problems, recognising cause and effect, sharing with friends
www.samenslim.nl	The internet	Online game	from 3 till 5 years	Learning to learn

Table 3 Results of the evaluation of the eight selected games

Main categories	Bumba Laptop	Teletubbies (1998)	Tweenies – Mega Knutselfeest (2004)	Computer Kid Friend	Disney - Het boek van Poeh – Verhaal met een staartje (2007)	Go Diego go! (Nick Jr) (2008)	Sesamstraat – De avonturen van Elmo in Mopperland (2004)	Samenslim.nl
Feedback	-	-	+/-	+/-	+/-	+	+	+
Learning goals	-	-	-	+/-	+/-	+/-	-	+/-
Instruction	+/-	+/-	-	-	-	-	+/-	+/-
Interface	+/-	+/-	+	+	+	+/-	+	+
Level	-	-	-	-	-	+/-	+/-	+/-
Content	-	-	-	+/-	+/-	+/-	+/-	+/-
Total unweighted quantified score (max. 12)	2	2	3	5	5	6	7	8

+ = good, +/- = satisfactory, -= unsatisfactory

Does available edutainment software comply with the list of criteria?

The results of the evaluation are discussed in terms of the six main categories of the checklist. In Table 3 the results of the evaluation are presented.

Feedback

There are considerable differences in the quality of feedback strategies between the eight selected games, as defined and measured by our checklist. Bumba Laptop and Teletubbies obtain the minimum score (zero) on this main category of the ESEC. These products lack the important characteristic of feedback. These scores are not acceptable in terms of powerful learning environments.

Computer Kid Friend, Disney and Tweenies score satisfactorily on this category. However, in all games global feedback is given and in the Tweenies game, feedback often sounds negative with a nagging voice when a child gets it wrong. In the Disney game, feedback is only given as a correction when a child does something wrong.

The games evaluated positively with the checklist are Go Diego Go, Sesamstraat and Samenslim. All three games score the maximum score on this part of the checklist. Specific, clear and positive feedback is given in these games, which is likely to stimulate the child to play another game or to try again in a difficult task.

Learning goals

For the *learning goals* of all the selected games in this study, there are four *unsatisfactory* and four *satisfactory* scores. No game was evaluated by the maximum score 'good' on this topic. However, all games formulated clear learning goals on the cover and/or in the manual.

It can be concluded that none of the selected edutainment games contain scientifically and theoretically founded evidence that these specific games cause improvement in one or multiple skills. All package covers promise that one or multiple skills will be learned by playing that specific game, but they do not provide scientific evidence for their claims.

The Samenslim website states that scientific research on the effectiveness of these games is still going on. The Samenslim game is the only game in which information is given about the theoretical foundations of the game in the form of a scientific article. In the manuals of the other selected games no information was available about empirical studies or theoretical foundations.

In the Teletubbies game it is unclear what the child has to do to reach the learning goal, that is, there is no clear in-game goal. One positive aspect of the Disney game is the possibility to check the performances of the child in comparison with the learning goals. Disney is the only game in which this check (to measure the degree of goal attainment) is possible.

Instruction

The instruction in the selected games is not optimal. Some games contain no instructions before the game starts: Tweenies, Go Diego Go or Computer Kid Friend and Disney. In the Teletubbies game there is no instruction before the game starts, but the manual describes how to play the game. The Disney game can be started when the child clicks on the left mouse button on a figure on the screen, but the child is not instructed to click to select a game. When the game starts, no instruction or demonstration is given about what to do to reach the game goal.

The eight selected games do not contain demonstration or practice possibilities. A positive aspect of most games is that they can be played independently (without supervision of an adult). Go Diego Go is a game for children from three years on. The name of the child has to be filled in before starting the game and in order to play the game the level has to be chosen. Also the language in the game, meant for children from three years of age, is sometimes too difficult to comprehend. This means that supervision during the start of the game and while playing this game is desirable, but the negative point is that the manual provides no information about how to assist the child

Interface

In all games graphics, colours and sounds are appropriate and clear. Sounds are used for appropriate instructional and attractive reasons and graphics are colourful and attractive. Some games contain language that is too difficult for the user group, for example too difficult animal names are used in Go Diego Go. Disney and Bumba Laptop (for children from *nine* months) sometimes use too difficult words in the sentences (English words, unfamiliar first names or difficult animal names), which makes instruction or interaction complex.

In most games the navigation buttons are clear and consistent, but in the Teletubbies game, it is unclear what the child must do to reach a specific goal in the game. In this game it is unclear how to play (where to click on) to make progress in the game. In our opinion it is difficult to independently operate the program. A positive aspect of most of the eight games is that they contain a high level of interactivity, as well as non-verbal actions of the figures and verbal actions of the figures in the game (e.g. asking questions).

Level

The ESEC checklist demonstrates a considerable variability in the quality of the levels: five of the selected games contain no levels, three games contain (adaptive) levels. This means that in five of these games there is no possibility to start at the appropriate level or that the game is not adaptive to the child's performances. Go Diego Go, Sesamstraat and Samenslim score *satisfactory* on this part of the checklist, because they contain multiple levels and they can be started at a higher or lower level. The reason why none of these games are evaluated as *good* is that none of them contain child criteria to play the levels adequately. No information is given about the properties of the child (e.g. cognitive skills, motor skills) that serve as criteria for deciding at which level the child should enter the game or continue the game. Insight into the progress of the individual child is not possible for parents or teachers in any of the eight games.

Content

All selected games are appropriate for both sexes and various ethnicities. A striking positive aspect is that in Teletubbies and Go Diego Go, black and white figures play a role in the game. On the cover of Bumba Laptop, a black and a white child are displayed. None of the games gives information about the appropriateness for both sexes or various ethnicities.

Most games contain variety and novelty: multiple games can be played and games change in for example settings or tasks. However, the goal of the Teletubbies game is not clear, Teletubbies stimulates the curiosity of the children by making various activities become visible if the child takes action. In this way curiosity of children can be achieved. Competitive elements are not present in the games, but children are regularly challenged in the games, by means of remarks of role players in the game, e.g. 'click again!' or 'no, that is not correct, we'll try another!'. Cooperation with peers is only stimulated in the Disney game, where 'playing together with friends' is mentioned in the game.

Conclusion

From the evaluation it can be concluded that only a small number of the eight selected Dutch edutainment software programs is moderately positively evaluated. Most games lack important characteristics of levels, content, instruction and learning goals. These games are negatively evaluated and are not sufficient to count as *powerful* learning environments.

The most positively evaluated characteristic of the selected games is the interface, which is evaluated as satisfactory or good. High interaction, attractive colours and sounds stimulate engagement and therefore playful learning of the child. The fact that the interface is the most positive aspect – and not for instance the goal or learning content – suggests that the makers of edutainment focus more on superficial aspects such as the visible interface, than on deeper aspects that relate to the aspect of powerful learning.

Another moderately positively evaluated characteristic is the feedback given in the games, which is mostly evaluated as satisfactory. However, this feedback is generally of a global and negative nature. In our opinion, characteristics in edutainment games should be improved, particularly in providing positive, specific and adaptive feedback instead of negative and global feedback. Concrete, positive feedback is crucial for powerful learning environments: it stimulates intrinsic motivation and engagement of the learner and as a consequence powerful learning can take place.

In spite of a moderately positive evaluation of the interface and the feedback strategies in the games, it can be concluded that only a small number of the games can be considered to be a *powerful* learning environment. Half of the games contain some, but not enough, characteristics of a powerful learning environment. Therefore they need to be further improved, and the currently lacking important characteristics of instruction, levels and learning goals (mentioned in the checklist) need to be compensated, in such a way that in the end the games can effectively foster powerful learning in young children.

Information about effects of empirical studies and theoretical foundations should be given in the manuals, in order to provide evidence that a specific game is really effective in the development of a young child. The content of the games can be improved by providing information about appropriateness with regard to gender, ethnicity and by introducing competitive elements in the games.

More research has to be done to study skills that are required for the child to be able to play a game or a particular game level adequately (entrance conditions). In other words, individual games have to be studied in detail in order to evaluate the appropriateness of each game or game level for the intended user group. After having done so, we can then proceed by providing norms that give insight into the performances and development of individual children.

It is therefore essential that software designers (together with educators) develop their edutainment software, taking into account the characteristics mentioned in the checklist. In this way edutainment software may function as a powerful learning environment for young children.

Current Dutch edutainment software does not seem to meet the theoretical requirements in the literature, in which characteristics of powerful learning environments are described. The edutainment software is particularly specialised in the entertainment characteristics instead of the educational aspect of the games. In the design of new edutainment games, the educational part of edutainment software should be more clearly emphasised. Instruction, feedback and content should be presented in such a way that young children are intrinsically motivated to learn in an environment that is as playful as it is powerful.

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Appendix I

Operationalisation of the main definitions used in the checklist (Figure 1)

1. **Feedback:** information presented in the program that allows comparison between an actual outcome and a desired outcome (Ramaprasad, 1983; Mory, 2004).

   Examples of feedback strategies in the context of this checklist
   - *Assistance:* 'You have to do this or that.
   - *Corrections:* 'No, that's not the correct answer'.
   - *Supportive feedback:* 'Go further' or 'well done!'

2. **Learning goals:** the general educational aims of the program. What will the child learn from playing the edutainment game? Learning goals focus on the child's skills or attitudes.

3. **Instruction:** a message (verbal or written) that is describing how the game should be played; instruction what the child has to do to play the game adequately. Instruction is given before the game starts (or during the start of the game) or is described in the manual.

4. **Calendar age:** the chronological age that is determined by the date of birth of the child.

5. **Cognitive skills:** are the basic mental abilities children use to think, study, and learn. Examples of cognitive skills are intellectual abilities such as logical reasoning, language comprehension or production, memory, writing, analysing and prioritising.

6. **Fine motor skills:** fine motor skills refer in this context to the small movements of the hands wrists and fingers to use the keys on the keyboard or to use the mouse adequately. In most types of edutainment software, the child has to be able to click and move the mouse to play the game adequately.

7. **Ethnicity:** represents social groups with a shared history, sense of identity, geography and cultural roots which may occur despite racial difference. Examples are black and white children or low and high socioeconomic status.

8. **Variety/diversity:** the appearance of the game (e.g. colours or game-setting), the task or learning goals vary.

   Examples of variety or diversity in edutainment software are
   - More games are available on the same CD-ROM, website or (mini) laptop
   - Games vary in setting, task, goal, sounds or reinforcement

9. **Competitive elements:** a 'combat' can take place in the game between two or more players or between the child and the figures in the game to strive for a goal which can not be shared.

10. **Cooperation with peers:** the child is stimulated to play the game with another child or together with a figure in the game (e.g. 'assisting' the figure in the game).

11. **Challenge:** through verbal or non-verbal feedback in the game, the child is challenged to play more games, go further when the task is difficult or when the child does not click or move the buttons or mouse (does nothing at all).

    Examples of challenge in edutainment software are
    - *Supportive feedback (see point 1 in this Appendix) or reinforcements.*
    - *Interactive elements in the game (e.g. 'Go! Go! You can do this!' Or 'Will you help me?' or 'Click on the mouse button when you know the answer')*
    - *(Adaptive) levels*
    - *A clear in-game goal (e.g. find ten golden coins, then you go a level higher)*