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UNDERSTANDING PURPOSE AND CIRCUMSTANTIAL CONTEXT IN THE USE OF EDUCATIONAL GAMES

Designing a Search Function and Updating a Metadata Model

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Abstract

As the amount of educational games on the market increases it becomes daunting task for pedagogues to find the most relevant and effective educational games for their teaching activities. In 2012 a metadata model was suggested to streamline descriptions of educational games for a database. This thesis identifies the need for an advanced search function which takes into consideration the notions of *purpose* and *contextual circumstance* of using educational games in order for such a database to be of greater usefulness for users. This thesis presents a design of such a search function, based on the theories of Purushotma (2005), Pannese and Carlesi (2007), Charsky (2010) and Reinders and Wattana (2011). Furthermore this thesis provides an updated metadata model to support such a search function. In the future the search function could be polished from a usability perspective and further developed to incorporate other types of serious games.

Key words: [educational games, search function, purpose, context, metadata model, database]

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1 Introduction

Educational games are getting increasingly common to use in education, both in the classroom and in the homes of the learners (Stansbury, 2009). At the same time the amount of educational games on the market is increasing tremendously. A few years ago when the amount of educational games was more limited, finding relevant educational games to use in educational purposes were not an as complicated task since there were not that many games to choose from within a subject. Today however, finding relevant games has become a daunting task as the amount of possible games to choose from has increased severely. It is simply too time consuming for a pedagogue, or a student, to manually search through all the possible educational games for a given situation, even within a single subject. The EduGameLab-Project (financed from the EU Lifelong Learning Programme) strives to combat this problem by creating a database in which information and user reviews of educational games can be stored. The idea is that collecting all information about educational games in a single place will make it easier for users such as pedagogues, students and parents to find relevant educational games for their intended purposes. This database is based on the *metadata model* suggested by Hendrix, Protopsaltis, Rolland, Dunwell, de Freitas, Arnab, Petridis and Llanas (2012).

The motivation for this thesis is that I believe the problem to be more extensive and not properly solved by simply gathering all the information in one place. Pedagogues and other users are not satisfied with finding a game; rather they want to find a good and relevant game, if not the best and most relevant game for a given situation. Storing all the information in one database is a step in the right direction but it still leaves the user with a lot of work left which she has to do manually. In order to further help the user, and solve the problem which the EduGameLab project sets out to solve, this thesis provides a literature review which investigates what affects the effectiveness of educational games. Based on the findings of the literature review this thesis presents a suggestion for what a search function for the database created in the EduGameLab project could look like. Complementing the database with a search function enables the user, be it a pedagogue, student or parent to easily find relevant educational games without having to put in too much effort, thus contributing to making educational games more accessible to teachers as well as learners.

Finally this thesis aims to suggest how the metadata model (Hendrix et al. 2012) has to be updated in order to support such a search function, since the model in its current state was developed with the intention of storing information about educational games, not necessarily searching for them or being able to compare their effectiveness against one another, which is a crucial part of being able to find the most effective educational game.

This thesis provides two types of results, one practical and one theoretical. The practical result is the search function which allows for comparisons of educational games effectiveness in given situations. The theoretical result is the updated metadata model, originally presented by Hendrix et al. (2012) which now supports the ideas presented in this thesis.

2 Background

Serious games is the research field of using games for other purposes besides pure entertainment, such as in for instance education, simulation, training, health care, marketing and public opinion. In this thesis the notion *educational games* is used frequently, it refers to the subcategory of serious games which consists of games with an educational purpose education.

This background section of the thesis presents a literature review of the field of educational games, with the goal of identifying factors which affect the effectiveness of educational games. Furthermore this section also strives to provide insight in how a relevant metadata model striving to describe educational games has been designed.

2.1 Purposes of Using Educational Games

While the general purpose of using educational games is more or less given away by the name; to educate, it is important to note that this overall purpose is achieved through various less overarching purposes. In this chapter we will look into why it is important to understand these sub-purposes and what they are.

2.1.1 Why is Understanding Purpose Important?

The value of using games in education is arguably undeniable, and the potential benefits of using educational games to complement traditional classroom instruction are unquestionable (Guillen-Nieto & Aleson-Carbonell, 2012). However exactly how educational games should be used and evaluated is not as clear as their obvious potential. Charsky (2010) describes how edutainment and instructional computer games where touted as the savior of education because of their ability to simultaneously entertain and educate. From this observation we can deduce that the purpose of using educational games according to Charsky (2010) is to educate. This is also the case according to Guillen-Nieto and Aleson-Carbonell (2012) and Purushotma (2005), who both agree that educational games aim to educate in one way or another. However, generally we want to be able to further say something about the effectiveness of the education provided by an educational game. This thesis will look a little deeper into two different ways in which different researchers have used, and argued for the use, of educational games. What we will see is that even though the researchers in both examples agree that the main purpose of using educational games is to educate the way in which they argue for the effectiveness of the educational games in their studies differ drastically, which makes it impossible to compare the effectiveness of the education provided.

Guillen-Nieto's and Aleson-Carbonell's (2012) research attempts to prove the effectiveness of an educational game called *It's a Deal!*, which aims to improve the users communicative competence in business English, by conducting pre- and post-tests with students using the game in question. Their experiment manages to prove that the participants did increase their communicative competence in business English; however, there is no comparison to how much more or less the skill was developed compared to a group which would have studied the same content through more traditional means, such as through literature study or classroom instruction. The only thing this experiment actually proves through these results is what the researchers previously stated themselves; there is a potential benefit in using educational games.

Purushotma (2005) argues how the strength of games in education is not necessarily the rate of the teaching or knowledge transfer, but rather the motivational aspects of games. Purushotma (2005) further discusses how language teachers lecture about how important continuous practice of languages is for learners, but homework exercises designed with a focus on being educational has a hard time competing with popular entertainment media. Using an educational game in language learning could be effective solely since it should be more entertaining and motivating than traditional homework. In this case, effectiveness does not refer to the rate or amount of skills learned or knowledge transferred, but rather the fact that some skill or knowledge is transferred where nothing would have been learned at all through the use of traditional teaching methods. Guillen-Nieto and Aleson-Carbonell, (2012) also notices the motivational aspects of using educational games, even if it is outside of the scope for their investigation: "*The students seemed to be very enthusiastic about the idea of playing a serious video game, which adds to the widespread perception that video games are motivational* " (Guillen-Nieto & Aleson-Carbonell, 2012, p. 443).

As we can see in the comparison above, it is simply not possible to compare the effectiveness of educational games the way Guillen-Nieto and Aleson-Carbonell (2012) evaluated it in their experiment with the way Purushotma (2005) suggests using educational games. To be able to compare the effectiveness of two educational games we will first have to agree on what we actually mean with effectiveness of educational games.

There have been various attempts to develop models for evaluating the effectiveness of educational games, for instance de Freitas and Oliver (2006) suggested the use of a four dimensional model for evaluating educational games. While this model certainly has its uses it requires the user of the model to manually evaluate every single educational game. The results from such an evaluation do suggest whether a game is useful in a particular situation or not, but it does not really help the user to determine which game would be best suited for a situation; from a larger population of games. De Freitas and Oliver (2006) model do help a user to determine whether an educational game could be effective or not, but it does little to tell how effective it is. How should this problem then be approached? To understand the notion of effectiveness of educational games we will have to look deeper into what purposes educational games actually serve in education.

2.1.2 Breaking Down the Purpose of Using Educational Games

As noted in the previous chapter the main purpose of using educational games is to educate. It was also shown that with this definition of the purpose, it is an incredibly daunting task to compare the effectiveness of different educational game's ability to educate. In order to resolve this, the purpose of using educational games will be broken down in regards to how educational games attempt to achieve the general purpose of education through various more specific purposes. The purposes which have been found in previous research are: *To motivate learners*, to *increase the rate of learning*, and to *teach higher level skills*.

2.1.3 Motivation

"*Learning that takes place is attributed to how well the students are motivated. Based on this theory, if students are motivated they will be successful in school.*" (Petkov & Rogers, 2011, p. 9). Petkov and Rogers (2011) argue that the American schools lack instructional technology in their curricula. That is, technology which the students have grown accustomed to in their everyday life. They further argue that traditional instructional methods are becoming obsolete. Lenhart, Kahne, Middaugh, Rankin, Macgill, Evans and Vitak (2008) presents statistics showing that 97% of teens ages 12 – 17 regularly play computer games and

50% play computer games on a daily basis. Petkov and Rogers (2011) suggest that: "*K-12 students do not want to read books or do homework assignments; they just want to play their video games.*" (Petkov & Rogers, 2011, p. 10). Continuing this argumentation Petkov and Rogers (2011) suggests that educators should be taking advantage of the apparent motivational aspects of computer games in education. Furthermore they raise the question of why serious gaming should not be introduced as a part of classroom instructional methodology due to students desire to engage with video games.

Purushotma (2005) identifies the same issue, although she is emphasizing the potential of motivational educational games in a home environment rather than in the classroom. She also notes how traditional homework is struggling to compete with entertainment focused media. Even if Purushotma's (2005) argument is that much of today's educational games are unable to compete with entertainment focused games when it comes to motivation, her argument supports the idea that one of the major purposes and strengths of using educational games in education is to motivate learners in order to achieve more effective learning.

2.1.4 Increased Rate of Learning

There have been several experiments done which have proven that educational games can increase the rate at which learning takes place. This is what Guillen-Nieto and Aleson-Carbonell (2012) attempted to prove in their study, however they lack the crucial comparison to traditional learning methods which results in them ending up not actually proving that the rate of learning is increased, simply that learning did actually take place.

Pannese and Carlesi (2007) present an analysis of several case studies using serious games, all of them educational games in nature. They argue that companies have a continuous need to adapt to the market and to constantly evolve the competencies of their staff, as the success of many modern corporations depends increasingly on the corporation's intellectual assets. However there is no time for traditional training. Pannese and Carlesi (2007) further argue that traditional learning instruments are no longer particularly effective. Based on the idea that serious games could provide learning in a more time efficient way they analyze three case studies where serious games have been used. The result from this analysis is that due to various aspects of educational games, educational games do provide the possibility learning at a higher rate than traditional learning. For instance due to the high degree of attention while playing as a result of the typical high interactivity of games (Pannese & Carlesi, 2007).

Another study attempting to prove that the rate of learning could be increased through the use of educational games is an investigation by Sotomayor and Proctor (2009) where the researchers investigated the results on learning of various groups of combat medics who had had access to various means of education. These methods of education were traditional course ware, multimedia course ware, and game based course ware. The results from their study showed that the group which had had access to the game based learning material had retained more learning in less time than the other groups. While there are possible flaws in this study which may lead one to question the accuracy of the result of the study, for instance not limiting all groups to a specific learning method, the group which learned through using the game based learning also had access to the multimedia course ware. Even if these particular results could be questionable it is interesting, and important for this thesis, to understand that there exists a possibility for using educational games with the purpose of increasing the rate of learning.

2.1.5 Teaching of Higher Level Skills

Charsky (2010) makes a somewhat different classification of serious games and educational games, or as he calls them in his work: "*edutainment*". To Charsky (2010) Edutainment is simple drill and practice exercises masked as games, whereas serious games are games which aim to "*facilitate gamers learning higher order thinking skills through using the characteristics to create game play that does not solely use masked drill activities.*" Charsky (2010) describes the two where edutainment is bad and outdated, whilst serious games is the proper and right way to do the same thing. In this thesis however educational games (and edutainment) are viewed as a sub-category of serious games. We lay no value in whether they aim to teach higher order skills (Charsky, 2010) or simple facts which may be effectively thought using drill and practice exercises. It is important to note that these two different types of games which Charsky (2010) identifies can both be educational games, but educational games with different purposes. One with the focus on teaching facts based knowledge and the other focusing on providing deeper knowledge or as Charsky (2010) puts it, learning higher level skills. Of these two types of educational games it is uninteresting for this thesis to argue for or against one or the other, it is however crucial to be able to differ between the two purposes of using the different types of games.

Several studies show that educational games in some cases can provide teaching of higher level skills which may be hard to achieve through the use of traditional learning methods. Siewiorek, Saarinen, Lainema and Lehtinen (2011) for instance, argue that leadership skills are extremely difficult, if not impossible, to teach through the use of traditional teaching methods according to previous research. To combat this difficulty Siewiorek et al. (2011) investigated whether it is beneficial for students to participate in business simulation gaming sessions in order to augment the development of leadership skills. Leadership skills is a good example of what Charsky (2010) refers to as higher level skills. The result of Siewiorek et al's. (2011) study is out of the scope of this thesis. This thesis is satisfied with showing how the purpose of using an educational game could be to teach higher level skills, which would be hard, and time or resource consuming, or even impossible, to teach with traditional learning methods.

2.1.6 Lack of Mutual Exclusiveness in Purpose

Before this thesis leaves the theme of purpose of using educational games it will discuss the correlation between the different purposes discussed in this chapter. It is important to understand that these different sub-purposes are not mutually exclusive. Any educational game might be both highly motivating while at the same time providing learning in some way, either through increasing the rate and / or providing teaching of higher level skills. In fact, one of the major strengths of educational games is to combine learning with entertainment, this assumes that educational games by definition are motivating at least to an extent, thus most games do at least strive to fulfill the purpose of motivation to some extent. This chapter will be wrapped up with the understanding that these sub-purposes are not mutually exclusive, but rather complimentary to one another.

2.2 Breaking Down of Effectiveness

Now that this thesis has looked at the different purposes for which educational games are used it can discuss how we measure how successful educational games' are at what they do, or rather what they intend to do. What we can see in the research within the field is that it is very common to talk about the *effectiveness* of educational games. Purushotma (2005) argue

that educational games are effective because they motivate the learner. Pannese and Carlesi (2007) argue that educational games are effective because they increase the rate at which the learning of the content takes place. Whereas Charsky (2010) and Siewiorek et al. (2011) mean that educational games are effective because they can teach content which is hard to teach through traditional means of education. This shows that there is no general cohesion of what the notion of effectiveness actually measures. This leads to various difficulties, for instance it is very hard to compare the effectiveness of one educational game to another since effectiveness can refer to very different concepts.

Based on the various purposes identified in this thesis the notion of effectiveness is broken down into measurements which more clearly measure the success of the actual purposes of an educational game, rather than the more arbitrary notion of effectiveness. This thesis suggests the use of the following measurements three measurements, instead of the overarching arbitrary measurement of effectiveness.

2.2.1 Motivational Power

This measurement will tell to what extent the learner (or learners) are motivated to partake in the educational content provided by a game. How motivational a game is not completely synonymous with how entertaining a game is, however generally the more entertaining a game is, the more motivating it would be. This measure would be relevant for games which main purpose is to motivate the learner to partake in educational content, such as discussed by Purushotma (2005).

2.2.2 Rate of Learning

This measurement will tell how much faster or slower the content is taught through the use of an educational game compared to if the same content would have been taught through the use of traditional educational methods. This measurement would be mostly relevant for educational games such as those discussed by Pannese and Carlesi (2007), which strive to learn the same content as traditional education, but at an increased rate.

2.2.3 Ability to Teach Higher Level Skills

This final measurement will tell to what extent an educational game manages to teach or train higher level skills compared to how well the same skill or skills would have been taught through the use of traditional educational methods. As compared to the measurement of the rate of learning; this measurement focuses solely on the quality of the result of using the game, disregarding whether it is more or less time and resource efficient. This measurement would be mostly relevant to games such as those discussed by Charsky (2010) and Siewiorek et al. (2011), where effectiveness refers to the ability to teach higher level skills.

2.3 Understanding Circumstantial Context

Now that the purposes in which serious games are used have been broken down and more clearly defined it is possible to take a look at the other ambiguous factor which makes it difficult to evaluate games and compare them to one another. Educational games are not used in a vacuum, rather; they are always used by someone somewhere. In this thesis this is referred to as the circumstantial context of the game. De Freitas and Oliver (2006) presented their four dimensional model for evaluating educational games. Two of these dimensions capture the circumstantial context of the game; the "*context*"; which in this thesis will be referred to as the location (since context in this thesis implies more than just the location), and "*learner specification*".

2.3.1 The Location

"Context can become an enabling factor for learner support, or can provide significant impediments to delivery." (de Freitas & Oliver, 2006, s. 253). The context, or in this case the location might be key to a game's ability to convey learning, but it may also impede the very same thing. While de Freitas and Oliver (2006) include macro-level contextual factors such as historical, political and economic factors into their analysis of the context this part of the thesis focuses on the physical location. That however does not make the above quotation by de Freitas and Oliver (2006) any less true; in this chapter we will look into how the physical location possibly affects the results and effectiveness of educational games.

While it is not the actual focus of Purushotma's (2005) work she does touch upon the effects of the location in which educational games are used. Her argument is built on the fact that educational games while used in a home environment struggles to compete with entertainment products, such as games, for the time of the learner. Purushotma (2005) further argues that educational games intended for use in a home environment has to learn from these entertainment games in order to be successful. The interesting observation to be done here, from the perspective of this thesis, is that educational games face different challenges depending on where it is intended to be used. Strictly looking at their ability to compete in entertainment value an educational game would, as Purushotma (2005) notes, have to compete with several types of entertainment products and activities in a home environment. In a classroom environment an educational game would have to compete with the entertainment value of traditional classroom education. Arguably one could assume that the entertainment products available in home environments generally are more entertaining than traditional classroom instruction. What this means in practice is that there might be different requirements of educational games in order to be useful and effective in a particular location. For instance a game intended to be used in a home environment might have to focus more on entertainment than education in order to be useful at all, even if that means that the rate of the learning is not increased as much as it could have been if the game did not have to focus as much on entertainment. This obviously assumes that education and entertainment has a negative correlation, when one increases the other decreases. This is of course not true in all cases but oftentimes this correlation exists in the educational games on the market today (Charsky, 2010; Purushotma, 2005).

Now that a basic understanding for how the location in which an educational game is used can affect the result of the learning outcome has been conveyed; we will look at a concrete example of how this ties in to the idea of purposes of using educational games. A pedagogue might have the intention of using an educational game in order to increase the rate in which her students learn spelling of certain vocabulary words. She has two games to choose from, we will call them Game A and Game B. Game A increases the rate of learning more than Game B (the purpose of increasing the rate of learning). Game A is however arguably less entertaining and motivating than Game B (the purpose of motivating the learner). Both these games can be chosen to increase the rate in which the students would learn to spell the words. The pedagogue also has to consider the location in which the game is to be used. In this example the pedagogue has two locations to choose from. Either the game is used in a classroom environment at school, or the game is used as a homework assignment in the students' homes. Based on the idea of purpose presented in the previous chapter, and Purushotma's (2005) arguments about educational games in home environments, table 1 shows the outcomes of the pedagogue's possible choices.

Table 1 Matrix of pedagogical outcomes.

	Game A	Game B
Use in a classroom environment	Rate is successfully increased since the game is more entertaining than traditional classroom education.	Rate is increased, but by a smaller amount since the game focuses more on entertainment.
Use in a home environment	The game is barely played since the game cannot compete with entertainment products. Little actual learning takes place.	Rate is increased, but by a smaller amount since the game focuses more on entertainment.

What this matrix shows is that while both games are able to increase the rate of learning we cannot say which game is better to use without taking into consideration the location in which the game is to be used. In the example above we can see that if the pedagogue intended to use the game in a classroom environment Game A would have been the better choice to increase the rate of learning. However if the game was to be used in a home environment the pedagogue should have chosen to use Game B.

Before leaving this chapter it is important to understand that the argumentation used in this chapter is based on generalization. There are of course cases which do not strictly follow this argumentation. For instance in the example above with the pedagogue, if the students which were to use the game would have been really motivated and responsible it is possible that they would have used Game A even in a home environment, if so then Game A might have proved a superior choice for this location as well. However as Purushotma (2005) notes; educational games generally struggle to compete for the student's time in a home environment. Furthermore, there is not necessarily an antagonism between education and entertainment, the aim of serious games are to combine the two, not choose one or the other, however many researchers including Purushotma (2005) and Charsky (2010) have observed that oftentimes these problems do exist in a lot of educational games.

2.3.2 The Learner

The other dimension captured by de Freitas and Oliver (2006) which falls under the notion of circumstantial context within the frames of this thesis is the learner. De Freitas and Oliver (2006) mean that when evaluating the learner, or the learner group, one should consider specific factors of how they learn, for instance learning background, styles and preferences. While this might be very relevant to evaluating a game from a researcher's, or pedagogue's, who is very well versed in the use of educational games, perspective, it is most likely too detailed and complex information for individuals with limited experience of games in general and educational games in particular. None the less it is important to understand that the notion of the learner could be broken down into very specific pieces of information. For the scope of this thesis however the learner will be looked at from a more pragmatic perspective.

The most basic information which is needed according to de Freitas and Oliver (2006) is for instance the age and level of the group. This is obviously important as when selecting an educational game it is important that the content of the game caters to the needs of the learners. For a pedagogue wishing to use a game to teach a math class about basic equations it is inappropriate to choose a game about quartic equations. While the game is a math game, focusing on equations, the level of the game is significantly higher than the level of the group. It is simply important to match the level of the subject to the level of the learner.

Another important issue when it comes to the learner has been identified by Reinders and Wattana (2011). They intended to investigate whether using a modified version of the game *Ragnarok Online* with students who studied English as a foreign language. Their hypothesis was that playing the game would increase their willingness to communicate in the English language, thus further increasing their English skills. After having completed their experiment they noticed an odd trend in their data. While the hypothesis proved true for several participants in the experiment there was also a significant number of participants who showed no improvement at all. After having done interviews with these students Reinders and Wattana (2011) concluded that the users who had not improved their language skills shared one common denominator. They all lacked experience with games similar to *Ragnarok Online*. And *Ragnarok Online* being a massively multiplayer online role playing game (mmorpg) can by all rights be considered quite complex. These students meant that the reason they had not improved their language skills was that they had struggled to understand the game, which left little room to focus on the learning objective of the exercise. The lesson to be learned from this is that we must not forget that educational games are still games. We do not expect someone to learn from a book before having learned how to read, and once an individual has learned to read we do not ask them to read the most complex literature at once. To finish up the analogy, we cannot expect learners without experience in computer games to learn from the most complex games out there. To summarize, this chapter shows that in order to find a game relevant to a specific user we must consider the users level of the educational aspect of the educational game, age, level of experience within the subject, and so forth. But we must also take into consideration the game aspect of educational games, what level of experience with games does the learner have, and how that limits the choice of relevant educational games.

2.4 Technological and Pedagogical Limitations and Aspects

Now that this thesis has looked at the purpose and the contextual circumstance of using educational games there is also some important knowledge to gain from understanding the technological and pedagogical limitations of using educational games.

As Hendrix et al. (2012) notes; educational games cannot be described exactly as other traditional learning objects, such as literature or videos or media learning resources, due to the fact that they are games, and games require further description which existing models for describing learning objects do not take into consideration. As a pedagogue attempting to find a relevant educational game this means that one would not only have to take into consideration the educational part of the educational game, but also the technological aspects of it and how these would affect the relevancy of a given educational game due to technological and pedagogical limitations. To illustrate one such technological example we will compare an educational game to a book. The book can always be read by a student, an educational game however requires a platform to run the game on. The game then, as opposed to the book, is technologically limited to the availability of the proper platform.

There are of course more technological aspects to games than the platform, for instance the representation, game genre, availability of multiplayer support and performance indicators, to name a few identified by Hendrix et al. (2012). It is important though to note that all of these technological aspects are not necessarily limitations. For instance a game as mentioned above cannot be played without the proper platform, game genre on the other hand does not render a game useless and can thus not be classified strictly as strictly a limitation, however it might still be relevant for a pedagogue to be able to take into consideration the technological aspects and not being limited to limitations of educational games while searching for relevant educational games.

Furthermore there are aspects which may be limited by pedagogical rather than technological aspects. For instance the time which the game is intended to be used has to fit with the time available to the individual pedagogue. Also the role the pedagogue plays in the activity might be a pedagogical limitation. Some games require the pedagogue to be an active part of the game. This obviously requires more expertise of the pedagogue in question. As in the case of the technological aspects it is crucial that a pedagogue is presented with the ability to take pedagogical aspects into consideration while searching for relevant educational games.

2.5 The Metadata Model

The metadata model (Hendrix et al. 2012) is a model for the data which Hendrix et al. (2012) find relevant in order to describe educational games as a learning object in a database for educational games. The metadata model consists of two major chunks of data. One set provided by the individual who enters an educational game in a database, and one set provided by individuals who review a game in a database. The metadata model is in turned based on the four dimensional framework for evaluating serious games (de Freitas & Oliver 2006). Thus the metadata model strives to take into consideration various aspects of the *learner specifics, context, pedagogy and representation,* as well as the more unique aspects of games, such as game genre, interaction type, and so forth. These aspects have already been covered and dissected in this thesis thus in this chapter they will not be looked into at greater depth again. Instead the focus of this chapter is to show how the metadata model by Hendrix et al. (2012) works with the various aspects of educational games.

The set of data provided by the individual who enters the game in a database focuses heavily on the technological and game focused aspects of educational games such as game developer, producer and sponsor, as well as game genre, content type and so forth. It also takes into consideration the representation (de Freitas & Oliver 2006), that is; how the game and the game world is represented to the player. The common denominator for the data provided at the entry of a game in a database is that this data would be the same for anyone using the game. Disregarding the location or the context in which the game is used; the genre, representation and game developer will be the same. Table 2 shows all the data intended to be submitted at entry in a database in Hendrix et al's. (2012) metadata model.

Table 2 The entry data set in Hendrix et al's. (2012) metadata model.

Field	Contents
Game Developer	Name of developer of the game
Producer	Name of the producer of the game
Sponsor	Name of the institution who commissioned or sponsored the development
Age Group	Intended age group
Content Type	Pedagogical content type. E.g., facts, reflexes, skills etc.
Game Genre	The genre of the game. E.g., action, shooter, puzzle etc.
Type of Game	Type of game. E.g., entertainment, education, other etc.
Representation	Virtual world, 3rd person, 1st person, board game etc.
Technical Platform	E.g., PC, Mac, iPhone, Playstation3, Wii etc.
Multi Player	No, on same device, online
Subject	General subject
Performance Indicators	E.g., In game score, time, completion, appreciation etc.
PEGI Rating	PEGI rating if available
PEGI Reasoning	PEGI reasoning if PEGI rating is available

The second set of data in Hendrix et al's. (2012) metadata model is submitted by individuals who review the game, rather than entering the game. Most characteristic for this set of data is that it can vary from user to user, as opposed to the entry set of data. The review set of data focuses on who is using the game; *learner specifics* (de Freitas & Oliver 2006), how and where the game is used; *context* (de Freitas & Oliver 2006), and what pedagogical methodology is used; *pedagogy* (de Freitas & Oliver 2006). Finally the review data attempts to describe the pedagogical quality of the educational game through the use of a star rating system, where the reviewer will rank the quality of the game from one to five. Table 3 shows how the review data set is structured in the metadata model of Hendrix et al. (2012).

Table 3 The review data set in Hendrix et al's. (2012) metadata model.

Field	Contents
Learner Specifics	Composed of each of the following sub fields Age Occupation
Pedagogy	Point on pedagogical model
Context	Context the game was used in (by the reviewer) composed of each of the following sub fields: Place Subject Time of pedagogical activity involving the game Supporting resources
Star Rating	(0, 1, 2, 3, 4, 5) indicating the subjective pedagogical quality, based on the distance between the aim and the result of the evaluator, compared to their usual approach.

3 Problem

As games become a more and more common and available tool in education the need to be able to describe educational games and their characteristics also increase. Games differ from other means of education, perhaps most predominantly through the use of high-fidelity video and audio media in order to enhance the learning experience. (Hendrix et al. 2012) Educational games are not however standardized tools. Educational games come in various shapes and sizes. Some games might be intended to be played for only a few minutes, others might require many hours of game time to reach out with its pedagogical message. Some may be designed to be used in a classroom environment whereas others might be intended for use in a home environment. As the amount of educational games on the market grows exponentially it becomes a more and more daunting task for a pedagogue who lacks or has very little experience of games, or educational games, to find games which would fit with, and improve, his or her teaching.

Hendrix et al. (2012) suggest the use of a metadata schema to describe and categorize educational games. This metadata schema is intended to serve as the foundation for a database, partially developed by the EduGameLab-project group at the University of Skövde, in which educational games can be uploaded and reviewed. Ultimately this database is intended to be a tool for end users, mainly pedagogues, but not excluding students, parents, researchers and other possible user groups, which can help them find educational games which are relevant to their educational context by providing all relevant information in a single database.

The metadata schema proposed by Hendrix et al. (2012) consists of two major parts. Technical information provided by the publisher (the individual who uploads the game to the database, not necessarily the game's official publisher) and subjective contextual reviews provided by end users. Hendrix's et al's (2012) research mainly focuses on how to describe and organize information about educational games in a database. Implicitly; the idea with such a database is for users to be able to search and find relevant games in the database based on the data available in the metadata schema. The idea is also to be able to store information about as many educational games as possible in a single database in order for users to find games which are relevant to themselves in the database, rather than having to commit themselves to a lot of manual searching they can find all the relevant information in a single source, the database. However, once the database actually reaches a point where it contains a large number of entries a simple search might result in a very large amount of possible hits in the database, once again, even though the amount of games to search through may have been limited there might still be an overwhelming amount of games to manually search through to find a game relevant to the user, especially for users who are new to games or educational games. One also has to remember that the intended user base such as pedagogues does not necessarily have a lot of technical experience with games, having to deal with the technical aspects of games might thus become problematic for a large portion of the user base.

To combat this issue of the possible eventual difficulty of finding relevant games for a user inexperienced in the field of games or educational games, this thesis will present a design of how a search function to support this user group in finding relevant games could be designed, based on the background research in this thesis especially focused on the notions of the

purpose and circumstantial context of using educational games. The thesis will investigate how the various parts of Hendrix et al's (2012) metadata schema could support such search function and furthermore evaluate how said metadata schema would have to be revised and / or complimented in order to efficiently support this search function. Thus the overall goal of this thesis is to be able to answer the following two research questions:

> *How could a search function for a database of educational games be designed in order to take into consideration the notion of purpose and circumstantial context of using educational games?*
>
> *And...*
>
> *How would the metadata model suggested by Hendrix et al. (2012) have to be changed or complimented in order to support a search function which takes into consideration the purpose and the circumstantial context of using educational games, in a database for educational games?*

This research questions will be answered by the suggestion of a design for a search function in a database for educational games based on the literature review presented in chapter 2 of this thesis. This thesis will further evaluate how the metadata schema (Hendrix et al. 2012) supports such a search function and how the metadata schema would have to be further developed in order to fully support the search function. Finally it is also within the aim of this thesis to evaluate this search function with user cases. The final result of this thesis will thus be a suggestion for a search function taking into consideration the factors affecting educational game's effectiveness identified in the literature review, and suggestions for changes or additions to support a search function in Hendrix et al's (2012) metadata schema.

3.1 Method

In order to answer the research questions presented in this chapter several smaller problems were identified, each sub-problem is associated with an objective in the thesis. By addressing each such objective the final results are answers to both research questions of the thesis:

- **Objective 1:** Identify which factors affect the effectiveness of educational games.
- **Objective 2:** Design a search function which takes into consideration the findings from objective 1.
- **Objective 3:** Suggest complements to the metadata model (Hendrix et al. 2012) needed to support the search function designed in objective 2.

The first objective was to identify what factors are important while finding relevant and effective educational games. This was done through a literature review in accordance to the

ideas of Bell (2005), within the field of serious games and educational games. Bell means that the main purpose of the literature review is to give an overview of the relevant research field and explain notions relevant to the work of the project, without overdoing it and creating a literature review which tries to describe everything within a field of research without considering its relevancy for the actual project. In this literature review this thesis also examined the metadata model suggested by Hendrix et al. (2012) in order to get a deeper understanding of how it attempted to describe educational games. Bell (2005) argues that there are two ways of limiting the sources of a literature review. This literature review is based on a problem oriented approach where the research question is known in advance, thus limiting the sources to sources which are relevant for the specific research questions. Further it is important to understand that while all of the sources used in the literature review are intentional sources (Bell, 2005) many of them have been used in a way where the process of their work have been more relevant for this thesis than their actual results. This is due to the fact that much research within the field of educational game strives to prove that games can be effective in education. For this thesis however it is not interesting whether or not educational games are effective, but rather assuming that they can be effective and investigating what in an external environment (not in the game) affects this effectiveness. This is something that many of the sources used in the literature review touches upon even if it is not the actual purpose of their work. This means that it has not been possible to find results which support or conflict with the results of this thesis, rather this thesis focuses on observations, and the researchers' comments about those observations, made in various studies.

The second objective was to design a search function based on the findings from the literature review based on the methodology described by Bell (2005). The goal of designing this search function was mainly to show how a search function based on the ideas identified as important in the literature review; the purpose and the circumstantial context of using educational games, could work and look like. Hasman, Tange and Vissers (1998) argue that prototyping is a strong complement to traditional scientific methods when designing systems where all the needs and wants of the users are not fully understood. In the case of this thesis the literature review is considered a traditional scientific research and the design of the search function is considered prototyping. It is also within the interest of this thesis that this search function is as useful as possible and not only a piece of theoretical work. To ensure this a usefulness approach, based on the ideas of Allen and Eckols (1997), was used while designing the search function. In order for the reader of this thesis to be able to better understand how the search function, and the database it is associated with, works, a case study is was made and presented in this thesis, giving the reader better insight in the project as a whole.

Finally the third objective of this thesis is to evaluate the metadata model (Hendrix et al. 2012) and present suggestions for complements to the metadata model which are needed in order for the model to properly support search functions which strive to take into consideration information of the purpose and the circumstantial context for using educational games.

The strength with this method is that it allows for the thesis to cover a relatively wide scientific field which is required as I was unable to find any research which had intentionally tried to investigate the same problems as this thesis, what affects educational games'

effectiveness. This might at the same time be considered a weakness since I am unable to go into too great depth in any particular field due to the lack of time available. Another weakness of this method is that I have oftentimes had to rely on observations done in other research projects rather than pure results, meaning that while these observations have been valid and discussed by the various researchers they have rarely been too in depth as they have not been the intended findings of the different research projects.

3.2 Working With the EduGameLab-Project Group

In parallel with producing this thesis I have been part of the EduGameLab-Project (financed from the EU Lifelong Learning Programme) with the goal of creating the Serious Games Database, which is described in the case study in chapter 4 of this thesis. This means that the implementation of the database and the search function by the EduGameLab-Group is influenced by the work presented in this thesis, and in the same way the work and the results presented in this thesis is influenced by ideas and discussions which have taken place within the EduGamelab-project. Figure 1 strives to illustrate how these two projects, the thesis and the creation of the database have worked in parallel, and how the two projects have influenced on another.

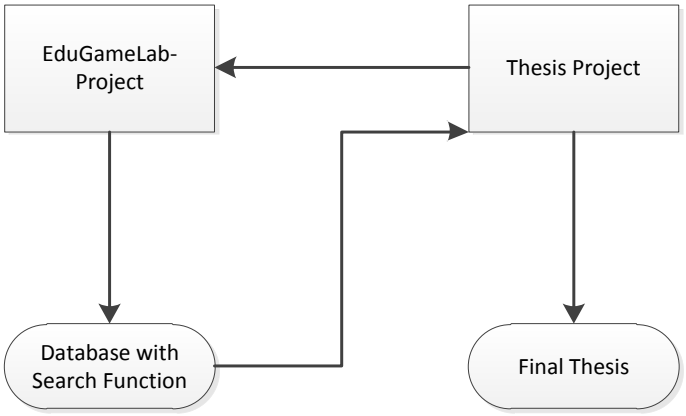

Figure 1 Cooperation of the thesis project and the EduGameLab-Project.

As figure 1 shows the work in this thesis has resulted in a practical result, through the EduGameLab-Project where the database based on Hendrix et al's. (2012) metadata model and the search function based on the work in this thesis have been implemented. And this implementation has in turn affected the thesis project through having a concrete implementation to work with, which has led to a lot of ideas and understanding of what is possible to do and what is not. This has resulted in that the design of the search function designed in this thesis is fully realistic and implementable. Finally it is important to note that this cooperation between the two projects has not been in the form of one time input but rather an iterative ongoing cooperation. There has thus throughout the project been ongoing feedback from my thesis project to the EduGameLab-project and through the implementation back to the thesis project.

3.3 Limitations of This Thesis

It was within the scope of this thesis to also evaluate the search function through usability tests with teacher students. An online survey was created with access to the database, and spread online to teacher students at the University of Skövde, this test group was selected due to them intending to become pedagogues who could have use of s tool such as the one developed in this thesis. The group was also selected as it was relatively easy to reach out to a large amount of individuals in a relatively short period of time. This usability test had to be done late in the thesis project however, due to the fact that the database with the search function had to be implemented. The online survey received an extremely low response frequency, close to 0%. Based on this I chose to not present the results of this survey in this thesis. If I had had more time available I would have made another attempt at spreading the survey however due to the limited time available to this thesis usability testing of the search function will have to be categorized as possible future work.

3.4 Ethical Considerations

Due to the theoretical nature of this essay there are not too many relevant ethical considerations in this work. The teacher students who received access to the usability test online survey were informed that participation was completely voluntary and any and all responses would be treated completely anonymously.

4 Case Study: Serious Games Database

In parallel with this thesis a database for serious games, based on the metadata model by Hendrix et al. (2012) is being developed as part of the EduGameLab project. Currently this database supports the actions of entering games, reviewing games, and searching for games. The search function is based on the design function designed in this thesis. The next chapter in this thesis will delve deeper into the process of designing this search function, but in order for the reader of this thesis to be able to fully understand some of the decisions of the design process, and the final functionality of the search function it is important to have at least a rough idea of what the database in which the search function is to be implemented in looks like.

Figure 2 shows part of the submitting process which a user of the database will go through while entering games in the database.

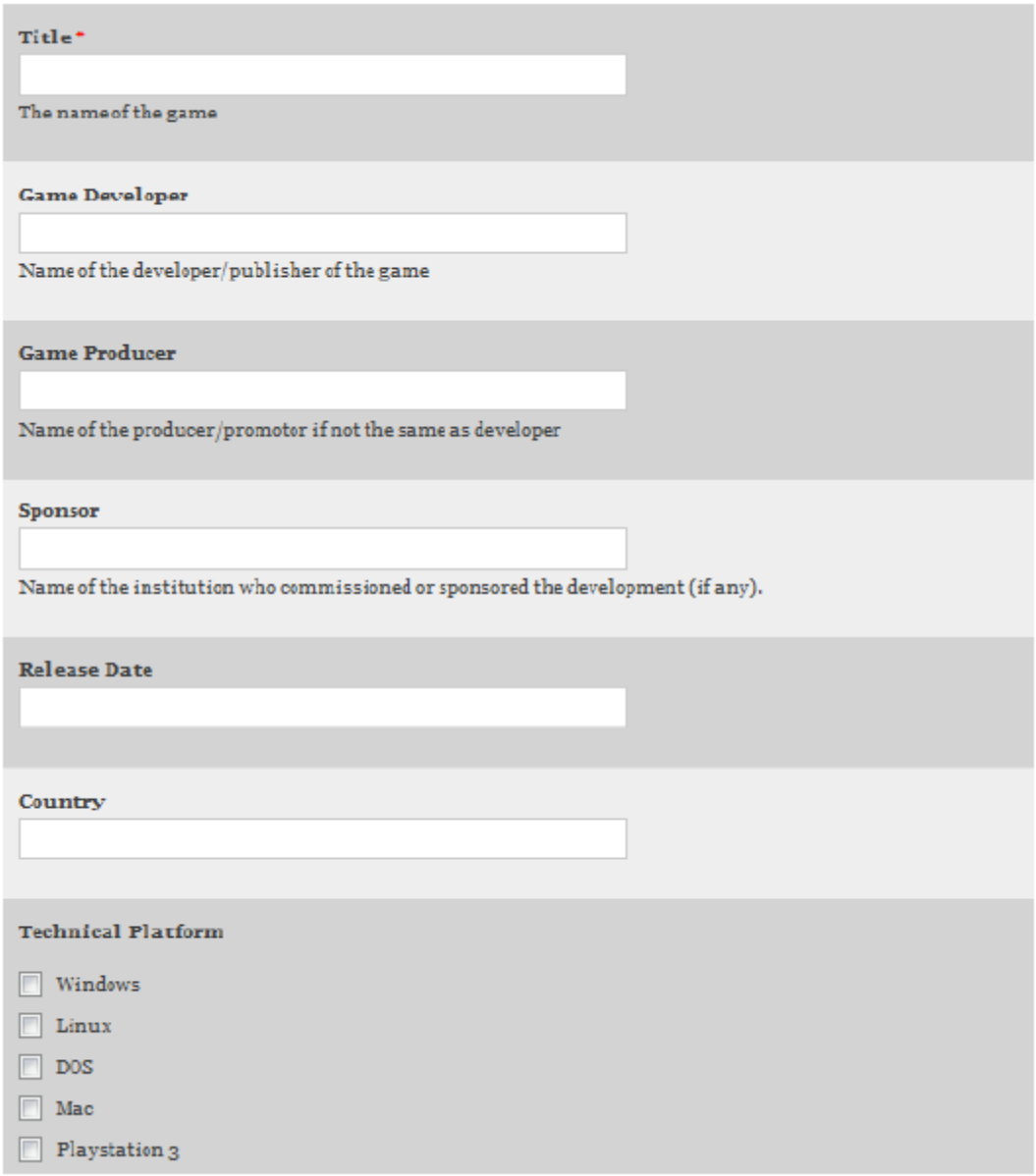

Figure 2 Part of the submitting process of the serious games database.

The user is prompted to enter the data either in the form of free text fields, as in the case of the title and game developer among others, or through selection of check boxes, as in the case with the technical platform. There are also cases where the user will be able to select his or her choice in a drop down menu, for instance in the case of the target age as shown in figure 3.

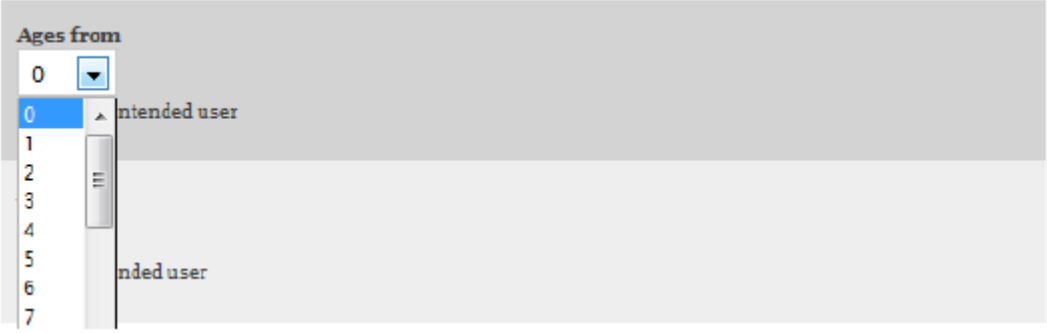

Figure 3 Drop down menu in the serious games database.

These are the three methods in which the user will interact with the database; free text fields, check boxes, and drop down menus. These are also the modes of interaction which will be used in the search function. The action of reviewing a game works much in the same way; only the data submitted in the review is subjective to the reviewer, whereas the data added in the entry process is of an objective, more informative nature.

As was discussed in the background chapter about Hendrix et al's. (2012) metadata model, which is the foundation of the serious games database, it was noted that the review data could vary from case to case, whereas the entry data is of a more static nature. A game would always be the same game, but various users (reviewers) could use the same game differently. This resulted in some inflexibility in the database. For instance many educational games are created by a developer who have in mind to create a game to augment the education in a specific subject. However it is very much possible for a pedagogue to use the game as a resource in another subject than that intended by the developer. In the process of designing the serious game database it was decided that such inflexibility had to be resolved somehow in order for the database to be a more useful tool. This was done through differentiating the notion of *intended subject* and *actual subject*. For instance while entering a game in the serious games database the entering individual is prompted to enter the subject(s) in which the game initially was intended to be used. This is shown in figure 3.

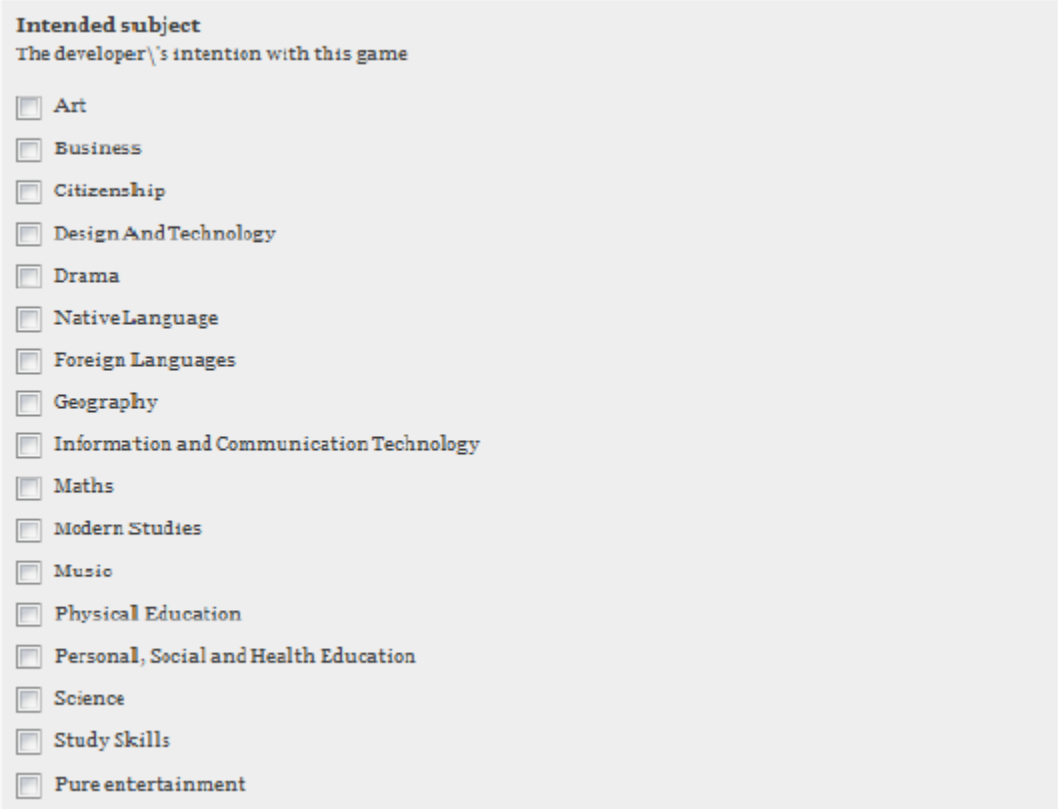

Figure 4 The user who enters a game is prompted to enter the intended subject in the serious games database.

As opposed to in the process of entering a game in the serious games database the reviewing user is prompted to enter information about the actual subject in which the game was used. This is shown in figure 5.

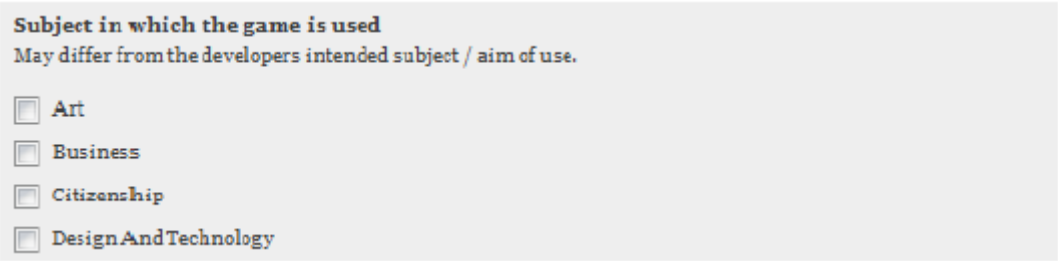

Figure 5 The reviewer is prompted to enter information about the subject in which the games was actually used.

Now that this thesis has provided some insight into the case in which the search function is designed for the thesis will proceed with discussing the actual design of the search function.

5 Designing a Search Function

The main intended user group of the database in development is pedagogues, but it is also intended to be a possible resource for students, parents and researchers. This means that parts of the user group, especially researchers in the field, are very used to the terminology and use of games, whereas many teachers and parents may have very little, or even no, experience in the field or its terminology. This means that the user group of the search function may range from experts to complete beginners. This presents us with a twofold challenge. The first is entirely based on the background research of this thesis; we have to be able to provide very specific searches for the experienced user and very general searches for the inexperienced user. The second part of the challenge is strictly usability focused. Due to the wide difference in experience of the intended user group we have to be able to present the search function in a simple enough way for it to not be overwhelming to the users, without sacrificing functionality.

5.1 List of Requirements

The purpose of the list of requirements is to provide an overview of what features will be needed in the search function, and also to have something to be able to go back to in order to verify that the search function lives up to its requirements once the design is complete.

Finally before moving on with the design it is important to understand that the resulting design will be a first draft for the search function. This thesis does in no way attempt to create the best, the final, or the perfect search function. The goal is simply to suggest how a search function could be intelligently designed in order to increase the usability of the database.

- Must be based on the research in the background research in this thesis (chapter 2):
    - Must take into consideration *the purpose* of using educational games.

The literature review in this thesis shows that it is more or less impossible to say anything about the effectiveness of educational games without taking into consideration what the goal, or the purpose, of using the educational game is. To be able to use a search function to find relevant and effective educational games the search function must take into consideration the purpose of using an educational game.

    - Must take into consideration *the circumstantial context* of using educational games.

The literature review in this thesis shows that the circumstantial context, that is the user and the place in which a game is used has the potential to heavily affect the effectiveness of an educational game.

    - Must take into consideration *technological and pedagogical limitations*.

The literature review in this thesis shows that there are technological and pedagogical limitations, such as the available and the accessibility to the necessary technologies such as game platforms also affect the effectiveness of educational games.

- Must be usable for inexperienced users.

Users with little, or even no, experience with educational games should be able to use the search function without being overwhelmed or being forced to enter a lot of complicated or detailed information requirements.

- Must allow for detailed searches for experienced users.

While not being overwhelming the search function must still allow the user to enter more detailed information, such as a more detailed filter of game details such as *multiplayer availability*, *game representation* and *game genre*. Such details would allow a more experienced user to find a more specific game.

5.2 The Search Fields

The first thing that has to be established to be able to design the functionality of the search function is to determine what information is possibly needed from the user. These search fields have been selected through an analysis of the background research presented in this thesis.

5.2.1 Field Type 1: Specifying the Subject

The Subject will consist of three choices which the user can make:

- Subject
- Detailed Subject
- Level of Education

In the field *The Subject* the user will be able to choose a general educational subject from a drop down menu; examples of general subjects are *math, physics, business, psychology* and so forth.

In the second field, the *Detailed Subject*, the user will be able to specify the subject through the use of a free text field. This cannot be done through a drop down menu since the amount of options to implement would be too vast. For instance if the general subject selected was *Math* the user could further specify the subject to include for instance *geometry, chance, equations* and so forth. This field exists so that a user can find the specific subject he or she is looking for if the user is looking for a very specific subject.

The third field includes the level of education; here the user will get to specify if the game is intended to be used in *pre-school, primary school, high school* and so forth. This is to ensure that the subject prior selected is on the proper level. There is a vast difference between for instance equations for primary education and equations in high school.

5.2.2 Field Type 2: Specifying the Circumstantial Context

In this field it is taken into consideration the learner in accordance to the research of Reinders and Wattana (2011). In chapter 2.3.2 of this thesis it was concluded that it was important to take into consideration the learners experience in both the learning and game part of educational games. However the learning part, including that the subject is correct and on the proper level, is ensured in the search field about the subject, thus there is no need to repeat the same information again. Instead these fields will focus on the age of the learner (age and level of education is not necessarily synonymous), and the learners experience with

games, which Reinders and Wattana (2011) found to play a crucial role in the learner's ability to learn from an educational game. Further we will also take into consideration the location where the game is used in accordance to the research by Purushotma (2005), who argues the importance which the location has on the result which is to be gained from educational games. Thus the search fields based on the circumstantial context will look as follows:

- User(s) Age
- User(s) Gaming Experience
- Place of Use

The first field will simply let the user specify the age of the learner (or learners), by selecting the lowest age and the highest age in the group. If the group only consists of one learner the user is expected to let both the lowest and highest age be the same.

The second field allows the user to specify the gaming experience of the group; this will be done through a selection from a drop down menu with options ranging from *beginners* to *experts*.

In the third field the user will once again be able to make a choice in a drop down menu, this time the choice represents the intended place of use of the educational game. In this thesis we have mostly looked at and compared the results from using educational games in the home or in a classroom. These places will be selectable but the user will also be able to select other locations in which educational games are used, for instance *museum* and *mobile*.

5.2.3 Field Type 3: Specifying the Purpose

As discussed in this thesis it is close to impossible (if not actually impossible) to say much about the effectiveness of educational games without taking into consideration the purpose in which it is used, or intended to be used in. (Purushotma, 2005; Guillen-Nieto & Aleson-Carbonell, 2012; Pannese & Carlesi, 2007; Charsky, 2010.) The idea of this search function is to be able to present the user with games which would be effective for their intended use. To be able to do this we must know what purpose the user is intending to use the educational game for. In chapter 2.1 three main purposes for which educational games are used were identified, to motivate, to *increase the rate of learning*, and to *teach higher level skills*. In the same chapter it was also concluded that these purposes were not mutually exclusive, thus a user must be able to select one or more purpose. This will be done through the use of check boxes where the user can select his or her purpose, ranging from no purpose to all three purposes.

5.2.4 Field Type 4: Specifying Technological Aspects and Limitations

As previously discussed in this thesis there are technological aspects which may affect the choice of educational game. Forcing the user to make too many technological considerations may make the search function hard to use for users who lack experience within the field of games. It is however crucial that more experienced users are allowed to make more detailed technological choices if they so please. The result of this is that we have to sort out the technological aspects which are crucial for every user, disregarding their gaming experience. These aspects are identified as follows:

- Platform(s)
- Game Language(s)
- Additional Technological Details

The selection of one or more platform is important for any user. It is technological knowledge which is not too complex. Further it would be frustrating for users to find results through the search function which would be unplayable due to them being run on an unavailable platform. Through the use of check boxes the user will be allowed to select any and all platforms available to the user.

By the same logic it would be frustrating for a user to find games which they and the learners might be unable to play due to the game only supporting the use of languages which are not shared with the learners. In the same fashion the user will through the use of check boxes be allowed to select the languages which would be relevant for the learners.

As mentioned previously in this chapter it is also crucial that more experienced users with more well defined ideas of what they are looking for are able to specify more technological details. Although these details will be hidden in default, as to not overwhelm less experienced users, there will be further technological search fields available to bring up with a single click of the mouse. The specification of these fields are outside of the scope of this thesis, thus no effort will be done to structure exactly which these technological aspects are, however some examples are *genre, multiplayer availability, representation,* and *scoring system*.

5.2.5 Field Type 5: Specifying Pedagogical Aspects and Limitations

Finally there are limitations and aspects to take into consideration which are connected with pedagogical activity. For instance the size of the learner group and the time available for the pedagogical activity, including playing an educational game, is oftentimes dictated by factors which are more connected with the pedagogical activity, for instance class sizes, duration of classes and availability to computers, as well as the pedagogues own ability to be involved in the game. To enable the user to communicate these aspects and limitations four search fields represent this information:

- Group Size
- Available Play Time
- Available Time for Pedagogical Activity
- Teacher Role

The first field *group size* will allow the user to specify the size of the learner group. This will be done through a *drop* down menu with predetermined group size spans. For instance *individual, 2 - 4 individuals, 5 - 10 individuals, 10 - 30 individuals* and so forth.

The *available play time* represents the time which the game is intended to be played. This will be specified by the user through the use of two fields. *Session duration* and *Total time*. This way the pedagogue can take into consideration both limitations in class duration as well as the total time available for the exercise with the educational game.

Available time for pedagogical activity mechanically works just as the *available play time* field, although it also takes into consideration the possibility of other exercises in connection to the actual playing of the educational game. This is important since it leaves room for the pedagogue to plan for other exercises in connection to the game, or the use of other learning resources which some educational games may provide.

Finally it is also important to allow for the user to specify the role which he or she as a pedagogue will have in the exercise of using the game. In some educational games the teacher is expected to actively participate in the game. This is something which not all pedagogues

might feel comfortable with, thus it is important for a pedagogue to be able to specify which role he or she wishes to have in the exercise of using the educational game. This will be done through the use of check boxes, allowing the user to specify as few or as many roles as he or she feels comfortable with.

5.2.6 Summarizing the Search Fields

In the last few chapters we have looked at the various search fields which have been deemed important in this thesis in order to create a search function which takes into consideration the purpose of using educational games, as well as the contextual circumstance of using serious games. We have looked at how they are used by the searching user and we have discussed how they connect to the previous research identified previously in this thesis. To give a greater overview of the search fields they are all gathered here in one place, disregarding of how they tie into the previous research:

- Subject
- Detailed Subject

- Level of Education
- User(s) Age
- User(s) Game Experience
- Place of Use

- Purpose

- Platform(s)
- Game Language(s)
- Additional Technological Details

- Group Size
- Available Play Time
- Available Time for Pedagogical Activity
- Teacher Role

These are the search fields which will work as the foundation for the search function designed in this thesis.

5.3 Potential Results from a Search

Before looking at how the search function actually works in greater detail we will look at what kind of results we expect the search function to provide. The search function aims to provide two types of results, which will fill slightly different purposes which will complement one another.

5.3.1 Games

The serious games database, which this search function is designed for allows for the storing of two types of information about educational games. The first is the actual game uploaded by the publisher, the entry data set. This is one of the two types of results which the search function aims to provide; entire games which fit well with the criteria entered in the various search fields. Being able to find games is important for teachers who either have not yet got a detailed idea of exactly how the exercise of using the educational game is going to look like, for the teacher who simply looks for inspiration for what games could be incorporated in his or her teaching and for the teacher who wants to plan the exercise of using a game with the game as the starting point, rather than the pedagogical situation available.

5.3.2 Pedagogical Cases

The second type of information about educational games intended to be stored in the database will be reviews of educational games in the database, the review data set. In these reviews the reviewer is expected to share information of how the educational game was used, thus not only providing a review of a game but also providing a sort of description of how a game could be used. These reviews will be known as *pedagogical cases* in this thesis. Finding pedagogical cases will allow for the searching individual to find results which are much more tailored to his or her specific search than the entire games can be. Pedagogical cases will be mostly useful for users who for one reason or another do not want to plan exactly how to use an educational game, the information about how it could be used comes along with the pedagogical case. It is also mostly relevant for users who are more strictly limited by pedagogical aspects and limitations and thus wishes to use their already existing planning as the starting point for designing the exercise of using an educational game.

5.4 The Mechanics of the Search Function

For the search function to provide relevant results it obviously takes more than just defining the relevant search fields. In this chapter we will look at how the search function mechanically works in order to provide relevant results for the user.

5.4.1 Finding Results

The first relevant step is to understand how the function comes up with its results. Here we will look at what determines whether the search function will find a game or not, without considering how the games should be sorted or presented to the user. Below we identify the search fields which determine whether a game should be found or not and go into detail of how the different criteria work. These general details and criteria are the same for finding both games and pedagogical cases.

Subject:

For a game or pedagogical case to be found by the search function the subject selected as search criteria must match the intended subject of the game, or the subject of actual use in the case of pedagogical cases.

Detailed Subject:

For a game or pedagogical case to be found by the search function the detailed subject must match the detailed subject of the game or the pedagogical case. Since this search field is a free text field there has to be some room for spelling errors and minor differences.

Level of Education:

For a game or pedagogical case to be found by the search function the level of education search criteria must match that of the game or the pedagogical case. It would be irrelevant to find games or pedagogical cases for a much more advanced or simple level of education.

User(s) Age:

For a game or pedagogical case to be found by the search function the user(s) age criteria must at least partially match the target age of the game or the user(s) age of the pedagogical case. In the case of pedagogical cases it is possible that the user age of a specific user case is limited to a single age (i.e. 15) as compared to the target age of games which are generally entered as an age span (i.e. 13 – 16). This means that it could be hard to exactly match the ages. For the search function such single age pedagogical cases will treat it as if the age of the pedagogical case is the single specific age +-2. For instance a pedagogical case where the user(s) were 15 years old will internally count as an age span of 13 – 17. For a game or a pedagogical case to be found it is enough if the user(s) age partially matches, this means that if the search criteria is 6 – 9 years old and a games target age is 8 – 12 years the game would be found as part of the criteria overlap target age.

User(s) Game Experience:

For a game or pedagogical case to be found by the search function, the user(s) game experience criteria must not be less than the advised game experience of the game or the user(s) game experience of the pedagogical case.

Place of Use: The place of use only affects the result of pedagogical cases in the process of finding games. For a pedagogical case to be found by the search function the place of use must match the pedagogical case.

Purpose: Purpose does not affect whether a game or pedagogical case is found.

Platform(s): For a game or pedagogical case to be found by the search function the game or pedagogical case must be available on at least one of the platforms selected in the search criteria.

Game Language(s): For a game or pedagogical case to be found by the search function the game or pedagogical case must be available in at least one of the languages selected in the search criteria.

Additional Technological Details: For a game or pedagogical case to be found by the search function the game, or the game used in a pedagogical case must match any additional technological details selected in the search criteria.

The following search fields do only relate to pedagogical cases and not to entire games:

Group Size: For a pedagogical case to be found by the function the group size search criteria must match the group size of the pedagogical case with room for an error of +-1 on the ordinal scale of group size where the scale: "*individual, 2 - 4 individuals, 5 - 10*

individuals, 10 - 20 individuals" is translated into group size 1, 2, 3 and 4. This means that a pedagogical case would be found if the search criteria match the actual group size or the on size smaller or larger group size on an ordinal scale.

Available Play Time: For a pedagogical case to be found by the function the available playtime must resemble the play time of the pedagogical case. The smaller amounts of time we are talking about the less room there is for error. For instance: if the search criteria is to find a game with a session duration of 2 hours and a total play time of 2 hours we would not want to find a game with a play time of 6 hours, that would be three times as much time as we had intended for. However if we want to search for a game of 2 hour session durations and a total play time of 20 hours it would not be as problematic if the actual play time is 16 hours. Even if the actual difference of total play time is the same in both examples. Thus as the amount of time increases the room for error should also increase. Thus the room for error in this category will have to be based on an equation rather than static. The error which this thesis will suggest is an error of +-1/4x, where x = the search criteria, both for session duration total play time. This means that the example with a single 2 hour session would be found by any search with a session duration and total play time ranging from 90 to 150 minutes (120+-120*1/4). The example with 2 hour sessions and a total time of 20 hours would be accepted by any search with a session duration ranging from 80 to 160 minutes (120+-120*1/4) and a total play time ranging from 15 – 25 hours (20+-20*1/4). This allows for larger errors the more general the criterion is.

Available Time for Pedagogical Activity: Available Time for Pedagogical Activity works exactly as Available play time.

Teacher Role: For a pedagogical case to be found by the function the teacher role(s) in the pedagogical case must match at least one of the teacher role(s) in the search criteria.

This is how all of the search criteria affect which games are found by the search function. To increase the usability of the search function there will be an option for all the criteria called *any*. Selecting any ensures that nothing is filtered out due to that criteria. Any will be the default criteria allowing for quicker searches for users who only wish to specify a few criteria.

5.4.2 Sorting Results

The previous chapter provided insight into how games are found by the search function. That should provide us with two lists, one of games, and one of pedagogical cases. These lists would contain games and pedagogical cases which could all be somewhat relevant for the user. To make this search function actually relevant for the user we would have to be able to go one step further and sort the games in accordance to how relevant they are to the user. Here we will return to the ideas of purpose (Purushotma, 2005; Guillen-Nieto & Aleson-Carbonell, 2012; Pannese & Carlesi, 2007; Charsky, 2010), and circumstantial context (Reinders and Wattana, 2011; Purushotma, 2005.).

As noted several times before in this thesis it is more or less impossible to say much about an educational game's effectiveness without considering what or which purposes it is used in. To ensure that we can use this database in order to find effective educational games we need a rating system which takes purpose into consideration. This is solved through letting reviewers rate the game's success in the three purposes identified in this thesis from one to five, where one is not at all effective and five is extremely effective. Reviewers may also rate a purpose as *not applicable* if they feel that the purpose was not relevant to how they used the game.

If we look back at the search criteria we can see that the searching individual was asked to specify the purposes of using an educational game, however the purpose search criteria did not affect whether a game was found or not. Instead the selection in this criterion will be the founding factor for how the games and the pedagogical cases are sorted and presented to the user. On the left side of the screen games will be listed, on the right side pedagogical cases will be listed. Both lists will be sorted with the most relevant games or pedagogical cases on the top of their respective list.

The most relevant game will be the game which is deemed most effective according to the purpose selected by the user. For the game the rating of a game will consist of the mean value of all its ratings provided by other users. Pedagogical cases are only rated by the user submitting them thus the rating that the submitting user provides will be the rating of that particular pedagogical case.

If the user has selected a single purpose for using the game; a game's rating in that specific purpose will determine how relevant it is considered. The most relevant game will accordingly be placed on top of the list. If two games share the same rating, for instance if the purpose *motivation* was chosen, and two games both have a rating of five for that purpose, the total amount of rating in the other purposes determines which game is more relevant. To show this we can compare two games, Game A and Game B:

Table 4 Comparative ratings of Game A and Game B.

	Game A	**Game B**
Motivation	5	5
Rate of Learning	1	3
Higher Level Skills	1	1

Since both games share the same rating in the selected field; motivation, the search function would have to look at the sum of the remaining rating to determine which is more relevant. In this case Game B would be deemed more relevant as (3+1) > (1+1). Had the rating of motivation of Game B been four instead of five; Game A would have been considered more relevant even though Game B still had a higher total rating. The ratings of the non-selected purposes are only relevant in case the rating in the selected purpose is the same.

As discussed earlier the purposes of using educational games are not mutually exclusive, and thus the searching user may very well select more than one purpose in the search criteria. If this is the case we have to compare games slightly differently in order to determine their relevancy. What will determine the relevancy is the total amount of rating in the selected purposes. So far it is relatively straight forward; however there is a case where we could end up with two games which have the same total rating, but whose rating still differ significantly. Here we will compare Game C and Game D, imagine that the searching user have selected both motivation and rate of learning is purposes in the search criteria:

Table 5 Comparative ratings of Game C and Game D.

	Game C	Game D
Motivation	5	3
Rate of Learning	1	3
Higher Level Skills	1	1

In this case we have both Game C and Game D with a total rating of six in the relevant purposes (5+1) and (3+3). As opposed to the case with a single purpose in the search criteria we will not initially look at the rating of the third criteria, instead we will look at the difference between the two selected purposes. We will assume that if the searching user really prioritized one criterion over the other he or she would only have selected that one purpose. When having selected two or more purposes we can assume that the user wishes for games which are effective in all the selected purposes. Thus we will look at the difference between the highest and the lowest of the selected purposes. A game with less difference between the purposes ought to better suit the needs of the searching individual than one with a great difference. Thus a game with less difference will be deemed more relevant. In the case of Game C and Game D; Game D would be deemed more relevant as (3-3) < (5-1). The rating in the third purpose will only be considered if the total rating of the selected purposes are the same and the difference between them are also the same.

The final case is if the searching user has selected all or no purposes. In this case the total amount of rating across all three purposes will determine which games are most relevant and the difference between the highest and lowest rated purposes will determine which game is more relevant in cases where the total rating is the same.

However as Purushotma (2005) noted educational games' effectiveness is also heavily influenced by the location in which they are used. This is something that we must take into consideration when determining the relevancy of an educational game. In the case of pedagogical cases this is not an issue, if we go back to the previous chapter, discussing how results are found we can see that pedagogical cases which do not match the location entered in the search criteria are filtered out. This is however not the case when it comes to the games in general. As mentioned earlier in this chapter the rating of an educational game is the mean rating of all individual ratings of the game. To take the location of use of these games into consideration we have to break out the reviews which match the location entered in the search criteria. This is possible since every reviewer has to enter the place of use when committing a review of a game. Thus when determining the rating of a game we will not look at the mean value of all ratings belonging to the game, but rather the mean value of all ratings which matches the place of use in the search criteria.

All these searching and sorting mechanics combined results in a search function which takes into consideration the searching users purpose and circumstantial context when determining the most relevant games for a user of the search function and the data base in which it is used.

5.5 The Usability Approach

In the requirements of the search function it was stated that the search function:

- Must be usable for inexperienced users.

And:

- Must allow for detailed searches for experienced users.

To ensure that these requirements are fulfilled three methods have been used in the design of the search function. Data has been hidden in order to not overwhelm users. Technological details have been separated into two groups advanced and simple details and the search function have been designed as a filter rather than a traditional search function. Here these methods are described in further detail:

1. The search fields have been collapsed so that only their names are visible while beginning the search process. The user can then expand each search field by clicking on them. This allows for the search fields to be presented in a non-overwhelming way. Due to this inexperienced users should find the search function more welcoming. Allen and Eckols (1997) in their work *Handbook of Usability Principles* argue that hiding information this way, presenting it to the user in chunks rather than everything at once helps the user to digest the information and make good use of it.

2. The advanced technological details have been separated from the simple technological details. This should make the environment friendlier to inexperienced users, while still allowing more experienced users to still add more technological details to their searches. Allen and Eckols (1997) state that only presenting the relevant information and functionality to the user helps provide a better experience. Experienced users should then be able to choose to use more advanced functions, rather than the other way around where new users would have to choose to not use them, by this time the user have already been exposed to potentially too much information.

3. The search function works like a filter rather than like a more traditional search function. This means that if nothing is selected in a search field, nothing is filtered away. As a result of this a user does only have to enter requirements in the search fields she wants to. This allows for both very unspecific searches, perfect for the inexperienced user. Allen and Eckols (1997) further mean that a system should be forgiving and not punish users for making mistakes. By filtering rather than searching the worst thing that can happen is that a user finds too many results, rather than ending up in a situation where no result is found and the searcher would manually have to work out every single search field. This way the search function better allows for mistakes and inexperienced users.

These three methods of usability and interaction design have been used to make the database a friendlier tool for users of any level of experience.

6 Updating the Metadata Model

In the background chapter this thesis looked at Hendrix et al's. (2012) metadata model for serious games, and also what other research literature had to say about the effects of purpose and circumstantial context of using serious games. Based on this literature review this thesis presented a design for a search function which makes it easier for end users such as pedagogues, students, researchers, and parents to find relevant educational games for their intended use. This thesis however makes no claim that the design of a search function presented in the previous chapter is the best design possible. The design is based on important findings which are partly already covered in the metadata model (Hendrix et al. 2012) and partly not covered by the same. In order to allow for others to be able to be able to work out similar designs of search functions, without losing the ideas of the purpose and circumstantial context presented in this thesis, this thesis will in this chapter update the metadata model (Hendrix et al. 2012) in order to include the findings of this thesis.

The metadata model (Hendrix et al. 2012) is in its current consisting of five different sets of information: Technological information (the entry data set) and information about the learner specifics, context, pedagogy and rating (the review data set). In this chapter we will look at each of these sets of information and suggest how each set should be complimented in order to take into consideration the findings of this thesis.

6.1 Technological information

This thesis does not identify any major shortcomings when it comes to the technological information, however this thesis does identify that there have been cases, as described by Reinders and Wattana (2011) where the complexity of the game has canceled any learning due to a mismatch of the technological complexity and the technological game experience of the user. To avoid such cases this thesis suggests adding a field in the technological information called *advised game experience*. To be able to make a good choice of an educational game for any user or user group it is important to know, in beforehand, what game experience is required (or at least suggested) in order to be able to assimilate any learning from an educational game.

6.2 Learner Specifics

The metadata model (Hendrix et al. 2012) when it comes to the learner is based on the four dimensional model for evaluating educational games (de Freitas & Oliver, 2006). As of such it goes in depth on the learner in connection to the educational aspects of educational games. This is still very important however it is crucial not to forfeit the actual game aspect of educational games. This issue is already solved due to the complement suggested to the technological information. By also taking into consideration the experience the user has with games (Reinders & Wattana, 2011) and not only the subject that is to be learned through using the educational game the metadata model will take into consideration a more complete picture of the learner.

6.3 Context

As noted in this thesis the context in which an educational game is used is an important factor affecting the effectiveness of educational games. Comparing the research of this thesis

with the information covered about the context in the metadata model (Hendrix et al. 2012) it becomes clear that the model does not need any update in this area.

6.4 Pedagogy

The metadata model (Hendrix et al. 2012) focuses heavily on what pedagogical principles educational games base their educational context on. This can of course be relevant but this thesis has identified a wider interpretation of pedagogy. For instance it was noted that the time available for pedagogical activities and the role a pedagogue had in an educational game were important factors for some pedagogues. As a result of these findings this thesis suggests to complement the metadata model (Hendrix et al. 2012) with information about the possible roles which a pedagogue can assume in the activity of using the educational game since the time of pedagogical activity is already considered.

6.5 Rating

The rating is the part of the metadata model (Hendrix et al. 2012) where this thesis identifies the greatest need for updating the model. The rating as it is now is simply a rating of the pedagogical quality ranging from one to five. As this thesis argues the difficulties of saying anything about the quality of educational games without defining the purpose for which the educational game is used. Thus the existing rating information in the metadata model (Hendrix et al. 2012) becomes very arbitrary. To solve this issue this thesis suggests that the metadata model must take into consideration the purpose of using educational games and rate them in their ability to deliver results in these various purposes. The ranking will still be represented on a scale from one to five, but rather than a single ranking educational games will be ranked in each purpose. This thesis, based on the literature review, identifies three purposes, the ability to *motivate* learners (Purushotma, 2005), the ability to *increase the rate of learning* (Pannese & Carlesi, 2007), and the ability to *provide learning of higher level skills* (Charsky, 2010).

6.6 The updated metadata model

In this chapter the various aspects of the metadata model (Hendrix et al. 2012) have been discussed, and various complements to the model have been suggested. In order to present thee suggestions in a comprehensive way this thesis presents updated versions of the two sets in the metadata model, the entry data set and the review data set. The fields marked with **bold text** are new additions to the metadata model; the fields marked with *italics* are fields where the metadata model has been modified.

Table 6 **The updated entry data set in the metadata model.**

Field	Contents
Game Developer	Name of developer of the game
Producer	Name of the producer of the game
Sponsor	Name of the institution who commissioned or sponsored the development
Age Group	Intended age group
Advised Gaming Experience	**None, beginners, moderate, experienced, experts**
Content Type	Pedagogical content type. E.g., facts, reflexes, skills etc.
Game Genre	The genre of the game. E.g., action, shooter, puzzle etc.
Type of Game	Type of game. E.g., entertainment, education, other etc.
Representation	Virtual world, 3rd person, 1st person, board game etc.
Technical Platform	E.g., PC, Mac, iPhone, Playstation3, Wii etc.
Multi Player	No, on same device, online
Subject	General subject
Performance Indicators	E.g., In game score, time, completion, appreciation etc.
PEGI Rating	PEGI rating if available
PEGI Reasoning	PEGI reasoning if PEGI rating is available

Table 7 The updated entry data set in the metadata model.

Field	Contents
Learner Specifics	Composed of each of the following sub fields Age Occupation **Gaming Experience**
Pedagogy	Point on pedagogical model *Time of pedagogical activity involving the game (Moved from context)* **Role of Pedagogue**
Context	Context the game was used in (by the reviewer) composed of each of the following sub fields: Place Subject Supporting resources
Rating	**(0, 1, 2, 3, 4, 5) indicating the subjective quality of the various purposes, based on the distance between the aim and the result of the evaluator, compared to their usual approach.** **Rating of Motivation** **Rating of Increased Rate of Learning** **Rating of Teaching of Higher Level Skills**

7 Summary of Results

This thesis presents two research questions. As a consequence this thesis provides both a practical and a theoretical result. The practical result being the search function discussed in detail in chapter 5, and the theoretical result being the updated metadata model (Hendrix et al. 2012) presented in depth in chapter 6.

The first research question of this thesis is:

> *How could a search function for a database of educational games be designed in order to take into consideration the notion of purpose and circumstantial context of using educational games?*

As a result of this research question this thesis suggests a search function which combines the information about the intended purpose and the circumstantial context for using an educational game, provided by the searcher, in order to find relevant and effective educational games within a database.

The search function is presented in greater detail in chapter 5 of this thesis. The search function takes into consideration the purpose and the circumstantial context of using educational games; two aspects of the use of educational games, which the literature review in this thesis finds crucial in order to make a proper selection of an educational game. This is done through allowing the search function to find both entire games and single reviews (pedagogical cases) of games in which the reviewer provides information about the contextual circumstance in which the game is used, as well as allowing for educational games to be ranked by reviewers not only in general but of their effectiveness in the three purposes for using educational games identified in this thesis; *motivate* the learner, provide an *increased rate of learning, and* to provide *learning of higher level skills*. By combining this information of games' effectiveness at the various purposes for using educational games with the information about the circumstantial context in which the games have been used the search function is able to determine which educational games in the database have been perceived as effective for what purposes, in which contexts.

The second research question of this thesis is:

> *How would the metadata model suggested by Hendrix et al. (2012) have to be changed or complimented in order to support a search function which takes into consideration the purpose and the circumstantial context of using educational games, in a database for educational games?*

As a result of this second research question this thesis suggests complements to the fields: *Learner Specifics*, *Pedagogy*, and *Rating* in the metadata model suggested by Hendrix et al. (2012).

These suggested complements are presented in detail in chapter 6 of this thesis. In short this thesis found that in order for a search function in a database for educational games to be effective and able to provide relevant results for the end users of the database the purpose

and the circumstantial context for using an educational game must be taken in consideration. This thesis found that in order for the metadata model (Hendrix et al. 2012) to support such search functions some complements had to be added to the metadata model. The notion of the learner (or the *learner specifics)* must be widened to not only include information of the pedagogical aspects of the learner, such as their level of education or occupation, but also include game aspects of the learner such as the general game experience of the learner (Reinders & Wattana, 2011). The notion of *pedagogy* in the metadata model (Hendrix et al. 2012) must be widened to not only include pedagogical principles but also include other pedagogical limitations and aspects of using educational games such as the pedagogical time involved and the role of the pedagogue in the use of an educational game. Finally the rating tool in the metadata model (Hendrix et al. 2012) is found too arbitrary. As a result of the literature review in this thesis the suggestion to solve this is to take the notion of purpose for using an educational games and thus instead of just ranking the arbitrary pedagogical quality of educational games, educational games instead get ranked in the more concrete purposes identified by this thesis; the educational game's ability to *motivate* the learner (Purushotma, 2005), provide an *increased rate of learning* (Pannese and Carlesi, 2007)*, and* to provide *learning of higher level skills* (Charsky, 2010).

8 Conclusion

This chapter discusses this thesis's role in a larger perspective and further evaluates how the work in this thesis could be expanded upon in future research.

8.1 Discussion

The EduGameLab project set out to gather information about educational games in a single database, with the intention of making educational games more accessible to users such as pedagogues, teachers and students. This thesis agrees with the EduGameLab project that educational games are not as accessible as they could be, though this thesis does not agree that the reason for this is the fact that they are hard to find. A simple search for *educational games* with a standard search engine such as *google.com* generates a massive amount of educational games, some available online, others available for purchase. Gathering information about all educational games in a single database is not a bad first step, but in reality it does little to make educational games more accessible. This thesis complements the work done in the EduGameLab-Project by providing a search function which helps the user in finding educational games which have been experienced as effective by other users. This is a feature which would make the database created by the EduGameLab project a unique and effective tool for making educational games more accessible to users.

To carry through this thesis project in parallel with the EduGameLab-Project has been a strength of this project. It has helped through the dialogue and sharing of ideas during the project, iterative implementations of the search function designed in this thesis and through providing clear deadlines for parts of the thesis, and the experience of being a part of a sharp research project. Parts of this cooperation can also be seen as a weakness. For instance I have been relying on implementations outside of my personal control in order to be able to test things, and the final implementation was not ready until rather late in the project. However even if this was part of the reason why the final usability testing did not make it into the thesis project, however this also means that for the future work there is a very robust system to test, rather than if I had created some sort of low-fi prototype to test during the project. The other reason why the usability test did not make it into this thesis project was due to the low response frequency of the online survey. Selecting to use an online survey may not have been the best way to ensure that the participants selected to reply, as proven by the very small response frequency (< 1%), however it was a choice I made due to the fact that the process of the survey could be highly automated which was important since it had to take place late in the process of the thesis project, during which I also had to put a lot of effort into finalizing the report. If I had had more time available I would have selected to use a qualitative method with observations for the usability tests instead, as this would have ensured results in a way that a survey cannot do.

In the literature review of this thesis several papers were found arguing for the effectiveness of educational games. Yet ultimately it was more or less impossible to compare the results of the various papers due to their liberal interpretation of *effectiveness*. There was simply no agreed upon meaning of the term. Some papers were investigating whether the learning speed increased when comparing with other learning tools such as literature and multimedia education (Sotomayor & Proctor, 2009). Others were investigating whether learning took place at all (Purushotma, 2005). Yet all claimed that there findings supported the fact that educational games could be effective tools in learning. For this thesis it was important to be

able to compare the effectiveness of educational games, not just to agree on whether they could be effective in general. In order to do so this thesis identified three different ways in which educational games could be considered effective: as *motivators*, as *enhancers of learning speed*, and as *enhancers of teaching of higher level skills*. This breaking down of the notion of effectiveness allowed for comparing educational games with one another, and the ability to say that two games are effective at various things and their effectiveness is not comparable. This deeper understanding of educational games' *effectiveness* is crucial for the work in this thesis, but it could also be useful for the entire research field investigating educational games since it makes for more concrete results and the ability to compare results.

When it comes to educational games and the term *effectiveness* it is important to understand the difference between what *makes* educational games effective and what *affects* educational games effectiveness. A lot of research has been done trying (and oftentimes succeeding) to prove that educational games can be effective tools in education. This thesis has made no attempt to argue with these findings or further refine them. This thesis has looked at what factors affect educational games' effectiveness. That is, once we have a particular educational game in our hands, what factors affect how effective it will be? It is important to understand this difference as this work is not striving to tell how an educational game should be made to be effective, but rather what should be considered by an end user when selecting an educational game to use in order to maximize its effectiveness. In conclusion, this thesis is mainly a piece of work for those who wish to find or select effective educational games, rather than creating them.

8.2 Future Work

The design of a search function presented in this thesis has only seen some internal testing within the research group, unfortunately there was not enough time within this work to conduct any proper user tests with individuals outside of the research group with the finished search function. This will have to go under future work since there might still be usability issues with the search function which would have to be resolved for the search function to actually be useful. For instance it is very possible that the end users do not instantly understand exactly what the three purposes (motivation, increased rate of learning, and teaching of higher level skills) means. One would have to find a simple way to convey their meaning to the users to make the search function useful. Most of these possible issues are strictly usability issues though and thus out of scope of this thesis even if some attempts have been done to make the search function useful from a usability perspective, see chapter 5.5. There is however a lot of possible future work before the search function is a polished and well working tool integrated in a database.

This thesis has provided a design for a search function to be used in the database created in the EduGameLab project. This search function is based on the factors found in the literature review which affected educational games' effectiveness. This search function simply allows for the user to find out how other users have experienced various educational games in a situation similar to the intended situation of the user. It would be possible to create a system which not only compared the situations, but would also be aware of to what extent various differences affect the result. As of now the search function simply discards reviews which situation does not match the intended situation of the user. Within this field there is much room for further research. Could it for instance be possible to predict the change in effectiveness by looking at what factors are different in the intended situation and in the

situation of the reviewer? If so then the search function could work with a larger data set (since no information is discarded) this would make the results more reliable since they would be based on a larger number of opinions. Until it is understood exactly how the various factors affect the effectiveness of educational games this remains impossible.

Furthermore this thesis provides a means of finding effective educational games. The function though is limited to be used with educational games. Within the field of serious games there are various uses of games, education is but one of many uses. Further research would have to be done in order for the search function in this thesis (or for a similar search function) to be able to include serious games of other types of serious games. This thesis identifies the purposes for why educational games are used, can a similar analysis be done with other types of serious games in order to increase the understanding of them, and perhaps even include them in a similar database with a search function increasing their accessibility?

Finally this thesis has worked with the notion of *effectiveness* in a way where the term has been broken down to allow for greater precision and to better allow comparisons between the effectiveness of various educational games, or educational games and other means of education. This breaking down of *effectiveness* is based on the theories of *motivation* (Purushotma, 2005), *rate of learning* (Pannese & Carlesi, 2007), and *teaching of higher level skills* (Charsky, 2010). It could be possible that future studies, similar to those which this thesis is based on could provide more specific and concrete results by adopting the way this thesis works with the notion of *effectiveness* of educational games.

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